IFAMR

SPECIAL ISSUE

FOOD DEMAND, DIET, AND HEALTH

The Role Played by Managers of Agribusinesses

United States Department of Agriculture

Special Thanks

A special thanks to the ERS Lead Editor, Christopher G. Davis, and Guest Editors, Andrea Carlson, Abigail Okrent, Timothy Park, and Richard Volpe for their intellectual support, excellent editing, and expertise in the field of Food Economics. Also, we would like to thank the reviewers for their masterful knowledge in the food and economics profession and for their comments and suggestions that helped make this Special Issue more precise and relevant to the industry.

Upcoming Call for Papers

A call for papers highlighting factors influencing the global poultry trade is forthcoming. The purpose of this Special Issue is to generate scholastic research papers that discuss key issues affecting the poultry trade, particularly: (a) bilateral and multilateral trade agreements; (b) Newcastle's disease, avian influenza, and sanitary restrictions; (c) demand growth in emerging markets and developing countries; (d) welfare implications of laying hen housing; (e) feed efficiency and/or disease resistant (productivity); (f) global price volatility; and (g) other issues affecting global poultry trade. Government employees, university faculty, and industry experts are welcome to submit proposals for this Special Issue. A call for papers is scheduled for release in March 2014.

International Food and Agribusiness Management Review

Editorial Staff

The IFAMR (ISSN #: 1559-2448) is published quarterly and is available at http://www.ifama.org. For copyright and publishing information, please contact: Kathryn White, Administrative Editor. IFAMA Business Office • 1511 15th Street, NW Suite 500 Washington, DC 20005 • USA • Tel: 1 (202) 429-1610 • Fax: 1 (202) 530-0659 • E-mail: ifamr@ifama.org • Web: http://www.ifama.org

Supporters and Partners

STRONG ROOTS - BRIGHT FUTURE

The IFAMR Open Access Project is supported in part through contributions from these institutions. Scholars, practitioners, students, and policymakers may now read and download the most current and archival content from the IFAMR website. The Board of Directors of the International Food and Agribusiness Management Association feel that open and immediate access to IFAMR's articles and case studies will dramatically elevate the quality of scientific inquiry and instruction around the world in the field of agribusiness. If you would like to support this effort please contact: **Kathryn White, Email:** ifamr@ifama.org.

International Food and Agribusiness Management Review
Volume 17 Issue A, 2014

TABLE OF CONTENTS

Introduction

Research

International Food and Agribusiness Management Review
Volume 17 Issue A, 2014

Editor's Note

The IFAMR continues to break new ground as it collaborated with Christopher Gazzara Davis and a team of editors from the United States Department of Agriculture's Economic Research Service (USDA-ERS) on this special issue looking at the intersection between food firms and the obesity epidemic. This special issue reflects the core mission of the IFAMR, giving scholars a voice and assuring them impact. ERS economists had the desire to advance the discussion concerning obesity. Instead of writing one article, these Guest Editors magnified their impact 10x and elicited a call for papers and published ten manuscripts on the topic. The editors also worked hard and published their issue in less than nine months. We'd like to thank our stellar blind review team, who are such a critical component in the process. This is our fifth Special Issue since 2011 and several more are in process. We stand ready to help scholars publish their own Special Issue. Just drop me an email at pgoldsmi@illinois.edu, and I can explain the simple turnkey system we use to support you in your efforts.

Enjoy the issue,

Peter Goldsmith, Executive Editor, IFAMR

International Food and Agribusiness Management Review
Volume 17 Special Issue A, 2014

Food Demand, Diet and Health- The Role Played by Managers of Agribusinesses[1]

INTRODUCTION

Timothy Park

Branch Chief, Food Markets Branch, FED, ERS, USDA
1400 Independence Ave., SW, Mail Stop 1800, Washington, DC 20250-0002 USA

The White House Task Force on Childhood Obesity noted that the childhood obesity is a national health crisis resulting in substantial economic costs and has acknowledged that both consumers and industry must play active roles in improving diet quality. The report noted that food and beverage companies (including restaurants, food retailers) have "an important role to play in creating a food marketing environment that supports, rather than undermines, the efforts of parents and other caregivers to encourage healthy eating among children and prevent obesity." The Institute of Medicine has also recognized that obesity creates serious health, economic and social consequences and an IOM committee has developed an action plan for measuring progress in obesity prevention efforts.

Obesity worldwide has nearly doubled since 1980 resulting in more than 1.4 billion adults, ages 20-years and older, who were overweight. The World Health Organization (WHO) emphasized that 65 percent of the world's population lives in countries where overweight and obesity kills more people than underweight. The WHO Global Strategy on Diet, Physical Activity and Health calls upon all stakeholders to take action at global, regional and local levels to improve diets and physical activity patterns at the population level.

Corresponding author: Tel: + 1.860.895.7926
Email: T. Park: tapark@ers.usda.gov

[1] Copyright 2014 .The judgments and conclusions herein are those of the authors and do not necessarily reflect those of the U.S. Department of Agriculture. The author is responsible for all errors.

In 2013 the WHO targeted the marketing of unhealthy food to children and stated that the food industry's has been "disastrously effective" at fueling the global obesity epidemic. The United Nations health agency advocated developing tighter regulations to prevent corporations from advertising fatty, salty, and calorie-heavy foods to kids and endorsed recommendations to guide countries in designing new polices on food marketing communications for foods high in in saturated fats, trans-fatty acids, free sugars, or salt. All 53 member states in the European region have signed on to consider restrictions on the marketing of unhealthy foods to children. The diversity of responses that are under consideration can be informed by the policy oriented research presented in the papers for this special issue.

In the United States the IOM report specifically commented on the variety of environmental and policy strategies that are being implemented at both the national, state, and city level and emphasized the need for rigorous scientific evaluation and assessment of how these programs influence behavior. Policy innovations create the demand for timely and meaningful data on consumer and business responses and this is a feature of the articles in this Special Issue.

This issue of IFAMR will examine how managerial decisions, firm strategy, and store format are tied to health issues and health claims through food marketing, advertisement, refrigeration, product labeling, packaging, product reformulation, and shipping. In other words, how are retail stores and the production and product sales of the food industry shaping consumer demand and health outcomes in the US or worldwide?

A set of four articles assess the impact of consumer preferences on nutritional quality of household purchases, consumer preferences for nutritious foods in a food desert, the role of information on meat consumption, and the choice of food shopping outlets in a developing country.

Berning examines how the nutritional content of breakfast cereal purchases by households is influenced by coupons. There has been limited research investigating how coupon-induced purchases influence the nutritional content of household purchases. Breakfast cereal is regularly consumed in the US and is a popular choice for breakfast among children and adults. Since breakfast cereal is primarily purchased at retail stores for at home consumption, a household model can account for the entire basket of breakfast cereal purchases.

The author finds that manufacturer and retailer coupons are associated with slight increases in the purchase of beneficial nutrients like protein and fiber. But coupons also lead the household to increase purchases of potentially detrimental nutrients such as fat, sodium and sugar. The managerial implications of the research lie in understanding how consumers are using coupons. For consumers who are mainly concerned about price and are less concerned about product quality, then coupon marketing programs such as double coupons or coupon stacking (using manufacturer and retailer coupons at the same time) may be effective marketing tools. If consumers are more concerned with taste or better nutritional content, then large price discounts may not be as important to consumers. In particular, promoting better nutritional content may need to be part of a more comprehensive marketing plan that not only offers price discounts, but also promotes the nutritional content of the cereals.

Weatherspoon et al. analyze demand for healthy food products in an urban food desert with the objective of identifying the factors that influence healthy food consumption. Food deserts are environments that lack the typical variety of foods that society has come to expect from a flourishing community, due primarily to limited choices among supermarket chains that usually provide quality, affordable, and nutritious food options.

The authors highlight that the lack of knowledge about the factors that influence demand for nutritious foods among poor, ethnic populations, and populations of color constrains the ability of both public- and private-sector interventions to expand the availability of nutritious foods while replacing unhealthy consumption of high calorie foods. The approach looks at the demand for fresh fruit and vegetables in a Detroit, Michigan food desert area and determines the factors that influence the consumption of fresh fruit and vegetables.

The article develops implications for retailers in how to improve access to nutritious foods for low income, urban households and identifies innovative entry and maintenance strategies are needed to make retailers viable in this setting. Adaptations to consumer shopping behavior are also mentioned such as research to increase the frequency of shopping trips per household, shifting the timing of shopping over the month, and ways to assess how shopping behavior is influenced by lack of food storage and appropriate facilities to prepare food.

Cordts, Spiller and Nitzko provide an international perspective on the emerging environmental and health literature mentioning the negative implications for consumers and societies due to the growing demand for and the production of meat. Some German scientists and government institutions are advocating for policies designed to reduce the domestic consumption of meat. This article developed a detailed understanding of the underlying motives for meat consumption among German consumers. The study focusses on four types of information regarding the negative effects of meat consumption on human health, climate, personal image or animal welfare and investigates which kind of information has the largest effect on consumption patterns of male and female consumers in Germany. Animal welfare aspects motivated the largest number of respondents, which might be due to the fact that animal welfare issues are very emotionally discussed and are able to directly cause high levels of concern in many consumers.

Meng et al. shift the research perspective to a developing country and assess the factors that influence consumer choice of food shopping outlets. This paper fills a research gap since there are few studies that examine consumer food retail format across both modern and traditional food outlets, especially in West Africa. Unique survey data from Ghanaian urban households is exploited to identify the key socio-demographic characteristics that affect consumer food shopping choices (supermarket vs. traditional outlets) and to illustrate how the food retail formats affect consumers' diet and health.

Consumer profiles in each food retail outlet provide insights to guide marketing strategies along with entry, exit, consolidation and expansion strategies of food manufacturers, distributors/marketers, and food retailers. A clearer understanding of food retail choices of consumers will show how food retail formats relate to consumer food selection, which further affects consumer diet, nutrition, and health.

A second theme that emerges in the Special Issue is the role of firm and industry strategies in influencing consumer demand, diet and health. *Hahn and Davis* measure how a tax on sodium would affect the demand for eight different types of lunch meats with the tax rates for the lunch meats varying by the sodium levels. The approach measures how these sodium taxes on lunch meats will affect consumers' economic welfare and develops measures of the accuracy of the tax-effect estimates. The paper uses a flexible model of consumer demand to translate price changes into estimates of economic welfare effects.

The authors carefully explain an unexpected result that sodium taxes will, in some cases, reduce the consumption of lower sodium alternatives by more than the high-sodium ones. Sodium taxes will increase the prices of all lunch meats and many of the high-salt lunch meats also have high prices. High-salt items would have the largest taxes but the percent increase caused by the tax is lower for high-salt items than for low-salt items since these items have high initial prices. The authors are careful to note the issues that are not addressed in this analysis including the absence of supply-side effects. Processors could react to lower demand by cutting their prices, implying that these estimates will overstate the value of taxing sodium.

Hooker and Downs note that food managers are continually developing and testing changes in the nutritional quality of diets. In this case study the authors compare a monitored industry self-regulation of *trans* fat (used in Canada) and a firm initiated strategy (US primarily) to alter the nutrient quality of new cookies launched between 2006-12. Differences between food labeling policies in the US and Canada are then compared to explore the merits of a conceptual model.

The finding highlights that *trans* fat levels in new products decreased over time in both countries. Cookies that did not contain *trans* fat, were significantly lower in energy, lower in fat and higher in protein and fiber in the US and Canada, suggesting that managers have innovated to provide more healthful options. *Tran* fat levels were already decreasing between 2001 and 2006 in the US, but the implementation of the labeling regulation in the US was associated with an additional reduction of nearly 50 percent.

Leschewski and Weatherspoon find that in food deserts, fast food restaurants and convenience stores often out number supermarkets. This motivates their study examining the pricing strategies of fast food restaurants in eight Michigan cities, comparing the four largest cities by population in Michigan that have areas characterized as food deserts with the four largest cities in Michigan that have no areas characterized as food deserts.

The findings indicate some fast food restaurants charge higher prices for select food items at restaurants located in food deserts, despite having similar ownership structure, offering similar amenities, and having similar business approaches. Evidence of differences in consumer preferences are also uncovered since food desert residents are more likely to dine at burger style restaurants than at sandwich shops (such as Subway), even though sandwich shops are often viewed as a healthier option than burger style restaurants.

Thapa and Lyford provide a systematic review of programs implementing tools of behavioral economics like nudging and choice architecture to promote healthy food choice and consumption in school lunchrooms. The findings show how the decisions of the food suppliers were altered.

An important contribution of this paper will be to consider whether businesses that supply foods to school lunchrooms have responded to the nutrition improvement efforts by changing their products.

In general the studies show that nudging in the lunchroom leads to an increase in healthier food choice decision. Most of the research conducted has often focused on increasing healthy food consumption, including fruits and vegetables. The authors note that incorporating the feedback and views of the food supplier is rarely considered. Studies examining the impact that changes in lunchroom choice architecture might have on food supplier decisions are also absent in the applied policy literature.

Lin et al. examine the potential nutritional impacts of changes in ready-to-eat (RTE) cereal purchases in response to a supermarket shelf-tag nutrition information system. The Guiding Stars Program (GSP) was implemented by a regional U.S. supermarket chain using starts to indicate higher overall nutritional quality of a food product. The authors simulate changes in RTE cereal intake predicted by estimating demand if a GSP or a 10 percent price manipulation were in effect in the United States, and measure the impact on intakes of whole grains, added sugars, sodium, and calories. The findings reveal small effects for the GSP and somewhat larger ones for a 10 percent price intervention.

Consumer responses were not uniform across the nutritional variables of interest but the program does simplify decision-making for consumers by grouping products according to the program's nutritional criteria. This paper provides information for food manufacturers and retailers on the potential dietary effects of changes in purchases associated with a shelf-tag labeling system. In general, it appears that private-sector pricing strategies such as sales on more nutritious cereals may be helpful in promoting diet and health, especially when paired with nutrition information or health promotion strategies.

Wilde et al. provide insight into how the definition of a food desert influences conclusions about the adequacy of food retail conditions across the nation and is useful in identifying the geographic areas that lack adequate retail food options. The approaches differ in the underlying household-level conditions that are used, embody different assumptions about the relationships between poverty, vehicle access, population density, and proximity to supermarkets, and use alternative methods to aggregate data from basic units (such as a census block group) to larger geographic units (such as a census tract). This article compares and contrasts the three approaches using a common data source—a representative random sample of more than 33,000 census block groups in the continental United States.

The authors develop recommendations for future work in measuring food retail adequacy. They advocate for stating explicitly the household-level or individual-level condition that represents inadequate food retail access and provide examples of conditions that are reasonable to use. Second, researchers need to carefully assess how results are influenced when aggregating from granular geographic data to larger areas such as census tracts or counties. The overall goal is to aggregate in a fashion that preserves the underlying information about the extent of hardship. Current methods of aggregation may cautiously classify some census tracts as having inadequate access even if many block groups or smaller geographic units contained in the census tracts have adequate food retail access. The authors also emphasize the policy implications that flow from the recent research literature on food retail adequacy.

International Food and Agribusiness Management Review
Volume 17 Special Issue A, 2014

Simulating the Potential Effects of a Shelf-Tag Nutrition Information Program and Pricing on Diet Quality Associated with Ready-to-Eat Cereals[1]

Biing-Hwan Lin[Ⓘa], Joanne Guthrie[b], Ilya Rahkovsky[c], Chung-Tung Lin[d], and Jonq-Ying Lee[e]

[a]*Senior Economist,* [b]*Nutritionist,* [c]*Economist, Economic Research Service/USDA, 355 E St. SW, Washington DC, 20024, USA*

[d]*Team Leader. Center for Food Safety and Applied Nutrition/FDA, 5100 Paint Branch Parkway, College Park, Maryland, 20740, USA*

[e]*Courtesy Professor, Department of Food and Resource Economics, PO Box 110249, University of Florida, Gainesville, Florida, 32611-0249, USA*

Abstract

Previous research has shown that the Guiding Stars Program™ (GSP), a shelf-tag nutrition information system used in some supermarkets in the United States (US), increases consumer demand for ready-to-eat (RTE) breakfast cereals that the program considers more nutritious. Further, consumer demand for cereals is found to respond to price. Here we simulate potential changes in RTE cereal consumption predicted by estimated demand if a GSP or a 10% price manipulation were in effect nationwide in the US, and measure the impact on intakes of whole grains, added sugars, sodium, and calories. We find small effects for the GSP and somewhat larger ones for a 10% price intervention.

Keywords: breakfast cereals, Guiding Stars Program, pricing intervention, dietary outcomes

Ⓘ Corresponding author: Tel: + 1. 202.694.5458
Email: B-H. Lin: blin@ers.usda.gov
J. Guthrie: jguthrie@ers.usda.gov
I. Rahkovsky: irahkovsky@ers.usda.gov
C-T. Lin: chung-tung.lin@fda.hhs.gov
J-Y. Lee: jonqying@ufl.edu

[1] The authors acknowledge the constructive comments received from the reviewers. The views expressed here are those of the authors, and may not be attributed to the Economic Research Service, the U.S. Department of Agriculture or the U.S. Department of Health and Human Services.

Introduction

A comparison of actual to recommended food purchasing patterns shows that US consumers typically underspend on healthy foods like whole grains and overspend on refined grains, fats, sugars and sweets (Guthrie et al. 2013). These purchasing patterns translate into poor diets, contributing to obesity, heart disease, stroke, cancer, diabetes, osteoarthritis, and other health conditions that impose considerable economic costs through increased health care expenditures and lost productivity. Medical costs of obesity alone were estimated to be as high as $147 billion, or 10% of all medical costs, in 2008 (Finkelstein et al. 2009; O'Grady and Capretta 2012; Tsai et al. 2011).

Such high social costs make dietary improvement an important public priority. Since 1980, the US government's nutrition policy has been based on the *Dietary Guidelines for Americans* (USDA and USDHHS 2011). These guidelines, updated every five years with input from an independent expert advisory group, draw on the current nutrition science to provide basic advice on what consumers should eat to be healthy. Federal agencies support a wide range of nutrition education efforts to disseminate this information (USDA and USDHHS 2011) and encourage Americans to make healthy food choices.

These informational efforts provide industry with an incentive to develop nutritionally improved products and promote them to health-conscious shoppers (Martinez 2013; Mancino and Kuchler 2012). Over the past two decades, the US market has seen an influx of nutritionally improved products such as lower fat dairy products and whole-grain breads and cereals (Martinez 2013; Mancino and Kuchler 2012; Rahkovsky et al. 2012). Nevertheless, American diets continue to differ from dietary guidelines recommendations.

US law regulates nutrition labeling of packaged foods to promote accurate consumer knowledge of specific products (FDA 2013). The required nutrition label, known as the Nutrition Facts label, appears on most packaged foods in the US, usually on the back or side of the package. Although intended to help shoppers select healthful foods, the Nutrition Facts label is seldom or never used by many consumers and others find it hard to understand (Rahkovsky et al. 2013; Rothman et al. 2006). Some private sector groups in the US and around the world have developed simplified nutrition information guides that may help address this problem (IOM 2012). One such guide is the *Guiding Stars Program*™ (GSP) implemented by Hannaford, a regional supermarket chain in the Northeast of the US (Sutherland et al. 2010). Using metrics designed by an expert group of nutritionists, foods sold in Hannaford supermarkets are placed in one of four categories, from 0 to 3 stars, with more stars indicating higher overall nutritional quality (Fischer et al. 2011). Starred products are identified with shelf tags next to their prices in the store. While this system lacks the detail of the Nutrition Facts label, its simplicity and visibility may lead to its use by many consumers.

Utilizing supermarket scanner data in the US, Rahkovsky et al. (2013) employed an economic model that incorporates factors affecting sales of ready-to-eat (RTE) cereals to evaluate the effect of the GSP in its first 20 months. By analyzing retail purchase data before and after the implementation of the GSP and utilizing a treatment-and-control approach, the GSP was found to result in an increased market share of products that the program considers more nutritious at the

cost of products that the program considers less nutritious. In addition, demand was found to be responsive to changes in cereal prices, suggesting that price manipulation might also encourage healthier cereal purchases. This is consistent with previous research finding that price manipulation influences consumption of healthier and less-healthy foods (Todd and Lin 2012; French et al. 2003).

Rahkovsky et al. (2013) provided evidence that the GSP helps consumers make more nutritious food choices, but they stopped short of estimating the effect on the nutritional quality of consumers' diets, which is the goal of private and public dietary interventions. Our research objective is to extend the analysis by Rahkovsky et al. (2013) by examining the potential nutritional impacts of changes in RTE cereal purchases in response to a hypothetical nationwide GSP in the US. Further, we use the RTE cereal demand elasticities generated in that study to simulate the potential dietary outcomes of a pricing intervention strategy. To accomplish our objective, we use a nationally representative food consumption survey data, namely the 2005-08 National Health and Nutrition Examination Survey (NHANES). The NHANES includes information on the foods consumed by a representative sample of Americans and the nutrients obtained from those foods. The nutritional outcomes of interest are intakes of food energy (calories), added sugars, whole grains, and sodium.

We focus on these nutritional outcomes because increasing whole grain intake and decreasing calories, added sugars and sodium are priority recommendations for improving diets and preventing obesity, a major global health problem (USDA and USDHHS 2011; WHO 2004). Intakes of calories, added sugars, and whole grains directly and indirectly affect body weight and RTE cereal choice may significantly affect an individual's overall intake of these dietary components. RTE cereals have been cited as an important source of whole grains (Bachman et al. 2008), but have also been criticized as a source of added sugars (Castetbon et al. 2012; Schwartz et al. 2008). These seemingly contradictory characteristics of RTE cereals arise from the considerable variation in the nutrient content of RTE cereals. Some are formulated to be high in whole grains with little or no added sugars and other ingredients; others are made from refined grains and are high in added sweeteners and other ingredients that may add calories or sodium. Therefore consumer choice within the product category is the key to the nutritional impacts of cereal consumption. Since RTE cereals are eaten on a daily basis by many US consumers, it is plausible that shifts to purchases of healthier cereals could improve overall diet quality.

In addition to examining the effects of the GSP, we also examine the potential effects of a separate, hypothetical price manipulation on cereal purchases and nutritional outcomes. Encouraging healthier food choices either by subsidizing healthier foods or taxing less-healthy choices has been suggested as a policy option (Todd and Lin 2012; Powell and Chaloupka2009). Examining the potential nutritional impacts of the GSP and price manipulation provides policy-relevant information to the public and private sectors. In this study, we also demonstrate that empirical results from food demand studies can be combined with food consumption and nutrition data to estimate dietary outcomes resulting from dietary intervention strategies.

Methods

We begin by briefly summarizing the empirical results on demand for RTE cereals of differing nutritional quality from Rahkovsky et al. (2013) that yield the elasticity estimates we will use in our simulation. We follow with a discussion of the NHANES, our dietary intake data source, and end with an explanation of our simulation approach.

GSP's Effect on Cereal Demand

Hannaford, a US supermarket chain, convened a scientific advisory panel to create the GSP, which evaluates the nutrient content of foods and beverages using nutrition data displayed on the US FDA-regulated Nutrition Facts label and the list of ingredients printed on product packaging (Fischer et al. 2011). An array of nutrients is evaluated, including nutrients that American consumers are encouraged to obtain more of (vitamins and minerals, fiber, and whole grains) and nutrients that American consumers are encouraged to limit (*trans* fatty acids, saturated fatty acids, cholesterol, sodium, and added sugars). For each nutrient, the minimum and maximum threshold values were established and fitted into the Guiding Stars algorithm to generate nutritional scores. A negative score is assigned when a food is rich in nutrient to limit (such as sodium), and a positive score is assigned for high value of a nutrient to encourage (such as fiber). The nutritional scores are totaled for each food, ranging from -24 to 7. The scores are then divided into four categories, from 0 to 3 stars, with more stars indicating higher overall nutritional quality. Because the star value is based on the overall composite nutritional scores, a food with higher star value does not necessarily score higher in every nutrient than a lower-starred food. A food with a star value of 1 to 3, has a tag with corresponding number of stars placed on the shelf next to its price, and a food not awarded a star value has no star in its tag.

Hannaford implemented the GSP in its stores starting in September 2006. Rahkovsky et al. (2013) used scanner data from 13,175 supermarkets in the US, collected between September 2005 and April 2008, to estimate a cereal demand model that assessed the effect of GSP on cereal purchases. There are 134 Hannaford stores in the data, and an equal number of non-Hannaford stores sharing similar characteristics with Hannaford are chosen to facilitate a treatment-control approach.

The approach was incorporated into a Rotterdam demand system (Barten 1964; Theil 1980) such that the effects of prices, income, marketing activities, and demographics on cereal demands were separated out of the GSP effect. The estimated Rotterdam model was used to predict the changes in market shares among the four types of cereals segmented by nutrition attributes and to derive the own- and cross-price demand elasticities among the four types of cereals.

The GSP was estimated to result in a decline of 0-star market share by 2.58 percentage points that are distributed among 1-, 2-, and 3-star cereals by 1.15, 0.89, and 0.54 percentage points, respectively[2]. Rahkovsky et al. (2013) reported four sets of demand elasticities measuring

[2] "0-star" cereals are termed as "unstarred" cereals by Rahkovsky et al. (2013), in the GSP, these cereals do not have any star tag placed on the grocery shelf. We use the term "0-star" for ease in exposition.

consumers' responsiveness to cereal prices before and after GSP at Hannaford (treatment) and control stores (Appendix Table 1). The own-price elasticities (numbers on the diagonal) range from -0.63 to -2.20, which are higher than the demand elasticities reported in the literature of US food demand (Andreyeva et al. 2010). This is expected because of highly aggregated food categories are modeled in the food demand literature, whereas cereals are separated into four categories by Rahkovsky et al. (2013). These four cereals are closer substitutes among themselves than between cereals and other food groups. The homogeneity condition in the economic theory therefore states that the own-price elasticities are larger for a cereal demand system than for a broad food system consisting of cereals and other foods.

National Health and Nutrition Examination Survey Data

Although findings from Rahkovsky et al. (2013) imply that both GSP and price manipulation have potential for improving the nutritional profiles of RTE cereals purchased, the lack of nutrient data in the store purchase data set made it impossible to directly assess the GSP effects on diet quality. To simulate the potential dietary outcomes of a hypothetical nationwide GSP or pricing intervention on cereal consumption, we use data on the food and nutrient intakes of a representative sample of Americans. We obtain these data from the 2005-08 National Health and Nutrition Examination Survey (NHANES), collected by the Centers for Disease Control and Prevention, US Department of Health and Human Services (CDC 2013). NHANES surveys a nationally representative sample of individuals of all ages, with respondents reporting all the foods they consumed over a 24 hour period and the amount of each food that they consumed. This information is used to estimate their nutrient intakes using the USDA's Food and Nutrient Database for Dietary Studies (USDA/ARS 2013).

There are more than 7,000 food items reported by NHANES respondents, including 209 unique food product codes for cereals. Each of these cereal product codes includes information on the cereal's nutrient content (including calories and sodium) and food group servings data for added sugars and whole grains (Bowman et al. 2008). Using these data, we evaluated each cereal according to the GSP's scoring algorithm and assigned star rating designation to each of the 209 cereal products. Among the 209 cereals, 72 cereals (34%) are 0-star, 72 are 1-star (34%), followed by 48 (23%) 2-star and the remaining 17 (8%) are 3-star. In terms of US consumption, 1-star cereals have the largest market share of 34%, followed by 2-star (31%), 0-star (30%), and 3-star (5%) (Table 1). On a given day, 36% of Americans consume any cereals, and 13, 15, 11 and 2% of Americans consume 0-, 1-, 2-, and 3-star cereals, respectively (Table 1).

Table 1 reports descriptive statistics on cereals consumed by the US population, as reported in the 2005-08 NHANES and their nutritional quality by GSP star value. The higher rated (starred) cereals are generally more nutritious than the lower rated cereals, although the nutritional differences vary across nutrients examined. As discussed earlier, the GSP algorithm considers all nutrients identified by scientific consensus as having health benefits or risks (Fischer et al. 2011). Therefore, a food with a higher star value does not necessarily have to be superior in every nutrient to a food with a lower star value. The calorie content of cereals declines with star

value, from 393 calories per 100 grams of 0-star cereals to 380 calories for 1-star, 354 calories for 2-star, and 327 calories for 3-star. Cereals of 0-star have 9.61 teaspoons (tsp) of added sugars per 100 grams, more than doubled the amount for 1-star (4.53). The added sugars content is particularly low among 3-star cereals with only 0.47 tsp per 100 grams of cereals. Consequently, the energy density of added sugars (tsp per 1,000 calories) is much lower for 3-star cereals than 0-star cereals (1.35 vs. 24.53 tsp per 1,000 calories), and we would expect a larger reduction in added sugars than calorie content by switching from lower starred cereals to higher starred cereals. All of the starred cereals are higher in whole grains than the 0-star cereals, but the 2-star cereals are actually richer in whole grains than the 3-star cereals. The 2- and 3- star cereals are lowest in sodium, with the 3-star cereals particularly low in sodium, but it is actually the 1-star cereal group that has the highest sodium level. These mixed profiles of the starred cereals may result in uneven benefits from use of the GSP across nutrients.

Table 1. Consumption and Nutritional Profile of Ready-to-Eat Breakfast Cereals by GSP Star Rating

	0-star	**1-star**	**2-star**	**3-star**
Percent of consuming population (%)	12.85	14.66	10.96	2.35
Share of the cereal consumption (%)	30.12	33.71	31.19	4.98
Nutrient density per 100 grams of cereals				
Calories (kcal/100 g)	392.59	379.51	354.01	326.51
Added sugars (tsp/100 g)	9.61	4.53	3.15	0.47
Whole grains (oz/100 g)	0.49	0.85	2.34	1.83
Sodium (mg/100 g)	564.40	651.14	472.07	124.76
Nutrient density per 1,000 calories				
Added sugars (tsp/1,000 kcal)	24.53	11.86	9.11	1.35
Whole grains (oz/1,000 kcal)	1.19	2.23	6.58	5.15
Sodium (mg/1,000 kcal)	1432.30	1719.26	1347.58	488.92

Source. 2005-8 National Health and Nutrition Examination Survey, 2 day data.

We assess the changes in consumption of added sugars, whole grains, and sodium in terms of energy density (e.g., ounces of whole grains per 1,000 calories) before and after the GSP or pricing interventions. The density approach addresses the quality of an individual's diet and is used as a key measure of how well an individual's diet adheres to US Federal dietary guidance (Guenther et al. 2007). For calories, we express the outcome as calories (kcal) per 100 grams of cereal.

NHANES also collects demographic and income data on respondents, allowing us to conduct subgroup analyses. Previous research suggests differences in RTE cereal consumption patterns between children and adults (Rahkovsky et al. 2013; Castetbon et al. 2012; Schwartz et al. 2008). In addition, Lin and Yen (2007) found adults living with children consumed fewer servings of whole grains than adults without children, suggesting that adult cereal consumption patterns may differ by presence of children. Therefore, we examine dietary outcomes for children, adults

living with children 18 years of age or younger, and other adults. NHANES does not report whether or not children are present in a household. However, it is possible to identify children in NHANES by using food security data, as food security data for children under the age of 18 are answered by an adult in the household. Using data on age and food security for children, we can separate NHANES respondents into children (under the age of 20), adults living with children under the age of 18, and adults who have no children in the household.

We also assess outcomes for individuals living in higher and lower income households. Households are separated into higher and lower income groups using a household income cut-off of 185% of the US government's poverty threshold (the income cutoff for the US Special Supplemental Nutrition Program for Women, Infants, and Children).

Simulation Analysis

For the simulation analysis, we use a population approach.[3] For each of the four star categories of RTE cereals, US cereal consumption is totaled using individual intake data and sample weight. The weighted total consumption is used as the base for simulation of both a nationwide GSP program and a pricing intervention. We conduct the simulations for the population as a whole and for each of the subgroups previously identified. These groups include individuals who may or may not consume cereals. Cereal is consumed by 36% of Americans on a given day. As shown in Table 1, the proportions of the population that consume 0- to 3-star cereals sum to 41%, indicating that only 5% of Americans consume multiple groups of cereals on a given day. In the case of price manipulation, cross-price elasticities are used to estimate the substitution or complementary effects, which cannot be estimated in the case of zero consumption because it remains zero when multiplied by cross-price elasticities. Therefore, simulations cannot be conducted on an individual basis. Instead, our results show the average dietary improvement for the broad population and subgroup-level effects of GSP or pricing interventions.

As shown in AppendixTable 1, there are four sets of demand elasticities that we employ in the simulation. The diagonal numbers are uncompensated own-price elasticities and off-diagonal numbers are cross-price elasticities. We use these elasticities to simulate the effect of a price intervention scenario, in which the price of 0-star cereals is increased by 10% and prices of 2- and 3-star cereals are decreased by 10% while leaving the price of 1-star cereals unchanged. Other price intervention scenarios, such as changing the price of 1-star or different price changes, can also be simulated but are not carried out in this study. We simulate pricing effects for all four sets of demand elasticities and then take a simple average to represent the pricing effect.

When simulating the GSP effects, changes in market shares reported by Rahkovsky et al. (2013) are used to predict shifts in consumption among cereals by star value under the nationwide GSP simulation. The total consumption amount is fixed, meaning that the GSP simulation does not

[3] This population approach differs from the individual-based simulation (Lin et al. 2011). In an individual approach, changes resulting from intervention are estimated for each individual. This individual approach facilitates the detection of a change in status for an individual, for example a change from obese to healthy weight, and then estimates a change in national prevalence of a status, such as reduction in the national obesity rate. As explained later, this approach is inappropriate for this study because consumers usually consume only one type of cereals.

change total cereal consumption, rather it reallocates total consumption among the four cereal categories. In simulating pricing effects, the simulated total consumption amount from the four cereal categories may differ from the observed (before pricing intervention) total consumption amount. Because we use density measures as our nutrient outcome variables, this approach will not affect our assessment of quality changes. It is important to note that the demand elasticities were estimated by a system consisting of four cereal groups; substitutes and complements of cereals were not included due to data limitations. Therefore, cross-price effects between cereals and their related food groups are not captured in the simulation.

As discussed earlier, we use the population approach to simulate dietary improvement. The delta method (Oehlert 1992) can be applied to the variance-covariance of the own- and cross-price demand elasticities to calculate the variances of predicted cereal consumption under each intervention. However, our outcome variables are expressed in terms of density, making it problematic to calculate the variances associated with the observed and predicted densities. We overcome this difficulty by bootstrapping, in which we use unrestricted random sampling method to draw 1,000 sample replicates from the NHANES data. The bootstrapping procedure is implemented by using Proc Surveyselect in SAS (SAS Institute 2009). For each sample, we calculate nutrient density before and after intervention and then from the 1,000 replicates we calculate the means, standard errors, and 99-percent confidence intervals of the means for each nutrient density. The confidence intervals allow us to test whether the nutritional quality of cereal consumption differs by demographics and whether the dietary improvements from interventions are significant.

Results

Appendix Table 2 shows the predicted changes in dietary intakes under a hypothetical nationwide GSP or 10% pricing intervention. The lack of overlap between the confidence intervals for baseline and predicted estimates indicates that both the GSP and the pricing interventions have statistically significant effects, at the 1% probability level, on dietary quality. This is true for the population as a whole, as well as for the subgroups defined by income or age. Appendix Table 2 also shows the ratio of the density of each nutrient before and after intervention. Those ratios indicate that although significant, the effects are small.

Dietary Improvement Associated with a Nationwide GSP for RTE Cereals

Our results predict that a nationwide GSP lead to small increases in whole grains and decreases in added sugars from cereal consumption. At the US population level, the density of added sugars and whole grains improves by 2.5%. The density of calories and sodium is predicted to decline, on average, by less than 1% (Appendix Table 2).

Population subgroups defined by income and age vary in the before-intervention quality of their RTE cereal choices (Appendix Table 2). Higher income individuals consume more nutritious cereals than their lower income counterparts; that is, cereals consumed by higher income individuals are significantly lower in calorie density (370 kcal/100 grams), added sugars (14.71 tsp/1,000 kcal) and sodium density (1379 mg/1,000 kcal) and higher in whole grain density (3.57 ounces/1,000 kcal), as compared with a density of 375 kcal/100 grams and an energy density of

16.22 tsp of added sugars, 1457 mg of sodium, and 2.89 ounces of whole grains per 1,000 calories among low-income adults.

Children consume RTE cereals that are significantly less nutritious than those of adults living with or without children. The differences in added sugars and whole grains are particularly noticeable. On a per-1,000 calorie basis, children consume the most added sugars and least whole grains—18.95 tsp of added sugars and 2.41 ounces of whole grains vs. 15.16 tsp and 3.34 ounces for adults living with children and 12.66 tsp and 3.98 ounces for adults without children. Adults living in households with children eat RTE cereals that are more dense in added sugars and calories and less dense in whole grains than other adults, but not different in sodium density. These results suggest lower income consumers and children would benefit most from changes in RTE cereal choice. The magnitudes of predicted changes from GSP for most subgroups were roughly similar, so although all subgroups improved their nutrient intakes from RTE cereals, the nationwide GSP does not seem to reduce the differences in diet quality by subpopulation groups. The small magnitude of these changes reflects the fact that 1-star cereals gain larger market shares than 2- and 3-star cereals from GSP. Although 1-star cereals are nutritionally superior to 0-star cereals, nutrition profiles by star value (Table 1) indicate that switching from 0-star to 2- and 3-star would lead to larger improvement in the selected nutrients than switching from 0- to 1-star. Further, the dietary improvements vary across nutrients. The added-sugars density of 1-star cereals is less than half that of 0-star cereals (see Table 1), while their whole grain density is 187% of that of 0-star cereals. However, the calorie density of 1-star cereals is not much lower than that of 0-star cereals (97%) and the sodium density is actually higher, so any improvements in calorie and sodium density would have to arise from shifts to 2- and 3-starred cereals.

Dietary Improvement Associated with a Pricing Intervention for RTE Cereals

When we examine the effect of applying a10% price increase to 0-star cereals and a 10% price decrease to 2- and 3-star cereals, we predict an almost 5% decline in the density of added sugars and an increase in the density of whole grains by 7% for the US population as a whole (Appendix Table 2). The predicted improvements in calorie and sodium density are very small at around 1%.

Subgroup analyses indicate similar changes across income and age groups for added sugars, calories, and sodium. For whole grains, there may be some differences in improvements across groups. The lower income individuals, on average, are predicted to improve the whole-grains density more than higher income individuals—8% vs. 6%. On average, children are predicted to improve their whole grains intake more than adults as a result of the pricing intervention than adults—9% for children vs. 6% for adults with children and 5% for adults without children.

We note that a nationwide GSP and a pricing strategy would improve the nutritional quality of RTE cereals consumed, but neither of the intervention is predicted to close the nutritional gap by demographics: lower income individuals continue to have lower whole grain densities than higher income individuals, and children continue to have the lowest whole-grain density of any subgroup examined. These results reflect the fact that the GSP and pricing effects as produced by Rahkovsky et al. (2013) are for the nation and do not vary across population subgroups.

Closing Remarks

RTE cereals eaten by Americans vary considerably in nutritional quality. Cereals in the least nutritious 0-star category, which made up 30% of reported cereal consumption, were highest in density of calories, added sugars, and sodium and lowest in whole grains. Shifting consumption to cereals that GSP rates as more nutritious offers the opportunity for dietary improvement. This is particularly true for lower income individuals and for children (i.e., those younger than 20 years old), whose cereal consumption is of significantly lower nutritional quality with regard to density of calories, added sugars, sodium, and whole grains.

Simplified front-of-package or shelf tag systems of identifying more nutritious choices within a food category have been adopted by several food manufacturers and retailers globally (Fischer et al. 2011; IOM 2012). Rahkovsky et al. (2013) demonstrated that the GSP, one US supermarket's shelf-tag system, can influence RTE cereal purchase choice. Our simulation of the nutritional effects of implementing a hypothetical nationwide GSP indicates that it would lead to statistically significant improvements in diet quality but the effects would be small. It should be noted that these effects are calculated for the population as a whole, including both consumers and non-consumers of RTE cereals. This is similar to the manner in which Bachman et al. (2008) estimated the contribution of major food categories, including RTE cereal, to whole grain and added sugar intakes of Americans, and allows insight into the public health importance of changes identified. Effects on regular cereal consumers would likely be larger.

Effects were not uniform across the nutritional variables of interest, with the GSP intervention having a bigger effect on added sugars and whole grains than on calories and sodium. This is unsurprising given that most of the simulated shift in cereal consumption was from 0-star to 1-star cereals. One-star cereals were considerably superior to 0-star cereals in relationship to added sugars and whole grains but less different in calorie content and actually higher in sodium content. For improvement in calorie or sodium density, more of a shift to the 2- and 3-star cereals would be necessary. The GSP simplifies decision-making for consumers by grouping products according to the program's nutritional criteria, but inevitably in grouping nutrient information there is a trade-off between gains in simplicity and loss in detail. For consumers who are highly concerned about a specific nutrient, such as sodium, the star rating system may not be as satisfactory as the specific information on the Nutrition Facts label. But for the many shoppers who do not regularly read the Nutrition Facts label or have trouble understanding it, the GSP could be helpful.

The nutritional effects of our price manipulation followed a similar pattern to those of the GSP manipulation—higher for added sugars and whole grains than for calories and sodium—but they were of a somewhat larger magnitude. This does not imply that any pricing intervention would be more or less effective than a nationwide GSP, since the effect of a pricing intervention is determined by the magnitude of price changes.

The findings from this study may be useful to policymakers and members of the food industry seeking to provide consumers with healthful options and assist them in making healthful choices. While the US government-mandated Nutrition Facts labels provide detailed nutrition information, simpler information such as the GSP may be easier for some consumers to use. The visibility of a

shelf tag may also increase consumers' awareness of nutrition as a factor in their choice decision. As policymakers seek to assess the merits of such systems (IOM 2012), this paper provides information on the potential dietary effects of changes in purchases associated with a shelf-tag labeling system. For food manufacturers and retailers considering the use of a front-of-package or shelf-tag label on their products, it provides information on the likely impacts on customers' diets.

Private-sector pricing strategies such as sales on more nutritious cereals may be helpful in promoting diet and health, especially when paired with nutrition information or health promotion strategies. Price manipulations by the public sector such as taxes on less nutritious cereals or subsidies on more nutritious cereals by the private sector may also encourage consumers to make healthful choices. Food taxes could be regressive, falling more heavily on lower-income consumers, while non-trivial price subsidies could be considerably more costly than informational approaches. These potential consequences make it necessary that the benefits and costs of public interventions such as taxes and subsidies would need to be well-established.

The small effects of GSP and price interventions indicate that other preferences, such as taste, have important influences on choice. This suggests a role for food technologists in improving the taste of nutritionally improved products. Some population subgroups make less nutritious cereal choices than others, particularly children, an issue of current public health concern (Harris et al., 2012). Further improvements in the quality of children's nutritional intakes from RTE cereals may require additional, more targeted interventions, such as development and marketing of more healthful cereals that are appealing to children.

This study investigated potential dietary outcomes of a nutrition information system and a pricing strategy, using the empirical results reported in Rahkovsky et al. (2013). We note several future research needs arising from both studies. These results apply to only one product category, RTE cereals. In participating stores, the GSP rating system is used with a wide range of food items. If the GSP has similar effects on other product categories, for example encouraging more purchases of whole-grain breads, the overall dietary effects of the program could be larger. However, consumers' purchase decisions may vary across product categories with healthfulness of more or less importance in a given category, so further investigation is needed before we can generalize findings.

It should be noted that the elasticities developed by Rahkovsky et al. (2013) used store-level data to estimate cereal demand for the whole population. Demand elasticity may vary across subgroups, which would generate more differences in response to the manipulation and the resulting dietary outcomes. Due to data limitations, the demand model estimated by Rahkovsky et al. (2013) included only four cereal groups but not other foods that are substitutes or complements of cereals. Future research is needed to investigate possible demographic differences in cereal demand and to incorporate other food groups in order to capture the substitution and complementary effects on diet.

References

Andreyeva, T., M. Long, and K. Brownell. 2010. The Impact of Food Prices on Consumption: A Systematic Review of Research on Price Elasticity of Demand for Food. *American Journal of Public Health* 100(2):216-222.

Bachman, J., J. Reedy, A. Subar, and S. Krebs-Smith. 2008. Sources of Food Group Intakes among the US Population, 2001-2002. *Journal American Dietetic Association* 108(5):804-814.

Barten, A.P. 1964. Family Composition, Prices and Expenditure Patterns, edited by P.E. Hart, G. Mills and J.K. Whitaker, J.K. in *Econometric Analysis for National Economic Planning.* Butterworth: London.

Bowman, S., J. Friday, and A. Moshfegh. 2008. *MyPyramid Equivalents Database, 2.0 for USDA Survey Foods, 2003-2004.* (U.S. Department of Agriculture, Economic Research Service) http://www.ars.usda.gov/ba/bhnrc/fsrg.

Castetbon, K., J. Harris, and M. Schwartz. 2012. Purchases of Ready-to-eat Cereals Vary Across US Household Sociodemographic Categories According to Nutritional Value and Advertising Targets. *Public Health Nutrition* 15(8):1456-1465.

Centers for Disease Control and Prevention, National Center for Health Statistics (CDC-NCHS) 2013. *National Health and Nutrition Examination Survey, 2005–2006 and 2007-2008.* (US Department of Health and Human Services) http://www.cdc.gov/nchs/nhanes/wweia.htm.

Finkelstein, E., J. Trogdon, J. Cohen, and W. Dietz. 2009. Annual Medical Spending Attributable To Obesity: Payer-And Service-Specific Estimates. *Health Affairs* 28(5):822-831.

Fischer, L., L. Sutherland, L. Kaley, T. Fox, C. Hasler , J. Nobel, M. Kantor, and J. Blumberg. 2011. Development and Implementation of the Guiding Stars Nutrition Guidance Program. *American Journal of Health Promotion* 26(2):55-63.

Food and Drug Administration (FDA). 2013. Labeling & Nutrition. http://www.fda.gov/Food/IngredientsPackagingLabeling/LabelingNutrition/default.htm.

French, S., M. Story, J. Fulkerson, and A. Gerlach. 2003. Food Environment in Secondary Schools: À La Carte, Vending Machines, and Food Policies and Practices. *American Journal of Public Health* 93(7):1161-1168.

Guenther, P., J. Reedy, S. Krebs-Smith, B. Reeve, and P. Basiotis. 2007. *Development and Evaluation of the Healthy Eating Index-2005.* (US Department of Agriculture, Center for Nutrition Policy and Promotion, Washington, DC.)

Guthrie, J., B. Lin, A. Okrent, and R. Volpe. 2013. Americans' Food Choices at Home and Away: How Do They Compare With Recommendations? *Amber Waves* (U.S. Department of Agriculture, Economic Research Service) http://www.ers.usda.gov/amber-waves/2013-february/americans'-food-choices-at-home-and-away.aspx.

Harris, J., M. Schwartz, K. Brownell, V. Sarda, C. Dembek, C. Munsell, C. Shin, A. Ustjanauskas, and M. Weinberg. 2012. *Cereal FACTS 2012: Limited progress in the nutritional quality and marketing of children's cereals.* Yale University. http://www.cerealfacts.org/media/Cereal_FACTS_Report_2012_7.12.pdf

Institute of Medicine (IOM). 2012. *Front-of-Package Nutrition Rating Systems and Symbols: Promoting Healthier Choices*. Washington, DC: The National Academies Press.

Lin, B., and S. Yen. 2007. *The US Grain Consumption Landscape: Who Eats Grain, in What form, Where, and How Much?* Economic Research Service, US Department of Agriculture. Economic Research Report No. 50, 35.

Lin, B., T. Smith, J. Lee, and K. Hall. 2011. Measuring weight outcomes for obesity intervention strategies: The case of a sugar-sweetened beverage tax. *Economics and Human Biology* 9(4): 329–341

Mancino, L. and F. Kuchler. 2012, Demand for Whole-Grain Bread Before and After the Release of the Dietary Guidelines. *Applied Economic Perspectives and Policy* 34(1):76-101.

Mancino, L., F. Kuchler, and E. Leibtag. 2008. Getting Consumers to Eat More Whole-grains: the Role of Policy, Information, and Food Manufacturers. *Food Policy* 33(6):489-496.

Martinez, S. 2013. *Introduction of New Food Products With Voluntary Health- and Nutrition-Related Claims, 1989-2010*. (U.S. Department of Agriculture, Economic Research Service) Economic Information Bulletin No. 108, 54.

Oehlert, G. 1992. A Note on the Delta Method. *American Statistician* 46(1): 27–29.

O'Grady, M. and J. Capretta. 2012. Assessing the Economics of Obesity and Obesity Interventions. (Robert Wood Johnson Foundation). http://www.rwjf.org/files/research/74094.5743.assessingobesityinterventions.0312.pdf

Powell, L. and F. Chaloupka. 2009. Food Prices and Obesity: Evidence and Policy Implications for Taxes and Subsidies. *Milbank Quarterly* 87(1): 229-57

Rahkovsky, I., B. Lin, C. Lin, and J. Lee. 2013. Effects of the Guiding Stars program on Purchases of Ready-to-Eat Cereals with Different Nutritional Attributes. *Food Policy* 43(4): 100-107.

Rahkovsky, I., S. Martinez, and F. Kuchler. 2012. *New Food Choices Free of Trans Fats are Aligning US Diets with Health Recommendations,* (U.S. Department of Agriculture, Economic Research Service) Economic Information Bulletin No. 95. p33.

Rothman, R., R. Housam, H. Weiss, D. Davis, R. Gregory, T. Gebretsadik, A. Shinatni, and T. Elasy. 2006. Patient Understanding of Food Labels: The Role of Literacy and Numeracy. *American Journal of Preventive Medicine* 31(5):391-398. (SAS Institute Inc. 2009). SAS™ User's Guide: Basics, Version 9.2 Edition. Gary, NC: SAS Institute Inc.

Schwartz, M., L. Vartanian, C. Wharton, and K. Brownell. 2008. Examining the Nutritional Quality of Breakfast Cereals Marketed to Children. *Journal of American Dietetic Association* 108(4):702-705.

Sutherland, L., L. Kaley, and L. Fischer. 2010. Guiding Stars: the Effect of a Nutrition Navigation Program on Consumer Purchases at the Supermarket. *American Journal of Clinical Nutrition* 91(4):1090-1094.

Theil, H., 1980. System-wide Explorations in International Economics, Input-Output Analysis, and Marketing Research. North-Holland, New York.

Todd, J. and B. Lin. 2012. What Role Do Food and Beverage Prices Have on Diet and Health Outcomes? *Amber Waves* (U.S. Department of Agriculture, Economic Research Service) http://www.ers.usda.gov/amber-waves/2012-september/what-role-do-food-and-beverage-prices.aspx.

Tsai, A., D. Williamson, and H. Glick. 2011. Direct Medical Cost of Overweight and Obesity in the USA: A Quantative Systematic Review. *Obesity Review* 12(1):50-61.

US Department of Agriculture, Agricultural Research Service. 2013. *USDA National Nutrient Database for Standard Reference*. Release 25. Nutrient Data Laboratory Home Page: http://www.ars.usda.gov/ba/bhnrc/ndl

US Department of Agriculture and US Department of Health and Human Services (USDA and USDHHS). 2011. *Dietary Guidelines for Americans, 2010*. 7th Edition, Washington, D.C.: US Government Printing Office, December.

World Health Organization (WHO). 2004. *Global Strategy on Diet, Physical Activity and Health.* Geneva, Switzerland: World Health Organization.

Appendix

Table 1. Demand elasticity estimates – before and after GSP implementation at Hannaford and control stores

	Before				**After**			
	Price Elasticity				Price Elasticity			
Hannaford	0-star	1-star	2-star	3-star	0-star	1-star	2-star	3-star
0-star	-1.4861*	0.176*	0.136*	0.0023	-0.9412*	-0.0557*	-0.126*	-0.0486*
1-star	0.8487*	-1.2829*	-0.3501*	-0.043*	0.0543	-0.9291*	0.03	0.0176
2-star	0.779*	-0.4004*	-1.1983*	-0.0033	-0.1333*	0.0357	-0.7143*	-0.0115
3-star	0.2206*	-0.1483*	-0.153*	-0.9188*	-0.247*	0.0608*	-0.0469*	-0.6287*
Control								
0-star	-1.187*	0.1176*	0.1035*	0.0294*	-1.257*	0.1789*	0.1133*	0.0283*
1-star	0.6039*	-1.7925*	-0.0426	0.0856*	0.5708*	-1.8306*	0.7966*	0.0345*
2-star	0.9069*	-0.064	-1.9394*	-0.0283	0.05142*	0.1168*	-1.7459*	-0.0101
3-star	0.7596*	0.4048*	-0.0845	-2.1972*	0.5495*	0.2109*	-0.0413**	-1.8363*

*Statistically different from zero at α = 0.05 level.
** Statistically different from zero at α = 0.10 level.

Table 2. Predicted changes in dietary intakes under a hypothetical nationwide GSP and pricing intervention

	Calories	**Added Sugars**	**Whole Grains**	**Sodium**
	kcal/100 grams	*teaspoon/1,000 kcal*	*ounce/1,000 kcal*	*milligram/1,000 kcal*
	Mean (99% confidence interval)			
US population				
Before intervention	371.97 (371.90, 372.03)	15.23 (15.21, 15.24)	3.33(3.33, 3.34)	1407 (1406, 1408)
National GSP				
After	371.05 (370.98, 371.11)	14.84 (14.83, 14.85)	3.41 (3.41, 3.42)	1403 (1402, 1404)
After/Before*100	99.75	97.47	102.48	99.72
Pricing intervention				
After	369.68 (369.61, 369.75)	14.48(14.47, 14.49)	3.57 (3.56, 3.57)	1391 (1390, 1393)
After/Before*100	99.39	95.12	107.05	98.86
High income				
Before intervention	370.26 (370.18, 370.35)	14.71 (14.70, 14.73)	3.57 (3.56, 3.57)	1379 (1378, 1381)
National GSP				
After	369.33 (369.24, 369.41)	14.33 (14.32, 14.35)	3.65 (3.64, 3.65)	1375 (1373, 1376)
After/Before*100	99.75	97.41	102.32	99.71
Pricing intervention				
After	367.98 (367.90, 368.07)	14.02 (14.01, 14.04)	3.79 (3.78, 3.79)	1362 (1360, 1363)
After/Before*100	99.38	95.31	106.24	98.77
Low income				
Before intervention	375.23 (375.17, 375.30)	16.22 (16.21, 16.24)	2.89 (2.88, 2.89)	1457 (1456, 1459)
National GSP				
After	374.35 (374.28, 374.41)	15.82 (15.81, 15.84)	2.97 (2.97, 2.98)	1454 (1453, 1456)
After/Before*100	99.76	97.53	102.88	99.79
Pricing intervention				
After	373.05 (372.98, 373.12)	15.41 (15.39, 15.43)	3.13 (3.13, 3.14)	1448 (1447, 1450)
After/Before*100	99.42	94.99	108.45	99.38
Children				
Before intervention	383.99 (383.93, 384.05)	18.95 (18.93, 18.96)	2.41 (2.40, 2.41)	1476 (1475, 1477)
National GSP				
After	383.17 (383.11, 383.23)	18.57 (18.56, 18.59)	2.49 (2.49, 2.50)	1473 (1471, 1474)
After/Before*100	99.79	98.03	103.64	99.8
Pricing intervention				
After	382.12 (382.05, 382.18)	18.17 (18.16, 18.19)	2.63 (2.62, 2.64)	1471 (1470, 1472)
After/Before*100	99.51	95.92	109.41	99.66

Table 2. *Continued*

	Calories	**Added Sugars**	**Whole Grains**	**Sodium**
	kcal/100 grams	*teaspoon/1,000 kcal*	*ounce/1,000 kcal*	*milligram/1,000 kcal*
	Mean (99% confidence interval)			
Adults with children				
Before intervention	371.43 (371.31, 371.54)	15.16 (15.13, 15.18)	3.34 (3.33, 3.35)	1385 (1383, 1387)
National GSP				
After	370.51 (370.39, 370.63)	14.78 (14.76, 14.81)	3.41 (3.40, 3.42)	1380 (1378, 1382)
After/Before*100	99.75	97.53	102.17	99.64
Pricing intervention				
After	369.36 (369.24, 369.48)	14.52 (14.50, 14.55)	3.53 (3.53, 3.54)	1367 (1365, 1370)
After/Before*100	99.44	95.82	105.85	98.7
Adults without children				
Before intervention	364.33 (364.22, 364.44)	12.66 (12.65, 12.68)	3.98 (3.98, 3.99)	1372 (1370, 1373)
National GSP				
After	363.51 (363.40, 363.63)	12.27 (12.25, 12.29)	4.07 (4.07, 4.08)	1369 (1367, 1371)
After/Before*100	99.78	96.88	102.24	99.78
Pricing intervention				
After	362.51 (362.39, 362.62)	12.15 (12.13, 12.16)	4.18 (4.17, 4.19)	1356 (1354, 1358)
After/Before*100	99.5	95.92	104.92	98.83

International Food and Agribusiness Management Review
Volume 17 Special Issue A, 2014

Costs of Taxing Sodium: A Lunch Meat Application[1]

William F. Hahn[ⓘa] and Christopher G. Davis[b]

[a]*Senior Ag Economist, Market and Trade Economics Division, Economic Research Service, U.S. Department of Agriculture, 355 E Street, SW, Washington DC, 20024, USA*

[b]*Senior Ag Economist, Market and Trade Economics Division, Economic Research Service, U.S. Department of Agriculture, 355 E Street, SW, Washington DC, 20024, USA*

Abstract

The current American diet contains excessive amounts of sodium and saturated fat, which are high risk factors for cardiovascular disease (US Dietary Guidelines for Americans 2010). Recently, the Centers for Disease Control and Prevention (CDC) reported lunch meats to be the second highest source of sodium in American diets. Using 2006 Nielsen Homescan data and an AIDS framework, this study estimates the demand for eight disaggregated lunch meat products to determine the welfare costs associated with consuming these meat products. The estimated welfare analysis revealed that a tax rate that increases the price of the highest-sodium lunch meat (pepperoni) by 25 percent can reduce lunch meat consumption as well as lower the intake of lunch meat sodium by 20 percent.

Keywords: lunch meats, sodium, welfare costs

ⓘCorresponding author: Tel: + 1.202.694.5175
Email: W. Hahn: whahn@ers.usda.gov
C. G. Davis: chrisdavis@ers.usda.gov

[1] The views expressed here are those of the authors, and may not be attributed to the Economic Research Service or the U.S. Department of Agriculture.

Introduction

According to the Centers for Disease Control and Prevention (CDC), the foods with the highest sodium content are not the so called "junk foods," but breads, followed by lunch meats (CDC 2012). Lunch meats are defined as processed, prepackaged meats made from turkey, pork, beef, chicken and other meats that are often molded, sliced, and served cold. Most lunch meats are relatively high in sodium and often contain nitrates, which studies have shown to be cancer-causing additives (Preston-Martin et al. 1982; Peters et al. 1994). The average person in the United States consumes about 3,300 milligrams (mg) of sodium per day (CDC, 2012). According to the U.S. Department of Agriculture's Agricultural Research Service, U.S. Department of Health and Human Services, and CDC, the daily recommended sodium intake for adults is 2,300 mg. According to the CDC (2012) consuming over 2,300 mg of sodium can lead to hypertension, expenses health-care bills, and death.

Improving diets and health has become a national priority (WHTF 2010). One intervention policymakers may consider is taxing some food products. The growing worldwide incidence of health problems related to food choice and over consuming has led to calls for taxes on foods perceived to be unhealthy (Fletcher, Frisvold and Tefft 2010; Kuchler, Tegene and Harris 2004; Jacobson and Brownell 2000) and for promoting greater health and nutrition awareness. One downside to taxing unhealthy foods is that the taxes will increase consumers' costs of living by increasing the price of purchased products. As price increases, consumers' economic welfare decrease and the benefits of an improved diet are expected to balance out against the increased costs of food. Because food taxes are regressive, what impact will a tax increase have on consumers' consumption of lunch meats?

The first objective of this study is to measure how a tax on sodium would affect lunch meat demands. We use lunch meat because it is high in sodium and it accounted for 26.3% of all fixed-weight meat sales in 2009 (based on scanner data from Information Resources Inc. and Freshlook Alliances). The second objective is to measure how these sodium taxes on lunch meats will affect consumers' economic welfare. Thus, a third objective is to measure the accuracy of the tax-effect estimates related to the sodium in lunch meats.

Related Studies Measuring Consumer Welfare Cost

Numerous studies have examined consumer welfare costs for retail foods and other products (Townsend, Roderick and Cooper1994; Godfrey and Maynard1988; Säll and Gren 2012; Harding and Lovenheim 2012; Kuchler, Tegene and Harris 2004; Mytton et al. 2007), but this study is the first to evaluate sodium associated with disaggregated lunch meat products. A disaggregated analysis is beneficial because it allows examination of consumers' preference for one type of lunch meat over another with different levels of sodium.

Taxation involving price increases in order to reduce consumption of unhealthy products has been one approach economists and policymakers have used to help address issues related to unhealthy food and product purchases. For example, studies have shown that increasing the price of alcoholic beverages and tobacco through taxes could reduce consumption (Townsend, Roderick, Cooper 1994; Godfrey and Maynard 1988; Institute of Alcohol Studies Alcohol and

Tax 2003). A Swedish study evaluating the environmental impact from a tax on meat consumption, particularly poultry, pork, and beef (Säll and Gren 2012) discovered that imposing a tax on the three meat products can reduce consumer demand, while simultaneously reducing the emission of greenhouse gases, and the amounts of nitrogen and phosphorus dispersed in waterways and aquifers.

However, it is often questioned whether taxing consumer purchases of unhealthy foods can actually improve individual physical conditions (Jacobson and Brownell 2000; Fletcher, Frisvold, and Tefft 2010). In examining the effects of nutrient-specific taxes on shopping behavior, Harding and Lovenheim (2012) found that a sugar tax could lead to reductions in sugar purchases, and consequently—caloric intake, and salt consumption. Kuchler, Tegene, and Harris (2004) conducted a study of taxing snack foods in an attempt to address issues related to obesity in the United States. Their findings suggest that relatively low tax rates of one cent per pound (of salty snack food) and 1% of the value would have little effect on consumers' diet quality or health outcomes but would produce millions of dollars in tax revenues. Mytton et al. (2007) found that taxing unhealthy foods led to a reduction in consumption of those foods while lowering consumers' salt intake, which could potentially save about 2,300 lives in the United States per year.

Similarly to Mytton et al. (2007), this study will evaluate a sodium tax on eight different types of lunch meats, particularly roast beef, ham, chicken breast, turkey, bologna, pepperoni, salami, and other lunch meats. The tax rates for lunch meats will vary depending on their sodium levels. This study explores the impacts a low (1%), medium (5%), and high (25%) tax rate will have on consumer expenditures for lunch meats. These tax rates are similar to those used by Jacobson and Brownell (2000) and Kuchler, Tegene, and Harris (2004). Like studies conducted by Harding and Lovenheim; Kuchler, Tegene, and Harris; and Säll and Gren, we expect a tax designed to reduce the consumption of lunch meats, would work as it did for salty snack foods, sugar products, and meats.

The AIDS Demand Model

A tax on sodium would change the prices of foods. Those foods with high levels of sodium would get a higher tax. To measure how sodium taxes would affect lunch meat consumption, we need to know how demand for each lunch meat changes in response to its own and other prices. We used an Almost Ideal Demand System (AIDS) to estimate these effects.

One of the advantages of using the AIDS is that it is based on a cost function. Economists use a concept called "compensating variation" (CV) to translate price changes into estimates of economic welfare effects. The cost function is defined as the minimum cost of achieving a given level of utility with a given set of prices. Typically, economists adopt a given set of prices and consumer expenditures as a baseline. We also assume that consumers make purchases to maximize their utility. If we then change prices, we can use the cost function and the baseline utility to calculate how much additional expenditure would be needed to maintain a baseline utility level. The difference between the minimum cost expenditure and the baseline expenditure is the CV that will be a positive value when all the prices increase.

The AIDS model was developed by Deaton and Muellbauer (1980). It can be derived from a cost function:

$$(1)\ \ln(x) = A(P) + v_0 B(P),$$

where*x* is consumer total cost, *P* is a vector of prices andv_0 is some target level of utility. The cost function in (1) can be rearranged to give a maximum level of utility, given *P*and *x*. That function is the indirect utility function. For our welfare analysis, we can take baseline expenditures and prices and find v_0, then use our estimates to get the costs associated with a new set of prices.

A(*P*) and B(*P*) are functions of prices:

$$(2)\quad A(P) = \sum_i\ a_i \ln(p_i) + \frac{1}{2}\sum_i\ \sum_j\ c_{ij} \ln(p_i)\ln(p_j),$$

$$(3)\quad B(P) = \prod p_i^{b_i}.$$

In (2) and (3),p_i is the price of item "*i*." The "*a*", "*b*," and "*c*" are model coefficients.

Cost functions have to be homogenous of degree 1 in prices. (Doubling all the prices will double the cost.) These conditions are ensured if the coefficients meet the following restrictions:

$$(4)\quad \sum_i\ a_i = 1,$$

$$(5)\quad \sum_i\ b_i = 0,$$

$$(6)\quad \sum_i\ c_{ij} = \sum_j\ c_{ij} = 0, \forall i, j.$$

Deaton and Muellbauer demonstrated that if the c_{ij}[2]are symmetric, then these coefficients are unique:

$$(7)\quad c_{ij} = c_{ji}, \forall i, j.$$

In theory, cost functions have to be negative, semidefinite (NSD) in prices. NSD is an inequality restriction. If the estimated cost function is not NSD, then it will be possible to increase all the prices and decrease total costs, yielding an illogical outcome. Some Economists often focus on the equality restrictions in their demand models and occasionally ignore or fail to check NSD.

Deaton and Muellbauer demonstrate that the AIDS is a locally flexible form; that is, one can take a set of prices, quantities, and expenditure and demand elasticities and find a set of AIDS parameters that will reproduce the demands and elasticities. The cost function being NSD implies that the matrix of compensated demands is also NSD. There are no equality conditions that will guarantee that the AIDS estimates are NSD; we can check a set of estimates to see if they are.A potential issue with the AIDS approach is that it can be NSD at one point and not at others. If the "c" and b" coefficients are all 0 and the "a" coefficients are all positive, then the AIDS will be globally NSD. In this extreme case, the AIDS implies the Cobb-Douglass utility

[2] Deaton and Muellbauer started their development of the AIDS with no restrictions on the c_{ij}. They noted that the c_{ij} show up in the demand equations as ½ (c_{ij}+c_{ji}). Imposing symmetry on the c_{ij} identifies these terms on the function A(P) and imposes symmetry on the AIDS demand equations.

function. With a Cobb-Douglas demands all the cross-price elasticities are 0, the own price are all 1, and all expenditure elasticities are 1.

Deaton and Muellbauer demonstrate that the AIDS is a locally flexible form; that is, one can take a set of prices, quantities, and expenditure and demand elasticities and find a set of AIDS parameters hat will reproduce the demands and elasticities. The cost function being NSD implies that the matrix of compensated demands is also NSD. There are no equality conditions that will guarantee that the AIDS estimates are NSD; we can check a set of estimates to see if they are.A potential issue with the AIDS approach is that it can be NSD at one point and not at others. If the "*c*" and *b*" coefficients are all 0 and the "*a*" coefficients are all positive, then the AIDS will be globally NSD. In this extreme case, the AIDS implies the Cobb-Douglass utility function. With a Cobb-Douglas demands all the cross-price elasticities are 0, the own price are all -1, and all expenditure elasticities are 1.

Deaton and Muellbauer derive the following demand equation from the cost function:

$$(8) \qquad w_{i,t} = a_i + \sum_j c_{ij} \ln(p_{i,t}) + b_i[\ln(x_t) - A(P_t)] + e_{i,t}.$$

$w_{i,t}$ is the budget share for product "*i*" in week "*t*" and the term $e_{i,t}$ is a random error term. By virtue of the model's construction, the sum of the error terms in each time period is 0. As a result, an equation must be dropped to estimate the model. If the model is estimated using maximum-likelihood methods, the model estimates are independent of the dropped equation.

Data

Lunch meats make up a significant category of all meats sold in supermarkets. Using scanner data (from Information Resources Inc. and Freshlook Alliances), we found that the lunch meat share of meat expenditures on lunch meats in 2009 was 7.8%, while the share of fixed-weight packaged lunch meats of all fixed-weight meat sales was 26.3%.

For this study, we estimate a demand system of eight lunch meat products and assume them to be weakly separable from each other. Nielsen 2006 Homescan retail data are used to estimate U.S. demand for lunch meats. The 2006 data are used because that is the last year for which Nielsen included the random weight category for meats and poultry products. Other grocery store scanner data do not disaggregate lunch meats using random and fixed weight purchases. From Nielsen Homescan data, a sample of the U.S. population was used in selecting consumers who agreed to scan the Universal Product Code (UPC) of purchased grocery items and to input prices paid for items over a 12-month period. Using the descriptions of the UPC and designated codes for each item, eight lunch meat categories were identified and included in this study: roast beef, ham, chicken breast, turkey, bologna, pepperoni, salami, and other lunch meats (which include pastrami, specialty meats, other cold cuts, coppa, and Canadian bacon). Each household's quantities and prices are reported for all eight products. Expenditures and shares are derived from observed quantities and prices after accounting for any coupons or promotions that were in effect. There are 25,123 households represented in this study, each of which purchased at least one of the eight lunch meat products in 2006. The data for all households were aggregated for

each week, which provided 52 observations for use in the model estimation. Purchases of all eight lunch meats over 52 weeks were then estimated using the AIDS model.

Estimation Results

We estimated parameters for the AIDS-model using what would be Full Information Maximum-Likelihood if the errors were normally distributed. Many of the b and c coefficients were statistically insignificant. We aggressively restricted the model by eliminating insignificant b and c coefficients. (A discussion of the restrictions applied and the results are shown in the Appendix). One of the interesting side effects of restricting the AIDS coefficients was that after these restrictions, the AIDS model estimates were NSD at all the points in the sample. The unrestricted estimates implied that demands were generally not NSD. Those statistically insignificant terms, that should have been 0, were also causing demand equations to violate economic theory.

Sodium Tax Analysis

According to the CDC, American's second largest source of sodium is lunch meats (after bread). Table 1 shows the sodium content of various types of lunch meat products. Based on the Agricultural Research Service online search tool, *"What's in the foods you eat"*, pepperoni has the highest sodium content of all eight lunch meat products. Ham has the second to the highest sodium per serving. The least amount of sodium per serving was found in turkey followed by bologna and chicken breast. The 2010 Dietary Guideline for Americans recommends only about 2,300 milligrams of sodium consumption per day; one serving of pepperoni will account for over 70% of the daily sodium allowanced (Dietary Guidelines for Americans, 2010). This information is useful to retail store managers because it identifies the lunch meats that potentially could be targeted the most due to their high level of sodium per serving.

Table 1. Average sodium found in lunch meat products

Variable	Serving	Milligrams
Quantities (sodium per serving)		
Bologna[1]	1	997
Chicken breast	1	1015
Ham	1	1330
Pepperoni	1	1653
Roast beef	1	1117
Salami[2]	1	1140
Turkey	1	772

Source. USDA-ARS.
[1] Bologna is made of chicken, pork, and beef.
[2] Salami is made of beef.

Our analysis does not include any measure of the benefits of sodium reduction. According to Bibbins-Domingo et al. (2010), a reduction in the mean population sodium consumption by 400 mg is estimated to help prevent about 28,000 deaths and save $7 billion in health care expenditures annually. Since many lunch meats contain a significant percentage of the

recommended daily allowance of sodium, measures to reduce consumption of those with higher sodium content may be considered by policymakers.

For this analysis, we assume that a tax on sodium in lunch meats will have no supply side effects. We assume that the post-tax price of lunch meat will be the pre-tax price plus the sodium tax. This assumption is typical used in studies of this type. The studies we cited on food-tax analysis all use this assumption. This type of relationship will exist as long as the supply of each lunch meat is perfectly elastic. If supplies are not perfectly elastic, then processors will response to the sodium tax by lowering the price of their products. Any supply-side response will mitigate the effects of the tax on consumers. Our measures of welfare losses are an upper bound on the total losses to consumers.

In order to evaluate the effects of sodium taxes on lunch meat consumption, we have to assume some level of taxation. Table 2 shows three different levels of sodium tax, low (1%), medium (5%), and high (25%) used to analyze changes in lunch meats consumption. These three tax rates are set to raise the price of pepperoni by 1%, 5%, and 25%. Pepperoni is both the highest sodium and the highest priced lunch meat. For our analysis, we assume that the "other" lunch meat category has the average sodium of the seven other identified lunch meats. We set our taxes based on the total amount of sodium in each serving of the lunch meat. Thus Pepperoni, with the highest sodium content, also has the highest tax per pound (Table 2), while turkey, with the lowest sodium content, has the lowest.

Table 2. Sodium taxes per pound and as a percentage of the average price

			Sodium tax per pound of lunch meat[3]			**Sodium tax as a percentage of the average price of lunch meat (tax rate)**		
	Average price per Pound[1]	MG sodium per serving[2]	Low	Middle	High	Low	Middle	High
Bologna	$2.646	997	$0.034	$0.170	$0.849	1.3%	6.4%	32.1%
Chicken	$3.495	1,015	$0.035	$0.173	$0.864	1.0%	4.9%	24.7%
Ham	$4.156	1,330	$0.045	$0.226	$1.132	1.1%	5.4%	27.2%
Pepperoni	$5.629	1,653	$0.056	$0.281	$1.407	1.0%	5.0%	25.0%
Roast beef	$4.577	1,117	$0.038	$0.190	$0.951	0.8%	4.2%	20.8%
Salami	$4.031	1,140	$0.039	$0.194	$0.971	1.0%	4.8%	24.1%
Turkey	$3.659	772	$0.026	$0.131	$0.657	0.7%	3.6%	18.0%
Other	$4.274	1,146	$0.039	$0.195	$0.976	0.9%	4.6%	22.8%

[1] Source—average price from Nielsen Homescan® data.
[2] Other lunch meat sodium per serving set to the average value of the seven specific products.
[3] Low, middle, and high taxes were set so as to increase pepperoni prices by 1%, 5%, and 25%.

As shown in Table 2, our taxes are in dollars per pound/sodium per serving. Pepperoni is the saltiest of the eight lunch meats, while turkey has the least amount of sodium per serving. Pepperoni also had the highest average price per pound among all lunch meat products followed by roast beef. The lowest average price per pound of lunch meat was held by bologna. The tax on the non-pepperoni lunch meats is pepperoni's tax times the sodium per serving of the lunch meat divided by pepperoni's sodium per serving. For example, bologna has only 60.3% (997/1653) of the sodium per serving of pepperoni, and thus its tax per pound is 60.3% of the pepperoni tax per

pound. Tax per pound of turkey, having the least amount of sodium per serving, is 46.7% of the pepperoni tax per pound.

Sodium tax per pound of lunch meat is also calculated and presented in Table 2. Ham had the second highest tax per pound at $0.045 (low), $0.226 (middle), and $1.132 (high). The sodium tax per pound of chicken was the second lowest at $0.035 (low), $0.173 (middle), and $0.864 (high). We made the low tax rate increase pepperoni's price by 1%. Thus, the medium and high rates increase pepperoni's price by 5% and 25%, and increase turkey's price by 0.7%, 3.6%, and 18.0%. Bologna has the second lowest sodium of the eight lunch meats and the lowest price. The tax on sodium has a larger percentage effect on bologna price than it does on pepperoni price. The low, medium, and high taxes on bologna are 1.3%, 6.4%, and 32.1% of its average price.

Statistical Properties of the Welfare Estimates

Our analysis of the effects of a sodium tax on lunch meat demands, sodium intake, and economic welfare is based on the AIDS system estimates. These estimates will vary randomly from the actual AIDS parameters. The random errors in the AIDS estimates will cause our welfare analysis to have random errors as well. Our tax impacts are nonlinear functions of the AIDS parameters.

Were the tax effects a linear function of the AIDS estimates, we could easily calculate the mean and variance of the tax effects using the means and variances of the AIDS coefficients. There are no simple functions for turning the randomness of the coefficients into randomness of the tax effects. For example, nonlinearities can and usually do induce bias in our estimates. The tax effects could be generally overstated or understated. It is also possible that the tax-effect estimates have large variances even if the coefficient estimates do not. Large variances imply that our analysis is likely to inaccurate and less useful for setting or evaluating policy. The randomness of our welfare measures means that we cannot be entirely certain about how a sodium tax is going to affect consumer health and economic welfare. We can improve our analysis by explicitly including information on the statistical distribution of the estimated welfare effects.

Previous research has dealt with the issue of nonlinear functions of demand system parameter estimates. Green, Rocke, and Hahn (1987) examined the statistical properties of elasticity estimates. They noted that there are large-sample approximations that allow one to calculate variances for nonlinear functions. They compared these large-sample results to small-sample results—they used bootstrapping to get the small-sample distributions of the nonlinear functions. We decided to use Monte-Carlo analysis.

For the Monte-Carlo analysis, we used the AIDS estimates as if they were the true values of the coefficients. We also used the estimated covariance matrix of the error as the true covariance matrix. We assumed normally distributed errors. We then simulated a new set of error terms for the equations and estimated the AIDS coefficients with the simulated data. The coefficient estimates were stored for later use. We ran 5,000 iterations of the model. We used the 5,000 sets Monte-Carlo coefficients to run our sodium tax analysis and saved those 5,000 sets of results. In

this way, we were able to translate the variations in model estimates into variations in the welfare analysis. Monte-Carlo or other types of numerical analysis can be applied to other problems where econometric estimates are used to evaluate business or public policy.

Sodium Tax Effects

Table 3 shows how the different levels of the sodium tax will affect the demand for the lunch meats and total sodium consumption from lunch meats. We express these effects in terms of the percent change from their baseline values. The columns headed by the term "estimate" are the changes in demand implied by our constrained AIDS model estimates. We also calculated 95% confidence intervals for these estimates using the 5,000 Monte-Carlo iterations.

Table 3. Changes in Consumption as a result of the sodium tax

	Low			**Middle**			**High**		
	95% Confidence Interval			95% Confidence Interval			95% Confidence Interval		
	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper
Bologna	-1.23%	-2.39%	0.03%	-5.86%	-6.96%	-4.67%	-23.71%	-24.65%	-22.74%
Chicken	-1.12%	-3.25%	0.96%	-5.35%	-7.43%	-3.33%	-22.05%	-24.00%	-20.15%
Ham	-1.01%	-3.52%	1.51%	-4.87%	-7.28%	-2.42%	-20.39%	-22.42%	-18.29%
Pepperoni	-0.82%	-3.29%	1.64%	-3.99%	-6.36%	-1.60%	-17.14%	-19.29%	-14.93%
Roast beef	-0.79%	-3.56%	2.01%	-3.84%	-6.50%	-1.13%	-16.65%	-18.92%	-14.29%
Salami	-1.07%	-5.40%	3.11%	-5.14%	-9.36%	-1.13%	-21.32%	-25.04%	-17.77%
Turkey	-0.74%	-2.74%	1.22%	-3.59%	-5.53%	-1.68%	-15.70%	-17.42%	-14.03%
Other	-0.94%	-3.14%	1.27%	-4.54%	-6.66%	-2.40%	-19.21%	-21.06%	-17.38%
Sodium	-1.01%	-1.17%	-0.84%	-4.84%	-5.00%	-4.68%	-20.22%	-20.33%	-20.10%

Data Source. Author calculations based on Nielsen Homescan® data. 95% confidence intervals based on 5,000 Monte Carlo iterations

Our AIDS model estimates imply that a sodium tax will decrease the demands for all eight lunch meats. The higher the tax rate, the lower the demand for each of the lunch meats. Higher taxes also lower sodium consumption from lunch meats (Table 3). At the low tax rate (1%), salt consumption drops by slightly more than 1%. The high tax rate (25%) is associated with a 20% drop in sodium consumption.

According to Table 3, changes in lunch meat consumption resulting from a 1% (low), 5% (middle), and 25% (high) increase in sodium tax, will cause bologna to decline by the most (-1.23%, -5.86%, -23.71%) and turkey by the least (-0.74%, -3.59%, -15.70%). Chicken had the second largest decrease in consumption due to a sodium tax of 1%, 5%, and 25%, followed by salami. Retail store managers may leverage potential impacts of a sodium tax by stocking their deli sections and coolers with more of the lunch meats for which consumption decline the least, namely turkey and roast beef. In addition, media advertisement may be used as a marketing strategy for retail store managers and the food industry to help improve consumers' awareness of the nutritional benefits of eating lunch meats.

Economic theory implies that the demand for a product is driven by its price relative to other product prices. A pure tax on sodium will raise bologna's relative price more than that of other lunch meats. This has the ironic effect of reducing the demand for one of the lowest- sodium lunch meats by more than the reduction in demand for the other lunch meats (Table 3). Because

pepperoni has a higher base price and a lower percentage change in its price due to the tax, its demand shifts less than bologna's under all the tax scenarios. Thus, these empirical findings inform retail store managers of the potential impacts a sodium tax will have on selective lunch meat prices. Given consumers' sensitivity to changes in price, retail store managers will be able to appropriately stock their deli sections and coolers based on projected increases in certain lunch meat prices.

The confidence intervals in Table 3 show that our estimated lunch meat demand shifts may not be that accurate. In the low-tax scenario, the AIDS estimates imply that the demand for all eight lunch meats will decline. However, the confidence intervals for the eight lunch meats in the low-tax scenario include actual increases in demand. Given that the expenditure for lunch meats is fixed, it is impossible to increase the consumption of all eight lunch meats when all eight lunch meats prices increase. An increase in the consumption of one lunch meat product has to be offset by decreases in the consumption of other lunch meats. A surprising outcome of the analysis is that the estimates of the effect of the sodium tax on salt consumption seem more accurate than those for the individual lunch meats.

Table 3 also has estimates of how much the taxes will reduce total lunch meat sodium consumption. These sodium reductions are calculated by comparing the pre-tax demands to the estimated post-tax demands. Our estimates show that the total sodium intake figures are more accurately estimated than the individual lunch meat's consumption changes. At the 95% confidence interval for the low tax, sodium is 1.17 to 0.84%, a range of 0.33%. Bologna is the lunch meat with the tightest confidence intervals. A 1% tax rate will place bologna's confidence interval at a 2.42% wide. The low tax rate reduces sodium consumption by slightly over 1%, while the high tax rate reduces sodium by about 20%.

Table 4 shows the results of our consumer cost analysis. A sodium tax that increases the prices of all lunch meats has the same effect as a reduction in consumer income. We used the estimated AIDS parameters to translate these price increases into income lost. In Table 4, this income loss is expressed as a percentage of the total market expenditure on lunch meats. For example, a 1% sodium tax increase will be equivalent to a 0.99% reduction in consumer expenditure on lunch meats. Likewise, a 25% sodium tax increase will amount to 24.70% less spending on lunch meats. To retail store managers, the implications of these findings translate into lower fixed-weight meat sales, for which lunch meats accounted for over one-fourth of all fixed-weight meat sales in 2009 (Information Resources Inc. and Freshlook Alliances).

Table 4. Economic welfare loss as a percentage of base lunch meat expenditures

		95% Confidence Interval	
Tax rates	Estimate	Lower	Upper
Low	0.99%	0.99%	0.99%
Middle	4.95%	4.94%	4.96%
High	24.70%	24.66%	24.74%

Data Source. Author calculations based on Nielsen Homescan® data. 95% confidence intervals based on 5,000 Monte Carlo iterations.

Because the welfare cost is a complicated, nonlinear function of the AIDS-parameter estimates, we expected that it would have "interesting" statistical properties such as large standard deviations and high bias. However, there was remarkably little variation in the welfare measure. It appears to be the most accurate estimate of all our effects. The confidence intervals for the costs are much narrower (on a percentage basis) than any of our other estimates. This set of econometric estimates does a better job of estimating the public policy impact of a sodium tax than it does the impact of the sodium tax on private companies.

Conclusion and Policy Implications

Although many studies have provided estimates of economic and demographic factors affecting the demand for meat, poultry, and fish, only one has focused on the consumption of specific lunch meat products (Davis et al., 2012). In this study, we analyze retail purchases of eight different lunch meat products: bologna, chicken breast, ham, pepperoni, roast beef, salami, turkey, and "other" lunch meats using Nielsen Homescan data. The objectives of this study are: (1) to measure how a tax on sodium would affect lunch meat demands; (2) measure how these sodium taxes on lunch meats will affect consumers' economic welfare; and (3) measure the accuracy of the tax-effect estimates.

We applied AIDS demand-system to estimate the effects of taxing sodium on lunch meat consumption and consumer costs. Food taxes will raise the prices of food and, consequently, consumers' cost of living. Costs are particularly a concern for consumers, so the regressive nature of food taxes should be kept in mind. The low tax rate raises pepperoni's price by 1%, and decreases lunchmeat-related sodium consumption by more than 1%. The 25% tax rate only decreases sodium from lunch meat consumption by 20%. Our estimates show that the ratios of sodium reduction to consumer costs are better at the lower tax rate. Policymakers may be more interested in sodium consumption effects than the effects on individual lunch meats, and the relative accuracy of the sodium consumption measures would support the use of these estimates for policy analysis.

One of the other objectives was to determine that accuracy of the welfare measures based on the sodium tax on lunch meats. We surprised by the accuracy of the welfare based measures. The 95% confidence intervals for the reduction in sodium consumption were narrower than the confidence intervals for any of the eight lunch meats. At the highest tax rate (25% of the value of peperoni) the width of the sodium tax confidence interval is 0.23%. The narrowest confidence interval for a lunch meat's consumption at the high tax rate is bologna (1.91%). Tax-rate equivalent costs are even more accurately measures. Given the high tax rate, the width of the tax-effect confidence interval is 0.08%.

The cost and benefit effects are invariably based on estimated consumer demands. It would be interesting to see if this type of accuracy holds for other types of welfare analysis. If it does, it will boost our confidence in the advice we provide to policymakers.

An unexpected result of our study is that sodium taxes will, in some cases, reduce the consumption of lower-sodium alternatives by more than the high-sodium ones. Many of the high-sodium lunch meats also have high prices. Sodium taxes will increase the prices of all lunch

meats. High-sodium items would have the largest taxes; however, because of their high initial prices, the percent increase caused by the tax is lower for high sodium items than for low-sodium items.

As noted, we do not include any supply-side effects in our analysis. If processors react to lower demand by cutting their prices, then our estimates will overstate the value of taxing sodium on consumers. Our analysis excludes the effects that these taxes may have on meat-processors and retail stores profits. Sodium taxes will lower the demand for lunch meats. This lower demand can translate into lower processor and retailer profits and less employment. The profits and wages from sales of lunch meats are another part of economic welfare. Lost profits and employment due to sodium taxes are economic costs that need to be balanced against the potential health benefits of reduced sodium consumption. While the supply-side effects may mitigate the effects of sodium taxes on consumers, they do so by transferring costs to the lunch meat producers and marketers.

Processors may react to sodium taxes by changing their lunch meat formulas to include less salt. To the extent that consumers find the low-sodium alternatives just as good as the saltier ones, a reformulation may lead to lower economic losses for both producers and consumers. Evaluating the effects of product-reformulation is outside the scope of this analysis. However, economists have used cost functions or compensating variation to evaluate new products or improvements in old ones. Future work could expand on our analysis to account for these potential reformulation effects.

A reduction in sodium intake is likely to lower the number of people who suffer from strokes and acute myocardial infarctions (Smith-Spangler et al., 2010). A sodium tax will impose costs on those who consume healthy amounts of lunch meats as well as those who over consume. A sodium tax, therefore, addresses the over-consumption problem by taxing even healthy consumption levels. Further, lunch meats are not the only source of sodium in consumers' diets. An evaluation of the effectiveness of sodium taxes would require expanding the scope of foods analyzed.

References

Bibbins-Domingo, K, G.M. Chertow, P.G. Coxson. A. Moran, J.M. Lightwood, M.J. Pletcher, and L. Goldman. 2010. Projected Effect of Dietary Salt Reductions on Future Cardiovascular Disease. *The New England Journal of Medicine* 362(7):590–9.

CDC. Vital Signs: Food Categories Contributing the Most to Sodium Consumption- United States, 2007 – 2008. http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6105a3.htm?s_cid=mm6105a3_w (accessed May7, 2012).

Davis, C.G., D. Dong, W. Hahn, J. Eales, and S. Yen. 2012. Economic and demographic factors affecting U.S. demand for lunch meats. *Food Economics* 9(4):231-240.

Deaton, A., and J. Muellbauer. 1980. An Almost Ideal Demand System. *American Economic Review* 70(3): 312-336.

Fletcher, J.M., D.E. Frisvold, and N. Tefft. 2010. The effects of soft drink taxes on child and adolescent consumption and weight outcomes. *Journal of Public Economics* 94 (11): 967-974.

Godfrey, C. and A. Maynard. 1988. Economic Aspects of Tobacco Use and Taxation Policy. *BMJ* 297(6644): 339–343.

Green, R.D., D. Rocke, and W. Hahn. 1987. Standard Errors for Elasticities: A comparison of Bootstrap and Asymptotic Standard Errors. *Journal of Business and Economic Statistics* 5: 145-150.

Harding, M. and M. Lovenheim. 2012.The Effect of Product and Nutrient-Specific Taxes on Shopping Behavior and nutrition: Evidence from Scanner Data. 9th Conference on Industrial Organization and the Food Processing Industry, Toulouse, June 21-22.

Institute of Alcohol Studies Alcohol and Tax. 2003.St Ives: Institute of Alcohol Studies.

Jacobson, M.F., and K.D. Brownell. 2000. Small Taxes on Soft Drinks and Snack Foods to Promote Health. *American Journal of Public Health* 90(6):854-857.

Kuchler, F., A. Tegene, and J.M. Harris. 2004. Taxing Snack Foods: What to Expect for Diet and Tax Revenues. USDA-ERS Agriculture Information Bulletin No. 747-08.

Mytton, O., A. Gray, M. Rayner, and H. Rutter. 2007. Could Targeted Food Taxes Improve Health? *Journal of Epidemiology and Community Health* 61(8):689-694.

Peters J., S. Preston-Martin , S.J. London, J.D. Bowthan, J.D. Buckley, and D.C. Thomas. 1994. Processed meats and risk of childhood leukemia (California, USA). *Cancer Causes & Control* 5(2): 195-202.

Preston-Martin, S., M.C. Yu, B. Benton, and B.E. Henderson. 1982. N-nitroso Compounds and Childhood brain tumors*:* A Case-control Study. *Cancer Research* 42(12):5240-5245.

Säll, S., and I.Gren. 2012. Green Consumption Taxes on Meat in Sweden. Swedish University of Agricultural Sciences, Department of Economics. Working Paper Series 2012:10. ISSN 1401-4068.

Smith-Spangler, T.A., B. Lin, and J. Lee. 2010. Taxing Caloric Sweetened Beverages: Potential Effects on Beverage Consumption, Calorie Intake, and Obesity. Economic Research Service, U.S. Department of Agriculture. Economic Research Report No. 100. p33.

Townsend, J., P. Roderick, and J. Cooper. 1994. Cigarette Smoking by Socio-Economic Group, Sex and Age: Effects of Price Income and Publicity. *BMJ* 309(6959):923-927.

U.S. Department of Agriculture. Agricultural Research Service. What's in the Foods you eat? http://reedir.arsnet.usda.gov/codesearchwebapp/(sare0effzk5ysxjcivdiz455)/codesearch.aspx (accessed 25 April 2012).

U.S. Department of Agriculture, Agricultural Research Service and U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. What We Eat In America, NHANES 2005–2006. http://www.ars.usda.gov/Services/docs.htm?docid=13793.(accessed September9, 2013).

U.S. Department of Agriculture. U.S. Department of Health and Human Services. Dietary Guideline for Americans 2010. http://www.cnpp.usda.gov/publications/dietaryguidelines/2010/policydoc/policydoc.pdf (Accessed 19 April 2012).

White House Task Force on Childhood Obesity Report to the President (WHTF). Solving the Problem of Childhood Obesity within a Generation. May 2010. (Accessed 16 September 2013). http://www.letsmove.gov/sites/letsmove.gov/files/TaskForce_on_Childhood_Obesity_May2010_FullReport.pdf

Appendix A

Developing the Restricted AIDS Model

As noted above, many of the *b* and *c* coefficients of the freely-estimated AIDS model were statistically insignificant. The free-model estimates were also not negative, semi-definite. We used a double-loop procedure to eliminate coefficients from the model.

We tested the coefficients one at a time. The computer selected the least-significant coefficient and set it to 0 for the following runs. With that least-significant term set to 0, we then retested the remaining coefficients, setting the least significant of coefficients to 0, and so on until we had eliminated all the c_{ij} and b_i from the model. We used likelihood ratio tests to test the coefficients. The asymptotically distribution of the likelihood ratio tests are chi-square. Table A shows the statistically insignificant tests.

Because of the symmetry $c_{ij}=c_{ji}$ we only tested the upper-triangle of the c_{ij}. These two sets of coefficients are also estimated subject to equations (5) and (6). We could have two coefficients go out at the same time when the rest of the terms in their "group" are already 0. For instance, at the 29th step, the c_{ij} for (turkey, ham) and (turkey, pepperoni) both go out at the same time because all the other six (turkey, whatever) c_{ij} are already 0.

We have two measures of statistical significance in Table A: step tests and cumulative tests. The step test shows the effect of dropping that last coefficient on the model's likelihood. These are 1-degree-of-freedom tests. The other is the cumulative test and compares the likelihood with all the terms dropped to date to the free model. The cumulative tests' degrees of freedom are "step." We have 30 insignificant coefficients in Table A, so that the last test has 30 degrees of freedom.

The step-test area has a column labeled Holm–Bonferroni level. The more hypotheses one tests, the more likely one is to see significance levels that are smaller than the 5% level. Statisticians have developed procedures to deal with the problem of multiple hypothesis tests; here, a version of the Holm-Bonferroni procedure is used. In the Holm-Bonferroni method, the tests are arranged from least to most significant. For a 5% significance level, the least significant test is compared to the 5% value, the second least to ½ of 5%, the third to 5% divided by 3, and so on. If the nominal significance level is lower than the Holm-Bonferroni level, one rejects the hypothesis. While not shown in Table A, both the step and cumulative tests are significant in the 31st step.

International Food and Agribusiness Management Review
Volume 17 Special Issue A, 2014

The Effect of Breakfast Cereal Coupons on the Nutritional Quality of Household Purchases

Joshua P. Berning

Assistant Professor, Department of Agricultural and Applied Economics, University of Georgia, 313a Conner Hall, Athens, Georgia, 30602, USA

Abstract

Grocery coupons require consumers to purchase specific products. This can alter a consumer's shopping basket. We examine what effect, if any, coupon use has on the nutritional quality of consumer purchases. We focus on breakfast cereals and evaluate their nutritional quality using fat, fiber, protein, sodium and sugar content. We find cereal purchases made with manufacturer or retailer coupons have greater sodium and sugar content. The change in fat, fiber and protein content are not economically significant. As part of a comprehensive marketing strategy, firms should evaluate how their customers use coupons to manage the cost and nutritional quality of their purchases.

Keywords: grocery coupons, breakfast cereal, nutrition

Corresponding author: Tel: + 1.860.895.7926
Email: J. P. Berning: jberning@uga.edu

Introduction

Given the vast number of products available at grocery stores, it is essential that food manufacturers and retail grocery store chains advertise to retain and attract new customers. For this purpose, Coca-Cola began promoting their product in 1887 with the first known coupons (Geuss 2010). Other food manufacturers followed suit and soon customer coupon use became prolific in the early part of the 20th century, especially during the Great Depression when consumers needed support to survive.

In the late 1990's, coupon use was in decline; however, during the latest economic recession, there was a dramatic increase in their use. In 2006, 2.6 billion coupons were redeemed, reversing a 15-year downward trend (CNN 2008). Their use peaked in 2011 and fell slightly to 2.9 billion coupons redeemed in 2012 (NCH Marketing Services 2013). For a time, coupons were primarily seen in Sunday newspaper ads. Now they are offered via multiple sources including daily papers, direct mail, mobile applications, online websites and directly at retail locations.

Coupons can encourage consumers to purchase items they would not given their budget and preferences. As such, coupons may motivate consumers to purchase more or less healthful products relative to their typical purchases and, knowingly or unknowingly, alter the nutritional content of their diet. Consumers may purchase cereals with better taste profiles, which often have higher levels of sugar or sodium. At the same time, coupons could also allow households to buy cereals with healthier nutritional content. Consequently, there are relevant health considerations pertaining to the tradeoff between price, taste and nutrition.

In addition, coupons play an important role as part of a comprehensive marketing strategy for firms. The interplay between price, taste and nutrition can influence the way firms choose to utilize coupons. Further, differences are likely to be present when comparing coupons provided by manufacturers with those offered by retailers. To date, there has been no research investigating how coupon-induced purchases impact the nutritional content of household purchases.

In this article, we examine the effect of retail and manufacturer coupons on the nutritional content of breakfast cereal purchases made by households, where nutritional content is measured in terms of fat, fiber, protein, sodium and sugar. We focus on breakfast cereals for several reasons. For one, breakfast cereal is regularly consumed in the US and is a popular choice for breakfast among children and adults. Further, breakfast cereal can be an important contributor to mental and physical health (Smith 1999). Finally, breakfast cereal is primarily purchased at retail stores for at home consumption so we can account for the entire basket of breakfast cereal purchases for most households.

For our analysis, we use AC Nielsen household-level purchase data for the greater New York area from 2006-2008, which includes household demographic information and daily household retail purchases of breakfast cereals. This data also identifies whether a coupon was used during purchase, the type of coupon used (retail vs. manufacturer) and the value of the coupon. Using this data, there are several estimation issues that we have to address.

First, unobserved household and market characteristics may effect a household's decision to use coupons and their cereal purchases. As such, the decision to use coupons is endogenous to the household purchase decision. Failing to account for unobserved characteristics would bias estimates of the effect of coupons on purchases. In addition, the effect of coupons on household purchasing behavior is likely to vary across households. Again, such heterogeneity can lead to biased estimates of the effect of coupons.

Another issue is that both household coupon use and cereal purchases are infrequent, resulting in numerous zeros in the data even after aggregating to the monthly level. This could represent infrequent use of coupons and cereal purchases or true corner solutions. In either case, we must control for censored observations for both coupons and cereal purchases.

To address these issues we estimate a two-step model similar to those proposed by Vella (1993) and Vella and Verbeek (1999). In the first stage, we estimate household coupon use using a cross-sectional Tobit model in each period to control for censored coupon use. As coupons come from both manufacturers and retailers, we do this for both types of coupons. From both of these Tobit models, we then calculate the generalized residuals in each period. In the second stage, we estimate the nutritional content of household cereal purchases as a function of coupon use using a random-effects Tobit model to control for censored purchase data. We include the generalized residuals from the first stage to control for endogenous coupon use. In addition, we include the interaction of the generalized residuals and the coupon variables to account for heterogeneous benefits of coupons.

Our results show that coupon use has a significant impact on the nutritional content of breakfast cereals purchased by households. Specifically, we find that cereal purchases made with coupons have higher average sodium and sugar content than purchases made without coupons. The average fat, fiber and protein content are also higher, but the difference is economically insignificant. In addition, we find that manufacturer coupons have a higher marginal impact than retailer coupons. Finally, our results reveal that coupon use is endogenous and has heterogeneous effects on household purchases, indicating that our two-step approach improves estimation by reducing bias.

In our study, it appears that consumers are choosing to redeem manufacturer and retailer coupons for products that are significantly higher in fat, fiber, protein, sodium and sugar. The increases in sodium and sugar are particularly large, which is a concern given their impact on consumer health. It is relevant to note that this is an empirical finding which may not generalize to all other markets. Given the prolific use of coupons by households, however, firms should evaluate how their customers use coupons to manage the cost and nutritional content of their purchases. This can be an important part of a comprehensive marketing strategy to promote products with better nutritional content (Chandon and Wansink 2012).

Motivation

Coupons play an important role in food marketing as they have a dual effect on consumers (Ward and Davis 1978). First, coupons inform and remind consumers about a product, thereby having an advertising effect. Further, coupons offer a price discount as well. Several authors

show that coupons have a positive impact on purchases for numerous food products. Ward and Davis (1978) and Lee and Brown (1985) find that even after accounting for consumer habit persistence, coupons have a positive impact on orange juice purchases. Dong and Kaiser (2005) find coupons impact US cheese purchases and that coupon use varies across ethnic groups. Dong and Leibtag (2010) find with fruit and vegetable purchases that price discounts using coupons have more of an effect than just price discounts, providing support for the dual effect of coupons. Finally, several authors find that coupons can lead to brand-switching as well (Gupta 1988; Neslin et al. 1985; Bawa and Shoemaker 1987).

Hawkes (2009) reviews the effect of sales promotions on food consumption patterns and finds that they tend to encourage consumers to eat more. Looking just at price discounts, however, Mhurchu et al. (2010) find they have no impact on nutrients that households purchase. To our knowledge, however, nobody has explicitly examined how coupons affect the nutritional content of purchases. If coupons affect consumer choices, an important health policy question is whether coupons contribute to a more or less healthful diet. In general, it is assumed that lower prices or excessive advertising for unhealthful foods leads to greater consumption, thereby reducing diet quality. The expected effect of coupons on diet is not as intuitively clear.

Consider that a household buys a basket of consumable goods identified by the vector x_j, with j = 1 to m. Given price vector (p) and income (w), the household will have preferences relative to some other basket of goods such that $x_j(p_j, w) \cdot p_j \geq x_k(p_k, w) \cdot p_k$ where k = 1 to n and at least one element of x_j is different from x_k. Next, assume that coupons are introduced, given by vector c, which affect price vectors p_j and p_k such that the preference ordering changes: $x_j\left(p_j(c), w\right) \cdot p_j \leq x_k\left(p_k(c), w\right) \cdot p_k$. This is not an unusual phenomenon as individuals often alter their purchases because of coupons.

Even one coupon can motivate a household to change multiple items in its basket of goods. Milkman and Beshears (2009) refer to this as a windfall effect. Specifically, they find that households who receive a coupon of value \$ c spend $\$c + \varepsilon$ on their total basket of goods where $\varepsilon > 0$. As such, in this study we consider how a household's entire basket of breakfast cereals changes given the use of at least one breakfast cereal coupon.

Of specific interest in this article is what happens to the nutritional content of household purchases after a coupon is introduced. Nutritional content can be measured in many dimensions, which we naively define using n, which is a vector with elements corresponding to each element in x. The household then purchases the aggregate nutritional content $n'x$. There are two important points to consider. First, there are different baskets of goods that provide similar nutritional content. In addition, household preferences are not necessarily inclusive of nutritional content. That is, households may not consider the nutritional content of the purchases they make.

After introducing coupons, we may observe several outcomes. It may be that $n_j'x_j = n_k'x_k$ so that there is no change in the nutritional content of household purchases when switching from $x_j$to x_k. In fact, a coupon could motivate a household to just purchase more of their usual basket of goods at a lower price. In this case, the household is better off and we would not observe any

change in the nutritional content received by the household. Alternatively, we may find that $n_j{}'x_j > n_k{}'x_k$ (or $n_j{}'x_j < n_k{}'x_k$) so that the nutritional content received from the basket of goods has changed. A change in nutritional content could be more or less healthful depending on the elements of *n.*

A priori, it is not clear how coupons will affect the nutritional content of a household's purchases. If a household is price sensitive, they may be willing to tradeoff better nutritional content for a price discount[1]. For example, a household may purchase a cereal that they know has worse nutritional content if it is cheaper. Alternatively, a coupon may allow a household to purchase a cereal with *better* nutritional content for a lower price. On the other hand, a household may not be concerned with nutritional content and seek only "better" taste, which is often a result of greater amounts of sodium or sugar. A coupon, therefore, may allow a household to purchase a better tasting cereal, with worse nutritional content, for a lower price. Given the different possible ways that coupons can affect a consumer's basket of good, the ultimate change in nutritional content is an empirical question.

Breakfast Cereal Nutrition

Breakfast cereals are regularly consumed in the US and a popular choice for breakfast among children and adults making them a relevant product to study. There is controversy regarding their overall nutritional benefit. After controlling for demographics and lifestyle differences, Smith (1999) found that those who consumed breakfast cereal every day reported better mental and physical health than those who consumed it infrequently. Additionally, cereal encourages complementary consumption of milk, which itself has important health benefits. Some research suggests that even sugar-sweetened cereals are beneficial to healthful diets as they provide important shortfall micronutrients that are often lacking in typical diets (Nicklas, O'Neil, and Myers 2004; Morgan, Zabik and Leveille 1981; Frary, Johnson and Wang 2004)[2].

At the same time, there is concern regarding the nutritional content of breakfast cereals, particularly for children. Harris et al. (2010) find that offering children high-sugar cereals leads to them consuming more total grams of cereal and more grams of sugar in their diet than children offered low-sugar cereal. As such, the nutritional profile of cereals that are consumed by children may have a greater impact on their total diet. Further, they note that the majority of children's cereals fail to meet national nutrition standards and suggest that recommendations of ready-to-eat breakfast cereals should consider their full nutrient profiles.

The purpose of this research is not to evaluate the nutritional content of breakfast cereals in general, as this is not our area of expertise, but to evaluate changes in the nutritional content of household purchases. Previous papers have examined breakfast cereal purchases using composite nutrition scores (Binkley and Golub 2011; Schwartz et al. 2010). This approach relies on

[1] In this context, we consider better and worse nutritional content in an abstract sense. Better nutritional content could mean that a cereal contains more fiber or protein and/or less fat, sodium or sugar. Worse nutritional content would be the opposite. Clearly there could be combinations of these nutrients as well. We discuss how we evaluate each nutrient more in the next section.

[2] Importantly, cereal manufacturers funded several of these studies.

systematically weighting various macro and micronutrients. While composite nutrition scores can be useful, they mask perceptible changes in specific nutrients of interest. With a composite score, a decrease in sugar could be compensated for with an increase in sodium. Consequently, we might not detect any impact of coupons on the nutritional content of cereal purchases using a composite score. Similarly, even if we did detect a change in a composite nutritional score, we would not necessarily be able to identify which nutrient, if any, was driving the change. We choose instead to focus separately on five main macronutrients provided in breakfast cereal: fat, fiber, protein, sodium and sugar[3]. By doing so, we are able to specifically identify how the nutritional content of purchases is changing.

We focus on these five macronutrients for several reasons. For one, these nutrients are clearly identified on nutrition facts panels and thus common information for all consumers. Further, the nutritional content of cereals varies across product category (i.e. children's cereals, adult cereals, etc.) as does the marketing of these cereals. Schwartz et al. (2008) state that cereals marketed to children contain more calories, sugar, and sodium and less fiber and protein per gram than non-children's cereals. Berning, Huang and Rabinowitz (2013) show that cereals advertised to adults tend to have higher levels of sodium and protein, whereas cereals advertised to children have larger amounts of fat and sugar per serving.

Even General Mills identified a "sweetness threshold" which determines cereals they market to children, stating that: "right around nine grams of sugar per serving, you're at the breaking point where the sugar level is so low that the sweetness is not enough for a kid to eat it on day two after trying it on day one" (Jargon 2011). Given the noted relationship of cereal advertising and nutritional content, it seems relevant to also examine the relationship of nutritional content and coupons.

There are also important nutritional considerations regarding these specific nutrients. Dietary fiber and protein are well-studied in the nutrition literature and are shown to provide important health benefits (Marlett 2002; Noakes et al. 2005). In addition, there is growing concern regarding the health effects of excessive sugar and sodium consumption (Johnson et al. 2009; Sacks et al. 2001), which are often abundant in breakfast cereals. As such, these five nutrients provide a relevant description of the nutritional content of household cereal purchases.

It could also be useful to examine the impact of coupon usage on the purchase of specific micronutrients. We choose not to pursue this for two reasons. First, a large majority of breakfast cereals in the US are fortified with vitamins (Harris et al. 2009). As such, it is not clear if there is sufficient variation in micronutrient content. In addition, the data used in this study does not provide complete information regarding micronutrient content. We next discuss the data in more detail.

[3] Binkley and Golub utilize a scoring mechanism that aggregates fat, fiber, protein, sodium and sugar. We examine the same nutrients separately.

Data

In this article, we use household level AC Nielsen data, which includes daily household retail grocery purchases made by households in the greater New York City Designated Marketing Area (DMA) from 2006-2008. For our analysis, we examine households that made breakfast cereal purchases during this time. Households will occasionally leave or enter a geographic region or stop participating with Nielsen altogether. The subtraction or addition of households to the data set shows up each calendar year, rather than at shorter intervals. For each year of data, we include households that make at least one breakfast cereal purchase for the given year. As an example, a household may be included in 2006 and 2007 but excluded in 2008 because they no longer make breakfast cereal purchases in the New York DMA. As such, the panel data set is unbalanced. Breakfast cereal is generally purchased at retail outlets such as grocery stores[4]. Although breakfast cereal purchased at a restaurant is not captured in this data set, we are relatively confident that we observe all of the breakfast cereal purchases for most households .

Our total data set includes 1,442 households that on average make purchases in 19.3 of the total 36 months (Table 1). The average household age (56) reflects the oldest household head, either female or male. The average household has less than one child and teenager. The majority of

Table 1. Data Summary Statistics

Variable	**Mean**	**St. Dev**	**Min**	**Max**
Total Households (count)	1,442			
Observations per HH	19.3	9.97	0	36
Age	56.7	12.4	26	94.0
Children	0.22	0.6	0	5.7
Teens	0.21	0.5	0	3.3
Renting	69%			
Not employed	26%			
Not married	28%			
Household Income				
Group	**Percentage**		**Group**	**Percentage**
Under $5,000	1.0%		$30,000-$34,999	5.7%
$5,000-$7,999	0.6%		$35,000-$39,999	4.8%
$8,000-$9,999	0.7%		$40,000-$44,999	5.4%
$10,000-$11,999	1.4%		$45,000-$49,999	5.7%
$12,000-$14,999	1.7%		$50,000-$59,999	9.4%
$15,000-$19,999	2.9%		$60,000-$69,999	9.3%
$20,000-$24,999	3.5%		$70,000-$99,999	20.9%
$25,000-$29,999	4.5%		$100,000 & Over	22.5%
Highest Education Level				
Grade School	0.3%		Some College	27.8%
Some High School	0.8%		Graduated College	33.4%
Graduated High School	16.04%		Post College Grad	21.6%

[4] Alternatively, with products such as carbonated soft drinks or salty snacks, households make purchases at restaurants and vending machines. Such purchases do not show up in these data sets.

households (69 percent) are renting their homes. About 26 percent of households are currently not employed, which primarily reflects retired households, but also includes a small percentage that report themselves as underemployed. The majority of households are married as well (72 percent). The household income is skewed towards the higher income categories and the highest level of household education for any household head is skewed towards college graduate (33.4 percent).

In addition to household demographics and purchase characteristics, the data also identifies whether households used a coupon for their purchase, the type of coupon used (retailer or manufacturer) and the value of the coupon. Manufacturer coupons are offered by the manufacturer to the consumer via numerous sources and can be redeemed nationwide. Retailer coupons are offered by specific grocery retail chains, which are generally regional, and are redeemable only at those stores. Households use retailer coupons more frequently (3.74 per year) than manufacturer coupons (2.58 per year) and the value of the retailer coupons is almost $0.70 higher than manufacturer coupons (Table 2). Compared with the frequency of purchases in Table 1, it appears that on average, households use coupons for about 32 percent of their purchases (calculated as 6.31/19.3). The average price paid per cereal is $3.24.

Table 2. Summary of coupon use, value and price paid

Variable	Mean	95% Confidence Interval	
Times used per year			
Manufacturer Coupons	2.58	2.54	2.62
Retail Coupons	3.74	3.68	3.80
Any Coupons	6.31	6.24	6.39
Value of coupons used			
Manufacturer Coupons	$1.37	$1.34	$1.39

The AC Nielsen purchase data describes product brand name (or private label name), flavor characteristics and UPC. The data does not, however, provide extensive information on a product's nutritional content. We rely on several sources to match products with a description of their macronutrient (Table 3). The largest single source of data is the USDA Agricultural Research Service's National Nutrient Database (2006-2008). This data is updated annually and contains the nutrient contents of most major brands of cereals. We supplement this data with Nutribase 9 Nutrition and Fitness Software (Personal Addition from www.nutribase.com), which provides detailed nutrition information for various cereal products. We also extract data from the Canadian Nutrient File database provided by Health Canada (2010). Much of the Canadian data is derived from the USDA data, but provides some product information that the USDA does not. After using these data sets, we still have to use online data sources for ~58 percent of the cereals purchased in the New York DMA. Brand label cereals for the largest manufacturers were found using manufacturer websites (General Mills, Kellogg's, Post and Quaker Oats). Less common cereals were found using the websites Calorie Count (caloriecount.about.com) or My Fitness Pal (myfitnesspal.com). If an online source was used, the data was verified with at least two online sources for consistency.

A large number of private label cereals also have online nutrition information available through grocery store websites (47.7 percent). In cases where we cannot find private label nutrition information, we substitute brand name equivalent nutrition information (52.6 percent). For example, with a private label product identified by AC Nielsen as "Bite size shredded wheat (frosted)", we would use Kellogg's brand Bite-Size Frosted Shredded wheat nutrition information. While this is not always a perfect substitute, private label products are often equivalent to their name brand counterparts in terms of ingredients.

Table 3. Breakfast cereal nutrition data sources

	All Cereals	**Brand Names**	**Private Labels**
Data Source	*n = 1081*	*n = 718*	*n = 363*
Online sources	57.8%	63.0%	47.7%
USDA National Nutrient Database (2008)	17.4%	26.2%	0.0%
USDA National Nutrient Database (2006)	15.9%	24.0%	0.0%
USDA National Nutrient Database (2007)	16.6%	24.9%	0.0%
Nutribase 9 Software (personal addition)	7.5%	11.3%	0.0%
Health Canada (2010)	5.5%	8.2%	0.0%
Comparable Cereal	18.5%	1.3%	52.6%

As can be seen in Table 3, cereals were often found in multiple sources, thus the columns sum to greater than 100 percent. Such repetition was used to check for consistency. While it is possible to link the year of the nutrition data with the year our products were purchased, we did not do this[5]. As such, product reformulation is not captured in our data set. At the same time, looking at a few reformulated cereals as an example (but not necessarily in our data set) we find that the macronutrients we are studying do not change dramatically. A sugar-sweetened, low-fiber cereal does not become a low-sugar, high-fiber cereal. There were 15 cereals (four private labels) for which we could not find nutrition information. Three of these cereals were one-time promotional cereals (for example Jerome Bettis' World Championship Crunch) and were purchased with low frequency. The remaining missing data were low-frequency purchases as well.

We normalize each nutrient by serving size (in grams) to allow for comparison and aggregation of different cereals in our analysis. The average serving size for cereals in our data is 31g or approximately 1 ounce. As a reference, we compare the average nutritional content of the cereals in our data set with two popular children's cereals (Table 4). The average cereal in our data set has lower levels of fat than Cheerios and lower levels of sodium than both Cheerios and Frosted Flakes. The fiber, protein and sugar content fall in between these two reference cereals. The sugar content in our data set, however, is seven times greater than that of Cheerios and about 70 percent as much as Frosted Flakes. Clearly, the sugar content is skewed towards the higher end.

[5] Based on verbal communication with the USDA, we find that the nutrition information in their database is not instantly (or even frequently) updated following a product reformulation.

Table 4. Nutritional content of breakfast cereals in data set compared with two popular cereals

Nutrient	Mean	St. Dev	95% Confidence Interval		*Cheerios*	*Frosted Flakes*
Fat (g) per g	0.051	0.051	0.048	0.054	0.071	0.000
Fiber (g) per g	0.074	0.074	0.070	0.078	0.107	0.033
Protein (g) per g	0.085	0.085	0.082	0.088	0.107	0.033
Na (mg) per g	4.244	4.244	4.073	4.416	5.714	4.667
Sugar (g) per g	0.257	0.257	0.249	0.264	0.036	0.367

We compare the demographics characteristics of households that make purchases using any coupon to those that do not (Table 5)[6]. As can be seen, coupon users are in slightly higher income and education levels. Further, they are older, more likely to be married, have fewer children but more teenagers. They are also more likely to be renting and not employed. While all comparisons are statistically significant, the actual differences do not seem economically significant. These results suggest that the households that use coupons are not that different from the households that do not use them.

Table 5. Purchases by household type and coupon use

	Purchase With Coupons				Purchase WithOUT Coupons				
	Mean	St. Dev	95%	CI	Mean	St. Dev	95%	CI	
Income category	21.79		21.66	21.92	21.45	5.76	21.37	21.53	*
Education level	4.63	1.02	4.60	4.65	4.57	1.04	4.55	4.58	*
Age	56.68	12.44	56.38	56.98	56.19	12.48	56.02	46.36	*
Renting	0.78				0.69				**
Not employed	0.26				0.24				**
Not married	0.17				0.22				**
Children	0.26	0.65	0.24	0.27	0.27	0.66	0.26	0.28	*
Teens	0.28	0.60	0.26	0.29	0.25	0.58	0.24	0.26	*

We also compare the types of purchases that are made with and without coupons (Table 6). Purchases with coupons tend to be higher in fat, sodium and sugar, and lower in fat and protein. Again, it is not clear if the difference in nutritional content is economically significant either. Other factors are also likely to impact coupon use, however, which we do not explicitly control for with this comparison. First, prices and income influence product demand and could therefore also influence the nutritional quality of purchases. Older households and households with higher levels of education may make different investments in their health compared with younger or less educated households. Households that are renting, single or not employed may also manage their financial resources differently than those that own a home, are married and employed. The composition of the household will likely influence purchases as well. In particular, households with children or teenagers are likely to have different taste preferences than those without. Finally, this comparison does not differentiate between the two types of coupons, the value of the

[6] For this calculation, households can appear as either a coupon user or a non-coupon user according to how they behave during their shopping trip. That is, in one period a household might be a coupon user whereas they may not be considered a coupon user in the next period.

coupons or the endogeneity of coupon use. We explore all of these issues further in the next section.

Table 6. Nutritional content of purchases with and without coupons

	Purchase With Coupons				Purchase WithOUT Coupons				
	Mean	**St. Dev**	**95%**	**CI**	**Mean**	**St. Dev**	**95%**	**CI**	
Fat (g) per g	0.041	0.021	0.040	0.041	0.039	0.028	0.039	0.040	*
Fiber (g) per g	0.075	0.047	0.074	0.076	0.076	0.056	0.076	0.077	*
Protein (g) per g	0.082	0.027	0.081	0.083	0.085	0.035	0.085	0.086	*
Na (mg) per g	5.374	1.774	5.331	5.417	5.092	2.197	5.062	5.121	*
Sugar (g) per g	0.235	0.108	0.233	0.238	0.231	0.122	0.230	0.233	*

* indicates significant difference between means using t-test at alpha = 0.05

Empirical Approach

The nutritional content of household breakfast cereal purchases is affected by numerous observable and unobservable characteristics. To study the effect of household coupon use on the nutritional content of cereal purchases made by households, while controlling for such factors, we specify the following model:

$$(1)\ NC_{it} = \alpha_i + \mu_i + \beta X_i + \delta_i coupon_{it} + \gamma price_{it} + \varepsilon_{it},$$

where *NC* is the nutritional content of the cereals purchased (measured using fat, fiber, protein, sodium or sugar) by household *i* at month *t, X* is a vector of household characteristics and ε is an idiosyncratic error term. We aggregate household purchases by month so that *coupon* is the real coupon value per ounce and *price* is the real weighted average price per ounce. Manufacturer and retailer coupons are estimated separately, but we describe the empirical model with the *coupon* variable for simplicity. The nutritional content is calculated on a per gram basis, e.g. sugar (g) per gram, and is therefore the weighted average per gram. The weights are based on the net weight of each cereal purchased each month.

The parameters $\alpha_i$and μ_i represent unobservable household and market characteristics. The term α_i is correlated with *coupon* and identifies potential endogeneity. In particular, unobserved household and market characteristics may be correlated with coupon use and purchasing certain types of *NC*. If we do not account for this term, the parameter estimate for coupons will be endogenous. The term μ_i is not correlated with any of the covariates and is essentially a random effect. $\beta$and γ are mean parameters to be estimated.

The effect of coupons on purchases varies according to δ_i, indicating a heterogeneous response to coupons. Coupons will cause some households to drastically change their purchases, whereas others will not. For example, certain households will view coupons as a reason to try a more indulgent cereal with added chocolate while others might seek more healthful cereal with added fiber. For other households, coupons will be a part of their normal shopping routine and have a minimal impact on their brand switching behavior. To account for this heterogeneity, we rewrite equation (1) as:

(2) $NC_{it} = \alpha_i + \mu_i + \beta X_i + (\delta_i - \bar{\delta})coupon_{it} + \bar{\delta}coupon_{it} + \gamma price_{it} + \varepsilon_{it},$

where $\bar{\delta}$ identifies the average effect of coupons on the nutritional content of household purchases. The term $(\delta_i - \bar{\delta})$ represents individual heterogeneity from the mean which will add bias to equation (1) if $(\delta_i - \bar{\delta}) \neq 0$.

To account for the bias identified by α_i, μ_i and $(\delta_i - \bar{\delta})$ we employ a two-stage approach. In the first stage we estimate coupon use as:

(3) $coupon_{it} = \pi X_i + \xi_{it},$

Given that coupon use is censored at zero, we estimate equation (3) using a cross-sectional Tobit model for each period *t* and calculate the generalized residuals for each period, $\hat{\xi}$. We use this to identify the following expectations:

(4) $E[\alpha_i | coupon_i, X_i] = \lambda\hat{\xi}_{it},$

(5) $E[\delta_i - \bar{\delta} | coupon_i, X_i] = \psi\hat{\xi}_{it}$

where $\lambda = \frac{Cov(\alpha_i, coupon_i)}{Var(coupon_i)}$ and $\psi = \frac{Cov(\delta_i, coupon_i)}{Var(coupon_i)}$.

We then insert (4) and (5) into equation (2) to create our final econometric specification:

(6) $NC_{it} = \mu_i + \beta X_i + \lambda\hat{\xi}_{it} + \psi\hat{\xi}_{it}coupon_{it} + \bar{\delta}coupon_{it} + \gamma price_{it} + \varepsilon_{it}.$

Households make infrequent purchases of cereal and even with aggregation we observe zero purchases in our data. As such, we estimate equation (6) using a random effects Tobit model, where μ_i is the random effects term. Using a t-test, we evaluate $\hat{\lambda}$ to determine if coupon use is endogenous. Additionally, we evaluate $\hat{\psi}$ to determine if there is heterogeneous response to coupons. Identification of the model relies on nonlinearity of equation (3) (Heckman and Navarro-Lozano 2004).

With our estimation approach, we are omitting the household's acquisition of coupons and focusing solely on their decision to use coupons. This is largely due to inadequate data regarding the supply of coupons by manufacturers and retailers. Implicitly, this assumes uniform access to coupons across households. Given the ubiquitous nature of coupons in today's market, compared to previous decades when coupons were found in Sunday newspapers, this may not be a heroic assumption. At the same time, a more robust analysis might consider the ability of consumers to acquire coupons. Further, we are ignoring any strategic behavior by firms (retailers and manufacturers) regarding the supply of coupons.

Results

We estimate equation (3) and (6) using the two stage procedure and five different dependent variables: fat (g), fiber (g) per serving, protein (g) per serving, sodium (mg) per serving and sugar (g) per serving. Further, we estimate the standard errors using 100 bootstrap iterations as the standard errors from the second stage Tobit are inefficient.

We first estimate our models with the coupon variables, the generalized residuals and interactions, and a limited number of other covariates including household income, age, and a month indicator to capture seasonal variation. We exclude other demographic variables from the model to focus on the impact of the coupon variables on the nutritional content of purchases. We find that manufacturer and retailer coupons have a significantly positive effect on the purchase of all five nutrients by households (Table 7, rows 1 and 2). The parameter estimate for the generalized residual for both the manufacturer and the retailer coupon are significant across all models (rows 3 and 4). This indicates that certain types of households are more likely to use manufacturer and retailer coupons to purchase cereals with different nutritional content than their typical purchases. The parameter estimate for the manufacturer residual interacted with the coupon variable is significant and negative across all nutrients (row 5). The same is for the retailer residual interacted with the coupon variable (row 6). This indicates that both manufacturer and retailer coupons have heterogeneous effects on purchases of cereals.

The effect of price is small and positive for fat, fiber and protein. This does not indicate a causative effect, i.e. higher prices lead to greater purchases of fiber cereals, but rather a correlation between the two variables. Prices are negatively correlated with sugar. Income has a positive effect on all nutrients except sodium and age has a negative association with fat, sodium and sugar. Finally, the random effects estimate is significant across all models

Table 7. Estimation results from two-stage model with limited covariates

	Dependent Variable				
Variables	**Fat**	**Fiber**	**Protein**	**Sodium**	**Sugar**
Manufacturer coupon	0.00115**	0.00281***	0.00326***	0.219***	0.00772***
Retailer coupon	0.00105***	0.000978*	0.00200***	0.179***	0.00678***
Manufacturer generalized residual	0.0151***	0.0261***	0.0245***	1.635***	0.0741***
Retailer generalized residual	0.0150***	0.0270***	0.0259***	1.679***	0.0756***
Manufacturer residual x coupon	-0.000424***	-0.000695***	-0.000929***	-0.0592***	-0.00224***
Retailer residual x coupon	-0.000383***	-0.000405***	-0.000639***	-0.0442***	-0.00199***
Price per ounce	0.000339***	0.000204***	0.000405***	0.00000692	-0.000214*
Income	0.000229***	0.000459***	0.000460***	0.00872	0.000828**
Age	-0.000196***	0.000037	-0.0000898	-0.0154***	-0.00188***
Month	-0.000189***	-0.000596***	-0.000608***	-0.0237***	-0.00162***
Constant	0.00196	-0.0121*	0.00198	1.715***	0.143***
Sgma u	0.0215***	0.0450***	0.0398***	2.435***	0.120***
Sigma e	0.0374***	0.0705***	0.0645***	3.981***	0.188***
Observations			48,816		
Number of HshldID			1,442		

*** p<0.01, ** p<0.05, * p<0.1

We next estimate the same models including additional demographic variables that may be endogenous to coupon use (Table 8). The impact of the coupon variables is similar across all models, as is the residual and interaction effects. With the newly added demographic variables,

we find that people who rent their homes and are not employed have small or insignificant differences. People who are single purchase less of all the nutrients, whereas having teenage children leads to an increase. Having children contributes to higher levels of fat, sodium, and sugar. This is perhaps not surprising as these cereals will have more favorable taste for children. Interestingly, households with a higher education level purchase less sugar. Overall, it appears that the impact of coupons is fairly robust across these two specifications.

Table 8. Estimation results from two-stage model with additional covariates

	Dependent Variable				
Variables	**Fat**	**Fiber**	**Protein**	**Sodium**	**Sugar**
Manufacturer coupon	0.000951**	0.00259***	0.00304***	0.197***	0.00668***
Retailer coupon	0.000924***	0.000805	0.00183***	0.165***	0.00612***
Manufacturer generalized residual	0.0154***	0.0264***	0.0249***	1.668***	0.0758***
Retailer generalized residual	0.0153***	0.0274***	0.0263***	1.710***	0.0771***
Manufacturer residual x coupon	-0.000397***	-0.000665***	-0.000899***	-0.0564***	-0.00211***
Retailer residual x coupon	-0.000366***	-0.000380***	-0.000614***	-0.0423***	-0.00190***
Price per ounce	0.000346***	0.000212***	0.000413***	0.000809	-0.00018
Income	0.0000328	0.000148	0.000204	-0.00774	0.000216
Age	-0.000149***	0.0000495	-0.0000695	-0.0104*	-0.00149***
Month	-0.000189***	-0.000597***	-0.000608***	-0.0237***	-0.00162***
Constant	0.00225*	0.00403*	0.00189	0.12	0.000315
Sigma u	-0.000164	0.00167	0.000515	-0.0881	-0.00808***
Sigma e	0.00126	0.00384*	0.00294	0.167	0.000909
Observations			48,816		
Number of HshldID			1,442		

*** p<0.01, ** p<0.05, * p<0.1

Implications

While many parameter estimates are statistically significant, a relevant question is what effect coupons might have on actual purchases, i.e. is their impact economically significant? Using our parameter estimates from our base model (Table 7), we calculate the average impact of manufacturer and retailer coupons on the nutritional content of cereal purchased by a household (Table 9). As a baseline, we use a 16.7 oz. box of cereal with a 32 gram serving size and assume a $1.70 coupon value, the average value of both types of coupons in our data set.

The first column reveals the average amount of fat, fiber, protein, sodium and sugar per serving size for cereal in our data (the initial amount per serving). The next column reveals the increase in each nutrient attributable to using a $1.70 manufacturer coupon. The third column reports the total amount of each nutrient that would be purchased with a coupon and the fourth column reports the percentage increase. Columns 5-7 report the same information based on the impact of a retailer coupon.

As can be seen, fat, fiber and protein increase by 29, 40 and 41 percent respectively when a manufacturer coupon is used. Given their low initial values, however, this does not result in a significant change in the actual amount of fat, fiber or protein purchased per serving. Alternatively, the amount of sodium purchased per serving increases by 71 mg, or 43 percent, when a manufacturer coupon is used. Given the general guidelines for maximum daily sodium consumption is 2,000 mg, this is a more significant change for a breakfast cereal.

Table 9. Simulated impact of coupon use on nutritional content of purchases

	Initial amount per serving	Increase from manufacturer coupon	Final amount per serving	% change	Increase from retailer coupon*	Final amount per serving	% change
Fat (g)	1.28	0.37	1.65	29.3%	0.34	1.62	26.8%
Fiber (g)	2.27	0.92	3.18	40.4%	0.32	2.58	14.1%
Protein (g)	2.57	1.06	3.63	41.3%	0.65	3.22	25.4%
Sodium (mg)	167.0	71.34	238.38	42.7%	58.31	225.35	34.9%
Sugar (g)	8.0	2.51	10.52	31.4%	2.21	10.21	27.6%

*The increase is calculated based on an average 16.7 oz. box of cereal, $1.70 coupon

The increase in sugar content per serving (2.51 grams) is statistically and economically significant as well. To put the increase into context, cereal purchased without a manufacturer coupon contains 25 percent sugar per serving. Cereal purchased with a manufacturer coupon contains 33 percent sugar per serving. Given the negative impacts of excessive sugar consumption and the fact that most people eat more than a serving of cereal, this is not a trivial increase. Although there is not a Recommended Daily Allowance of sugar, the American Heart Association recommends ~36 grams per day (9 teaspoons) for men with a 2200 calorie diet and ~20 grams per day (5 teaspoons) for women with an 1800 calorie diet (Johnson et al. 2009). The Institute of Medicine recommends added sugar limited to 25 percent of total kcal or ~ 138 grams for men and ~113grams for women (Accessed at www.IOM.edu on October 20, 2013). While our calculation does not represent household consumption, it is clear that the type of purchases being made with coupons make it more likely that households will consume greater amounts of sugar via their breakfast cereals.

The use of retailer coupons has a lower marginal effect on the nutrients that are purchased compared to manufacturer coupons. The increase in sodium and sugar are both economically significant however, suggesting that retailer coupons also lead to purchases of cereals with less healthful nutritional content.

Discussion

The use of coupons has increased greatly over recent years, particularly during the latest economic recession. Coupons play an important role in the retail environment as they have become widely accessible through many different sources. While there is evidence that coupons affect product choice, there has been no research to date on how coupons affect the quality of the choices made, which has important implications for consumers and firms.

Our preliminary results suggest that coupons do have an impact on the average nutritional content of breakfast cereals purchased by households. In summary, we find that manufacturer and retailer coupons lead to small increases in the purchase of beneficial nutrients like protein and fiber. Alternatively, they also lead to larger increases in potentially detrimental nutrients: fat, sodium and sugar. By focusing on these five nutrients individually, we are able to gain a better idea of how household purchases change given the use of coupons.

An important consideration is why do we observe this behavior by households? The behavior of households in our data set could reflect two different tradeoffs. Households may be giving up

more healthful nutritional content for a lower price. Alternatively, households could be purchasing better taste (via increased sodium and sugar) for a lower price. With our data, it is not clear which behavior is dominant, only that the purchase of sugar and sodium increase with coupon use.

From a firm's perspective, it is important to understand how consumers are using coupons. As healthful cereals are often more expensive, they may prohibit some consumers from purchasing them. Promoting healthful foods using coupons may be an effective way, therefore, to motivate consumers to make better choices. At the same time, if consumers are more concerned with better nutritional content, then large price discounts may not be as important to consumers. In particular, promoting better nutritional content may need to be part of a more comprehensive marketing plan that not only offers price discounts, but also promotes the nutritional content of the cereals.

If consumers are primarily interested in the taste of cereals (with high sodium or sugar) or are more price conscious than nutrition conscious, promoting healthful cereals with coupons may not be as effective of a marketing strategy. Coupon marketing programs such as double coupons or coupon stacking (using manufacturer and retailer coupons at the same time) may be effective marketing tools with consumers that are price sensitive and less concerned about nutritional quality. Some retailers even go so far as to accept other retailer coupons as part of a price match program. From a policy perspective, however, these strategies could have detrimental long-term impacts on household purchase quality.

It is interesting to note the difference in the effect of manufacturer and retailer coupons on purchases made by households. This could reflect a difference in the strategic use of coupons by manufacturers and retailers. Manufacturers often use coupons to promote new products or product lines. As such, a manufacturer coupon is more likely to result in brand switching and, therefore, a greater probability that a household purchases a cereal with different nutritional content from their typical purchase. Alternatively, retailers are more knowledgeable about their customer base and may choose to offer coupons for products that they know will be purchased as maintaining customer loyalty is a priority. Ultimately, what we find is that manufacturers and retailers are using coupons to promote cereals that are higher in sodium and sugar content than the average household purchase. Although firms may also use coupons to promote more healthful cereals as well, their use is minimal as consumers primarily redeem coupons for less healthful cereals.

As cereal is highly consumed in the US, further consideration should be given to how breakfast cereals are marketed using coupons. Firms may be able to help consumers with their search for healthful foods using combined marketing tools such as nutrition labels or displays. Households that are seeking a healthful diet and using coupons for price discounts need to be cognizant of the products they purchase when using coupons.

There are certain limitations to this study that suggest potential future research. For one, we are not able to monitor how household purchases change for all other food items. Although breakfast cereal is often a stand-alone meal, households may alter their purchases of other food products to compensate for changes in their breakfast cereal purchases. In addition, we are neither able to

account for consumption behavior nor track the health impacts of changes in purchase bundles. Over time, it is not clear what the cumulative effect would be. Finally, future studies may benefit from examining how firms strategically offer coupons as part of a comprehensive marketing strategy.

Acknowledgments

This research was supported by USDA Hatch Project #CONS00876. I thank the Food Marketing Policy Center at the University of Connecticut for providing the AC Nielsen purchase data. I also thank Adam Rabinowitz and Hualu Zheng for their help with data and other empirical work. I received helpful feedback from seminar participants at the AAEA/EAAE Joint Symposium "Food Environment: The Effects of Context on Food Choice". I also thank Janice Davidson and Baxter Panola for their useful comments.

References

Bawa, K., and R. Shoemaker. 1987. The Effects of a Direct Mail Coupon on Brand Choice Behavior. *Journal of Marketing Research* (24):370-76.

Berning, J.P., R. Huang and A. Rabinowitz. 2013. An Evaluation of Government and Industry Proposed Restrictions on Television Advertising of Breakfast Cereals to Children. *Journal of Consumer Policy* doi: 10.1007/s10603-013-9233-1.

Binkley, J. K., and A. Golub. 2011. Consumer demand for nutrition versus taste in four major food categories. *Agricultural Economics* 42(1): 65-74.

CNN. 2008. Economic shock gives rise to coupon cutting. http://edition.cnn.com/2008/US/10/09/coupons/index.html. [accessed February 25, 2011].

Chandon, P. and B. Wansink. 2012. Does food marketing need to make us fat? A review and solutions. *Nutrition Reviews* 70(10): 571-593.

Dong, D. and H.M. Kaiser. 2005. Coupon Redemption and Its Effect on Household Cheese Purchases. *American Journal of Agricultural Economics* 87(3): 689-702.

Dong, D. and E. Leibtag. 2010. Promoting Fruit and Vegetable Consumption: Are Coupons More Effective Than Pure Price Discounts? *Economic Research Report* No. 96, U.S. Dept. of Agriculture, Economic Research Service (June).

Frary C.D., R.K. Johnson and M.Q. Wang. 2004. Children and adolescents' choices of foods and beverages high in added sugars are associated with intakes of key nutrients and food groups. *Journal of Adolescent Health* 34:56-63.

Geuss, M. 2010. Coca-Cola and the Birth of the Coupon. *Wired* (November).

Gupta, S. 1988. Impact of Sales Promotion on When, What and How Much to Buy. *Journal of Marketing Research* (25): 342-355.

Harris, J. L., M. B. Schwartz, K. D. Brownell, V. Sarda, M. E. Weinberg, S. Speers, J. Thompson, A. Ustjanauskas, A. Cheyne, and E. Bukofzer. 2009. Cereal FACTS: evaluating the nutrition quality and marketing of children's cereals. Yale University Rudd Center for Food Policy & Obesity.

Harris, J.L., M.B. Schwartz, A. Ustjanauskas, P. Ohri-Vachaspati and K.D. Brownell. 2010. Effects of Serving High-Sugar Cereal on Children's Breakfast-Eating Behavior. *Pediatrics* 127(1): 71-76.

Hawkes, C. 2009. Sales promotions and food consumption. *Nutrition Reviews* 67(6): 333-342.

Heckman, J, and S. Navarro-Lozano. 2004. Using matching, instrumental variables, and control functions to estimate economic choice models. *Review of Economics and Statistics* 86(1): 30-57.

Health Canada, Nutrition Research Division. 2010. *Compilation of Canadian Food Composition Data.* www.hc-sc.gc.ca.

Jargon, J. 2011. Success is only so sweet in remaking cereals. *Wall Street Journal* 11:B1.

Johnson, R. K., L. J. Appel, M. Brands, B. V. Howard, M. Lefevre, R. H. Lustig, F. Sacks, L. M. Steffen, and J. Wylie-Rosett. 2009. Dietary sugars intake and cardiovascular health a scientific statement from the American Heart Association. *Circulation* 120 (11): 1011-1020.

Lee, J. and M. G. Brown. 1985. Coupon Redemption and the Demand for Frozen Concentrated Orange Juice: A Switching Regression Analysis. *American Journal of Agricultural Economics* (August):647-53.

Marlett, J. A., McBurney, M. I., and J.L. Slavin. 2002. Position of the American Dietetic Association: health implications of dietary fiber. *Journal of the American Dietetic Association* 102(7): 993-1000.

Mhurchu, C.N., T. Blakely, Y. Jiang, H.C. Eyles, and A.Rodgers. 2010. Effects of price discounts and tailored nutrition education on supermarket purchases: a randomized controlled trial. *The American Journal of Clinical Nutrition* 91(3): 736-747.

Milkman, K.L. and J. Beshears. 2009. Mental Accounting and Small Windfalls: Evidence from and Online Grocer. *Journal of Economic Behavior and Organization* 71: 384-394.

Morgan K.J., M.E. Zabik and G.A. Leveille. 1981. The role of breakfast in nutrient intake of 5- to 12-year-old children. *American Journal of Clinical Nutrition* 34: 1418-1427.

NCH Marketing Services, Inc. 2013. CPG Coupons: US Market Analysis. 2013 Annual NCH Coupon Facts.

Neslin, S., C. Henderson, and J. Quelch. 1985. Consumer Promotions and the Acceleration of Product Purchases. *Marketing Science* 4(2):147-165.

Noakes, M., J. B. Keogh, P. R. Foster, and P.M. Clifton. 2005. Effect of an energy-restricted, high-protein, low-fat diet relative to a conventional high-carbohydrate, low-fat diet on weight loss, body composition, nutritional status, and markers of cardiovascular health in obese women. *The American Journal of Clinical Nutrition* 81(6): 1298-1306.

Nicklas T.A., C. O'Neil and L. Myers. 2004. The importance of breakfast consumption to nutrition of children, adolescents, and young adults. *Nutrition Today* 39:30-39.

Sacks, F. M., L. P. Svetkey, W. M. Vollmer, L. J. Appel, G. A. Bray, D. Harsha, E. Obarzanek et al. 2001. Effects on Blood Pressure of Reduced Dietary Sodium and the Dietary Approaches to Stop Hypertension (DASH) Diet. *New England Journal of Medicine* 344 (1): 3-10.

Schwartz, M. B., C. Ross, J.L. Harris, D.H. Jernigan, M. Siegel, J. Ostroff, and K.D. Brownell. 2010. Breakfast cereal industry pledges to self-regulate advertising to youth: Will they improve the marketing landscape? *Journal of Public Health Policy* 31(1): 59-73.

Schwartz M.B., L.R.Vartanian, C.M.Wharton and K.D. Brownell. 2008. Examining the Nutritional Quality of Breakfast Cereals Marketed to Children. *Journal of the American Dietetic Association.* 108:702-705.

Smith, A.P. 1999. Breakfast Cereal Consumption and Subjective Reports of Health. *International Journal of Food Sciences and Nutrition* 50: 445-449.

U.S. Department of Agriculture, Agricultural Research Service. 2006. USDA National Nutrient Database for Standard Reference, Release 19. Nutrient Data Laboratory. Online: http://www.ars.usda.gov/ba/bhnrc/ndl.

U.S. Department of Agriculture, Agricultural Research Service. 2007. USDA National Nutrient Database for Standard Reference, Release 20. Nutrient Data Laboratory. Online: http://www.ars.usda.gov/ba/bhnrc/ndl.

U.S. Department of Agriculture, Agricultural Research Service. 2008. USDA National Nutrient Database for Standard Reference, Release 21. Nutrient Data Laboratory. Online: http://www.ars.usda.gov/ba/bhnrc/ndl.

Vella, F. 1993. A Simple Estimator for Simultaneous Models with Censored Endogenous Regressors. *International Economic Review* 34(2): 441-457.

Vella, F. and M. Verbeek. 1999. Two-step estimation of panel data with censored endogenous variables and selection bias. *Journal of Econometrics* 90: 239-263.

Ward, R.W., and J.E. Davis. 1978. A Pooled Cross-Section Time Series Model of Coupon Promotions. *American Journal of Agricultural Economics* 60(3):393-401.

International Food and Agribusiness Management Review
Volume 17 Special Issue A, 2014

Understanding Consumer Preferences for Nutritious Foods: Retailing Strategies in a Food Desert[1]

Dave D. Weatherspoon[Ⓘa], James F. Oehmke[b], Marcus A. Coleman[c] and Lorraine J. Weatherspoon[d]

[a]*Professor, Agricultural, Food and Resource Economics, 213c Justin S. Morrill Hall of Agriculture, 446 West Circle Dr.,, Michigan State University, East Lansing, Michigan, 48824, USA*

[b]*Professor Emeritus, Agricultural, Food and Resource Economics, 202 Justin S. Morrill Hall of Agriculture, 446 West Circle Dr., Michigan State University, East Lansing, Michigan, 48823,USA*

[c]*Dean of Students, Southern University and A&M College, Smith-Brown Memorial Union, Suite 206 500 Jesse Stone Ave., PO Box 13405, Baton Rouge, Louisiana, 70813, USA*

[d]*Associate Professor, Food Science and Human Nutrition, 140 G.M. Trout FSHN Building Michigan State University, East Lansing, Michigan, 48824, USA*

Abstract

Demand and access to affordable, nutritious food are major concerns in food deserts. Primary data from Detroit, Michigan was analyzed to understand demand for fresh fruits and vegetables (FFV) as a proxy for determining the factors that influence healthy food consumption. Logistic analysis showed that those who could not afford FFV, or share food with others had a lower propensity to consume FFV and that consumers who shop frequently, eat healthy, are food secure, or are able to travel to suburban supermarkets had a higher propensity to consume FFV. Recommendations for policy makers and retailer strategies are detailed.

Keywords: food desert, fresh fruit and vegetable consumption, consumer demand

Ⓘ Corresponding author: Tel: + 1.517. 353.9850
Email: D. D. Weatherspoon: Weathe42@msu.edu
J. F. Oehmke: oehmkej@gmail.com
M. A. Coleman: marcus_coleman@subr.edu
L. J. Weatherspoon: weathe43@msu.edu

[1] The authors would like to thank the Morris Chair in State and Local Government Finance and Policy and the John A. Hannah Distinguished Professor in Land Policy at Michigan State University for funding the data collection and analysis for this study.

Introduction

Demand and access to affordable, nutritious food is at the forefront of the food desert problem, a growing concern in the U.S. Food deserts have the peculiar feature that nutritious food is scarce, or, if available, it is usually of low quality and sold at exorbitant prices (Lewis et al. 2005; Moore and Roux 2006) Not having access to nutritious food increases risk for diet-related problems such as obesity and associated co-morbidities or mortality (U.S. Department of Health and Human Services 2001;(Freedman et al. 1999; Glenny et al 1997; Kitzmann and Beech 2006; and Centers for Disease Control 2009a). Cummins and Macintyre (2006) and Diez-Roux, Link and Northridge (2000) found that living in a low-income or deprived area is associated with a poor diet (more specifically high fat, high calorie diets that are low in fruit and vegetables) and the prevalence of morbidities, such as obesity. Chen and Snyder (2009) establish the links from food deserts to malnutrition to obesity to morbidity. Because obesity and co-morbidities have reached epidemic proportions and continue to increase (Flegal et al. 2010) there is "a growing need to develop public health policies and innovative intervention strategies to increase retail availability of fresh fruits and vegetables (FFV) in disadvantaged communities" (Hosler et al. 2008), as well as retail strategies that provide these consumers with affordable and nutritious food choices while providing profits for the entire food supply chain, in particular the retailers. Developing retail strategies for these disadvantaged areas may holistically seem philanthropic in nature (Seelos and Mair 2007), but there is immense symbiotic profit potential in this U.S. market segment.

Bitler and Haider (2010) conclude that most of the literature on U.S. food deserts examine the definitions of food deserts and food access, but none specifically examine why they exist or the direct impact they have on affected populations nor the potential for firms looking for new market opportunities. Specifically, the lack of knowledge about the determinants of demand for nutritious foods among poor, ethnic populations, and populations of color limits the ability of both public- and private-sector interventions to replace unhealthy consumption of high calorie foods with nutritious foods. Consequently, an understanding of the demand for nutritious foods in a food desert is a prerequisite to addressing the impact on poor urban consumers' nutritional status, as well as providing a basis to target the untapped profit potential for food retail firms in these areas.

Selling FFV, as well as other nutritious foods, in a food desert presents a potential new retail opportunity for food retailers. Understanding demand for FFV is the first step in aiding retailers to develop effective food retail strategies for food deserts. The critical issues for retailers are:
1) is there demand for healthier food products in a food desert; 2) what is the best mechanism by which nutritious foods can be offered in a food desert; and 3) will these products be profitable in such a setting? Detroit is selected as a study site because it is arguably one of America's worst food deserts in terms of size and number of people impacted, and the fact that it was ranked the 5th most obese city in 2009 at the time of data collection. The obesity rates in the metropolitan Detroit area continue to grow with over 30% of the population being obese in 2011, equivalent to those of the "fattest state, Mississippi in 2012" (Ruiz 2007; Centers for Disease Control 2009b). FFV consumption has been shown to be associated with healthier weights and positive health outcomes (Ford and Mokdad 2001; Bazzano et al. 2008; He et al. 2004). Investigating these critical issues will aid in understanding the viability of supermarkets, small grocers, non-

governmental organizations and other supply chain entrants in food deserts who wish to market healthier food products.

The objectives of this paper are to: 1) understand the nature of demand for fresh fruit and vegetables in a Detroit, MI food desert area; and 2) determine the factors that influence the consumption of fresh fruit and vegetables. The next section puts Detroit's food desert in context and supports the necessity for primary data collection to fully understand consumer behavior. The data collection and the general trends are subsequently discussed. The method section incorporates the procedures and estimation methods with which the data were analyzed. Regression results and implications are presented next. The last section concludes with implications for policy makers and retailers.

Detroit's Food Desert in Context

Food deserts are environments that do not have the variety of foods that society has come to expect from a flourishing community, primarily because they lack supermarket chains that usually provide quality, affordable, and nutritious food options (e.g. Lewis et al.2005; Moore and Roux 2006). In 2007 it was estimated that Detroit had 500,000 people living in a food desert (Gallagher 2007) with no full-service supermarket chains operating within the 139 square mile city (one national retailer and one regional retailer opened stores within Detroit's city limits in 2013). Most inner-city Detroit residents rely on convenience, liquor, or other non-mainstream grocery stores for food (Gallagher 2007). These "fringe retailers" focus on high-calorie, high-fat and/or salty snack foods and sugary drinks, and are located on average 0.2 miles from the household; mainstream grocers, including small independent grocers, are located two to three times that distance(Gallagher 2007). Low income families are disproportionately impacted by this dire healthy food access situation. In 2007, 92% of Detroit's food stamp retailers were gas stations, liquor stores, party stores, dollar stores, bakeries, pharmacies, convenience stores, and other fringe food retail venues (Gallagher 2007) that offer limited, if any, nutritious food choices.

Traveling to the suburbs to shop at a mainstream supermarket chain has its challenges, which compounds the problem. Detroit has an inadequate public transportation system and many of its residents in the poor areas do not have access to a vehicle. Public transportation in Detroit is limited to a small, light-rail train covering a three mile loop in the downtown area and a limited number of bus routes connecting Detroit with suburban areas (Weatherspoon et al. 2013). From the primary study location in Detroit at the time of data collection in 2009, it took 56 to 66 minutes to reach the nearest Meijer's (a regional supermarket chain that has several hypermarkets in the Detroit metro area) and 72 minutes or more to reach the nearest Wal-Mart Supercenter[2]. Each of these trips requires walking to the bus stop and making a transfer to a second bus, which adds additional travel time and transaction costs (Weatherspoon et al. 2013). For persons suffering from health complications that limit mobility, accessibility to nutritious foods is further compromised.

[2] Google Maps.

During the study period (2009), job loss, economic deterioration, and increases in food prices placed additional stress on already strained household food budgets in Detroit. Sunnucks (2009) and Isidore (2008) show that the Detroit metropolitan area lost over 135,000 jobs. *Forbes* named Detroit as one of the fastest dying cities (Zumbrun 2008). For example, between 2000 and 2008, 111,232 inhabitants fled from the Wayne County, Michigan area with collateral associated job losses of 13,518 (Adelaja et al. 2009). There were also 6,448 new foreclosures in the city between August 2009 and February 2010 (Southeast Michigan Council of Governments). Detroit is comprised of 59 square miles of abandoned buildings and vacant land, an area the size of San Francisco (Gallagher 2009). In addition, many schools in the city were closed, in receivership, and/or have been assigned an emergency manager by the Governor of Michigan. With families having to travel further for work, school, and food, living in Detroit's food desert areas is becoming more expensive from a financial and time perspective.

Piety Hill, the specific study area, is part of the greater Detroit area and is located north of Mid-Town. Weatherspoon et al. (2012, 2013) provide great detail of the area and how the collaborative non-profit grocer originated. U.S. census data shows that the census tract study area lost 35% of its population from 2000 to 2010 (U.S. Census). Piety Hill has a mean income lower than 95.6 % of U.S. neighborhoods and a childhood poverty rate of 38%, higher than 89.9% of U.S. neighborhoods. The poverty rate exceeds 60% for the 18–64-year age-group and the unemployment rate exceeds 34% (Data Driven Detroit 2013). The neighborhood contains numerous abandoned, occupied and/or burnt buildings in various states of disrepair. The Piety Hill community is a predominantly African-American neighborhood (which is representative of the racial demographic of inner-city Detroit), where most of the residents are elderly, low income (median household income is $20,150[3]), and lack personal transportation (which is similar to most of inner-city Detroit). In 2009, Piety Hill was serviced by an independent grocer, one small, non-profit fresh produce retailer (Peaches & Greens, which operates a retail store and a produce truck that services the community), and approximately 27 liquor/convenience stores. Prior to Peaches & Greens opening, this neighborhood depicted the extreme definition of a food desert, where consumers had little access to affordable, quality healthy food products.

It is unclear whether the Piety Hill and broader Detroit food deserts are a consequence of limited demand for nutritious foods, general economic decline, or supermarket chains choosing to abandon the city. The literature does, however, link residence in food desert-like areas to under-consumption of nutritious foods, specifically FFV. Lavin (2005) found a positive association between FFV access and consumption, as well as consumption and access to a variety of nutritious foods in general. Hendrickson, Smith and Eikenberry (2006) show that the absence of quality, affordable food for low-income residents prevents or diminishes the ability to choose foods that help maintain a healthy lifestyle in Minnesota.

Similarly, the literature relevant to retail strategies to improve consumer options in food deserts and supportive public policy is not pellucid. Short, Guthman and Raskin. (2007) argue that small, full service markets, well-dispersed in several low income neighborhoods, can and do provide a

[3] The estimated median household incomes are cited from http://www.city-data.com/zips for 2008. It is important to note that this zip code expands beyond the boundaries of the Piety Hill neighborhood. But given the gap in data, this is the only information available.

wide variety of culturally acceptable foods at relatively low prices, but are cautious about product quality and actual affordability based upon the low-income demographic they may serve. Similarly, Raja Ma, and Yadav (2008) state that policies supporting small, high-quality grocery stores may be a more efficient strategy for ensuring access to and demand for healthful foods in predominately low income, inner-city, minority neighborhoods. Rose et al. (2009) show that living in a food desert essentially raised the cost of access to food, either through higher prices at corner stores, increased consumption of fast foods, or transportation costs to supermarkets. Mobley (2006) shows that the presence of convenience stores is associated with higher obesity rates among low-income women; and that the presence of supermarkets is associated with lower obesity rates. Morland et al. (2002) found that for inner-city African American neighborhoods, FFV intake increased by 32% for each additional supermarket in the area. This small-store option has been embraced by the Obama administration, which funded 632 corner stores in Philadelphia to stock fresh fruits and vegetables, with the intent to help turn a food desert into a food oasis (Kliff 2012).

The question is then; will urban food desert consumers consistently purchase and consume FFV if they have adequate access? The answer for this particular population is not obvious from the literature. The causal relationships between food deserts and under-consumption of nutritious foods are not well understood, despite the clear associations between the two. In particular, it is unclear whether food options are not available in food deserts because residents cannot (for reasons other than access, such as low income) or will not consume nutritious foods, or whether the lack of access to nutritious foods is the primary cause of under-consumption of FFV. Multiple studies have found factors such as price, access, income, education, gender, age and transportation to be significantly related to the consumption of FFV across the U.S. (e.g. Dibsdall et al. 2003; Rose and Richards 2004; Havas et al. 1998; Casagrande et al. 2007; Zenk et al. 2005; Cassady, Jetter and Culp 2007; Powell et al. 2007a; Pearson et al. 2005). In these studies the typical defining characteristics of U.S. urban food desert residents are: low income, low education, and lack of personal transportation, similar to the Detroit inner city scenario for low income citizens. However, few studies examine the direct relationship between access to and demand for nutritious foods, and consumption in food deserts. Part of the insufficient literature comes from the lack of private retail data, and access restrictions on public data such as Supplemental Nutrition Assistance Program (SNAP) data (i.e. the Michigan Department of Human Services does not share SNAP data).

Without private retail and quality public data, it is difficult to understand consumer demand for nutritious foods. This lack of data clouds the judgment of supermarket chains seeking to enter this environment since there are no reliable sources to put into their location models to determine if they should/ should not invest in a food desert area. These areas could represent a growing profitable market opportunity in the U.S. This paper focuses on latent demand approaches to determine consumer preferences for FFV in a food desert setting, to address this knowledge gap. This approach allows for the consideration of barriers to consumption if FFV are readily available. The study results allow both retailers and public policy makers to understand the market potential for healthy food, such as FFV, and establish a basis for the creation of effective strategies/policies to ensure sufficient access to quality nutritious food for urban poor.

Food Desert Survey Data

A survey instrument was designed to gather information on household characteristics, environmental characteristics, food access and affordability, and food consumption patterns. The household characteristic questions included demographic (household size, composition, age, etc.), food storage and preparation ability, tastes and preferences, perception of food consumption adequacy relative to healthy levels, shopping frequency, access and affordability questions related to availability and quality of FFV, transportation options, and income (employment and other). Environmental characteristics included distance to nearest food store, ease of access to respondents' three most preferred stores, perceived safety in travel to the store, ability to store and prepare fruit and vegetables, and access to public transportation, among others. Food access and affordability questions included directly asking about fruit and vegetable affordability, questions relating to reduced fruit and vegetable consumption due to price/income issues, food quality, and use of food assistance (governmental and non-governmental). Food consumption patterns were surveyed by including the fruit and vegetable food frequency component of the National Health and Nutrition Examination Survey instrument (National Health and Nutrition Examination Survey 2012).

Pre-testing of the survey was conducted first with a group of faculty and graduate students at Michigan State University that were familiar with the study area and then with a group of local Central Detroit Christian staff who lived and/or worked in the study area. Pre-testing included a focused discussion to establish face validity with each of the two groups. The survey questionnaire is available from the authors upon request.

The data were collected in November and December of 2009 in the Piety Hill community of Detroit. At this time, Peaches & Greens was still in the start-up phase, just one year old and attempting to figure out how to market FFV to a community that had not had local access to affordable quality FFV for decades. This new concept took time to gain traction in the neighborhood with 90% of the respondents saying that they had never shopped at Peaches & Greens, largely because they did not know of the store.

The survey was administered by trained interviewers to adult participants (individuals over 18 years of age). To assist in data collection efforts, the Central Detroit Christian (CDC) staff coordinated with the authors in organizing several data collection sites, which primarily included their retail location, headquarters, and a local community event they sponsored. Because CDC works with the poor and the local event included food distribution, conducting surveys at these venues likely resulted in a representative sample of the social makeup, but at the lower end of the income spectrum. For example, respondents 'median income from all sources of $500-700/month, put them below median levels of $20,150/year for the local population. There were a total of 161 respondents in the sample population where 85.3% were African American, 76.6% were female, 64% were between 35 and 64 years of age, 94.5% were receiving SNAP benefits (EBT food assistance cards), 56% had consistent access to a vehicle, and 79% had at least one minor living in their household. In comparison, the census tract data showed a composition of 92.3% African Americans, 49.7% females, and 50% were 35 – 64 years of age (Data Driven Detroit 2013).Therefore, the study sample (approximately 10% of the local census tract

population) was older, poorer, had more females and less African Americans. Representative data on fresh fruit and vegetable consumption for Detroit are not available for comparison.

Given the challenges inherent in collecting quality data in an urban food desert, it is also important to note several successful strategies implemented by the authors: 1) partnering with a trusted community organization, 2) data collection in a high foot traffic area, and 3) enlisting recognizable and trusted individuals from the community to legitimize the survey team to the participants. It is critical that respondents trust the stated purpose of the research to facilitate participation. For participation, respondents received a $5 gift certificate for FFV and a full size grocery bag of Michigan red apples from Peaches & Greens.

A summary of the household level data in terms of household and environmental characteristics, and food access and affordability categories are provided in Appendix A. It is notable that in this location 31.1% of the respondents believed that they ate plenty of FFV for a healthy diet. One of the pertinent findings is that almost half of the respondents had difficulty storing FFV at home. The primary reasons for this included the lack of secure storage and/or the facilities to prepare the produce for consumption. The majority of respondents lived and shared food with others: 84.5% of the participants lived with someone else; 80% of those who lived with others lived with their children/grandchildren and shared food with them; 16% of those who lived with others lived with other relatives; and, only 7% of the respondents lived with non-relatives. Two-thirds of the respondents shopped only 2-3 times or less per month where the national average is 1.7 times per week (Food Marketing Institute 2012). Only 23% of the respondents shopped specifically for FFV when they purchased food.

Interestingly, concerns for personal safety when shopping was not a concern for this community. A greater concern was they did not like their local store and 28.1% had transportation issues. The food access variable of distance to their primary store, with a mean distance of 2.55 miles, reinforces that the respondents did not like the offerings of the local grocer closest to their census tract.

Just over half of the respondents found FFV to be too expensive which is not surprising considering the average earnings and total income from all sources reported in see Appendix A. The use of emergency food options such as food banks and church food giveaways were important for food security in this neighborhood. Fifteen percent of the respondents stated they sometimes too often do not get enough food to eat.

Method

A stepwise approach was used to determine the factors that influence FFV consumption behavior. First descriptive analysis of FFV consumption was used, followed by ANOVA of various contributing factors, and then several multivariate regressions were estimated.

Selection of explanatory variables was determined in some cases by the number of non-blank responses received. In particular, significant proportions of respondents chose not to answer questions about income (i.e. 112 provided a total income question response and only 69 reported wage earnings). It was anticipated these would be sensitive questions among low income

populations. Consequently, a two-step approach was used to analyze questions of interest. First, bivariate statistical procedures were used to determine the relationships between food consumption and each of a variety of explanatory variables. For those variables that had a large sample size and were randomly distributed, logistic regression analysis of the dichotomous food consumption variable was used to quantify changes in the likelihood that the respondent would eat FFV approximately every day.

Logistic regression analysis of the dichotomous food consumption variable was performed for several models. There are two reasons for estimating and presenting multiple models. The first is that regression is a parametric technique, and estimated effects can be sensitive to parameterization, including the selection of independent variables. The second is that for some survey datasets, including this one, respondents preferred not to answer all questions as stated earlier (non-response to some questions is typical, e.g. Zenk et al. (2005) found that only 266 of 456 (58%) Detroit survey respondents completed an entire questionnaire related to fruit and vegetable consumption (Rose and Richards 2004). Consequently, including those explanatory variables significantly reduces usable sample size, raising the possibility that estimated coefficients may be sensitive to the subsample used in the regression. By estimating multiple models which include different variables (and therefore different usable sample sizes), the reader can observe the degree to which the estimated effects do or do not depend on model parameterization and variable selection. Estimated effects that are robust across models are typically considered to be reliable estimates.

Results

Table 1 shows the frequency of FFV consumption for 152 of the 161 respondents. The questionnaire included eight positive responses for this question plus “don’t know” and “refused”. Only 7.3% of the respondents come close to meeting the USDA recommended dietary guidelines of 2-3 servings of fruit and 3-5 servings of veggies per day depending on type (U.S.D.A. and U.S.D.H.H.S. 2010). Approximately 28% of this population consumes FFV five or more times per week, but what is of concern is that over a third of this population consumes FFV less than once per week.

Due to small cell counts (five of the eight cells have counts less than 20), a decision was made to create a dichotomous variable taking the value of zero if the respondent consumed FFV four times per week or less and the value one if the respondent consumed FFV 5-6 times per week or more. This decision represents the visual break between the cell counts for cells [2]-[4] and the cell counts for [5] and [6]; it also represents a break between those who usually (5-6 times per week) or always consumed FFV on a daily basis, and those who did not. In subsequent discussion, it is interpreted as representing (with a value=1) those respondents who consumed FFV most (days) or every day.

Table 1. Frequency of Fresh Fruit and Vegetable Consumption

Variable	Frequency Count	Frequency Percentage
Consume fresh fruit and vegetables (152 responses)		
[1] 1 time per month or less	15	9.9
[2] 2-3 times per month	37	24.3
[3] 1-2 times per week	28	18.4
[4] 3-4 times per week	30	19.7
[5] 5-6 times per week	17	11.2
[6] Once or twice per day	14	9.2
[7] 3 to 5 times per day	8	5.3
[8] 6 or more times per day	3	2.0
Consume fresh fruit and vegetables at least 5-6 times per week		
NO (=0)	110	72.4
YES (=1)	42	27.6

A number of potential explanatory variables were difficult to include in the regression analysis because of low numbers of responses. ANOVA was used to ascertain whether the dichotomous FFV consumption variable was randomly distributed across the cells for these categorical variables. The null hypothesis of random distribution was rejected ($p < .10$) for income, average earnings, frequency of access to a vehicle, dislike of fruits and vegetables, and two food security variables (see Table 3), indicating that these variables were correlated with and/or caused FFV consumption. These results are used to help inform the logistic regression model and results.

Table 2. ANOVA of Fresh Fruit & Vegetable Consumption and Limited Response Explanatory Variables

Categorical Variable	ANOVA of daily fresh fruit and vegetable consumption
Income	F = 2.57, P = .0173**
Average earnings	F = 2.66, P = .0234**
Frequency of access to a vehicle	F = 2.38, P = .0548*
Dislike fruits and vegetables	F = 4.43, P = .0369**
Dislike nearby store	F = 0.66, P = .4173
Delayed shopping for any reason	F = 2.71, P = .1019
Food Security (categorical)	F = 4.48, P = .0049***
Food Security (dichotomous)	F=11.96, P = .0007***

*** is significant at the 1% level, ** is significant at the 5% level, * is significant at the 10% level

Five logistic regression models were estimated and reported in Table 3. All models performed well, with Wald $\chi 2$ tests showing the joint significance of the explanatory levels at p-values of .0005 or smaller. The pseudo R2s range from .26 to .61, which demonstrate excellent goodness-of-fit for logistic regression models. Incidence ratios (IRs) and p-values are reported for each variable. The IR show the effect of the variable on the likelihood of consuming FFV most days or every day. An IR of one indicates no effect (an increase in the variable makes the likelihood of consuming FFV one time as likely as with no increase, or exactly the same); an IR less (greater) than one indicates a decrease (increase) in the likelihood of consuming FFV most or every day. Since there is a fair degree of robustness of IRs and inference across models, discussion will focus on the explanatory variables (rather than model selection).

Table 3. Predictors of Fresh Fruit and Vegetable Consumption Logistic Regression Model

	Model 1 n=142	**Model 2 n=116**	**Model 3 n=85**	**Model 4 n=85**	**Model 5 n=82**
Can't afford FFV (0-1)	.434	.326	.412	.092***	
	(.117)	(.156)	(.467)	(.002)	
Difficult storing FFV (0-1)	.271**	.242*	.082*		.061***
	(.019)	(.063)	(.075)		(.004)
Eat plenty FFV for health (0-1)	2.509*	3.038*	3.704	3.917*	3.575
	(.062)	(.061)	(.152)	(.094)	(.156)
Frequency of grocery shopping (categorical)	1.383	1.833***	2.648***	2.338**	2.836***
	(.096)	(.006)	(.009)	(.010)	(.002)
Frequency of shopping specifically for FFV (categorical)	1.306	1.282	2.581***	2.329***	2.827***
	(.202)	(.359)	(.005)	(.001)	(.001
Share food with children (0-1)	.489	.097**	.0071***	.024***	.004***
	(.206)	(.019)	(.000)	(.000)	(.001)
Live with others (count)		.545**	.3810***	.457**	.384**
		(.037)	(.008)	(.042)	(.022)
Distance1to store (continuous)			1.324***	1.221**	1.366***
			(.001)	(.021)	(.007)
Food security (0-1)					5.876*
					(.083)
Log pseudo likelihood	-60.39	-40.54	-21.66	-24.15	-19.12
Wald χ^2	26.12	27.30	30.09	32.87	28.12
Prob > χ^2	.0002	.0003	.0002	.0000	.0005
Pseudo R^2	.2594	.4148	.5793	.5310	.6143

*** is significant at the 1% level, ** is significant at the 5% level, * is significant at the 10% level

The "can't afford" variable IR was statistically significant in model 4 only. However, the IR coefficient was consistently less than one for all five models. In Model 4, the coefficient of .092 indicates that a respondent experiencing difficulty affording FFV is only 9.2% as likely as a respondent not reporting affordability difficulty to consume FFV most or every day. This result supports the ANOVA findings that income and average earnings are significantly related to FFV consumption.

Forty-eight percent of the sampled population stated they had difficulty storing their FFV at home. "Difficult storage" has IR values less than one in all models and is statistically significant in models 1-3 and 5 (it is omitted in model 4). Respondents who have difficulty storing or preparing fruits and vegetables are 6-27% as likely as a respondent not reporting storage or preparation difficulty to consume FFV most or every day.

Thirty-one percent of the respondents believe they eat enough FFV for a healthy diet. From the models they are 2.5 to 3.9 times more likely to consume FFV most or every day. The IR is statistically significant in models 1, 2 and 4.

Frequency of shopping has a positive influence on FFV consumption in all models. The IR is statistically significant in every model ranging from 38% to 184% increase in the likelihood of consuming FFV most or every day. Appendix A shows that two-thirds of the respondents shop less than three times per month, which is significantly below the national average. This is an important consideration for retailer strategies to be profitable in food desert zones.

Sharing food with children has a negative effect on FFV consumption and the measured effect is very large and statistically significant in models 2-5. Respondents who share food with children are only 0.4% to 10% as likely to consume FFV most or every day as are respondents who do not share food with children. It is possible that the adult respondents are ceding their FFV consumption to the children. However, particularly given the income and food-access status of the population, it seems more likely that respondents who share food with children are struggling to keep food on the table and are therefore substituting inexpensive, calorie-dense foods for fruits and vegetables (note that in model 5 this children effect is robust to the inclusion of a food security variable). This is of greater concern if indeed it means that both respondents and associated children are consuming too few FFV for a healthy diet. Unfortunately, the survey does not provide information on children's FFV consumption (e.g. even if the respondent does not consume FFV, children may have some access through school breakfast and lunch programs). Given the importance of childhood diets in determining lifetime healthy eating behaviors (Braveman et al. 2009; Palloni 2006), this finding merits further investigation.

Living with other people has a negative and statistically significant effect. For each additional person in the household, the respondent is only 38-54% as likely to consume FFV most or every day as are respondents who do not live with others. Anecdotal discussion with respondents indicated two potential effects: living with other people meant that food expenditures had to be stretched to cover more people, leading to higher purchases of inexpensive, calorie-dense foods; and living with others (especially extended family or in group homes) meant that others are likely to consume their FFV. Hence, such purchases and consumption are significantly lower.

Distance to the nearest store has a positive and statistically significant effect on FFV consumption. At first glance, this seems counter-intuitive and in contrast with other studies (Rose and Richards 2004) and the notion that distance matters as an accessibility indicator (Rose and Richards 2004; Zenk et al. 2004; Dean and Sharkey 2011; Inagami et al. 2006; and Laraia et al. 2004). However, recall that the sample is taken from a single neighborhood. This implies that the variation in the "Distance" variable comes not from household location but from store selection, with those households shopping at the neighborhood store (with very limited FFV selection) having a low value of "Distance" and those shopping at a large grocery store or supermarket having a high value of "Distance". Hence, this result intuitively indicates that those who are better able to access grocers and supermarkets that carry a selection of FFV (e.g. if they own or have access to a car) are more likely to consume FFV. This is evident in the fact that driving an additional mile to access a better store raises the likelihood of consuming FFV most or every day by 22-37%. This variable is included in models 3-5 and is significant in each. Previous studies have shown that closer proximity to FFV translates into increased consumption (Morland et al. 2002). This finding is key to understanding the potential market size which is calculated below.

Food security (dichotomous), defined as a positive response to we get "enough of the kinds of foods we want to eat", was introduced into the final model as an alternative to affordability of foods. Food secure respondents are nearly six times as likely as food insecure respondents to consume FFV most or every day.

Model 4 deserves additional comment as it addresses the issue of co-linearity between the variables "Can't afford FFV" and "Difficult storing FFV". Model 4 drops the storage variable from Model 3. This induces a large decrease in the estimated IR for "Can't afford FFV", indicating that consumers who cannot afford FFV are less than 10% as likely to consume FFV as those who can afford FFV; and the effect becomes statistically significant (p=.002). The IR estimates for the remaining variables are robust in size, including "Eat plenty of FFV for a healthy diet", which regains statistical significance (p=.094). This indicates that affordability is in fact a primary determination in FFV consumption.

Market Size

According to the Social Compact Incorporation (2008), using 2000 census data, Detroit residents spend an estimated $4.9 billion on retail services annually. Retail leakage was estimated at $1.5 billion, comprising roughly 30% of residents' total expenditures. At that time, a total of 81 full-service grocers captured 69% of Detroit households' grocery expenditures. Grocery leakage was estimated at $200 million and could potentially support an additional 583,000 square feet of additional grocery retail space. Overall retail leakage for full service grocery was estimated as $2.6 million annually with an estimated residential expenditures on groceries of $14.4 million annually for the Middle Woodward Census Block (Piety Hill census tract is included in this census block).

To estimate the potential market size of the census tract where Piety Hill is located, census data, ERS and Data Driven Detroit data were used to complement the model estimations (U.S. Census Bureau 2013; ERS Food Access Research Atlas 2013; Data Driven Detroit 2013). Specifically, census tract level analysis was used to estimate an approximately one mile market radius (contiguous tracts) of those that would consume fresh fruit and vegetables at least 5-6 times per week. Appendix C shows that the John C Lodge Freeway bisects the one mile radius with the Piety Hill tract (26163532400) being on the East side of the John C Lodge Freeway. Hence the estimation of the market size requires three estimations: those without cars within a one mile radius and to the East of the John C Lodge Freeway; those with a car within a one mile radius and to the East of the John C Lodge Freeway; and, those with a car within a one mile radius and to the West of the John C Lodge Freeway. The primary assumption is that without a car most potential customers would not try to cross the John C Lodge Freeway with a bag full of FFV. The potential market size for FFV in this food desert ranges from 5,573 to 6,364 customers (approximately 38% to 43% of the total population in the one mile radius) who will consume vegetables 5 or more times per week (see Appendix B for the calculations).

Powell et al. (2007b) found that 48%, 35%, 92% and 80% of the 4,404 zip codes in their urban sample had at least one available chain supermarket, non-chain supermarket, grocery store and convenience store, respectively. Each zip code had a minimum of 10,000 people. The census tracts considered in the Piety Hill analysis had a total of 14,752 people, which implies that it is

large enough to support a full service chain supermarket among other retailers. However, Powell et. al. (2007b) later show that in predominately African American neighborhoods, full service supermarket chains are present only 41% of that of White urban zip codes and that low income zip codes have significantly fewer full service supermarket chains and more small or independent grocers.

Conclusions

This study found through ANOVA that income, average earnings, frequency of access to a vehicle, dislike of fruits and vegetables, and food security were correlated with and/or increased the likelihood of FFV consumption. Logistic analysis showed that those who could not afford FFV, had difficulty storing FFV, and who shared food with children or others had a lower propensity to consume FFV. Logistic analysis also showed that consumers who shopped frequently, shop specifically for FFV, ate plenty of FFV for health purposes, were food secure, or were able to travel a further distance to shop at suburban supermarkets had a higher propensity to consume FFV.

This study highlights the fact that consumers traveled to grocers specifically to purchase FFV, which indicates that there is (latent) demand for FFV in this food desert even though income and affordability are barriers to the consumption of FFV.

Implications for Policy Makers

The affordability barrier can be addressed in two ways: a) incentivize and encourage low cost healthy food providers to locate in food desert areas through tax incentives, low cost loans, distribution of free refrigerated cases, or other public support to retail outlets (this also addresses the access barrier); and b) provide year-round targeted subsidies to the consumers to increase their consumption of healthy foods. One such example, is the Double-Up Food Bucks[4] program that currently operates only a few months out of the year in Michigan. This program is essentially a voucher program that doubles the value of a dollar up to $20 when applied to purchasing Michigan produce.

The other potential barrier is the food desert residents' lack of knowledge about what comprises a healthy diet. Even if healthy food retailers were present, there would be no guarantee that consumption would increase dramatically in this area. The goal of the Expanded Food and Nutrition Education Program and Supplemental Nutrition Assistance Program-education programs is to teach families how to make economical healthy food choices. These programs may need to be tailored more specifically to this population given the challenges they face in attaining and storing healthy foods. In addition, these programs are not located in every county of the state and the approach to recruiting participants may also need to be adjusted to increase the reach of the programs.

[4] http://www.doubleupfoodbucks.org

Implications for Retailers

Rethinking food supply chains in food deserts may improve how nutritious foods are provided to low income, urban households. This process must account for the improvement of the supply of affordable, healthy foods as well as provide profits for all the supply chain participants in order to be successful. Current food supply chain structures in food deserts are not effective in ensuring sufficient access, nor are the food delivery mechanisms conducive to sustainable practices. Our results show that there is demand for FFV and that consumers' ability to shop frequently increases the probability of FFV consumption.

There are undoubtedly deterrents to FFV purchases outside the control of food retailers. Detroit provides a unique retail environment where inner-city consumers have not had adequate access to fresh and affordable products for decades. Innovative entry and maintenance strategies are needed to make retailers viable in this setting.

One potentially viable strategy would be to create more accessible "one-stop shopping" retail outlets with inexpensive, but quality fresh products for these low income consumers. Capitalizing on SNAP (EBT) transactions as well as unique programs like the Double-Up Food Bucks Program can drive foot traffic to a store. An example of innovative retailing is ShopRite in Philadelphia which has attracted urban food desert consumers to their stores by building stores within food deserts, offering banking services to the previously unbanked, and housing health clinics within the store, where consumers can get nutrition and other health counseling.

Retailers may also consider partnering with local Land Grant University Extension educators to facilitate healthy eating behavior change. Using social and other marketing strategies to enable food desert consumers to recognize the health benefits of consuming more FFV while making purchasing decisions, may aid in increasing consumption rates and could drive profits. This would be especially pertinent when children are in the home, based on this analysis. With income playing a major role in the types of food that make up the diets of food desert consumers, retail pricing and product mix strategies are paramount.

What requires more research is how to increase the frequency of shopping trips per household. The average trips per month are dramatically different from the national average. The timing of the shopping trips for this group may be associated with when their electronics SNAP benefits card has available funds. This could create a flood-drought cycle of customers and make it difficult to manage the perishable food supply chain.

This study also found that lack of food storage and appropriate facilities to prepare food were major constraints for those surveyed. Forty-eight percent of respondents in this study indicated that FFV were difficult to store/prepare at home. These factors were shown to be significant factors in the decision process of customers to purchase FFV or not. We speculate that the types of FFV consumed/purchased are heavily influenced by these same constraints. Understanding this constraint may influence retailers' marketing strategies for the various types of FFV based on storability. Hence, loss leader promotions may be totally different in these types of market areas versus in the suburbs. Using a community-based participatory approach will likely maximize the probability of success.

Given the barriers that these consumers face in purchasing fresh, healthy food products, retail strategies must be developed to entice consumers away from their normal eating habits of calorie dense products, which typically do not provide a healthy lifestyle. Improved access is the first step in this process. The market size calculations suggest that a full service supermarket could be supported in the Piety Hill area if FFV of good quality and at reasonable prices were available to consumers, particularly since 50% of the respondents did not like their local grocer and traveled on average 2.55 miles to what they considered their primary food retailer.

Limitations

This study has several limitations that should be noted. The primary survey instrument was based on recall, introducing a possible source of error. Another limiting factor is that while the study area has similar demographic characteristics to much of inner-city Detroit, cross-neighborhood comparisons in Detroit were not directly accounted for. Therefore, generalizations or predictions for the City of Detroit as a whole as well as other food deserts in the U.S. are limited.

References

Adelaja, S.,Y. Hailu and A. Gibson. 2009. *The Economic Impacts of County Population Change in Michigan*. Land Policy Institute. Michigan State University.

Bazzano, L.A. et al. 2008. Intake of fruit, vegetables, and fruit juices and risk of diabetes in women. Diabetes Care 31(7): 1311-1317.

Bitler, M. and S.J. Haider. 2010. An Economic View of Food Deserts in the United States. *Journal of Policy Analysis and Management* 30(1):153-176.

Braveman, P. and C. Barclay. 2009. Health disparities beginning in childhood: a life-course perspective. *Pediatrics* 124(Supplement 3): S163-S175.

Casagrande, S.S. et al. 2007. Have Americans increased their fruit and vegetable intake? The trends between 1988 and 2002. *American Journal of Preventive Medicine* 32(4): 257-263.

Cassady, D., K.M. Jetter and J. Culp. 2007. Is price a barrier to eating more fruits and vegetables for low-income families? *Journal of the American Dietetic Association* 107(11): 1909-1915.

Centers for Disease Control. 2009a. Study Estimates Cost of Obesity May be as High as $147 Billion Annually. (accessed July 12, 2013). http://www.cdc.gov/media/pressrel/2009/r090727.htm.

Centers for Disease Control. (2009b). SMART: BRFSS City and County Data.(accessed October 15, 2013). http://apps.nccd.cdc.gov/BRFSS-SMART/.

Centers for Disease Control, National Health and Nutrition Examination Survey. (accessed November 13, 2013). http://www.cdc.gov/nchs/nhanes/nhanes_questionnaires.htm.

Chen, S., R. Florax, S.D. Snyder. 2009. Obesity in urban Food Markets: Evidence from Georeferenced Micro Data presented atAgricultural and Applied Economics Association Annual Meeting. July. Milwaukee, Wisconsin.

Cummins, S. and S. Macintyre. 2006. Food environments and obesity - neighbourhood or nation? I*nternational Journal of Epidemiology* 35(1):100-104.

Data Driven Detroit. 2013. (accessed November 14, 2013) www.datadrivendetroit.org

Dean, W.R. and J.R. Sharkey. 2011. Food insecurity, social capital and perceived personal disparity in a predominantly rural region of Texas: an individual-level analysis. *Social Science & Medicine* 72(9): 1454-1462.

Dibsdall, L.A. et al. 2003. Low-income consumers' attitudes and behaviour towards access, availability and motivation to eat fruit and vegetables. *Public Health Nutrition* 6(2):159-68.

Diez-Roux, A.V., B.G. Link and M.E. Northridge. 2000. A multilevel analysis of income inequality and cardiovascular disease risk factors. *Social Science & Medicine* 50(5): 673-687.

Double up Food Bucks Program. (accessed November 14, 2013). http://www.doubleupfoodbucks.org

ERS Food Access Research Atlas. (accessed November 1, 2013). http://www.ers.usda.gov/data-products/food-accessresearch-atlas.aspx.

Flegal, K.M. et al. 2010. Prevalence and Trends in Obesity Among US Adults, 1999-2008. *Jama-Journal of the American Medical Association* 303(3): 235-241.

Food Marketing Institute. 2012 . Supermarket Facts 2012. (accessed November 15, 2013) http://www.fmi.org/research-resources/supermarket-facts

Ford, E.S. and A.H. Mokdad. 2001. Fruit and vegetable consumption and diabetes mellitus incidence among US adults. *Preventive Medicine* 32(1):33-39.

Freedman, D.S. et al. 1999. The relation of overweight to cardiovascular risk factors among children and adolescents: The Bogalusa heart study. *Pediatrics* 103(6):1175-1182.

Gallagher, M. 2007. *Examining the Impact of Food Deserts on Public Health in Detroit*. Mari Gallagher Research & Consulting Group: Chicago. http://www.marigallagher.com/projects/

Gallagher, M. 2009. *Chicago 2009 Food Desert Progress Report*. Mari Gallagher Research and Consulting Group. http://www.marigallagher.com/projects/

Glenny, A.M. et al. 1997. The treatment and prevention of obesity: A systematic review of the literature. *International Journal of Obesity*.21(9):715-737.

Havas, S. et al. 1998. Factors associated with fruit and vegetable consumption among women participating in WIC. *Journal of the American Dietetic Association* 98(10): 1141-1148.

He, K. et al. 2004. Changes in intake of fruits and vegetables in relation to risk of obesity and weight gain among middle-aged women. *International Journal of Obesity* 28(12): 1569-1574.

Hendrickson, D., C. Smith and N. Eikenberry. 2006. Fruit and vegetable access in four low-income food deserts communities in Minnesota. *Agriculture and Human Values* 23(3): 371-383.

Hosler, A.S. et al. 2008. Assessing retail fruit and vegetable availability in urban and rural underserved communities. *Preventing Chronic Disease* 5(4):A123.

Inagami, S. et al. 2006.You are where you shop: grocery store locations, weight, and neighborhoods. *American Journal of Preventive Medicine* 31(1): 10-17.

Isidore, C. *Michigan's Economic Woes on the Ballot*. 2008. CNN Money. (accessed November 12, 2010). http://money.cnn.com/2008/01/15/news/economy/michigan_ economy_election/index.htm.

Kitzmann, K.M. and B.M. Beech. 2006. Family-based interventions for pediatric obesity: methodological and conceptual challenges from family psychology. *Journal of Family Psychology* 20(2):175-89.

Kliff, S. 2012 Will Philadelphia's experiment in eradicating 'food deserts' work? The Washington Post (Blog), June 8. http://www.washingtonpost.com/blogs/wonkblog/post/will-philadelphias-experiment-in-eradicating-food-deserts-work/2012/06/08/gJQAU9snNV_blog.html.

Laraia, B.A. et al. 2004. Proximity of supermarkets is positively associated with diet quality index for pregnancy. *Preventive Medicine* 39(5): 869-875.

Lavin, M. 2005. Supermarket access and consumer well-being. *International Journal of Retail & Distribution Management.* 33(5): 388-398.

Lewis, L.B. et al. 2005. African Americans' access to healthy food options in South Los Angeles restaurants. *American Journal of Public Health* 95(4): 668-73.

Mobley, L.R. et al. 2006. Environment, obesity, and cardiovascular disease risk in low-income women. *American Journal of Preventive Medicine* 30(4): 327-332.

Moore, L.V. and A.V.D. Roux. 2006 Associations of neighborhood characteristics with the location and type of food stores. *American Journal of Public Health* 96(2): 325-331.

Morland, K., et al. 2002. Neighborhood characteristics associated with the location of food stores and food service places. *American Journal of Preventive Medicine* 22(1): 23-29.

Palloni, A. 2006. Reproducing inequalities: Luck, wallets, and the enduring effects of childhood health. *Demography* 43(4):587-615.

Pearson, T. et al. 2005. Do 'food deserts' influence fruit and vegetable consumption? - a cross-sectional study. *Appetite* 45(2): 195-197.

Powell, L.M. et al. 2007a. Access to fast food and food prices: relationship with fruit and vegetable consumption and overweight among adolescents. *Advances in Health Economics and Health Services Research* 17: 23-48.

Powell, L.M. et al. 2007b. Food store availability and neighborhood characteristics in the United States. *Preventive Medicine* 44(3):189-195.

Raja, S., C.X. Ma, and P. Yadav. 2008. Beyond food deserts - Measuring and mapping racial disparities in neighborhood food environments. *Journal of Planning Education and Research* 27(4): 469-482.

Rose, D. and R. Richards. 2004. Food store access and household fruit and vegetable use among participants in the US Food Stamp Program. *Public Health Nutrition* **7**(8):1081-1088.

Rose, D. et. al. 2009. Deserts in New Orleans? Illustrations of Urban Food Access and Implications for Policy. University of Michigan National Poverty Center /USDA Economic Research Service Research, Understanding the Economic Concepts and Characteristics of Food Access Conference. Washington, D.C. http://www.npc.umich.edu/news/events/food-access/rose_et_al.pdf.

Ruiz, R. 2007 America's Most Obese Cities. Forbes. (accessed August 12, 2010). http://www.forbes.com/2007/11/14/health-obesity-cities-forbeslife-cx_rr_1114obese.html.

Seelos, C. and J. Mair. 2007. Profitable business models and market creation in the context of deep poverty: A strategic view. *Academy of Management Perspectives* 21(4): 49-63.

Short, A., J. Guthman and S. Raskin. 2007. Food deserts, oases, or mirages? Small markets and community food security in the San Francisco bay area. *Journal of Planning Education and Research* 26(3): 352-364.

Social Compact Inc. *Detroit Grocery Initiative Catalyzing Grocery Retail Investment in Inner-City Neighborhoods*. 2008. (accessed November 18, 2013). http://www.socialcompact.org/

Southeast Michigan Council of Governments. 2011. Southeast Michigan Community Foreclosures, 2010. (accessed November, 2013). http://library.semcog.org/InmagicGenie/DocumentFolder/ForeclosureQuickFacts2-22-11.pdf

Sunnucks, M. 2009. Phoenix, Detroit post worst job losses among large markets. *Phoenix Business Journal* (accessed November 10, 2010. http://www.bizjournals.com/phoenix/stories/2009/04/27/daily36.html.

U.S. Census Bureau. 2010. United States Census 2010. (accessed November 1, 2013). http://www.census.gov/2010census/

U.S. Department of Health and Human Services. 2001. The Surgeon General's Call to Action to Prevent and Decrease Overweight and Obesity. Rockville, MD, Public Health Service, Office of the Surgeon General.

U.S. Department of Agriculture and U.S. Department of Health and Human Services. 2010. *Dietary Guidelines for Americans.* 7th Edition, Washington, DC: U.S. Government Printing Office, December. http://www.cnpp.usda.gov/DGAs2010-PolicyDocument.htm

Weatherspoon, D. et al. 2013. Price and Expenditure Elasticities for Fresh Fruits in an Urban Food Desert. *Urban Studies* 50(1): 88-106.

Weatherspoon, D. et al. 2012. Will Long Term Food Desert Consumers Purchase Fresh Fruits and Vegetables? *Choices* 27(3):1-5.

Zenk, S.N. et al. 2005. Fruit and vegetable intake in African Americans - Income and store characteristics. *American Journal of Preventive Medicine* 29(1):1-9.

Zumbrun, J. 2008. America's Fastest-Dying Cities. *Forbes* (accessed November 12, 2010). http://www.forbes.com/2008/08/04/economy-ohio-michigan-biz_cx_jz_0805dying.html.

Appendix A.

Household Descriptive Statistics

Variable	Count (pct.)
Household Characteristics	
Eat plenty FFV for health (0-1) (n=161)	50 (31.1%)
Difficult storing FFV (0-1) (n=161)	77 (47.8%)
Number of people in household you share food with (n=131)	
1	22 (16.8%)
2	31 (23.7%)
3	24 (18.3%)
4	22 (16.8%)
5+	32 (24.4%)
Share food with children (0-1) (n=161)	110 (68.3%)
Frequency of grocery shopping (n=148)	4 (2.7%)
Never	34 (23.0%)
Once a month or less	61 (41.2%)
2 or 3 times a month	16 (10.8%)
Once a week	20 (13.5%)
2 or 3 times a week	9 (6.1%)
4 or 5 times a week	4 (2.7%)
Daily	
Frequency of shopping specifically for FFV (n=147)	
Never	12 (8.2%)
Only on special occasions	20 (13.6%)
Only on special sales	12 (8.2%)
Occasionally	43 (29.2%)
Usually	26 (17.7%)
Every time or almost every time I buy food	34 (23.1%)
Environmental Characteristics	
Safety concerns (0-1) (n=96)	1 (1.0%)
Problems with shopping at local store (0-1) (n=96)	48 (50.0%)
Transportation issues (0-1) (n=92)	27 (28.1%)
Food Access & Affordability	
Can't afford FFV (0-1) (n=161)	90 (55.9%)
Average earnings (n=69)	
Less than $8/hour	16 (23.2%)
At least $8/hour but less than $10/hour	13 (18.8%)
At least $10/hour but less than $13/hour	11 (15.9%)
At least $13/hour but less than $17/hour	8 (11.6%)
At least $17/hour but less than $25/hour	2 (2.9%)
$25/hour or more	4 (5.8%)
Other	15 (21.7%)

Household Descriptive Statistics
Food Access & Affordability-*Continued*

Variable	**Count (pct.)**
Income from all sources (n=112)	
Less than $250/month	16 (4.3%)
At least $250/month but less than $500/month	25 (22.3%)
At least $500/month but less than $750/month	29 (25.9%)
At least $750/month but less than $1000/month	8 (7.1%)
At least $1000/month but less than $1500/month	18 (16.1%)
At least $1500/month but less than $2000/month	5 (4.5%)
At least $2000/month but less than $3000/month	5 (4.5%)
$3000/month or more	6 (5.4%)
Use of emergency food options (n=156)	65 (41.7%)
Food security (n=146)	
Enough of the kinds of food we want to eat	80 (54.8%)
Enough but not always the kinds of food we want	43 (29.4%)
Sometimes not enough to eat	20 (13.7%)
Often not enough to eat	3 (2.0%)

	Mean	*Std. Dev.*	*Min.*	*Max.*
Distance to primary store in miles (n=114)	2.55	3.21	0.1	15.8

Appendix B.

Potential Market Size Calculation

1. Those without cars within a 1 mile radius and to the East of the John C Lodge Freeway Market Size without transportation = (frequency of FFV consumption rate from the survey, table 2) X East Side of the John C Lodge Freeway Population (census tracts 26163511400, 26163534300, 26163532300, 26163532400, 26163533900.
   27.6% X 9215 = 2543 people
   The total potential walking population is 2543.

2. Those with a car within a 1 mile radius and to the East of the John C Lodge Freeway Market Size With Transportation, East Side = (frequency of FFV consumption rate from the survey, table 2) X East Side of the John C Lodge Freeway Population (census tracts 26163511400, 26163534300, 26163532300, 26163532400, 26163533900) X Percent of the population who has transportation X the effect on those that now have a store closer to them (logistic regressions 3-5 Distance Variable, this parameter is squared because the Distance sample mean was 2.55 miles to the nearest supermarket and now the store would be within a half mile of this population).
   2543 X .5 X 1.22^2 = 1893
   2543 X .5 X 1.37^2 = 2387

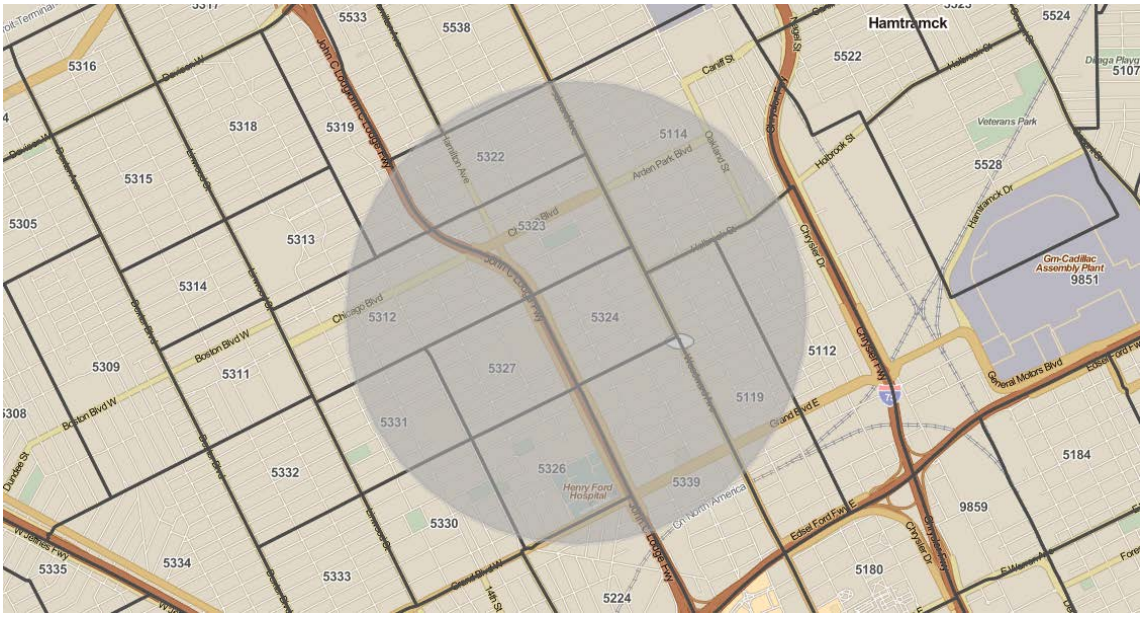
The total additional population that has transportation on the East side is from 1551 to 1742 potential customers.

3. Those with a car within a mile radius and to the West of the John C Lodge Freeway
   The difference with this calculation is that we only consider those that have transportation for those that live West of the John C Lodge Freeway. This highway is a major barrier and would require the potential customer to walk to a cross road and then to the store.

4. Market Size With Transportation, West Side = (frequency of FFV consumption rate from the survey, table 2) X West Side of the John C Lodge Freeway Population (census tracts 26163532700, 26163532600, 26163531200) X Percent of the population who has transportation X the effect on those that now have a store closer to them (logistic regressions 3-5 Distance Variable, this parameter is squared because the Distance sample mean was 2.55 miles to the nearest supermarket and now the store would be within a half mile of this population).
   27.6% X 5537 X .5 X 1.22^2 = 1137
   27.6% X 5537 X .5 X 1.37^2 = 1434
   The total additional population that has transportation on the West side is from 1137 to customers.
   The potential market size for FFV in this food desert ranges from 5573 to 6364 for customers that will consume vegetables 5 or more times per week.

Appendix C.

One Mile Radius Piety Hill Market Size with Census Tracts



International Food and Agribusiness Management Review
Volume 17 Special Issue A, 2014

Consumer Response to Negative Information on Meat Consumption in Germany

Anette Cordts[a], Sina Nitzko[ⓘb], and Achim Spiller[c]

[a] *Researcher, Georg-August-University of Goettingen, Department of Agricultural Economics and Rural Development, Platz der Goettinger Sieben 5, Goettingen, 37073, Germany*

[b] *Post Doctorate, Georg-August-University of Goettingen, Department of Agricultural Economics and Rural Development, Platz der Goettinger Sieben 5, Goettingen, 37073, Germany*

[c] *Professor, Georg-August-University of Goettingen, Department of Agricultural Economics and Rural Development, Platz der Goettinger Sieben 5, Goettingen, 37073, Germany*

Abstract

Evidence from several studies suggests that the growing demand for meat consumption has negative effects on the sustainability of the environment and the health and psychological welfare of individuals. This study investigates whether media coverage of certain negative attributes of meat consumption can potentially affect demand for meat in a western European country. Using Germany as a case study, 690 survey participants were each given one of four different fictitious "newspaper articles" describing negative effects of meat consumption – either in terms of adverse effects on human health, on climate change, on animal welfare or on personal image. The analyses show that animal welfare and health arguments have the strongest effects at reducing meat consumption in both men and women. Based on the results, we discuss implications of our findings for the meat industry in Germany.

Keywords: meat consumption, information, gender

ⓘCorresponding author: Tel: +49.551.39.4833
Email: A. Cordts: anette.cordts@agr.uni-goettingen.de
S. Nitzko: snitzko@uni-goettingen.de
A. Spiller: a.spiller@agr.uni-goettingen.de

Introduction

Meat and meat products are an important component in the daily diet of a large proportion of society, especially in industrialized countries. However, in most of these countries, meat consumption exceeds the amount recommended by health institutions like the World Cancer Research Fund (WCRF/AICR 2007). Much of the environmental- and health-related literature has argued that the growing demand for and production of meat have negative implications for the individual and society. In light of these adverse consequences, scientists (e.g., Dagevos & Voordouw 2013, Reisch et al. 2013) as well as government institutions (e.g., in Germany: Scientific Advisory Board for Agricultural Policy at the German Federal Ministry of Food, Agriculture and Consumer Protection, WBA 2012) are advocating for policies aimed at motivating consumers to reduce their meat intake. This requires the detailed understanding of the underlying motives for meat consumption. The present empirical study aims to determine the effect of information on the negative attributes of meat consumption on demand for meat in Germany, with the focus on four particular attributes: animal welfare, human health, personal image and climate change. For the meat industry, knowledge about consumer reactions to negative information about meat consumption, which may be presented in the media, is relevant from a strategic marketing perspective in order to be able to develop appropriate strategies regarding e.g. product policy or public relations.

In the following, we describe the possible adverse consequences of meat consumption in more detail and focus on important motives for eating meat. Furthermore, gender is discussed as an important socio-demographic determinant of meat consumption and related attitudes. We identify consumer information as an appropriate political instrument to reduce meat consumption, forming the basis for the framing experiment with fictional "newspaper articles" on meat consumption. After presenting and discussing our empirical results, we finally derive recommendations for the meat industry.

Background

Negative Consequences of Meat Consumption

From a nutritional perspective, meat can be regarded as a valuable food that provides important vitamins and minerals in the diet and constitutes the major protein source in the Western diet. However, a diet rich in meat also has potential negative effects due to, e.g., its high content of cholesterol and saturated fatty acids (Rohrmann et al. 2013; Singh et al. 2003; WCRF/AICR 2007). In recent decades, the demand for meat has increased significantly in industrialized countries, including Germany (DGE 2012; Rohrmann et al. 2013). Therefore, the per capita consumption of meat exceeds the recommendations of health and nutritional organizations. Because of the lack of general recommendations, the suggested consumption amounts differ between institutions (e.g., DGE 2011; WCRF/AICR 2007). For instance, the World Cancer Research Fund recommends consuming less than 500 g red meat per week and minimizing the consumption of processed meat (WCRF/AICR 2007, 382), whilst the German Nutrition Society recommends a maximum of 300 to 600 g of meat and sausages per week, regardless of the type of meat (DGE 2011). In contrast, the results of the German National Nutrition Survey II (MRI

2008, 44) show that women consume on average 581g and men 1120g meat (including sausages and meat-based products) per week, which is nearly twice as much as the recommended allowance.

Regarding adverse health consequences, the consumption of red and processed meat is, in comparison to white meat, especially problematic (Micha et al. 2010; McAfee et al. 2010). Empirical studies have shown an association between increased consumption of (processed and/or red) meat and a higher risk of developing coronary heart diseases (Micha et al. 2010; Pan et al. 2012; Rohrmann et al. 2013), type 2 diabetes (Aune et al. 2009; Micha et al. 2010) and different types of cancer (Chao et al. 2005; Pan et al. 2012; Rohrmann et al. 2013). Furthermore, empirical results show a positive association between the degree of obesity and the amount of meat consumed independent of dietary patterns, total energy intake, physical activity, smoking, sex, education and other potential confounders (Vergnaud et al. 2010; Wang & Beydoun 2009). Overall the authors of two comprehensive cohort studies conducted in Europe (Rohrmann et al. 2013) and in the U.S. (Pan et al. 2012) conclude that individuals with a high consumption of red (Pan et al. 2012) or processed (Rohrmann et al. 2013) meat carry an increased risk of early death, adjusted for smoking, alcohol consumption, obesity, physical activity and other potential confounders. For the German population, meat consumption has been shown to be positively correlated with the consumption of many other "unhealthy" food products, i.e., when meat consumption increases, the consumption of beer, soft drinks, sweets, butter, oil, sauces, bread and other food products, as well as overall calorie intake, also increases (Cordts et al. 2014). The fact that meat dishes in Germany are often served with fatty sauces or fried potatoes and are additionally energy-dense due to the preparation methods of the meat component (e.g., frying or roasting in fat), suggests that a reduction of meat consumption leads to an overall reduced energy intake, which is consistent with results obtained by Carvalho et al. (2012) and Wang and Beydoun (2009).

Meat consumption behavior can also affect the image of a person. Whereas in the first half of the 20th century vegetarians suffered from a distinctly negative image (Ruby 2012), nowadays the popular perception of meat eating has changed in many Western societies. There is increasing evidence from consumer surveys that a large proportion of consumers from different countries (e.g., Canada, USA, Netherlands, Norway) are reducing their meat consumption (Ruby 2012; Dagevos & Voordouw 2013). Although meat still has a dominant position in most contemporary food cultures (Dagevos & Voordouw 2013), it is now broadly accepted that meat no longer represents a symbol of wealth in today's industrial societies. This is supported by the inverse relationship between meat consumption and social class now observed in many industrial countries (Ruby 2012), including Germany and the U.S. (MRI 2008, 61; Gossard & York 2003). Going into more detail, Gossard and York (2003) found education and occupational status being negative predictors of the amount of meat consumed in the U.S., while income had no effect on total meat consumption. In the representative German National Nutrition Survey II, people from the upper social class (captured as an aggregate index variable including education, occupational status and income (MRI 2008, 9)) eat significantly less meat compared to the other groups (MRI 2008). On an individual level, meat consumption can affect the perceived attractiveness of a person, as some studies about the influence of meat consumption on body odor suggest (Potts & Parry 2010; Havlicek & Lenochova 2006). According to Havlicek and Lenochova (2010), the body odor of male university students was rated to be significantly more attractive and pleasant

after a two-week period of a non-meat diet compared to a diet rich in red meat over the same period.

Alongside the above-mentioned, considerable individual consequences of high meat consumption, there are also social and global consequences. Various studies have found that consumption behavior can contribute to climate change. High levels of consumption of animal products are associated with a clear negative effect on an individual's carbon footprint. Due to energy losses along the food chain, animal products cause more greenhouse gas emissions than the equivalent calories provided by plant products (McMichael et al. 2007), and beef is particularly problematic in this respect (Carlsson-Knyama & González 2009). Hence, it has been suggested that a diet lower in animal products is better for the climate and additionally has a less negative effect on the environment as a whole (McMichael et al. 2007).

The intense competition and productivity drive in the meat sector in industrial countries has contributed to the fact that various animal welfare aspects have been neglected in favor of economic considerations (Lusk & Norwood 2011). Modern animal production systems are economically optimized, but increasing societal demands for animal welfare and ethical animal husbandry methods are, partly due to financial pressures, insufficiently met. The availability of inexpensive and safe meat is now no longer sufficient for some consumers (Deimel et al. 2010). This has developed against a background of increasing alienation of the public from farming practices, whereby livestock are increasingly perceived as equivalent to pets (Kayser et al. 2012). In addition, studies from the field of animal ethology have shown considerable emotional and cognitive competencies of livestock species, emphasizing the importance of animal welfare aspects (Franz et al. 2012).

Non-economic Determinants of Meat Consumption

To understand consumer behavior concerning meat, we need to take a closer look at the underlying motives for consumption or avoidance of meat. Besides ethical, psychological, economic, cultural and ecological aspects, medical and nutritional factors can play an important role (Richardson et al. 1994). Because of their importance in this empirical study, four motives will be explained more in detail: (1) health consciousness, (2) animal welfare considerations, (3) awareness of climate effects and (3) perceived effects on personal image.

Increasing awareness of potential negative health consequences associated with meat consumption has been shown to lead to a reduction in the consumed amount of meat, according to the results of multiple linear regression analyses on the determinants of meat consumption (e.g., Guenther et al. 2005; Lea & Worsley 2001).

Furthermore, the knowledge about negative consequences of the production of meat on animal welfare influences attitudes towards meat. As Grunert (2006) showed, animal welfare considerations can be seen as a lifestyle-trend with substantial impact on meat consumption. Consumers concerned with environmental sustainability prefer meat from animal friendly production (Harper & Henson 2001), and critical attitudes towards animal welfare are associated with a reduction of meat consumption (de Boer et al. 2007).

In terms of climate and environment, empirical studies indicate a negative association between environmental awareness or, more generally, universal values (e.g., the beliefs that people should protect the environment and care for social justice) and meat consumption (Cordts et al. 2014; de Boer et al. 2007). Wandel and Bugge (1997) also showed the influence of environmental and climate-related attitudes on meat consumption. However, McCarthy et al. (2004) found no effect of environmental concerns on attitudes toward meat, therefore it seems the empirical findings are inconsistent in this area.

So far, there has been a lack of empirical results concerning associations between meat consumption and personal image. However, meat is no longer a symbol of welfare in industrialized countries. Instead, meat consumption is inversely associated with the level of education, as was shown e.g. for the population of 10 European countries (Vergnaud et al. 2010) and overall social class (MRI 2008).

Gender-Specific Aspects of Meat Consumption

Besides other socio-demographic aspects like income and ethnicity, gender has an important influence on meat consumption (Beardsworth & Bryman 2004; Gossard & York 2003; Guenther et al. 2005). In general, females show a higher degree of health consciousness than males (Fagerli & Wandel 1999). Furthermore, women are characterized by a healthier lifestyle (von Bothmer & Fridlund 2005), which can be seen in different areas, e.g. nutrition. Thus, females eat more "healthy" food, like fruit and vegetables (Wardle et al. 2004).

Regarding meat consumption, women are more often vegetarians (Kalof et al. 1999) and men overall consume a greater amount of meat than women (Vergnaud et al. 2010; de Boer et al. 2007; Gossard & York 2003; Guenther et al. 2005; Leahy et al. 2011; MRI 2008; Praettaelae et al. 2007). Moreover, women prefer white meat, whereas men eat more red and processed meat, which is associated with negative health consequences (Cosgrove et al. 2005; Kubberød et al. 2002).

Beyond this, empirical studies show gender-specific patterns concerning the motives for meat consumption. In women, difficulties and health concerns associated with vegetarianism (e.g., lack of iron) were the most important positive predictors, and universal values were negative determinants of meat consumption, whereas for meat consumption in men the number of vegetarian friends was the most important predictor (Lea & Worsley 2001). Women also report a higher environmental benefit of a more plant-based diet (Tobler et al. 2011). In general, a gender-specific approach appears necessary when undertaking attempts to influence individual meat consumption (cf. Lea & Worsley 2001).

Consumer Information as an Instrument to Reduce Meat Consumption

Given the negative consequences that are linked to high levels of meat consumption, there are increasing calls for state interventions to reduce meat consumption and to promote the consumption of meat of higher quality in industrialized countries (e.g., in Germany: Scientific Advisory Board for Agricultural Policy at the German Federal Ministry of Food, Agriculture and Consumer Protection, WBA 2011, 2012). State interventions to reduce meat consumption can be

implemented at different levels. We can distinguish between consumer information (information/ social marketing), financial incentives (taxes) and regulatory measures (prohibitions, requirements) (see Figure 1, Tänzler et al. 2005) with an increasing depth of intervention in market processes from consumer information to regulatory measures.

The present study focuses on consumer information as a political instrument to reduce meat consumption that is characterized by a low depth of intervention in market processes (Ahlheim 2011). We concentrate on consumer information because given the political climate in Germany, it is more likely that the German government would implement consumer information policies rather than consumption taxes on meat (Ahlheim 2011; Dagevos & Voordow 2013), especially after the withdrawal of the Danish fat tax (Alemanno & Carreno 2013; Jensen & Smed 2013). Furthermore, the implementation of such policies, including e.g., awareness-raising campaigns about the diverse negative effects of meat consumption, is considered as an important precondition for building consumer acceptance of more invasive measures (Dagevos & Voordow 2013).

Consumer Information		**Financial Incentives**	**Regulatory Measures**	
Information / Social Marketing	**Labeling**	**Taxes**	**Requirements**	**Prohibitions**
▪ Information campaigns ▪ Programs for behavior modification	▪ Climate label ▪ Warning labels	▪ "Fat tax" ▪ Meat tax ▪ Subsidies for meat substitutes	▪ Obligatory veggie-days in public catering	▪ Ceilings for meat portions
Increasing depth of interventions in market processes →				

Figure 1. Overview: Demand Management Policy Measures and Examples (adapted from Cordts et al. 2013a).

However, there have as yet been no studies on how information about negative attributes of meat consumption would affect demand for meat. Furthermore, the importance of gender has largely been neglected. Against this background, the present study analyzes the effect of information pertaining to the negative attributes of meat consumption on meat demand using a gender-specific approach. Focusing on four types of information regarding the negative effects of meat consumption on human health, climate, personal image or animal welfare, we investigate which kind of information has the largest effect on male and female consumers in Germany.

Methods

Sample Description and Survey

This study is based on data collected in a quantitative online survey carried out in January 2013. A sample of 590 consumers was recruited through a professional panel provider using a standardized questionnaire. The aim was to obtain a representative sample of the German population regarding basic socio-demographic characteristics. For sex, income, and region of residence the obtained sample is well matched to official statistics of the German population, with differences from the

overall population data amounting to less than four per cent. In contrast, for age and education, there are substantial deviations from official statistics on the population in Germany, with middle-aged people between 40 and 59 years being overrepresented and people aged 60 and above being underrepresented. Regarding school education, participants with a university entrance qualification are overrepresented and the share of less educated people is lower than in the overall population. With regard to household size, the most obvious deviation from the German population as a whole is the relatively small number of single households (see Table 1). These discrepancies might be due to the fact that older people, who more often possess lower school leaving certificates and more often live in single households compared to the overall German population (Statistisches Bundesamt 2012, 52, 78), tend to be underrepresented in online panels.

Table 1. Socio-demographic Characteristics of Respondents (n = 590) Compared to the Population in Germany as a Whole (Overall Population Data from 2010 and 2011).

Variable	Respondents (%)	Population in Germany (%)
Sex		
Female	48.1	49.1
Male	51.9	50.9
Age (years)[1]		
18-24	5.3	9.8
25-39	26.1	21.6
40-59	52.3	37.2
60 +	16.3	31.4
Net household income (USD/month)		
0 - 1,212	12.2	13.1
1,213 - 2,020	22.8	23.6
2,021 - 3,503	32.2	32.4
3,504 - 6,065	26.6	23.0
6,066 and above	6.1	7.9
Education		
Advanced school-leaving certificate[3]	47.1	29.0
Intermediate school-leaving certificate[4]	38.4	31.3
Lower secondary school-leaving certificate[5]	13.3	39.5
Household size		
1 person	27.6	40
2 persons	39.6	34
3 persons or more	32.8	25
Region		
North	15.6	16.1
South	30.3	28.6
East	17.5	19.9
West	36.3	35.4

Source. Statistisches Bundesamt 2012, p. 26 (sex), p. 31 (age), p 51 (household size), p 78 (education); Statistisches Bundesamt 2011, p. 47 (income); Statistische Ämter des Bundes und der Länder 2011 (region). [1]For age groups, the percentages in the Statistical Yearbook were given for ages beginning from under one year; since our sample does not include children we converted the percentages of the age groups from the Statistical Yearbook assigning 100 % to the population aged 18 or older. [2] The original data was given in Euros per month, which was converted into USD per month using the conversion factor 1.00 EUR = 1.34821 USD. [3](Fach-)Abitur. [4]Realschulabschluss/ Polytechnische Oberschule or similar. [5]Volks-/Hauptschulabschluss.

Besides socio-demographic characteristics, questions on topics including health behavior and consumption of meat and other food products were posed and attitudes were recorded using a 5-point Likert scale. Related to meat consumption, respondents were asked if they generally consume meat and if so, how frequently. Furthermore, meat consumers were asked about their beliefs about their own meat consumption in future ("Do you believe that you will in the future eat more, less or approximately the same amount of meat?").

In a subsequent experimental framing design, each respondent was randomly given one of four different fictional results (on animal welfare, human health, personal image and climate change) of a scientific investigation, reporting the negative effects of meat consumption. The reports were structured as newspaper articles and identical apart from the argumentation (framing) used (see Appendix).

After the presentation of the information, the respondents were asked to rate on a 5-point scale (1 = *"I don't agree at all"* to 5 = *"I completely agree"*) to what extent they found the study results concerning and how credible they find such media reports. Those respondents who had stated that they consume meat were also asked if, and to what extent, they base their eating behavior on such results. The question related to meat consumption in the future was then posed again.

Data Analysis

To obtain a general overview about the differences between men and women regarding meat consumption, health-related lifestyle choices and attitudes towards food, independent samples t-tests were conducted using SPSS 21.

Taking average mean values of the variables related to the content of the four different "newspaper articles", respondents' overall reaction was analyzed for the whole sample and, additionally, differences between men and women were tested with independent samples t-tests. To analyze differences in the respondents' answers as a reaction to the contents of the frames, chi-square statistics and as post-hoc multiple mean comparison tests were carried out (Bonferroni when homogeneity of variance could not be assumed according to the results of Levene tests, and Games-Howell in the case of homogenous variances, cf. Field 2009, 347ff.).[1] The analyses were conducted for the whole sample and separately for men and women. To check whether potential differences in respondents' reaction to the "newspaper articles" might be due to differences in the socio-demographic structures of the four subgroups, we compared the percentages of men and women, average age, income group, education level and region of residence as stated in Table 1 using mean comparisons and Chi-squared tests. Since no significant differences were found, with error probabilities being in most cases far above the 10 % level (the lowest error probability was 18 % for sex), we can assume that the results

[1]Additionally, we conducted a multiple linear regression with the "level of concern" ("I find the results of the study worrying") as dependent variable and the "newspaper articles" (as dummy variables that were coded with 0 for "read" and 1 for "not read") and socio-demographic characteristics as independent variables. Since this did not lead to additional information (e.g., the socio-demographic variables were not significant), we have not documented the results in this paper.

concerning the reactions of the four subgroups of respondents to each of the four articles are not influenced by differences in the socio-demographic structure of the sample subgroups.

Results

The vast majority of the study participants eat meat (95.8 % of the female and 96.1 % of the male respondents). Further analysis of meat consumption habits and related attitudes reveals substantial differences between men and women. Although men on average state a higher frequency of meat and sausage consumption in the last seven days, women more often believe that they eat more meat and sausages compared to other persons of the same sex. The gender specific results for questions related to health aspects show a similar pattern, with a slightly higher BMI in men and, at the same time, women being less satisfied with their body weight. However, no differences between the sexes can be observed in the rating of the state of overall personal health (see Table 2).

Table 2. Meat Consumption and Health-related Aspects in Men and Women

	All Responders (n = 590)	**Men (n =306)**	**Women (n = 284)**	
Variable	**Arithmetic Mean (s.d.)**			**t-test[6]**
Meat consumption frequency[1]***	9.41 (5.21)	10.30 (4.96)	8.46 (5.32)	t(564) = 4.25
Perceived amount of meat consumption compared to other persons[2]***	2.82 (1.00)	3.06 (0.89)	2.57 (1.04)	t(525.77) = 5.94
Body mass index (kg/m^2)[3]*	26.47 (5.42)	26.93 (5.49)	25.95 (5.31)	t(505) = 2.04
Subjective perception of body weight[4]**	6.16 (1.47)	5.98 (1.47)	6.35 (1.44)	t(572) = -3.10
Subjective perception of health state[5ns]	2.32 (0.82)	2.37 (0.86)	2.27 (0.77)	t(575.82) = 1.47

[1]Index ranged from 0 to 21 times in which meat was consumed within the last seven days, based on three questions answered by 294 men (m) and 272 women (w) who stated before to generally eat meat: "How often did you eat meat or sausages within the last seven days for breakfast?"/ "...lunch?"/ "...evening meal". Only meat consumers were asked the following question: "Comparing yourself to other people of the same sex, would you say you eat the same amount, less or more meat and sausages than other people?", scale from 1 = "very much more" to 5= "very much less", n = 288 m and 267 w. [3]n = 265 m and 242 w.[4]"I find my body weight...", scale from 1 = "much too low" to 9 = "much too high", n = 297 m and 277 w. [5]"My general state of health is...", scale from 1 = very good to 5 = very bad, n = 302 m and 276 w. [6]The independent samples t-test was used to test significant differences between men and women; * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$, [ns] $p > .05$

Besides consumption behavior, attitudes related to meat consumption also differ between men and women, with men questioning the production and consumption of meat to a lesser extent than women. Overall, women perceive possible motivations for reducing meat consumption (positive effects for animal welfare, environment and personal health) as more important than men, whereas men attach a higher importance to possible barriers (meat consumption as habitualized behavior, meat as an indispensable element of a balanced nutrition and a negative image of vegetarianism) to a reduction of meat consumption compared to women.

Despite these differences, there are also similarities regarding the relative importance of the different aspects: Whereas image-related considerations ("Eating meat is unfashionable") are of comparatively low importance for both sexes (9.7 % of the male respondents and 11.8 % of the

female respondents "agree" or "fully agree" to this statement), a large proportion of participants are worried about health-related issues (68.9 % of men and 76.4 % of women "agree" or "fully agree" to the statement that "Antibiotics in meat are a threat to my health"). With regard to animal welfare, 37.1 % of male respondents and 48.9 % of female respondents say they feel sorry for the farm animals, and 29.6 % of male respondents and 36.5 % of female respondents also "agree" or "fully agree" that animal husbandry and the production of animal products place a large pressure on the environment (cf. Table 3).

Table 3. Barriers to and Motivations for Reducing Meat Consumption in Men and Women

	All Responders (n = 590)	**Men (n = 306)**	**Women (n = 284)**	
Item	**Arithmetic mean (s.d.)**			**t-test[2]**
"I see no need to eat (even) less meat."[1]***	3.36 (1.23)	3.55 (1.13)	3.14 (1.30)	t(561) = 3.95
"To me, a proper meal requires meat."[1]***	2.87 (1.19)	3.14 (1.11)	2.58 (1.20)	t(572.78) = 5.82
"Eating meat is unfashionable."[1]**	2.08 (1.10)	1.94 (1.08)	2.22 (1.10)	t(578) = -3.08
"My friends would look at me strangely if I would eat a vegetarian meal." [1]***	2.27 (1.26)	2.55 (1.31)	1.96 (1.13)	t(584.19) = 5.90
"Farm animals experience fear and suffering." [1]***	3.34 (1.15)	3.17 (1.14)	3.52 (1.14)	t(587) = -3.73
"I feel sorry for farm animals." [1]***	3.39 (1.16)	3.16 (1.18)	3.63 (1.09)	t(584) = -4.92
"Meat is indispensable for a balanced diet."[1]***	3.31 (1.09)	3.52 (1.03)	3.08 (1.11)	t(588) = 5.02
"Antibiotics in meat are a threat to my health."[1]***	4.02 (1.01)	3.87 (1.02)	4.17 (0.98)	t(584) = -3.62
"Farming animals and producing animal products (e.g., milk or meat) has a considerable negative environmental impact."[1]**	3.07 (1.12)	2.95 (1.12)	3.19 (1.11)	t(584) = -2.58
"A vegetarian diet is more environmentally friendly than a diet including meat."[1]*	3.10 (1.21)	2.98 (1.21)	3.23 (1.19)	t(588) = -2.54

n = 293 men and 270 women for the item with the smallest number of respondents. [1]Scale from 1 = "do not agree at all" to 5 = "fully agree". [2] The independent samples t-test was used to test significant differences between men and women; * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$

Bearing in mind the general characteristics of men and women related to meat consumption, we now focus on the gender-specific and overall impact of the fictional "newspaper articles" as an element of possible information campaigns – in the first instance disregarding potential differences due to the four different themes of the articles (Table 4). Overall, the level of concern after having read the "newspaper articles" reaches mean values around three (= "neutral), with

women expressing slightly higher levels of concern than men. Accordingly, statements about skepticism regarding a change in individual meat consumption ("I don't make my eating habits dependent on the results of some study" and "I don't think that my eating habits will really change") have mean values around 3.7 (men) and 3.5/3.4 (women) and range between the answering categories "neutral" and "agree" with a tendency towards "agree" in male participants. The overall degree of mistrust related to the given information from the "newspaper articles" also had neutral levels of agreement, around 3 for men and slightly above for women.

A distinct difference between men and women occurred in response to the statement "I am trying to reduce my meat consumption anyway" indicating again the higher skepticism towards meat consumption by women, shown in Table 3.

Table 4. General Impact of the Fictional "Newspaper Articles" about Negative Consequences of Meat Consumption

	All Responders (n = 590)	**Men (n = 306)**	**Women (n = 284)**	
Item	**Arithmetic mean (s.d.)**			**t-test[2]**
"I find the results of the study worrying."[1]**	3.15 (1.27)	3.05 (1.27)	3.26 (1.26)	t(588) = -2.04
"I don't make my eating habits dependent on the results of some study."[1]**	3.64 (1.08)	3.74 (1.04)	3.53 (1.11)	t(589) = 2.44
"I am trying to reduce my meat consumption anyway."[1]***	3.06 (1.21)	2.79 (1.22)	3.35 (1.14)	t(565) = -5.70
"I don't think that my eating habits will really change."[1]**	3.55 (1.09)	3.68 (1.04)	3.42 (1.13)	t(560) = 2.84
"Media reports are often unreliable. I don't trust the findings."[1]**	3.17 (1.01)	3.29 (1.02)	3.05 (0.98)	t(585,51) = 2.88

n = 291 men and 271 women for the item with the smallest number of respondents. [1]Scale from1= "do not agree at all" to 5 = "fully agree". [2]The independent samples t-test was used to test significant differences between men and women; * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$

Additionally to the mean comparisons displayed in Table 4 using the aggregate data from the combined results from the four "newspaper articles", independent samples t-tests comparing men and women were also conducted separately for each of the four different topics. Surprisingly, most of the means did not differ when measured on a significance level of $p \leq .05$[2]. A reason for this could be the reduced number of cases in the four groups, since each article was only randomly given to a quarter of the participating men and women. Therefore, in the following section we concentrate on the analysis of the overall sample population, combining men and women. Whereas the overall effectiveness of the "newspaper articles" at first glance seems limited due to

[2]Consistent with the results displayed in Table 4, the level of concern in most cases reached slightly higher, but not significant means for women compared to men, and for the items expressing mistrust or skepticism towards the given information or individual behavior change, the opposite was observed. Significant differences were found in the following statements: "I am trying to reduce my meat consumption anyway" with higher level of approval in women for each one of the four contents and, "I don't think that my eating habits will really change" for the climate content (men: mean = 3.70, SD = 0.94; women: mean = 3.25, SD = 1.11).

relatively low levels of approval, a detailed analysis of the respondents' reactions to the different content of the articles reveals clear differences. Respondents who read the animal welfare article, detailing the suffering of animals on modern farms, showed by far the highest level of concern compared to those who read the other articles. The readers of the health and climate-related articles hold an intermediate position, and the readers of the image-related article express a low level of concern. Consistent with this, the inverse can be observed regarding the level of mistrust in the media reports and the given information, which is most pronounced for the image-related article and least clearly pronounced for the animal welfare article. The skepticism towards a reduction in individual meat consumption in response to the different articles does not differ between the animal welfare, health and climate content, but is significantly higher after having received the image-related article. Interestingly, after having read the image article fewer respondents stated "I am trying to reduce my meat consumption anyway" (Table 5).

Table 5. Impact of the Different Topics of the Fictional "Newspaper Articles" about Negative Consequences of Meat Consumption (Whole Sample)

Item	Animal welfare (n = 161)	Health (n = 141)	Climate (n = 134)	Image (n = 154)	F (df)	Post hoc test
			Arithmetic mean (s.d.)			
"I find the results of the study worrying."[1]***	3.91^{HCI} (1.05)	3.01^{AI} (1.26)	3.27^{AI} (1.04)	2.40^{AHC} (1.19)	F(3, 586) = 47.04	G-H
"I don't make my eating habits dependent on the results of some study."[1]***	3.29^{HI} (1.05)	3.62^{AI} (1.10)	3.59^{I} (0.97)	4.06^{AHC} (1.01)	F(3, 586) = 14.82	B
"I am trying to reduce my meat consumption anyway."[1]***	3.28^{I} (1.23)	3.10^{I} (1.21)	3.13^{I} (1.13)	2.73^{AHC} (1.21)	F(3, 562) = 5.75	B
"I don't think that my eating habits will really change."***	3.29^{I} (1.09)	3.59 (1.16)	3.50 (1.04)	3.84^{A} (0.99)	F(3, 557) = 6.71	B
"Media reports are often unreliable. I don't trust the findings."[1]***	2.80^{HCI} (1.08)	3.24^{AI} (0.94)	3.15^{AI} (0.90)	3.53^{AHC} (0.94)	F (3, 583) = 14.85	G-H

n = 561 for the item with the smallest number of respondents. [1]Scale from1= "do not agree at all" to 5 = "fully agree"; * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$, significant differences to... [A] animal welfare, [H] health, [C] climate, [I] image according to Bonferroni's test (B) when variances are equal and Games-Howell procedure (G-H) when variances are unequal.

In addition to the analysis of the respondents' reactions to the different "newspaper articles" measured by the ratings of the above described attitudinal statements, we also measured the number of respondents who stated their belief to reduce meat consumption in future, before and after having read one out of the four articles (Table 6). In general, after having read an article, the percentage of respondents intending to reduce future meat consumption increased, suggesting that the provision of information about negative consequences of meat consumption in newspaper articles could be an effective instrument for campaigns to reduce meat consumption. Going into more detail, a gender-specific analysis reveals that the content of the "newspaper

articles" is relevant for the percentage of male respondents who state their intentions to reduce meat consumption. Whereas the animal welfare and the health articles motivate an above average number of male participants to decrease meat consumption, the image-related article does not seem to effectively contribute to a reduced meat consumption since the share of respondents stating to reduce future meat consumption even reduced compared to before having read the article. The climate change article also seems to have a limited effect on men. For women, the specific content of the articles appears to be less relevant than for men, since no significant differences were found between the four articles. As a tendency, the image content seems to be the least promising, but, in contrast to the male participants, the percentage of women willing to reduce meat consumption is still greater than before having read the article.

Table 6. Percentage of respondents believing to reduce meat consumption in future before and after having read one out of the four "newspaper articles"

	Without newspaper article (n = 556 with 290 men and 266 women)	**Average of the four articles** (n = 564 with 272 men and 292 women)	**Animal welfare** (n = 150 with 68 men and 82 women)	**Health** (n = 136 with 75 men and 61 women)	**Climate** (n = 128 with 71 men and 57 women)	**Image** (n = 149 with 78 men and 71 women)
All Responders	12.8	20.7	28.0	23.5	18.8	12.1
Men**	11.4	18.2	27.9	24.0	15.5	6.4
Women^{ns}	14.3	23.5	28.0	23.0	22.8	18.3

*$p \leq .05$, ** $p \leq .01$, *** $p \leq .001$, ^{ns} $p > .05$, related to differences after having read one out of the four "newspaper articles". The differences between "Without newspaper article" and "Average of the four articles" are significant at least with $p \leq .05$ for men, women and the whole sample.

Discussion

Large empirical studies indicate that food consumption and general health-related lifestyle aspects (e.g., smoking) constitute a health risk more often in men than in women (e.g., MRI 2008). Concerning nutrition, one substantial difference between men and women is in the amount of meat consumed, with men eating approximately twice as much meat as women, as was observed in the German population (MRI 2008). Similar patterns were found for other European countries (Vergnaud et al. 2010). Additionally, Vergnaud et al. (2010) showed that as consumption of meat increases, so do problems with health relevant behaviors or behavioral outcomes like overall calorie intake and BMI. This is true for both men and women, but for a lesser extent in women.

The present study focused on this challenge, confirming initially the differences between aspects of male and female consumption behavior, with men eating meat more frequently and having a higher a BMI and, at the same time, questioning their behavior less. Accordingly, men perceived barriers for reducing meat consumption (e.g., strongly habitualized consumption patterns, negative opinions of their friends regarding vegetarianism and indispensability of meat as a necessary dietary component) as more important and motivations for reducing meat intake (regarding health effects, animal welfare and environmental benefits) as less important than women.

Regarding respondents' attitudes after having been confronted with one of the fictional "newspaper articles" in a split sample approach, men accordingly expressed lower levels of concern and higher levels of mistrust in the given information. At the same time, their estimated probability that their eating behavior will actually change was lower than that of the women. The analysis of these attitudes, separately for each of the four articles, showed that independent of sex, the animal welfare article provoked the most profound reactions and the highest level of concern, followed by the human health and climate-related articles. In contrast, the image-related article was not attributed with high credibility. In accordance with this, the percentage of respondents stating their intention to reduce future meat consumption reached the highest value in those people who had read the article about animal welfare problems associated with meat production. The article about potential damage to their image due to high meat consumption again motivated only a small number of people, whereas both the health and the climate-related articles affected a moderate number of respondents regarding their stated motivation to reduce future meat consumption. However, the described differences between the articles were much more apparent in men. In the female sample, the same pattern tended to appear, but the differences were not significant.

Interestingly, not health, but animal welfare aspects motivated the largest number of respondents, which might be due to the fact that animal welfare issues are very emotionally discussed and are able to directly cause high levels of concern in many consumers. The ongoing public debate regarding animal welfare and factory farming in Germany (Efken et al. 2013; Franz et al. 2010) might also have contributed to these results. One reason for the comparatively low reaction to the article related to climate change consequences of meat production might be that the wider consequences of meat production are not yet commonly known. This observation is supported by Tobler et al. (2011), who demonstrated that consumers tend to be unaware of the environmental consequences associated with meat production, which seem to be rather abstract and less intuitively comprehended than reports about animal suffering in modern farming practices. Our study also reveals that information about the image-related consequences of meat consumption as presented here does not appear to be effective. Generally, information focusing on animal welfare and human health aspects can reach both sexes equally and most effectively. With respect to the environmental consequences of meat production, general awareness in the population should be promoted, in particular towards men, as indicated in our results.

Overall, we observed that the percentage of respondents willing to reduce meat consumption increased after having read any of the articles – with the exception of the image-related article in men – suggesting that similarly designed newspaper articles in fact could be an effective instrument in awareness-raising campaigns aimed at reducing meat consumption.

Finally, we also need to mention the limitations of our study. Despite our overall comparatively large sample, the number of male and female respondents that were presented with each of the four "newspaper articles" was small, which might have contributed to the fact that some differences in the reaction to the different newspaper articles and between men and women were not significant in our data. The availability of a larger sample might provide greater details regarding the above-mentioned differences. Furthermore, it should be noted that our methodological approach measured respondents' stated reaction to the four different contents immediately after being

confronted with them. We have no information whether the stated behavioral changes would actually be implemented and if so, if they would be maintained in the long term.

Our results should be interpreted as specific for the situation in Germany, where e.g., animal welfare issues are widely discussed in the media, due, among other things, to recent food scandals (e.g., Efken et al. 2013). Our data did not differentiate between the types of meat, or between different income groups of respondents, both of which might be useful distinctions for further research on awareness-raising campaigns. Since research suggests that the group of heavy meat consumers contains a disproportionately large number of men with lower social status (Cordts et al. 2013b), it might be interesting for further research to concentrate on low-income men, when consumer reactions to information about meat consumption are investigated or strategies for reducing meat consumptions are developed. In this context, also the impact of meat prices on consumer behavior would be of interest for further research.

Implications for the Meat Industry

For the meat sector in industrialized countries, the described sustainability and health problems associated with meat consumption pose challenging strategic questions. Their best customers, men with high meat consumption, are also those with the highest incidence of severe health problems attributable to their meat consumption behavior (cf. Vergnaud et al. 2010).

Since the empirical analysis presented above concerns the population in Germany, the obtained results are particularly relevant for the German meat industry. With 83,000 employees and a sales volume of more than 37 billion Euros in 2012[3] (Gewerkschaft Nahrung-Genuss-Gaststätten 2013), the meat sector has the highest turnover of all the sectors within the German food industry (BVE 2013). Germany is one of the most important meat producers in the EU, alongside France and Spain (DBV 2012, 251).

Our empirical results show that there was a lower level of concern among men in response to the fictional "newspaper articles" compared to women, and male heavy meat consumers are also the ones with low health consciousness and awareness for sustainability and animal welfare issues (Cordts et al. 2013b). It can therefore be concluded that, even with increased media coverage, levels of meat consumption will remain relatively stable in the short term, although in the long term, increasing public awareness of sustainability-related topics may lead to changes in consumption even in high meat consuming groups.

Firms could react in different strategic ways to risks from sustainability- and health-related campaigns. The well-known Miles and Snow approach (Miles et al. 1978) distinguishes four types of strategic behavior: prospector, defender, analyzer, and reactor. Prospectors try to find new market opportunities, e.g., artificial meat from algae. Defenders aim to protect the current market via proactive strategies like public relations. Analyzers combine both strategies by moderate innovation

[3] Regarding the processing and preserving of meat and production of meat products. The number of employees relates only to companies with more than 50 employees. 37 billion Euros equals 49.9 billion USD (at 1.00 EUR = 1.34821 USD).

on a stable basis. Regarding the meat industry in Germany, most companies have long been working like reactors, trying to ignore the human health, animal welfare and sustainability problems associated with meat consumption and production, while concentrating on heavy meat consumers (Franz et al. 2010, 2012).

In the recent past, German meat manufacturers began to use proactive strategies. One example of an animal welfare-related strategy is the recent implementation of a nationwide voluntary animal welfare label, which was developed by scientists in cooperation with leading processors from the meat industry (Vion Food Group and PHW Group/Wiesenhof) and the German Animal Welfare Association (Deutscher Tierschutzbund). The label ensures animal husbandry conditions that go beyond the basic legal animal welfare requirements (BMELV 2013; Efken et al. 2013). Since January 2013, meat products with these labels have been available in various supermarket chains (Efken et al. 2013). Producers, manufacturers and food marketers can take part in this government-supported program and apply for certification to the German Animal Welfare Association (Deutscher Tierschutzbund n.d.). However, so far only a small number of producers have adopted the label (45 producers were certified by May 2013, with further companies currently undergoing the qualification procedure) (Deutscher Tierschutzbund 2013).

Related to health marketing, innovative meat products have been launched on the German market, e.g., minced meat with plant-based protein and reduced fat and cholesterol content (Vion Food Group 2010).

Regarding the different types of meat, the literature indicates that for a health reasons, poultry is clearly preferable to red meat (e.g., McAfee et al. 2010; Micha et al. 2010), and correspondingly, German consumers perceive poultry as significantly healthier than beef or pork (Kayser & Spiller 2012). Therefore, producers and sellers of poultry should be in a strong position when health-related campaigns are conducted. On the other hand, producers of poultry and also pork are disadvantaged in the case of campaigns with an animal welfare focus, since the husbandry conditions of poultry, but also pigs, are perceived as particularly problematic and considerably less animal-friendly than the husbandry conditions of cattle (Kayser et al. 2012; Tonsor & Olynk 2010). Furthermore, beef is perceived as a high quality product and a more appropriate meat for special occasions when compared to poultry and pork (Kayser & Spiller 2012).

In conclusion, the above considerations show that the meat industry is facing important challenges when the consumer-awareness of the negative consequences of meat production and consumption increases.

Acknowledgements

The authors wish to acknowledge the financial support of the Edmund Rehwinkel Foundation to carry out the research within the project “Effects of lower consumption of animal products in OECD countries on global market balances and food prices”.

References

Ahlheim, M. 2011. Verbraucherschutz als ordnungspolitische Aufgabe. *Orientierungen zur Wirtschafts- und Gesellschaftspolitik* 129: 2-6.

Alemanno, A., and I. Carreno. 2013. 'Fat Taxes' in Europe and Beyond – A Legal and Policy Analysis Under EU and WTO Law. *European Food and Feed Law Review* 2:97-112.

Aune, D., Ursin, G., and M. B. Veierød. 2009. Meat consumption and the risk of type 2 diabetes: a systematic review and meta-analysis of cohort studies. *Diabetologia* 52(11): 2277–2287.

Beardsworth, A. D., and A. Bryman. 2004. Meat consumption and meat avoidance among young people - An 11-year longitudinal study. *British Food Journal* 106(4): 313-327.

BMELV (Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz). 2013. Aigner: Das neue Tierschutzlabel schafft Transparenz für die Verbraucher. Press release No. 9 from January 16, 2013, Online: http://www.bmelv.de/SharedDocs/Pressemitteilungen/2013/009-AI-Vorstellung-Tierschutzlabel.html [accessed November 18, 2013].

BVE (Bundesverband der Deutschen Ernährungsindustrie). 2013. Ernährungsindustrie 2013, Berlin, Online: http://www.bve-online.de/presse/infothek/publikationen-jahresbericht/bve-statistikbroschuere2013-1[accessed November 27, 2013].

Carlsson-Knyama, A., and A. D. González. 2009. Potential contributions of food consumption patterns to climate change. *American Journal of Clinical Nutrition* 89(5): 1704S-1709S.

Carvalho, A. M., C. L. César, R.M. Fisberg, and D. M. Marchioni. 2012. Excessive meat consumption in Brazil: diet quality and environmental impacts. *Public Health Nutrition* 16: 1-7.

Chao, A., M. J. Thun, C. J. Connell, M. L. McCullough, E.J. Jacobs, W. D. Flanders, C. Rodriguez, R. Sinha and E. E. Calle. 2005. Meat consumption and risk for colorectal cancer. *The American Journal of the American Medical Association* 293(2): 172-182.

Cordts, A., N. Duman, H. Grethe, S. Nitzko, and A. Spiller. 2014. Potenziale für eine Verminderung des Fleischkonsums am Beispiel Deutschlands und Auswirkungen einer Konsumreduktion in OECD-Ländern auf globale Marktbilanzen und Preise für Nahrungsmittel. Paper presented at the Gewisola Tagung Berlin 2013, Berlin (Germany), September 25 - 27, 2013; accepted for publication in *Schriften der Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaus e.V.* 49 (2014).

Cordts, A., Duman, N., Grethe, H., Nitzko, S., and A. Spiller. 2013a. Auswirkungen eines verminderten Konsums von tierischen Produkten in Industrieländern auf globale Marktbilanzen und Preise für Nahrungsmittel. In: Edmund Rehwinkel-Stiftung der Landwirtschaftlichen Rentenbank (Eds.), *Schriftenreihe der Rentenbank*, 29:103-135. Frankfurt a. M., Online: http://www.rentenbank.de/cms/dokumente/10011465_262637/65e61959/Schriftenreihe_Band29_final.pdf [accessed 08/02/2013].

Cordts, A., F. Wittig, B. Schulze, M. Eisinger-Watzl, T. Heuer, A. Spiller and I. Hoffmann. 2013b. A typology comparing male organic purchasers and male non-organic purchasers: Nutrition, health and buying behaviours. *Ernaehrungs Umschau International* 60: 36-42.

Cosgrove, M., A. Flynn, and M. Kiely. 2005. Consumption of red meat, white meat and processed meat in Irish adults in relation to dietary quality. *British Journal of Nutrition* 93(6): 933-942.

Dagevos, H. and J. Voordow. 2013. Sustainability and meat consumption: is reduction realistic? Sustainability: Science, Practice & Policy 9(2): 60-69.

DBV (Deutscher Bauernverband). 2012. Situationsbericht 2012/13. Trends und Fakten zur Landwirtschaft, Berlin, Online: http://media.repro-mayr.de/80/560180.pdf [accessed November 26, 2013].

De Boer, J., C.T. Hoogland and J. J. Boersema. 2007. Towards more sustainable food choices: Value priorities and motivational orientations. *Food Quality and Preference* 18: 985-996.

Deimel, I., A. Franz, M. Frentrup, M. Von Meyer, A. Spiller and L.Theuvsen. 2010. Perspektiven für eine Europäisches Tierschutzlabel, Bonn, Online: http://download.ble.de/08HS010.pdf [accessed February 10, 2013].

Deutscher Tierschutzbund. 2013. Zweistufiges Tierschutzlabel: Machbarer Weg, erfolgreicher Start. Press release from May 27, 2013. Online: http://www.tierschutzbund.de/news-storage/landwirtschaft/270513-tierschutzlabel-erfolgreicher-start.html [accessed Novmeber 26, 2013].

Deutscher Tierschutzbund. n.d. Zeichen für ein besseres Leben. Zertifizierungsprogramm für das Tierschutzlabel “Für Mehr Tierschutz”, Bonn. Online: http://www.tierschutzlabel.info/fileadmin/user_upload/Dokumente/Zertifizierungsprogramm.pdf [accessed November 26, 2013].

DGE (Deutsche Gesellschaft für Ernährung). 2012. 12. Ernährungsbericht, Bonn, Germany.

DGE (Deutsche Gesellschaft für Ernährung). 2011. Vollwertig essen und trinken nach den 10 Regeln der DGE. Online: http://www.dge.de/pdf/10-Regeln-der-DGE.pdf [accessed November, 16, 2013].

Efken, J., M. Haß, D. Bürgelt, G. Peter, and K. Zander. 2013. Der Markt für Fleisch und Fleischprodukte. *German Journal of Agricultural Economics* 62 (supplement): 67-84.

Fagerli, R. A. and M. Wandel. 1999. Gender differences in opinions and practices with regard to a "healthy diet". *Appetite* 32(2): 171-190.

Field, A. 2009. *Discovering statistics using SPSS (3rd edition)*. London: Sage Publications.

Franz, A., I. Deimel, and A. Spiller. 2012. Concerns about animal welfare: A cluster analysis of German pig farmers. *British Food Journal* 114(10): 1445-1462.

Franz, A., M. v. Meyer, and A. Spiller. 2010. Prospects for a European Animal Welfare Label from the German Perspective: Supply Chain Barriers. *International Journal on Foodsystem Dynamics* 4: 318-329.

Gewerkschaft Nahrung-Genuss-Gaststätten. 2013. Branchenbericht 2012. Schlachten und Fleischverarbeitung. Online: http://www.ngg.net/branche_betrieb/fleisch/branchen_info/Branchenbericht-fleisch-2012.pdf [accessed November 26, 2013].

Gossard, M. H., and R. York. 2003. Social structural influences on meat consumption. *Human Ecology Review* 10(1): 1-9.

Grunert, K.G. 2006. Future trends and consumer lifestyles with regard to meat consumption. *Meat Science* 74(1): 149-160.

Guenther, P.M., H. H. Jensen, S.P. Batres-Marquez and C. F. Chen. 2005. Sociodemographic, knowledge, and attitudinal factors related to meat consumption in the United States. *Journal of the American Dietetic Association* 105(8): 1266-1274.

Harper, G., and S. Henson. 2001. Consumer concerns about Animal Welfare and the impact on food choice. EU FAIR CT98-3678, University of Reading, UK. Online: http://ec.europa.eu/food/animal/welfare/eu_fair_project_en.pdf [accessed 08/02/2013].

Havlicek, J., and P. Lenochova. 2006. The effect of meat consumption on body odor attractiveness. *Chemical Senses* 31(8): 747–752.

Jensen, J. D., and S. Smed. 2013. The Danish tax on saturated fat – Short run effects on consumption, substitution patterns and consumer prices of fats. *Food Policy* 42: 18-31.

Kalof, L., T. Dietz, P.C. Stern and G.A. Guagnano. 1999. Social psychological and structural influences on vegetarian beliefs. *Rural Sociology* 64(3): 500-511.

Kayser, M., K. Schlieker and A. Spiller. 2012. Die Wahrnehmung des Begriffs Massentierhaltung aus Sicht der Gesellschaft. *Berichte über Landwirtschaft* 90(3): 417-428.

Kayser, M., and A. Spiller. 2012. Das Image der verschiedenen Fleischarten aus Konsumen-tInnensicht. Hambrusch, J. et al. (Eds.). Jahrbuch der österreichischen Gesellschaft für Agrarökonomie 21(1): 23-33.

Kubberød, E., Ø.Ueland, M. Rødbotten, F. Westad and E. Risvik. 2002. Gender specific preferences and attitudes towards meat. *Food Quality and Preference* 13(5): 285-294.

Lea, E., and A. Worsley, A. 2001. Influences on meat consumption in Australia. *Appetite* 36(2): 127-136.

Leahy, E., S. Lyons and R. S. J. Tol. 2011. Determinants of vegetarianism and meat consumption frequency in Ireland. *The Economic and Social Review* 42(4): 407-436.

Lusk, J. L., and F. B. Norwood. 2011. Animal Welfare Economics. *Applied Economic Perspectives and Policy* 33(4): 463-483.

McAfee, A. J., E. M. McSorley, G. J. Cuskelly, B.W. Moss, J.M.W. Wallace, M.P. Bonham and A. M. Fearon. 2010. Red meat consumption: An overview of the risks and benefits. *Meat Science* 84(1): 1-13.

McCarthy, M., S. O´Reilly, L. Cotter and M. de Boer. 2004. Factors influencing consumption of pork and poultry in Irish market. *Appetite* 43(1): 19-28.

McMichael, A. J., Powles, J. W., Butler, C. D., and R. Uauy. 2007. Food, livestock production, energy, climate change, and health. *The Lancet* 370: 1253-1263.

Micha, R., Wallace, S. K., and D. Mozaffarian. 2010. Red and processed meat consumption and risk of incident coronary heart disease, stroke, and diabetes mellitus: A systematic review and meta-analysis. *Circulation* 121: 2271-2283.

Miles, R. E., Snow, C. C., Meyer, A. D. and H. J. Colemann, Jr. 1978. Organizational Strategy, Structure, and Process. *The Academy Management Review* 3(3): 546-562.

MRI (Max Rubner-Institut, Bundesforschungsinstitut für Ernährung und Lebensmittel). 2008. Nationale Verzehrsstudie II. Ergebnisbericht, Teil 2. Die bundesweite Befragung zur Ernährung von Jugendlichen und Erwachsenen, 2008. Online: http://www.mri.bund.de/de/veroeffentlichungen/archiv/2008.html [accessed May 15, 2012].

Pan, A., Sun, Q., Bernstein, A. M., Schulze, M. B., Manson, J. E., Stampfer, M. J., Willett, W.C., and F. B. Hu. 2012. Red meat consumption and mortality: results from 2 prospective cohort studies. *Archives of Internal Medicine* 172: 555-563.

Potts, A., and J. Parry. 2010. Vegan sexuality. Challenging heteronormative masculinity through meat-free sex. *Feminism & Psychology* 20(1): 53–72.

Praettaelae, R., L. Paalanen, D. Grinberga, V. Helasoja, A. Kasmel and J. Petkeviciene. 2007. Gender differences in the consumption of meat, fruit and vegetables are similar in Finland and the Baltic countries. *European Journal of Public Health* 17(5): 520-525.

Reisch, L., U. Eberle and S. Lorek. 2013. Sustainable food consumption: an overview of contemporary issues and policies. *Sustainability: Science, Practice, & Policy* 9(2): 7-25.

Richardson, N.J., H.J.H. MacFie, and R. Shepherd. 1994. Consumer attitudes to meat eating. *Meat Science* 36 (1-2): 57-65.

Rohrmann S, K. Overvad, H. B. Bueno-de-Mesquita, M. U. Jakobsen, R. Egeberg, A. Tjønneland et al. 2013. Meat consumption and mortality – results from the European Prospective Investigation into cancer and nutrition. *BMC Medicine* 11(63): 1741-7015. http://doi.org/mcr.

Ruby, M. B. 2012. Vegetarianism. A blossoming field of study. *Appetite* 58: 141-150.

Singh, P. N., J. Sabaté and G. E. Fraser. 2003. Does low meat consumption increase life expectancy in humans? *The American Journal of Clinical Nutrition* 78 (supplement): 526S - 32S.

Statistische Ämter des Bundes und der Länder. 2011. Gebiet und Bevölkerung – Fläche und Bevölkerung. http://www.statistik-portal.de/statistik-portal/de_jb01_jahrtab1.asp [accessed March 4, 2013].

Statistisches Bundesamt. 2012. Statistisches Jahrbuch Deutschland und Internationales 2012. Wiesbaden. Online: https://www.destatis.de/DE/Publikationen/StatistischesJahrbuch/StatistischesJahrbuch.html [accessed February 4, 2013].

Statistisches Bundesamt. 2011. Statistisches Jahrbuch 2011 für die Bundesrepublik Deutschland mit Internationalen Übersichten, Wiesbaden. Online: https://www.destatis.de/DE/Publikationen/StatistischesJahrbuch/StatistischesJahrbuch2011.pdf?__blob=publicationFile [accessed February 4, 2013].

Tänzler, D., A. Schulz, and A. Carisus. 2005. Nachhaltigkeit und Verbraucherpolitik: Ansätze und Maßnahmen in anderen Ländern. Online: http://download.ble.de/04HS049.pdf [accessed October 2, 2013].

Tobler, C., V. H. M. Visschers and M. Siegrist. 2011. Eating green. Consumers' willingness to adopt ecological food consumption behaviors. *Appetite* 57(3): 674–682.

Tonsor, G. T., and N. J. Olynk. 2010. U.S. Meat Demand: The Influence of Animal Welfare Media Coverage. Kansas State University, September 2010.

Vergnaud, A.-C., Norat, T., Romaguera, D., Mouw, T., May, A. M., Travier, N., Luan, J., Wareham, N., Slimani, N., Rinaldi, S. et al. 2010. Meat consumption and prospective weight change in participants of the EPIC-PANACEA study. *American Journal of Clinical Nutrition* 92(2): 398-407.

Vion Food Group. 2010. Hackplus® – 100% mincemeat enjoyment for those who favour a healthy diet. Press release from November 9, 2010. Online: http://www.vionfoodgroup.com/index.php?id=1492&tx_maxnews_pi2[action]=show&tx_maxnews_pi2[controller]=Post&tx_maxnews_pi2[post]=95&cHash=11bac2836029dd894d8c184e3385ca13 [accessed October 2, 2013].

Von Bothmer, M. I. K., and B. Fridlund. 2005. Gender differences in health habits and in motivation for a healthy lifestyle among Swedish university students. *Nursing & Health Sciences* 7(2): 107-118.

Wandel, M., and A. Bugge. 1997. Environmental concern in consumer evaluation of food quality. *Food quality and Preference* 8(1): 19-26.

Wang, Y., and M. A. Beydoun. 2009. Meat consumption is associated with obesity and central obesity among US adults. *International Journal of Obesity* 33(6): 621-628.

Wardle, J., A. M. Haase, A. Steptoe, M. Nillapun, K. Jonwutises, and F. Bellisie. 2004. Gender differences in food choice: The contribution of health beliefs and dieting. *Annals of Behavioral Medicine* 27(2): 107-116.

WBA (Wissenschaftlicher Beirat für Agrarpolitik beim Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz). 2012. Ernährungssicherung und nachhaltige Produktivitätssteigerung (January 2012). *Berichte über Landwirtschaft* 90(1): 5-34.

WBA (Wissenschaftlicher Beirat für Agrarpolitik beim Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz). 2011. Kurzstellungnahme zur Einführung eines Tierschutzlabels in Deutschland. *Berichte über Landwirtschaft* 89(1): 9-12.

WCRF/AICR (World Cancer Research Fund/American Institute for Cancer Research). 2007. Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective. Washington, DC: AICR.

Appendix

"Newspaper article" on meat consumption and animal welfare

In the following, we present an extract from an article from the Frankfurter Allgemeine Zeitung ("FAZ": a popular broadsheet newspaper) from the 28th September 2012 on the topic of meat consumption. Please read the article first, and then answer the following questions.

Animals suffer from modern farming methods more than previously thought, according to the findings of a recent scientific study from Harvard University in the US involving more than 35,000 animals. The study reports that 13 % of pigs are conscious during the slaughtering process. In addition, crowded conditions, pens covered in excrement and germs, and the preventative use of antibiotics remains the standard in modern factory farming. Maltreatment, such as the castration of male piglets without anesthetic and the dehorning of cattle or beak-cutting of hens, is also still common.

"Newspaper article" on meat consumption and health

In the following, we present an extract from an article from the Frankfurter Allgemeine Zeitung ("FAZ": a popular broadsheet newspaper) from the 28th September 2012 on the topic of meat consumption. Please read the article first, and then answer the following questions.

Those who eat a lot of meat are damaging their health more than previously thought, according to the findings of a recent scientific study from Harvard University in the US involving more than 35,000 participants. The study reports that meat-lovers have a 13 % lower life-expectancy and are more frequently affected by strokes, heart attacks, diabetes and various types of cancer. The mortality rate of study participants increased if they ate meat for one main meal per day, and further increased if they additionally ate sausage, ham or other processed meat.

"Newspaper article" on meat consumption and climate

In the following, we present an extract from an article from the Frankfurter Allgemeine Zeitung ("FAZ": a popular broadsheet newspaper) from the 28th September 2012 on the topic of meat consumption. Please read the article first, and then answer the following questions.

Global meat production damages the climate more than previously thought, according to the findings of a recent scientific study from Harvard University in the US involving more than 35,000 participants. The study reports that a person who eats large quantities of beef is responsible for 13 % more greenhouse gas emissions than the average person. This includes all emissions that are directly or indirectly caused by meat production, from the production of chemical fertilizers to grow the feed, through the reduced CO_2 sequestration in areas used to keep animals and produce their feed, to the disposal of the meat packaging.

"Newspaper article" on meat consumption and personal image

In the following, we present an extract from an article from the Frankfurter Allgemeine Zeitung ("FAZ": a popular broadsheet newspaper) from the 28th September 2012 on the topic of meat consumption. Please read the article first, and then answer the following questions.

People who eat a lot of meat are less popular in both their professional and private lives, according to the findings of a recent scientific study from Harvard University in the US involving more than 35,000 participants. The study reports that meat-lovers have 13 % fewer friends than people who occasionally or never eat meat. The relationships of carnivores are generally shallower and less trusting. At work, people with high meat consumption have greater problems working in a team. The reasons for these phenomenon are not fully understood, however, evidence shows that higher meat consumption contributes to a worse image.

International Food and Agribusiness Management Review
Volume 17 Special Issue A, 2014

Consumer's Food Shopping Choice in Ghana: Supermarket or Traditional Outlets?

Ting Meng[Φa], Wojciech J. Florkowski[b], Daniel B. Sarpong[c], Manjeet S. Chinnan[d], and Anna V.A. Resurreccion[e]

[a] *Graduate Research Assistant, Department of Agricultural and Applied Economics 306 Conner Hall The University of Georgia, Athens, Georgia, 30602, USA*

[b] *Professor, Department of Agricultural and Applied Economics 1109 Experiment St. 212 Stuckey Building, The University of Georgia, Griffin, Georgia, 30223-1797, USA*

[c]*Associate Professor, Department of Agricultural Economics and Agribusiness, University of Ghana-Legon, Legon, Accra, Ghana*

[d] *Professor Emeritus,* [e] *Professor, Department of Food Science and Technology, 1109 Experiment St. The University of Georgia, Griffin, Georgia, 30223-1791, USA*

Abstract

Diet-related chronic health conditions such as obesity, diabetes, and heart disease have attracted a lot of attention. Food retail outlets play a significant role in affecting consumers' diet-related health and nutrition by the foods they sell and prices they charge. This study assessed the relative importance of different food retail outlets, identified the socio-demographic profiles of consumers associated with shopping in each retail format, and then illustrated how the food retail outlet choices might affect consumers' diet and nutrition, using the surveyed data set collected in 2011 from three big cities in Ghana (Accra, Tamale, and Takoradi).

Keywords: open-air market, hawkers, ordered logit model, socio-demographic factors

Corresponding author: Tel: + 1. 706.614.5943
Email: T. Meng: tingmeng@uga.edu
W. J. Florkowski: wojciech@uga.edu
D. B. Sarpong: dsarpong@ug.edu.gh
M. S. Chinnan: manjeet.chinnan@gmail.com
A. V. A. Resurreccion: annaresurreccion@gmail.com

Introduction

A tremendous dietary change and nutrition transition is occurring in developing countries. For the most part, this change is due to the substantial economic growth and rapid disposable income increase during the last decades. Consumers have become more concerned about the diversity, nutrition, and quality of food products they eat. Between 1963 and 2003, there was a decline in root and tuber consumption in developing countries, but a large increase in calorie-dense food products including meat (119%), sugar (127%), and vegetable oils (199%) (Kearney 2010). In the Eastern Asia/Pacific Rim region, including China and Thailand, pesticide free is considered as key food attribute (Moser et al. 2011). Similarly, demand for organic food products has increased, in addition to demand for quality assurance measures such as product labeling and traceability (Mashinini 2006). Now consumers are able to exercise these preferences due to increasing access to the expanded retail sector.

In addition to this large shift in food preferences, the food supply system in these developing countries, especially food retail formats, is also undergoing a dramatic change. Driven by the new food demand and liberalization of retail foreign direct investment (FDI), the "supermarket revolution" wave began in developing countries in the early 1990s and then spread to Latin America, followed by East/Southeast Asia and East/South Africa, then finally West Africa (Reardon et al. 2003; Reardon et al. 2004; Reardon and Hopkins 2006). In China, many international retailers, such as Walmart, are present and expanding quickly (McLoughlin et al. 2012) and their share amounts to 5-20% of national food retail sales (Hawkes 2008).

Numerous previous studies comprehensively explored the effect of supermarkets. The reports include the competition between supermarkets and existing actors in the food system (Reardon et al. 2009; Neven et al. 2006), the challenges faced by small farms and small processing/distribution firms (Louw et al. 2007 and 2008), as well as the macro impacts on domestic market development, local employment, and economic growth (Shepherd 2005; Emongor and Kirsten 2009). However, as the final link in the food supply chain, the consumer's role has often been neglected or underestimated. Among the previous studies, very few investigate supermarket expansion in developing countries and how it relates to the consumer food outlet choice. Consumers' selective adoption of supermarkets was first identified by Goldman (2000), who noted "consumers who regularly shop in supermarkets continue to purchase fresh food in traditional outlets". Okello et al. (2011) used interview information to access consumer choice of retail outlets when purchasing fresh vegetables in Kenya. Gorton et al. (2011) applied a consumer-centered model to investigate the extent to which supermarkets can capture food retailing in Thailand. Unfortunately, many developing countries do not have resources to conduct consumer surveys about food consumption and diet (Kearney 2010). Our study expands this literature by explicitly considering consumer decisions. We examine consumer food retail format choice of both modern and traditional food outlets in terms of consumer's socio-demographic characteristics in West Africa.

Growing incomes, expanding retail outlets, and changing consumer preferences in developing countries call for an examination of determinants of consumer retail food outlet choice. This

study investigates consumers' food retail shopping choices and explores how the choices could affect their diet, nutrition, and health. The present study contributes to the empirical literature addressing consumer outlet choice, and specifically fills the gap in such studies in sub-Saharan Africa by analyzing consumer choice of retail outlets for food purchasing, using the survey data collected from Ghana's urban households in 2011. The objectives of the study are to: a) explore the food retail system structure in urban Ghana; b) identify what factors, including socio-demographic characteristics, affect consumer food shopping frequency in supermarkets and traditional outlets, i.e., open-air markets and hawkers; c) illustrate the potential association between food retail outlet choice and consumer diets.

In recent decades, diet-related chronic health conditions such as obesity, diabetes, and heart disease have attracted a lot of attention. Dietary patterns can be influenced by the availability and accessibility of different types of foods (Farley et al. 2009). The increased consumption of energy-dense foods rather than foods such as fresh vegetables and fruits may be the reason for an increased prevalence of poor nutrition, obesity, and chronic diseases (Donkin et al. 2000).

The retail food outlets including supermarkets, hawkers, and open-air markets connect consumers to their food choices. These food retail outlets play a significant role in affecting consumers' diet-related health and nutrition, by the foods they sell and prices they charge. Both the promotional strategies used by some retail outlet types, and the implemented nutrition-related activities (Hawkes 2008; Tessier et al. 2010) may lead to disparities in diet and health (Moore and Diez Roux 2006). However, there is a lack of consensus on which food retail format is the best for promoting optimal nutrition for consumers. For example, in Chile, the traditional markets still compete strongly in the fruit and vegetable sector (Faiguenbaum et al. 2002). This ability to compete is a result of consumer perceptions that traditional markets offer both good prices and freshness (Goldman et al. 2002). In several large Chinese cities, about 49% of consumers reported buying the bulk of their fresh vegetables from supermarkets (Hu et al. 2004). For those participants in the US food stamp program, supermarket access was a positive predictor of fruit consumption (Rose and Richards 2004). Some studies find that limited access to supermarkets may result in poor nutrition by reducing consumption of healthy fresh foods (Morland et al. 2006; Tessier et al. 2008; Farley et al. 2009).

Additionally, supermarkets play a crucial role in introducing new processed foods or nutritious products, such as exotic out-of-season fruits or conveniently packaged vegetable snacks (Hawkes 2008). However, there are also some critics of different food outlets (i.e., supermarket, open-air market, and hawkers). For instance, supermarket expansion may be related to modern health problems such as obesity (Michimi and Wimberly 2010). Also, it has been shown that low food quality is often closely related to food products offered by hawkers (Mensah et al. 2002; Hanashiro et al. 2005; Toh and Birchenough 2000; Rane 2011). Similarly, practicing appropriate sanitation guidelines and periodic bacteriological control is necessary in open-air markets to reduce food contamination (Angelidis and Koutsoumanis 2006; Filiousis et al. 2009).

Results of an econometric model using the ordered logit regression indicate that supermarkets are accepted by urban households, especially those with high incomes or the higher education. Such households are more likely to have been exposed to exotic or out-of-season vegetables and fruits, processed food products, and new, highly nutritious food products. However, consistent

with a previous study (Field et al. 2010), the traditional retail food outlets continue to be a significant part of the agri-food system in Ghana. Results of the current study suggest that open-air markets still dominate the food retail system in Ghana, and are preferred by non-college educated households. Open-air markets especially provide large households with locally produced foods including fresh meat, vegetables, and fruits. The significant role of hawkers (the oldest food retail format) has been confirmed in Ghana's food retail system. They are favored by the low-income and less-educated households with small children, competing in terms of convenience. Thus, individuals frequently buying from hawkers are more likely to consume ready-to-eat foods, convenience foods, or beverages.

For decades, researchers focused solely on supermarkets as retail outlets (Mai and Zhao 2004; Min 2006; Theodoridis and Chatzipanagiotou 2009). Several studies explored the product attributes in supermarkets and traditional markets such as price, quality, and variety (Goldman and Hino 2005; Minten and Reardon 2008). However, there is a lack of adequate studies assessing and comparing both modern and traditional food retail outlets in terms of consumer food shopping frequency, especially in West Africa, and the corresponding development of consumer profiles. Therefore, the present study fills the gap with a unique and comprehensive, as permitted by gathered data, illustration of consumer's food shopping choice issue in Ghana. The identified consumer profiles in each food retail outlet type provide insights to private organizations. Food manufacturers, distributors/marketers, or potential food retailers gain knowledge essential for marketing strategy, including entry or expansion decisions. Furthermore, knowledge of food retail choices shows how various food retail formats are associated with consumer food selection, which affects consumer diet, nutrition, and eventually, health. This valuable information can be used by public agencies concerned about improving local diet, nutrition, and health by promoting certain healthy foods through different food retail outlets.

Food Retailing in Ghana

In the 1990s, the supermarket expansion spread to developing countries. Supermarket format appealed to consumers with adequate buying power. In East Africa, supermarkets developed from a tiny niche to an active food retail outlet in Kenya taking a fifth of food retail, while more than a third of their sales were from better off consumers (Neven et al. 2006). In South Africa, the number of supermarkets has been steadily growing, and has become a strong competitor for local stores (D'Haese and Huylenbroeck 2005). Regarding traditional food outlets, urbanites in Nigeria tend to buy their food from street vendors and hawkers (Nigeria 2013). Similarly, evidence suggests that expansion of the modern supermarket sector continues in Ghana, even though traditional food retail outlets such as open-air markets and street hawking remain important in food shopping. The latter two represent a significant part of the agri-food system that meets the needs of low-income and rural households (Reardon et al. 2004; Field et al. 2010).

McClelland's (1962) definition states, "Supermarkets are large self-service food shops." In our study, "supermarket" typically implies a larger grocery store owned by an independent proprietor. It also includes some large chain stores located in shopping centers. Supermarkets sell a wide variety of products such as dry goods, meats, bakery items, beverages, frozen foods, dairy products, and non-food goods, and provide food-processing services.

In Ghana, supermarkets sell high-quality organic and natural foods including freshly prepared meats, baked bread, and garden fresh produce, while a large number of products are imported. Also exotic, out-of-season fresh fruits and vegetables and processed fruits and vegetables are sold in supermarkets, consumption of which benefits consumers' health. Ready-to-eat food items such as pizza, burgers, fried rice, potato chips, and grilled/roasted/fried chicken are also provided in Ghana's supermarkets. Additionally, although the car ownership remains quite low-one vehicle for every 22 Ghanaians, the sale of cars experienced a substantial increase, 40 % in 2011, which likely contributed to the supermarket expansion (Ghana 2013). Currently, the domestically owned supermarkets dominate the supermarket sector. For example, Max Mart Limited, a subsidiary company of Kwatsons Ghana Limited, opened their first business operation on August 8, 2001; by the end of 2011, it had four branches in the greater Accra region (Kwatson Ltd. 2013). However, the country's economic growth is also encouraging international supermarket chain expansion. For instance, at the end of May 2013, Carrefour, the world's second-largest retailer, stated it would enter eight West and Central African countries including Ghana in the near future (Carrefour Group 2013).

The open-air market is a public marketplace selling food and merchandise. In Ghana, it is an integral part of the food retailing system (Field et al. 2010). Ghana is famous for its open-air markets. For example, Techiman's food market claims to be the largest food and agricultural market in West Africa, and Market Circle in Takoradi is also well known for their open-air markets. Some open-air markets operate every day, while others on a regular cycle. Most goods sold there are of domestic origin or locally produced foods, including fresh vegetables, fruits, and meat. Some markets, such as Makola Market located outside Accra, even offers live crab, chicken, and fish, which would not normally be sold in open-air markets. Although open-air markets lack cold storage facilities and proper protection of product freshness, they appeal to buyers with competitive prices and travel convenience.

Hawkers are persons traveling through towns and neighborhoods to sell goods. In large cities, they usually occupy major street intersections. Items sold by hawkers range "from plantain chips to chewing gum to book bags to live puppies" (Davis 2008). Most foods sold by hawkers are ready-to-eat or prepared food products for on-site consumption. Spicy foods and beverages are also sold by hawkers at reasonable and affordable prices (Johnson and Yawson 2000). In Ghana and most West African countries, hawkers are still a necessary part of the food retail system. Street hawking is both time and cost effective for consumers, since transactions can occur through buyer car windows, avoiding the potential troublesome travel to markets. Hawkers often sell food at competitive prices because the products are usually sold by item instead of bulk (Davis 2008). People lacking marketable skills, or employment, turn to hawking to earn income. Occasionally, even school children hawk to supplement their family earnings. Because of a lack of knowledge, education, and regulation, food sold by hawkers is potentially a source of public health problems due to microbial contamination (Toh and Birchenough 2000).

Food selection in each retail outlet does not vary greatly with locations; however, various locations add to the offered foods a few local items. For example, open-air markets in the city of Tamale tend to serve more local dishes such as boiled or stewed rice. In addition, due to the uneven economic development, local supermarkets are more concentrated in the southern Ghana in Accra and Takoradi than in the Northern Region e.g., in Tamale.

Conceptual Framework

Our study employs a utility-maximization model with the following assumptions: a) each household's utility depends on the quantity of both food products and non-food products they consume; b) the food shopping frequency in each food retail outlet is proportional to the corresponding quantity of purchased food products; c) in cross sectional data applications, after controlling for regional differences, prices of both food and non-food products are reasonably assumed to be stable.

Individual household wants to maximize the utility level by choosing the optimal quantity of both food and non-food products within the budget constraint (Equation 1 and 2):

$$(1) \qquad Max\ U = U(F_{\sup er}, F_{open}, F_{haw\,\ker}, NF)$$

$$(2) \qquad s.t.\ \mathrm{I} = \mathrm{P}_{\mathrm{F}_{\mathrm{super}}} \bullet F_{\sup er} + \mathrm{P}_{\mathrm{F}_{\mathrm{open}}} \bullet F_{open} + \mathrm{P}_{\mathrm{F}_{\mathrm{hawker}}} \bullet F_{haw\,\ker} + NF$$

where F's are food quantities purchased in each food outlet, NF is the non-food consumption quantity, and P's are the corresponding price indexes (the price of non-food goods are normalized). By solving the above constrained maximization model, the optimal consumption quantity is a function of price index, income, and the household preference parameter w (Equation 3). Here, k denotes different food retail outlet formats. It is worth noting that w captures the particular utility function form.

$$(3) \qquad F_k^* = f(P_{F_{\sup er}}, P_{F_{open}}, P_{F_{haw\,\ker}}, \mathrm{I}, \omega)$$

Given the price stability assumption, the optimal food shopping frequency Fre_k^*, which is positive and proportional to the corresponding food product quantity, is a function of both income and household preference parameter.

$$(4) \qquad Fre_k^* = f(\mathrm{I}, \omega \,|\mathrm{P}_{\mathrm{F}_{\mathrm{super}}}, \mathrm{P}_{\mathrm{F}_{\mathrm{open}}}, \mathrm{P}_{\mathrm{F}_{\mathrm{hawker}}})$$

Although household preferences are often unobservable, they can be shaped by socio-economic factors, such as education and occupation (McDowell et al. 1997; Bittencourt et al. 2007; Jolly et al. 2008), and demographic factors including age, gender, and household composition (Han and Wahl 1998; Ricciuto et al. 2006; Bittencourt et al. 2007; Quaye et al. 2009).

Data

This study uses data generated by a project focusing on the urban population in Ghana. For the purpose of learning about urban population food purchase and consumption habits, three cities were selected: Tamale, Takoradi, and Accra. The cities are located in two distinct ecological zones. Tamale is in the northern part of the country in the dry savannah zone, while Takoradi and Accra are in the coastal zone. Tamale and Takoradi are two centers of regional economic and cultural activity, while the inclusion of the greater Accra area was dictated by its sheer size and leading commercial role in the country. This selection also captures differences in regional

economic development and possible differences in household structure and behavior resulting from varying ethnicities in the local populations. Ethnic differences posed a challenge in data collection, since it required training a different set of enumerators fluent in the local languages (besides English) in the northern and coastal areas.

The data was collected using a survey instrument specifically developed from a larger project in Ghana. The survey instrument included several sections, and each was devoted to a different issue. One section was on general shopping habits, including questions about food expenditure, while other sections probed for the type of foods consumed and food attributes as well as consumption frequency of selected foods. Respondents were also asked about household characteristics such as income, education, and household size.

After the preparation of the questionnaire, data collection in the three cities took place between February and June, 2011. Households surveyed in Tamale were part of the sample surveyed by the National Statistical Service and the enumerators had previously participated in data collection through personal interviews there. Pilot testing of the questionnaire took place on the first day of data collection and did not reveal any potential problems in communicating issues or respondent difficulty in providing answers. During the following days, completed questionnaires were immediately reviewed for potential response errors and data were entered concurrently into a spreadsheet. Similar procedures were applied to data collection in Takoradi and Accra. Households in the two cities were selected based on the previous experience of the surveying team from earlier surveys. A total of 1,010 completed questionnaires were collected including 188 households in Tamale, 210 in Takoradi, and 612 in Accra.

Table 1A (see Appendix) shows the summary of the important descriptive statistics of the variables included in this study, and provides variable description and units of measurement. The respondents' ages range from 17 to 80 years old and the mean age is 39.2 years. More than 98 % of respondents are females, who are commonly in charge of food shopping and preparation in Ghana, and 75.3 % of respondents are married. Also, 64.2 % of respondents are self-employed, 24.2 % work in the government sector or civil departments, while the remaining 11.6 % are retired, students, or unemployed. In the month preceding the survey, the recorded income ranges from 5 Ghanaian cedis to 8,500 Ghanaian cedis with the mean of 646.6 Ghanaian cedis ($1 = 1.4965 Ghanaian cedi on May 1, 2011).

Empirical Model

Choice of food retail outlets and the patronage frequency related to each store format is assumed to reflect consumer purchasing behavior, which is further determined by certain key factors such as socio-economic and demographic characteristics. To explore the determinant of food retail outlet choice, three parallel equations are applied to examine the determinants of household food purchase frequency at each food outlet type (supermarkets, open-air markets, and hawkers). The shopping frequency at each food outlet is measured on a scale from one to five with the increasing number indicating more frequent shopping in a certain outlet type (i.e., 1=almost never, 2=once a month, 3=every other week, 4=once a week, 5=more than once a week), which is the dependent variable. The explanatory variables include socio-demographic characteristics

and location (i.e., household income, education, occupation, age, marital status, household composition, and regional location).

First, the ordinal logit regression model is applied in this study to investigate the socio-demographic factors effect on an urban household's food shopping frequency at each food outlet. Social science research commonly uses ordinal numbers to measure and quantify phenomena transformed into variables. The ordinal logit model, also known as the proportional-odds model, has been broadly applied to analysis of categorical data and has a simple interpretation of the odds ratio (Fullerton 2009). The basic framework of the ordinal logit regression is in Equation 5, where Y* is the latent variable behind the food shopping frequency, X denotes the selective explanatory variable vector, B is the coefficient vector, and e is the error term which is assumed to follow logit distribution.

$$(5) \quad Y^* = X\beta + \varepsilon$$

The relation between the latent variable Y* and the dependent variable Y is defined in Equation 6. When the latent variable is between particular cut points, the dependent variable is equal to a certain ordinal level, where Cut's are parameters needing to be estimated assuming $Cut_{i-1} < Cut_i$ (because of convenience in model expression, Cut_0 and Cut_5 are used to denote negative infinite and infinite) (Sajaia 2008). The probability of food shopping frequency equaling a certain number i can be expressed as the difference between two Cumulative Distribution Functions (CDFs) of logit distribution (Equation 7). For each food retail outlet format equation, the likelihood function of the empirical model (Equation 8) is the product of all possible probabilities with the indicator variable d as corresponding power, and N is the total sample size.

$$(6) \quad Y = i, \text{ if } Cut_{i-1} < Y^* < Cut_i, \text{ where i} = 1, 2, 3, 4, 5$$

$$(7) \quad \begin{aligned} \Pr ob(Y = i) &= \text{Prob}(Cut_{i-1} < Y^* < Cut_i) \\ &= \text{Prob}(Cut_{i-1} - \text{X}\beta < e < Cut_i - \text{X}\beta) \\ &= \text{F}(Cut_i - \text{X}\beta) - \text{F}(Cut_{i-1} - \text{X}\beta) \end{aligned}$$

$$(8) \quad Likelihood = \prod_j \prod_i \Pr ob(Y = i)^{d(Y=i)}, \text{ where j} = 1,2, \ldots \text{N},$$

$$\text{d} = 1 \text{ if Y} = \text{i; d} = 0 \text{ otherwise.}$$

Second, the marginal effects are further computed to quantify each significant socio-demographic factor's effect on the probability of each food shopping frequency level. For example, the marginal effects of income measure the change in the probability of shopping for food in each frequency category (i.e., almost never, once a month, every other week, once a week, and more than once a week) caused by a one-unit increase in income. The calculation equation can be seen in Equation 9 (Greene 2003).

$$(9) \quad \frac{d\Pr ob(Y = i)}{dX_l} = -\beta_l[\text{f}(Cut_i - \text{X}\beta) - \text{f}(Cut_{i-1} - \text{X}\beta)]$$

Results

Food Retail System Structure

The survey provides information about the shopping frequency in each retail outlet type. Among responding households, 7.3 % report shopping for food at supermarkets "more than once a week," 9.8 % "once a week," 8.4 % "every other week," 25.0 % "once a month," and the remaining 48.5 % "almost never." In terms of outlet type, given the above mentioned frequency categories, the proportions of households that report buying food in open-air markets are 36.3, 32.8, 16.3, 11.4, and 3.3 %, respectively; for "shop food from hawkers," the percentages are 16.5, 9.9, 11.9, 10.8, and 51 %, respectively. Based on the shopping frequencies for each food retail outlet type listed above, it is clear that the open-air market dominates the food retail system in Ghana. Nearly 70 % of responding urban households report shopping for food at least once a week in open-air markets.

As the oldest and most common food retail format, hawkers still play an active role in Ghana's food supply. About 16.5 % of households reported buying their food from hawkers more than once a week. Compared with the two traditional outlets, the supermarket has been accepted as one of the main food retail outlets by nearly twenty percent of the responding households, who buy their food from supermarkets "once a week" or "more than once a week".

Determinants of Food Shopping Frequency

According to the results from the ordinal logit estimation (Table 1), the demographic factors (i.e., marital status, age, household structure), socio-economic factors (i.e., income, occupation, and attained education level), and location are found to have a statistically significant effect in determining the food shopping frequency. Tables 2, 3, and 4 show the marginal effects of key factors associated with the food purchase frequency for each of three outlet types, i.e., supermarket, open-air market, and hawkers.

Supermarkets. Income has a significant positive influence on food shopping frequency in supermarkets. The result is consistent with a previous finding in Kenya (Okello et al. 2011). However, in our study, a 25 % growth of the household monthly income decreases the probability of "almost never" buying food in a supermarket by only one percent. Although income is an essential factor, the magnitude of its effect is still quite small.

Moreover, respondents with a secondary or college education are more likely to buy food in supermarkets frequently. This finding is similar to the result obtained in the study conducted in greater Tunis (Tessier et al. 2010). In the present study, respondents admitting to have a college education have a 14.4 % higher probability to patronize supermarkets "more than weekly." Well-educated households are more concerned about food quality and variety (Sanlier and Karakus 2010) and supermarkets can address their concerns. Supermarkets offer a wide choice of food items and the high quality standards and nutrition of procured products (Rao and Qaim 2011).

Table 1. Estimation results of the food purchase frequency by three outlet types in urban households of Ghana, 2011.

Variable name	Supermarket	Open-air market	Hawker
		Demographic factors	
Married	0.25349*	-0.24350*	0.04522
	(0.151)	(0.142)	(0.149)
Age	-0.00431	-0.01200**	0.00704
	(0.006)	(0.006)	(0.006)
Age_3	-0.02985	0.16904*	0.20744**
	(0.102)	(0.10348)	(0.104)
Age_12	-0.07427	0.09581	0.02942
	(0.063)	(0.06008)	(0.060)
Age_18	-0.05023	0.06092	-0.02516
	(0.055)	(0.053)	(0.054)
Age_60	0.08472**	0.09567**	0.11536***
	(0.038)	(0.038)	(0.037)
Age_61	-0.03926	0.02435	0.12588
	(0.122)	(0.119)	(0.126)
		Socio-economic factors	
Income	0.00022***	-0.00009	-0.00040***
	(0.000)	(0.000)	(0.000)
Employ_self	-0.08531	-0.38872**	-0.01709
	(0.198)	(0.193)	(0.200)
Employ_gov	0.20216	-0.32851	-0.13058
	(0.228)	(0.224)	(0.238)
Educ_sec	0.87222***	-0.15811	-0.17102
	(0.144)	(0.139)	(0.144)
Educ_col	1.52828***	-0.93490***	-0.627**
	(0.225)	(0.216)	(0.249)
		Location	
Tamale	0.07856	0.09129	1.10924***
	(0.183)	(0.175)	(0.175)
Takoradi	0.78090***	-0.39179**	0.61091***
	(0.159)	(0.155)	(0.161)
Cut1	0.79496	-4.54563	0.600
	(0.359)	(0.397)	(0.362)
Cut2	2.04273	-2.78762	1.11436
	(0.365)	(0.359)	(0.364)
Cut3	2.66764	-1.73911	1.75667
	(0.36961)	(0.353)	(0.367)
Cut4	3.66458	-0.25385	2.416
	(0.382)	(0.347)	(0.370)

Note. *, ** and *** denote significant at 10%, 5%, and 1% levels, respectively. Standard errors are in parentheses.

Table 2. Marginal effects in food purchase frequency of supermarkets.

Variable name/ dy/dx	Almost never	Once a month	Every other week	Once a week	More than once a week
			Demographic factors		
Married*	-0.0632387 (0.03756)	----------	0.0147729 (0.00876)	0.0169546 (0.00977)	0.0135593 (0.00771)
Age_60	-0.0211027 (0.00939)	0.0054482 (0.00252)	0.0049871 (0.00228)	0.00588 (0.00267)	0.0047874 (0.00217)
			Socio-economic factors		
Income	-0.0000555 (0.00002)	0.0000143 (0.00001)	0.0000131 (0.00001)	0.0000155 (0.00001)	0.0000126 (0.00000)
Educ_sec*	-0.2121363 (0.03359)	0.0435194 (0.00876)	0.0500256 (0.00921)	0.0636016 (0.0119)	0.0549896 (0.01113)
Educ_col*	-0.3300998 (0.038)	----------	0.06942 (0.0092)	0.1264217 (0.02123)	0.1442641 (0.03269)
			Location		
Takoradi*	-0.1872556 (0.03586)	0.0276917 (0.00639)	0.0445592 (0.00954)	0.0604423 (0.01423)	0.0545624 (0.01416)

Note. This table only reports the results at 10% significance level. Standard errors are in parentheses; (*) dy/dx is for discrete change of dummy variable.

Table 3. Marginal effects in food purchase frequency of open-air markets.

Variable name/ dy/dx	Almost never	Once a month	Every other week	Once a week	More than once a week
			Demographic factors		
Married*	0.0055726 (0.00322)	0.0205246 (0.01152)	0.0233722 (0.0136)	----------	-0.0562913 (0.03327)
Age	0.0002908 (0.00016)	0.001056 (0.00054)	0.0011583 (0.00059)	----------	-0.0027301 (0.00138)
Age_60	-0.0023241 (0.001)	-0.0084385 (0.00338)	-0.0092564 (0.00372)	----------	0.0218166 (0.00864)
			Socio-economic factors		
Employ_self*	0.0089824 (0.00454)	0.0329462 (0.01591)	0.0372042 (0.01837)	----------	-0.0895679 (0.04485)
Educ_col*	0.0321641 (0.01141)	0.1017855 (0.02837)	0.0814316 (0.01619)	----------	-0.1854857 (0.03607)
			Location		
Takoradi*	0.0106317 (0.00503)	0.0372135 (0.01592)	0.0373742 (0.01475)	---------	-0.085626 (0.03248)

Note. This table only reports the results at 10% significance level. Standard errors are in parentheses; (*) dy/dx is for discrete change of dummy variable.

Table 4. Marginal effects in food purchase frequency of hawkers.

Variable name/ dy/dx	Almost never	Once a month	Every other week	Once a week	More than once a week
			Demographic factors		
Age_3	-0.0518047	0.0040733	0.0112732	0.0126589	0.0237993
	(0.02592)	(0.00221)	(0.00576)	(0.00645)	(0.01198)
Age_60	-0.0288084	0.0022651	0.006269	0.0070396	0.0132347
	(0.00931)	(0.00088)	(0.006269)	(0.00238)	(0.00431)
			Socio-economic factors		
Income	0.0000991	-7.79e-06	-0.0000216	-0.0000242	-0.0000455
	(0.00003)	(0.00000)	(0.00001)	(0.00001)	(0.00001)
Educ_col*	0.152306	-0.0192142	-0.0365495	-0.03569	-0.0608523
	(0.05764)	(0.01018)	(0.01522)	(0.0133)	(0.02046)
			Location		
Tamale*	-0.2654835	----------	0.0395799	0.0646276	0.1628604
	(0.03819)		(0.0061)	(0.01075)	(0.03174)
Takoradi*	-0.1510829	0.0053541	0.0283664	0.0374848	0.0798776
	(0.03894)	(0.00242)	(0.00694)	(0.01026)	(0.02385)

Note. This table only reports the results at 10% significance level. Standard errors are in parentheses; (*) dy/dx is for discrete change of dummy variable.

Furthermore, respondents from married households are found to purchase food more frequently in supermarkets, and have a six percent lower probability in "almost never" patronizing supermarkets than households of the unmarried. The finding differs from an earlier study conducted in Turkey, which indicated that supermarkets appeal equally to married and unmarried shoppers (Kaynak and Borak 1981). The current study result is consistent with a study of Chinese consumer behavior, which suggests that the positive relation between married status and supermarket patronage is due to the required single shopping trip (Mai and Zhao 2004).

In addition, household size has a positive influence on food shopping frequency in supermarkets. One additional adult increases the probability of buying food in supermarkets "more than once a week" by 4.8 %. Large households, especially those consisting of two or three generations, may demand a wide range of foods (Florkowski et al. 2002). The wide diversity of products including both food and non-food items make a supermarket the most convenient one-stop store for large households. Furthermore, results indicate that the appeal of supermarkets varies by location. Comparing with Accra households, households in Takoradi are more likely to shop for food in a supermarket, plausibly because Takoradi is a large port and commercial center of Ghana.

Open-air markets. Occupation has a significant effect on food shopping frequency in open-air markets. Compared with the unemployed, students, the retired, or the self-employed buy foods less frequently in the open-air markets. Because of the possible flexible work time, the self-employed households may spend some time in cultivating back-yard gardens to supplement their food needs.

Moreover, college-educated households have an 18.5% lower probability of shopping "once a week" for food in open-air markets, because an open-air market may not meet their high

expectations for food quality. In addition, married households are found to buy food less often at the open-air markets. Compared with unmarried households, married households have a 5.6% lower probability of patronizing open-air markets for food shopping more than weekly. It is plausible that married households demand more diverse foods and the open-air markets, providing only locally produced food products, cannot satisfy their needs.

Food needs decrease with advancing age. The likelihood of purchasing food in open-air markets "more than weekly" decreases significantly with the respondent's age. The result supports the finding of a significant relationship between age and frequency of visits to open-air markets in Hungary (Czakó and Sik 1999). In the case of the present study, 10 years added to a respondent's age decreases the probability of shopping for food "more than once a week" in open-air markets by 2.7%.

Larger households shop for foods in open-air markets more frequently. Because a large household demands a high volume of individual food products, the need for large quantities of food is easily satisfied in open-air markets because fewer foods are prepackaged or sold in uniform size packages. The presence of an additional adult in a household increases the likelihood of food shopping in an open-air market "more than weekly" by 2.2%. Location also influences the shopping frequency of open-air markets. A Takoradi household shops for food less often with a 6.5% lower probability than an Accra household in open-air markets. It appears that open-air markets appeal less to Takoradi residents.

Hawkers. Higher income households buy food items less often from hawkers than lower income households. A 25% increase in household monthly income would decrease the probability of buying food from hawkers by 1.6%. The finding of this study confirms that income significantly influences where consumers shop (Goldman et al. 1999). Furthermore, the college-educated respondents buy less frequently from hawkers, and have a 15.2% higher probability of "almost never" buying food from hawkers than respondents with less education. Due to low quality and narrow selection, hawker-sold foods could be unattractive to well-educated households.

The number of very young children (younger than 3 years old) and the number of adult household members (19-60 years old) both have a positive effect on the food shopping frequency from hawkers. Most foods sold by hawkers are ready-to-eat or prepared foods such as bagged roasted peanuts, which may appeal to households with small children. Also, households with a large number of adults have a higher demand for ready-to-eat food, because adults are likely to work. When traveling to and from work they are likely to purchase snacks and beverages from hawkers as suggested by casual observations.

Both Tamale and Takoradi residents have a higher food shopping frequency from hawkers than Accra-located households. Hawkers seem to be quite numerous outside the capital. At present, the development of Ghana's urban areas is still uneven, and hawkers adapt to various environments; in the capital they are quite visible along major routes and main intersections, while in other cities they may be more mobile and travel through neighborhoods rather than limiting their presence to heavily traveled roads.

Consumer Profile, Food Retail Outlet Choice, and Diet and Health

Results of the study indicate that supermarkets are preferred by high-income and well-educated households especially in the city of Takoradi. Because a typical supermarket has a wide selection of food products, households that frequently shop in supermarkets are more likely to be exposed to a number of healthy food products that might not be traditional to the Ghanaian diet. Offerings may include but are not limited to out-of-season vegetables and fruits or international products with high nutritional density. However, frequently, supermarket shoppers are also likely to purchase high-calorie food items including potato chips, burgers, and pizza, which have been linked to potential weight and obesity problems.

Open-air markets are found to continue to dominate the food retail system in Ghana, with 70 % of households reporting to patronize them "once a week" or "more than once a week". Open-air markets are traditional food outlets particularly attractive to large households in Accra. Thus, it is the larger households that are more likely to consume domestic and local food products including in-season vegetables and fruits, and purchase live poultry and locally supplied fish.

The mobile hawkers offering convenient shopping are more likely to attract food purchases by low-income and less-educated large households especially those having small children. Therefore, convenience foods including mostly of ready-to-eat and some food snacks sold by hawkers are more likely to be purchased by households of a lower socio-economic status than households of the better educated or higher income.

Conclusions and Implications

The expectations regarding food quality, selection, and service are growing among African consumers. The expansion of modern food retail outlet types, such as supermarkets, has begun in West Africa in recent years. Previous studies have investigated the influence of supermarket expansion from various perspectives. However, due to data limitations, very few researchers have explored the changing retail outlets from the consumer viewpoint. Modern food retailers need comprehensive information about the food supply chain to make entry or expansion decisions, while traditional food retailers need suggestions to improve their products and service to keep their business economically viable. In addition, policy makers concerned about improving consumer diets need insights to guide their strategies by recognizing the consumer group profile of each food retail outlet. Local food formats vary substantially by neighborhood demographic and socio-economic composition (Moore and Diez Roux 2006).

Different food retail formats affect consumer diet and nutrition through the food products and services they provided (Hawkes 2008; Tessier et al. 2010). This study assessed the relative importance of different food retail outlets (i.e., supermarkets, open-air markets, and hawkers, identified the socio-demographic profiles of consumers associated with shopping in each retail format, and then illustrated how the food retail outlet choices might affect consumer diet and nutrition, using the surveyed data set collected in 2011 from three big cities in Ghana (Accra, Tamale, and Takoradi).

The Relative Importance of Different Food Retail Outlets

Results of food shopping frequencies indicate that the traditional open-air markets still dominate the food retail system in Ghana. Only 3.3% of households reported that they never shop for foods in open-air markets. A large number of basic and inexpensive food products are sold in open-air markets, and it remains an integral part of the food supply chain.

Hawkers, as a traditional food retail format, fill a niche to meet consumers' specific demand for ready-to-eat foods, and attract buyers by offering shopping convenience.

As a modern food outlet, supermarkets have been gradually accepted by urban households, and the results indicate that about 17% of households purchased food in supermarkets at least weekly. Currently, supermarkets provide a wide variety of high-quality food item, and play a dynamic role in the food supply of Ghana.

Implication for Food Marketers

This study provides a broad understanding of consumer profiles and their food shopping frequency in three main food retail outlets. The gained insights facilitate the examination of an urban household's choice among food outlet types by revealing their food shopping habits and preferences, an essential prerequisite for food sales. Supermarkets have been adopted as a food retail outlet by high-income and well-educated households, especially large married households from developed urban areas. To attract additional buyers, modern food retailers may need to keep and enhance their advantage by providing quality, variety, and service. Modern retailers provide potential consumers with product or promotion information and encourage them to try the new shopping experience in supermarkets.

In spite of the expanding presence of supermarkets in West Africa, the open-air market remains a major outlet in the agri-food supply system. The open-air markets especially meet the needs of less-educated households by offering convenience and availability of inexpensive basic foods. Large households of retired or unemployed households also frequently shop in open-air markets. To retain their dominant market share, open-air market traders may need to employ strict guidelines and adopt necessary storage/protection technology to enhance food quality and the shopping environment.

Large-size, low-income, or less-educated households with small children, especially those in a non-capital area, tend to buy foods from hawkers because of the convenience and relative price. Street hawkers may retain their shopper base by providing additional ready-to-eat foods such as snack foods and beverages to attract on-site consumption.

Implications for Public Sector

Supermarkets play an increasingly substantial role affecting the diet of urban Ghana households through their mix of offerings. High-income and well-educated households, who shop regularly in supermarkets, are more likely to consume healthy food items including imported vegetables and fruits, as well as new highly nutritious food products. The wide food selection in a supermarket offers households who frequently shop there a balanced diet. Nevertheless, these

frequent supermarket shoppers are also at a relatively high risk of unhealthy weight gain because calorie-dense food items such as potato chips and chicken are also offered in supermarkets. However, policy makers need to keep in mind that the effect of any nutrition or diet intervention in modern food outlets is still limited in terms of consumer population, and those interventions generally reach only those who shop in supermarkets regularly.

The traditional food retail outlets such as open-air markets and hawkers remain essential elements in the food supply system of Ghana. Specifically in open-air markets, households can access most locally produced foods including in-season fresh vegetables and fruits. Large households, especially those with small children, buy frequently from hawkers. Therefore, monitoring the traditional food outlets is crucial to gauge food access and advance consumer diet and health, especially among low-income households in Ghana's less-developed regions. There is a need for public agencies to continue efforts to reduce the threat of food-borne diseases, by encouraging proper handling and storage of food.

Limitations of the Study

The food format's influence on consumer diet, nutrition, and health varies across countries and areas, and is affected by numerous factors including the local food retail system, the level of economic development, and consumer food purchases, perceptions, and culture. Therefore, the implications that any food retail format has positive or negative effects on consumer diet and health are uncertain. The present study illustrates implications for diet in terms of available foods in each food outlet and the profile of consumers regularly patronizing any of the three food outlet types. Future studies are needed to fully address the correlation between food availability and actual consumer purchase in each food outlet.

References

Angelidis, A. S. and K. Koutsoumanis. 2006. Prevalence and concentration of Listeria monocytogenes in sliced ready-to-eat meat products in the Hellenic retail market. *Journal of Food Protection* 69(4): 938-942.

Bittencourt, M. V. L., R. P. Teratanavat and W. S. Chern. 2007. Food consumption and demographics in Japan: Implications for an aging population. *Agribusiness* 23(4):529-551.

Carrefour Group. http://www.carrefour.com/news-releases/carrefour-partners-cfao-develop-its-banner-through-various-store-formats-eight-african (accessed July 16, 2013).

Czakó, Á., and E. Sik. 1999. Characteristics and origins of the Comecon open-air market in Hungary. *International Journal of Urban and Regional Research* 23(4): 715-737.

Davis, J. 2008. Selling wares on the streets of Accra: A case study of street hawkers in Ghana's capital. *FOCUS on Geography* 51(3): 32-36.

D'Haese, M. and G. V. Huylenbroeck. 2005. The rise of supermarkets and changing expenditure patterns of poor rural households case study in the Transkei area, South Africa. *Food Policy* 30(1):97-113.

Donkin, A., E. A. Dowler, S. J.Stevenson and S. A. Turner. 2000. Mapping access to food in a deprived area: the development of price and availability indices. *Public Health and Nutrition* 3(1):31-38.

Emongor, R., and J. Kirsten. 2009. The impact of South African supermarkets on agricultural development in the SADC: A case study in Zambia, Namibia and Botswana. *Agrekon* 48(1):60-84.

Faiguenbaum, S., J. A. Berdegue and T. Reardon. 2002. The rapid rise of supermarkets in Chile: effects on dairy, vegetable, and beef chains. *Development Policy Review* 20(4):459-471.

Farley, T. A., J. Rice, J. N. Bodor, , D. A. Cohen, R.N. Bluthenthal and D. Rose. 2009. Measuring the food environment: shelf space of fruits, vegetables, and snack foods in stores. *Journal of Urban Health* 86(5):672-682.

Field, S., O. Masakure and S. Henson. 2010. Rethinking localization—a low-income country perspective: the case of Asian vegetables in Ghana. *Cambridge Journal of Regions, Economy and Society* 3(2):261-277.

Filiousis, G., A. Johansson, J. Frey and V. Perreten. 2009. Prevalence, genetic diversity and antimicrobial susceptibility of *Listeria monocytogenes* isolated from open-air food markets in Greece. *Food Control* 20(3):314-317.

Florkowski, W. J., W. Moon, P. Paraskova, J. Jordanov, A.V.A. Resurreccion, M.S. Chinnan, and L. R. Beuchat. 2002. Customer profiles of retail food outlets in the emerging market economy of Bulgaria. *Journal of Food Distribution Research* 33(2):14-24.

Fullerton, A. S. 2009. A conceptual framework for ordered logistic regression models. *Sociological Methods & Research 38*(2):306-347.

Ghana. 2013. Ghana: 1.12 million registered vehicles. http://african.howzit.msn.com/africa-entertainment/africa-entertainment- gallery.aspx?cp-documentid=256379131&page=10 (accessed Dec 17, 2013).

Goldman, A. 2000. Supermarkets in China: The case of Shanghai. *The International Review of Retail, Distribution and Consumer Research* 10(1):1-21.

Goldman, A., and H. Hino. 2005. Supermarkets vs. traditional retail stores: diagnosing the barriers to supermarkets' market share growth in an ethnic minority community. *Journal of Retailing and Consumer Services* 12(4), 273-284.

Goldman, A., R. Krider and S. Ramaswami. 1999. The persistent competitive advantage of traditional food retailers in Asia: wet markets' continued dominance in Hong Kong. *Journal of Macromarketing* 19(2):126-139.

Goldman, A., S. Ramaswami and R. E. Krider. 2002. Barriers to the advancement of modern food retail formats: theory and measurement. *Journal of Retailing* 78(4):281-295.

Gorton, M., J. Sauer and P. Supatpongkul. 2011. Wet markets, supermarkets and the "big middle" for food retailing in developing countries: Evidence from Thailand. *World Development* 39(9):1624-1637.

Greene, W. H. 2003. Econometric Analysis, 5th edition: Pearson Education India. p.738.

Han, T., and T. I. Wahl. 1998. China's rural household demand for fruit and vegetables. *Journal of Agricultural and Applied Economics* 30: 141-150.

Hanashiro, A., M. Morita, G.R. Matté, M.H. Matté and E. A. Torres. 2005. Microbiological quality of selected street foods from a restricted area of Sao Paulo city, Brazil. *Food Control* 16(5):439-444.

Hawkes, C. 2008. Dietary implications of supermarket development: A global perspective. *Development Policy Review* 26(6):657-692.

Hu, D., T. Reardon, S. Rozelle, P. Timmer and H. Wang. 2004. The emergence of supermarkets with Chinese characteristics: challenges and opportunities for China's agricultural development. *Development Policy Review* 22(5): 557-586.

Jolly, C. M., R.T. Awuah, S.C. Fialor, K.O. Agyemang, J. M. Kagochi and A.D. Binns. 2008. Groundnut consumption frequency in Ghana. *International Journal of Consumer Studies* 32(6):675-686.

Johnson, P.N. T., and R. M. Yawson. 2000. Enhancing the food security of the peri-urban and urban poor through improvements to the quality, safety and economics of street-vended foods. Report on Workshop for "Stakeholders, Policy makers and regulators of Street food vending in Accra," Miklin Hotel, Accra, Sept 25-26.

Kaynak, E. and E. Borak. 1981. Retailing institutions in developing countries: determinants of supermarket patronage in Istanbul, Turkey. *Journal of Business Research* 9(4): 367-379.

Kearney, J. 2010. Food consumption trends and drivers. *Philosophical Transactions of the Royal Society B: Biological Sciences* 365(1554): 2793-2807.

Kwatson Ltd. http://www.kwatsons.com/activities/maxmart.asp (accessed July 16, 2013).

Louw, A., D. Jordaan, L. Ndanga and J. F. Kirsten. 2008. Alternative marketing options for small-scale farmers in the wake of changing agri-food supply chains in South Africa. *Agrekon* 47(3):287-308.

Louw, A., H. Vermeulen, J. Kirsten and H. Madevu. 2007. Securing small farmer participation in supermarket supply chains in South Africa. *Development Southern Africa* 24(4):539-551.

Mai, L. and H. Zhao. 2004. The characteristics of supermarket shoppers in Beijing. *International Journal of Retail & Distribution Management* 32(1):56-62.

Mashinini, N. 2006. Ross McLaren, Retired President and CEO, Shaw's Supermarket, Inc. - The Changing Consumer: Demanding but Predictable. *International Food and Agribusiness Management Review* 9(2):103-108.

McClelland, W. G. 1962. Economics of the supermarket. *The Economic Journal* 72(285):154-170.

McDowell, D. R., J. E. Allen-Smith and P. E. McLean-Meyinsse.1997. Food expenditures and socioeconomic characteristics: focus on income class. *American Journal of Agricultural Economics* 79(5):1444-1451.

McLoughlin, D., S. Bourne, M. Shelman, F. Bradley, and A. Connolly. 2012. Towards a branded food economy in China: Industry speaks. *International Food and Agribusiness Management Review* 15(4):177-184.

Mensah, P., D. Yeboah-Manu, K. Owusu-Darko and A. Ablordey. 2002. Street foods in Accra, Ghana: how safe are they? *Bulletin of the World Health Organization* 80(7):546-554.

Michimi, A., and M. C. Wimberly. 2010. Associations of supermarket accessibility with obesity and fruit and vegetable consumption in the conterminous United States. *International Journal of Health Geographics* 9(49):94-112.

Min, H. 2006. Developing the profiles of supermarket customers through data mining. *The Service Industries Journal* 26(7):747-763.

Minten, B. and T. Reardon. 2008. Food prices, quality, and quality's pricing in supermarkets versus traditional markets in developing countries. *Applied Economic Perspectives and Policy* 30(3):480-490.

Moore, L. V. and A. V. Diez Roux. 2006. Associations of neighborhood characteristics with the location and type of food stores. *American Journal of Public Health* 96(2): 325-331.

Morland, K., A. V. Diez Roux and S. Wing. 2006. Supermarkets, other food stores, and obesity: the atherosclerosis risk in communities study. *American Journal of Preventive Medicine* 30(4):333-339.

Moser, R., R. Raffaelli and D. Thilmany-McFadden. 2011. Consumer preferences for fruit and vegetables with credence-based attributes: A review. *International Food and Agribusiness Management Review* 14(2):121-141.

Neven, D., T. Reardon, J. Chege and H. Wang. 2006. Supermarkets and consumers in Africa: the case of Nairobi, Kenya. *Journal of International Food & Agribusiness Marketing* 18(1-2):103-123.

Nigeria. Food in Nigeria - Nigerian Food, Nigerian Cuisine. http://www.foodbycountry.com/Kazakhstan-to-South-Africa/Nigeria.html. (accessed December 17, 2013).

Okello, J. J., Lagerkvist, C.-J., Hess, S., Ngigi, M., and Karanja, N. 2011. Choice of fresh vegetable retail outlets by developing-country urban consumers: the case of kale consumers in Nairobi, Kenya. *European Journal of Development Research* 24(3): 434-449.

Quaye, W., O. Gyasi, P. Larweh, P.N.T. Johnson and P. Obeng-Aseidu. 2009. The extent of marketability and consumer preferences for traditional leafy vegetables–a case study at selected markets in Ghana. *International Journal of Consumer Studies* 33(3):244-249.

Rane, S. 2011. Street vended food in developing world: hazard analyses. *Indian Journal of Microbiology* 51(1):100-106.

Rao, E. J. and M. Qaim. 2011. Supermarkets, farm household income, and poverty: insights from Kenya. *World Development* 39(5):784-796.

Reardon, T., C. B. Barrett, J. A. Berdegué and J. F. Swinnen. 2009. Agrifood industry transformation and small farmers in developing countries. *World Development* 37(11): 1717-1727.

Reardon, T., and R. Hopkins. 2006. The supermarket revolution in developing countries: policies to address emerging tensions among supermarkets, suppliers and traditional retailers. *The European Journal of Development Research* 18(4): 522-545.

Reardon, T., C. P. Timmer, C. B. Barrett and J. Berdegue. 2003. The rise of supermarkets in Africa, Asia, and Latin America. *American Journal of Agricultural Economics* 85(5): 1140-1146.

Reardon, T., P. Timmer and J. Berdegue. 2004. The rapid rise of supermarkets in developing countries: induced organizational, institutional, and technological change in agrifood systems. *Electronic Journal of Agricultural and Development Economics* 1(2):168-183.

Ricciuto, L., V. Tarasuk and A. Yatchew. 2006. Socio-demographic influences on food purchasing among Canadian households. *European Journal of Clinical Nutrition* 60(6): 778-790.

Rose, D. and R. Richards. 2004. Food store access and household fruit and vegetable use among participants in the US Food Stamp Program. *Public Health Nutrition* 7(8):1081-1088.

Sajaia, Z. 2008. Maximum likelihood estimation of a bivariate ordered probit model: implementation and Monte Carlo simulations. *The Stata Journal* 4(2):1-18.

Sanlier, N. and S. S. Karakus. 2010. Evaluation of food purchasing behaviour of consumers from supermarkets. *British Food Journal* 112(2):140-150.

Shepherd, A. 2005. The implications of supermarket development for horticultural farmers and traditional marketing systems in Asia. Rome, FAO.

Tessier, S., P. Traissac, N. Bricas, B. Maire, S. Eymard-Duvernay, J. El Ati and F. Delpeuch. 2010. Food shopping transition: Socio-economic characteristics and motivations associated with use of supermarkets in a North African urban environment. *Public Health Nutrition* 13(9):1410.

Tessier, S., P. Traissac, B. Maire, N. Bricas, S. Eymard-Duvernay, J. El Ati and F. Delpeuch. 2008. Regular users of supermarkets in greater Tunis have a slightly improved diet quality. *The Journal of Nutrition* 138(4):768-774.

Theodoridis, P. K. and K. C. Chatzipanagiotou. 2009. Store image attributes and customer satisfaction across different customer profiles within the supermarket sector in Greece. *European Journal of Marketing* 43(5/6):708-734.

Toh, P. S. and A. Birchenough. 2000. Food safety knowledge and attitudes: culture and environment impact on hawkers in Malaysia. Knowledge and attitudes are key attributes of concern in hawker foodhandling practices and outbreaks of food poisoning and their prevention. *Food Control* 11(6):447-452.

Appendix

Table 1A. Descriptive statistics of variables included in the empirical model.

Variable name	Variable description / units of measurement	Mean	Std dev
Dependent variable:			
Freq_market	How often do you buy food products in the market? Almost never=1; once a month=2; every other week=3; once a week=4; more than once a week=5	3.870	1.100
Freq_super	How often do you buy food products in the supermarket? Almost never=1; Once a month=2; Every other week=3; Once a week=4; More than once a week=5	2.056	1.292
Freq_hawker	How often do you buy food products from the hawkers? Almost never=1; once a month=2; every other week=3; once a week=4; more than once a week=5	2.272	1.538
Independent variables:			
	Demographic factors		
Married	=1 if a respondent is married	0.753	0.431
Age	Actual age in years	39.222	10.656
Age_3	Number of household members 3 years old or younger	0.363	0.645
Age_12	Number of household members between 4-12 years old	0.945	1.067
Age_18	Number of household members between 13-18 years old	0.983	1.205
Age_60	Number of household members between 19-60 years old	2.087	1.751
Age_61	The squared number of household members 61 years old or older	0.153	0.505
	Socio-economic factors		
Income	Household income in the month preceding the survey / in Ghanaian cedis	646.070	785.081
Employ_self	=1 if a respondent is self-employed	0.642	0.480
Employ_gov	=1 if a respondent is gov/civil employee	0.243	0.429
Educ_sec	=1 if a respondent has a secondary education (including Senior high/GCE O-A level, Vocational school, Technical school, or Teacher training)	0.382	0.486
Educ_col	=1 if a respondent has a college education (including university postgraduate)	0.134	0.340
	Location		
Tamale	=1 if a household is in Tamale	0.186	0.389
Takoradi	=1 if a household is in Takoradi	0.208	0.406

International Food and Agribusiness Management Review
Volume 17 Special Issue A, 2014

Trans-Border Reformulation: US and Canadian Experiences with *trans* Fat

Neal Hooker[ⓘa] and Shauna Downs[b]

[a]*Professor, John Glenn School of Public Affairs, The Ohio State University, 210R Page Hall, 1810 College Road, Columbus, Ohio, 43210, USA*

PhD. Candidate, Menzies Centre for Health Policy, The University of Sydney, Victor Coppleson Building - D02, Sydney, NSW 2006 Australia

Abstract

Food managers are engaged in altering the nutritional quality of diets. They do so directly through product innovation strategies (food manufacturers) and the selection of products available in stores (grocers and restaurants) and indirectly through distribution and promotion strategies and prices. Decisions to alter products, menus, assortments and marketing strategies are drivers of supply, which interact with consumer demand to impact the nutritional quality of food available, purchased and eventually consumed. The sequence of managerial decisions leading to product-level marketing mixes is explored.

This case-study provides a comparison of monitored industry self-regulation of *trans* fat (Canada primarily) and more autonomous firm strategy (US primarily) on the nutrient quality of new cookies launched between 2006-12. Cookies were selected for this case-study given that they are commonly consumed and have traditionally contained *trans* fat. Differences between food labeling policies in the US and Canada are then compared to explore the merits of a conceptual model.

Keywords: food reformulation, adoption, assimilation, public health

ⓘCorresponding author: Tel: + 1.614. 292-8188
Email: N. H. Hooker: hooker.27@osu.edu
S. Downs: shauna.downs@sydney.edu.au

Introduction

Product innovation and reformulation has the potential to improve diet quality, provided that consumers purchase and consume adjusted products. Reformulation and launch of novel products with better quality lipid ingredients serves as a simple test of managerial response to food policy. Do managers respond to changes in labeling policy? This case study explores two nuances of the role of managers in shaping food demand, diet and health - adapting to the local environment and the role of voluntary initiatives. We conducted a comparative study of the responses of managers in the US and Canada to similar policy approaches. The main difference between the approaches taken by the two countries was the Canadian government's threat of additional legislation if managers did not comply with voluntary *trans* fat limits in food by 2009. However, many cookies are available for sale on both sides of the border. Thus, certain managerial decisions may impact the availability of *trans* fat in both nations. We explore if there were different food innovation responses in the US and Canada.

To impact public health through food innovation at least five sequential steps in managerial decision making play a role (see Figure 1). 1) Managers need to be aware of external/internal, demand/supply or policy drivers of change (diffusion); 2) when, and how will new ingredients be used (adoption); 3) how much will processing and product characteristics be changed (assimilation); 4) will these changes be consistent (adherence); and finally, 5) what balance of marketing strategies will distribute, communicate and value these product changes? Merging traditional industrial organization (Structure-Conduct-Performance) and population health (belief-behavior-cues to action) frameworks into the theory of diffusion of innovation (Rogers, 2003) we present a conceptual model of a path towards the impact of these managerial decisions on food demand, diet and health. This model is presented within the context of a particular public health-food innovation dynamic and comparative study – *trans* fat in the US and Canada (Schleifer 2011, 2012 and 2013).

Background

The World Health Organization (WHO) has acknowledged the role that the private sector can play in limiting the levels of saturated and *trans* fat in processed food products, through product reformulation (WHO 2004). These innovations need to be part of broader efforts to improve the quality of the food supply, inform and educate consumers in order to reduce the risk of diet-related chronic disease (WHO 2004).

Artificial *trans* fat is produced through the process of hydrogenation resulting in a stable fat that can withstand repeated heating at high temperatures while providing an extended shelf life. Although it was previously favored by the food industry because of these properties, its consumption has been associated with an increased risk of cardiovascular disease (Teegala et al. 2009, Mozaffarian et al. 2009). In response to these public health consequences various efforts to remove *trans* fats from the global food supply have been attempted. Unlike any other food component artificial *trans* fats serve no beneficial nutrition purpose and their consumption should be reduced as much as possible (Uauy et al. 2009). In order to maximize health gains from removing *trans fat*, the WHO recommends replacing it with unsaturated fats (WHO 2004 and 2013). Indeed, the US Food and Drug Administration (FDA) has recently proposed a policy

which would categorize partially-hydrogenated vegetable oils (PHVOs) as unsafe, requiring pre-market approval for their continued use (FDA 2013). Food processing firms can (and in the future may have to) help improve diet quality by reducing the use of certain fats while controlling the level of other nutrients. This paper tracks managerial responses to the inclusion/standardization of *trans* fat information on food labels in the US and Canada.

The US and Canada chose subtly different strategies to promote the reduction of artificial *trans* fat in processed foods. Both included *trans* fats on Nutrition Facts panels around the same time (December 2005/January 2006 for Canada/US respectively). The US selected a threshold of 0.5g/serving above which products could not claim on the front of the pack to be *trans* fat free. Canada selected a more restrictive threshold of 0.2g/serving in addition to the more binding constraint of less than 2g/serving for the sum of *trans* and saturated fat[1]. In addition, Health Canada adopted the recommendations of the *Trans Fat Task Force* setting two public health goals to be met by 2009 (Health Canada, 2006):

1. Limit the *trans* fat content of vegetable oils and soft, spreadable margarines to 2% of the total fat content, and
2. Limit the *trans* fat content for all other foods to 5% of the total fat content, including ingredients sold to restaurants.

Although the Canadian Government had threatened legislation if the food industry didn't meet the recommendations by 2009, neither nation chose to ban *trans* fats in processed foods unlike other countries worldwide (Downs et al. 2013). The US and Canada opted for a collaborative, industry partnership and communication approach. Similar efforts, such as the provision of front of pack nutrition marketing messages (Van Camp et al. 2012b) have met with mixed success. Further, the recent move by the FDA suggests that the US will now take a stronger regulatory approach (FDA 2013).

This voluntary environment provided opportunities for managerial responses at various stages of the food supply chain. This can be characterized by the speed, nature, and completeness of product and process innovation and the set of marketing strategies selected by food firms operating in each nation, retailers and food manufacturers' alike.

The FDA adopted this policy in 2003 in response to a petition from the Centre for Science in the Public Interest and to published studies linking *trans* fat intakes with increased cholesterol levels in blood (FDA 2003). The FDA adopted labeling policies in 2003 and Health Canada in 2004 in order to provide consumers with additional standardized product information needed to make healthier food choices. As both countries adopted regulation a few years prior to it being implemented, companies likely started reviewing *trans* fat in their products prior to the deadline for compliance. In 2001-02, 42% of cookies sold in the US used PHVOs as their main oil ingredient and by 2005-06 this had already dropped to 15% (Unnevehr and Jagmanaite 2008). Heath Canada (2006) suggested cookies were "easy" (for firms) to find an alternative for *trans* fat, while cautioning that consumers might be led into choices with a higher saturated fat content.

[1] Serving size for cookies is 30g in the US and 30-40g in Canada.

Our study builds on Rahkovsky et al. (2012) and Van Camp et al. (2012a) for the US and Ratnayate et al. (2009) and Health Canada (2006) for Canada which document initial reductions in *trans* fat content of processed foods prior to 2006.

There were likely three main market incentives which led to the reduction of *trans* fat in food over the period 2003-12: mandatory disclosure of *trans* fat information on food labels; product liability and lawsuits; and the banning of products by countries, states and cities (Unnevehr and Jagmanaite 2008). The media attention garnered by the labeling regulation and by *trans* fat bans in Denmark and New York City (which happened prior to 2006) likely contributed to increased consumer demand for low *trans* fat products, fueled by enhanced knowledge and awareness of *trans* fat (Eckel et al. 2009).

What do we know about Food Innovation?

Traditional studies of food innovation build from the ***diffusion*** literature (Rogers 2003) where an internal or external driver for change (or policy environment) raises the awareness of an issue, process or product attribute. Responding to this, managers and consumers are placed along the continuum of early adopter-mainstream-laggard. Such an approach can accommodate the joint supply and demand aspects of ***adoption*** so may be useful in this discussion where firms supply products in part due to consumer interest and also to increase awareness and demand. As a next step, Sporleder et al. (2008) and Shanahan et al. (2008) provide a basis to consider the combined processes of adoption and ***assimilation*** of food innovations using the context of the US National Organic Program. In this study both are prompted by a trigger, here the policy requirements of *trans* fat labeling. Think of the adoption decision as the selection of key inputs and food processing steps by the firm targeting *trans* fat (and saturated fat in Canada). Assimilation then considers the "spread" (or contagion) over the various products within a firms' portfolio as managers become aware of, recognize and then accept the benefits of the innovation.

An industrial organization Structure-Conduct-Performance model (e.g., Marion 1976; Porter 1987) might consider this a change in basic conditions, prompting a new pattern of conduct (innovation) and performance (change in diet quality) with feedback loops perhaps altering the structure of the (sub) sector. For example, a successful new cookie with low *trans* fat might garner consumer attention, sales and profit and then be mimicked by other brands. Cooper and Zmud (1990) add a focus on the use of the innovation within firms (and by extension consumers). The 6-step implementation process (initiation, adoption, adaptation, acceptance, routinization, and infusion) is more concisely packaged by Lewin (1951) as unfreezing, changing and refreezing. This might suggest that once change has been accepted (adoption), and once the next managerial decision of how much to implement this change (assimilation) is made that ***adherence*** through routinization (Cooper and Zmud 19990) or refreezing (Lewin 1951) will suggest the resultant level of compliance. This may not be the case if a new trigger or impetus for innovation (consumer demand, external competition or a new internal managerial decision) or novel feedback loop becomes important for a particular firm (e.g., adaptation highlights food processing concerns, ingredient sourcing, etc.). Again, firms may be placed at various stages along the early adopter-mainstream-laggard spectrum. As discussed by Henson and Heasman (1998) more research is needed to understand such compliance (policy) or more generally adherence (voluntary) decisions of food firms.

Finally, from the perspective of managerial decision making, a ***marketing*** strategy is then designed to distribute, promote and value the innovation. Integrating an understanding of the population drivers of adoption of health behaviors (e.g., Cohen et al. 2000), prices, advertisements and locations (convenience) all interact with product strategies to encourage the selection (purchase) and use (consumption) of innovative foods.[2] However, it is important to note that the conceptual model is part of a broader process of change that remains under studied. A schematic of this sequence of managerial decisions is presented in Figure 1. This conceptual framework will be applied to the findings of the case-study.

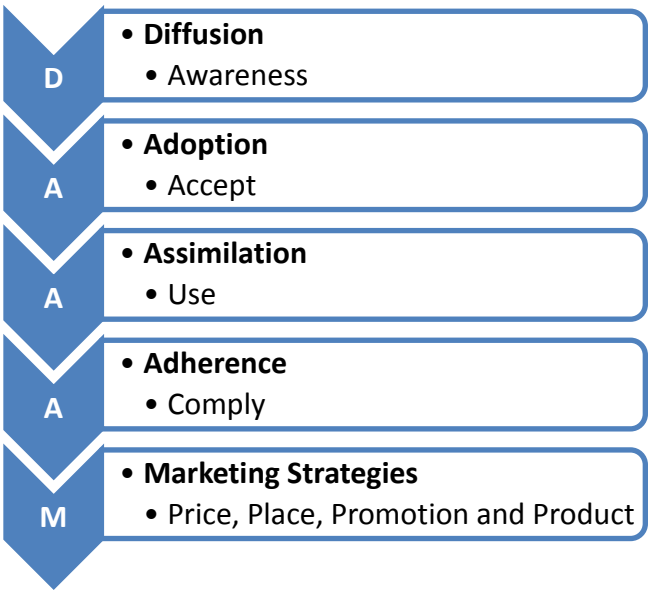


Figure 1. Conceptual Model: DAAAM A Process of Change

Objective

The overall objective of this study was to determine whether the different approaches to reduce *trans* fat in cookies implemented in the US and Canada altered the degree and speed of diffusion, adoption, assimilation, adherence and marketing of food innovations by firms. To do this we examined: 1) the nutrition composition and type of oil used, 2) the presence of front of pack nutrition claims, and 3) cookie prices.

Methods

The Mintel/GNPD (Global New Products Database) data were used to examine new cookies (all types of sweet biscuits/cookies) launched in the US and Canada between 2006 and 2012. GNPD documents a rich array of new product information and is used for competitor tracking between

[2] An extension of this framework might consider lessons from the TAM – Technology Acceptance Model (Davis et al., 1989) which relies upon the perceptions and realizations of usefulness and ease of use. The perceptions of all stakeholders; firms, consumers and policy makers would need to be incorporated.

rival companies. New product launches sold in supermarkets, drug stores, natural food stores/health shops, gas stations, convenience stores and independent outlets are included in the database. The data are compiled by looking at food label information and not through food composition analysis. Key nutrient levels for each product were compared over time, and across each country.

We selected cookies as the food category of interest in this study given that they are frequently consumed, have traditionally used *trans* fat rich PHVOs as their major lipid ingredient and progress towards *trans* fat removal in this category has been slower than other food categories (Downs et al. 2013; Unnevehr and Jagmanaite 2008). Moreover, the food industry has indicated that there may be challenges in finding a replacement lipid in bakery products given the organoleptic properties demanded by consumers (Eckel et al. 2007).

In order to compare nutrient contents across cookies with different serving sizes, we used a standardized 100g serving. Although the average suggested serving size is approximately 30 grams, consumers often exceed recommended serving sizes. The main type of oil used was identified by examining the ingredients list of individual cookie products. Given that ingredients are listed in the order of largest to smallest contribution to the cookie, we identified the first oil/fat type listed on the label as the primary oil ingredient. In many cases several types of oils are listed. However, our analyses focused on the main oil ingredient. In order to identify the proportion of oil types used, we divided the total number of cookies with each primary oil by the number of cookies per country and year.

All statistical analyses were performed using SPSS (version 19). T-tests and one-way ANOVAs were used to assess differences among groups using continuous variables and chi-squared tests were used to assess differences of categorical variables. Non-parametric tests (Mann-Whitney U-test and Kruskal Wallis test) were used to assess differences among groups of abnormally distributed variables. A p-value of <0.05 was considered statistically significant.

Results

Our data set include a total of 2,701 new cookies launched in the US and 965 in Canada over the period 2006-12. Numbers of cookie innovations are reasonably consistent over time with the exception of a recessionary dip in 2008 and 2009 in the US.

Overall, 12.2% of cookies contained *trans* fat in the US as compared to 29.6% in Canada ($p<.001$) which is surprising to see if one believes these markets to have similar diffusion-adoption-assimilation drivers. Figure 2 depicts the proportion of cookies with and without *trans* fat. The proportion of cookies without *trans* fat significantly increased over time in both countries ($p<.01$). In both countries there was a decrease in the proportion of cookies containing *trans* fat in 2009 as compared to earlier years. More specifically, in 2008 12% of US cookies contained *trans* fat as compared to 9% in 2009. In Canada, 35% of cookies in 2008 contained *trans* fat as compared to 28% in 2009. It is therefore impossible to attribute the decline in Canada to the deadline for compliance with self-regulation. Further, there is mixed evidence for Canada after this date, with little improvement in the proportion of cookies reporting any *trans* fat content (and for 2012 a reversal) perhaps indicating a step back in adherence.

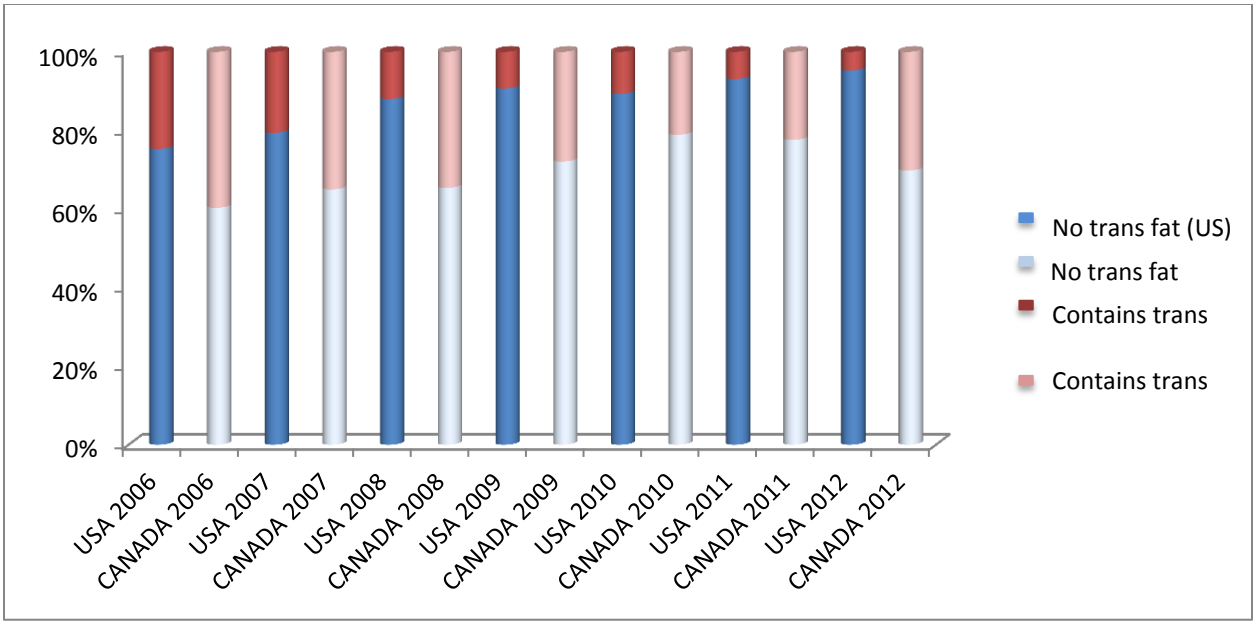


Figure 2. The proportion of products containing *trans* fat in the US and Canada from 2006 to 2012.

Although there were differences in the proportion of cookies that contained *trans* fat between the two countries the actual quantity of *trans* fat did not differ (p=.347). Table 1 (see Appendix) depicts the composition of cookies over time. There were no significant differences in key nutrients in Canadian and US cookies with the exception of 2009 where Canadian cookies had significantly more saturated fat (9.0 ± 5.6 vs 10.7 ± 6.5; p=0.015) and energy (p=0.023) than US cookies. However, sodium levels were significantly higher in the US (308.0 ± 142.4 vs 255.6 ± 145.5; p=0.002). In the US, saturated fat was higher in 2012 as compared to 2006 and 2007 and *trans* fat levels decreased over the same time period. In Canada, with the exception of reductions in *trans* fat over time, there were no differences in the composition of cookies from 2006 to 2012.

Products Containing trans Fat

The cookies that contained *trans* fat differed from those that did not contain *trans* fat in both countries. More specifically, the cookies without *trans* fat were significantly lower in energy, lower in fat and higher in protein and fiber in the US and Canada. Overall, 19% of US and 24% of Canadian cookies had front of pack product positioning claims related to *trans*, saturated or total fat. Of those cookies, 98.3% contained no *trans* fat. The relationship between saturated fat and *trans* fat was different between the two countries, though not apparently due to the joint saturated plus *trans* fat requirements of Canada. In the US, saturated fat content was significantly higher in the cookies that did not contain *trans* fat but in Canada saturated fat levels were significantly lower because those products with *trans* fat had markedly higher saturated fat contents (11.5g/100g Canada vs. 7.9 g/100g US, a significant difference). We interpret this to be partial support for the role of assimilation. Firms select nutrition quality among their product portfolios in distinct ways across the two nations.

Private Labels

Overall, there was no difference in the proportion of branded or private label cookies (12% vs 12.6%) containing *trans* fat in the US. However, in Canada 26% of branded products contained *trans* fat as compared to 45.6% of private label cookies ($p<0.01$). Retailers differ across nations, food processors less so. This therefore may be interpreted as partial support of the role of adoption decisions across types of firms in each country if one believes those contract manufacturing firms producing private label cookies in the US are not similarly producing for Canadian grocery chains.

Price

Price was significantly related to the presence of *trans* fat in cookies. Median price per 100 grams was $US 0.75 (interquartile range: $US 0.46, $US 1.48) in US cookies containing *trans* fat as compared to $ US 1.36 (interquartile range: $US 0.82, $US 2.66) in cookies without *trans* fat ($p<.001$). In Canada, the same relationship was found where cookies that did not contain *trans* fat were more expensive (Median: $US 1.79; interquartile range: $US 1.02, $US 3.51) than those containing *trans* fat (Median: $US 1.43; interquartile range: $US 0.87, $US 2.58; $p=.001$). Following the recommendations of two reviewers we referenced two producer price indices (US Bureau of Labor Statistics, 2003-13) to consider cost-based drivers of these price changes. Both the cookie and cracker manufacturing and fats and oils refining and blending series exhibited significant increases over the 2007-9 period for the former and 2007-8 period for the latter. This period coincided with general food inflation at the consumer level - firms altering marketing mixes (both product and price). Yet this general trend doesn't suggest why we see changes in the various types of fats/oils used (see below).

Product Launch Type

There were no significant differences in the energy or macronutrient content among the different types of product launches. However, cookies that were being launched with new packaging had significantly less sodium than new products and new variety/range extensions in the US ($p<.001$) and Canada ($p=.016$). Cookie re-launches were the least likely to contain *trans* fat (6.3%) as compared to other launch types (new product (17%), new variety/range (19%), new packaging (14%), new formulation (10%); $p<0.05$). This result is perplexing, while diffusion may play a role as cookies pass through a life cycle (launch-re-launch/reformulation) it isn't clear why re-launched products should be the "best." Indeed, more novel products appeared to have higher *trans* fat content.

Type of Oil Used

Overall, 71% of US and 70% of Canadian cookies contained more than one oil ingredient. Figures 3 and 4 depict the different types of oils used as the main fat ingredient in cookies launched between 2006 to 2012 in the US and Canada, respectively. In the US, the main fat ingredient was PHVOs in 2006 but by 2012 it was palm oil. In Canada, vegetable oils were the main fat ingredient used in both 2006 and 2012. Overall, in both countries the use of PHVOs decreased over time and by 2012 only 8.3% of cookies in the US and 1.3% in Canada used

PHVOs as the main oil ingredient. However, many of the shortenings - most of which were made up of hydrogenated fat in combination with another type of oil - included smaller quantities of PHVOs. In the US 31% included PHVOs as compared to only 5.4% in Canada. Of the cookies that did not report *trans* fat quantities on the label, 11.7% in the US still contained PHVOs or shortening containing PHVOs as the main oil ingredient. In Canada, only 2.7% of cookies that did not report *trans* fat on the label included PHVOs as the main oil ingredient. Cookies launched in the US provided information in the ingredients list on use of interesterification and high-oleic oils (Flickinger 2004). In 2012, 6% of cookies used interesterification and 6.8% used high-oleic oils.

Vegetable oils were blends of a variety of oils usually including a soft oil (mono or polyunsaturated) and a hard oil (palm, palm kernel or coconut). In the US, the most frequent combination was soybean and palm and in Canada it was canola and palm. Many of the cookies provided a list of oils that they may use. For example, "canola or soy and palm and palm kernel" or "sunflower or safflower", etc. In some cases, the ingredients list would provide up to six possible oils that may be used including PHVOs. Overall, 12% of US and 6% of Canadian products gave multiple possibilities for the oil used. Again, the provision of such marketing information (product and promotion strategies) is an important final step in the conceptual model.

Implications and Limitations

Managers often call for flexibility in meeting standards or new rules and regulations. Other stakeholders question the effectiveness of self-regulation and advocate for mandatory regulation. In the US this has led for continued calls for further attention to the role of *trans* fat in the diet as characterized by FDA's recent proposed policy change to classify PHVOs as unsafe (FDA, 2013). Within the food environment, manufacturers and retailers can be encouraged to change the nutritional quality of products available (whether through choice editing of the assortment or through product innovation) and to play a role in information dissemination and education. How do managers decide strategy? This case study provides a comparison of two sets of responses to self-regulation primed by mandatory inclusion of *trans* fat on food labels.

Although *trans* fat levels were already decreasing between 2001 and 2006 in the US and Canada, we found a further reduction of nearly 50% coinciding with the implementation of the labeling regulation. The types of replacement oils used in the different product formulations were variable (i.e., high in saturated fat versus high in unsaturated fats). The way managers respond to different policies in terms of product reformulation has potential health implications. We found some benefit to considering the multi-step managerial decision making process (DAAAM) but clearly more work is needed if this model is to have any predictive merit.

Given the resources required to reformulate products, it may be an opportunity not only to remove *trans* fat but also address other key nutrients as well. This would further complicate the already dense diffusion-adoption-assimilation-adherence-marketing process to overlay multiple dimensions of nutrition quality. But towards this goal, we found that cookies that did not contain *trans* fat in both countries were also less energy dense and had less fat than those that did contain *trans* fat. Moreover, the Canadian cookies that did not contain *trans* fat also had lower saturated

fat levels. These differences are important from a public health nutrition perspective, particularly for individuals who consume cookies frequently. Incremental increases in energy and fat have the potential to lead to weight gain over time and increase the risk of diet-related disease. These differences are therefore encouraging from a public health perspective but would need to be extended into a consumption data set to determine if the supply of more nutritious products is related to better quality diets. There has been some concern that industry would simply replace *trans* fat with saturated fats, which may only have a nominal impact on health. However, this case-study demonstrates that product reformulation was done in a way that resulted in relatively healthier cookies, though not uniformly. Although the reformulated products were 'healthier', it is important to note that cookies are an energy-dense, nutrient poor, ultra-processed food product and consumption should therefore be limited.

It is important to acknowledge the importance of price in both consumer decision-making and the decision-making of managers. We found that products that contained *trans* fat were cheaper than their non-*trans* fat containing counterparts. This relationship has also been found in other studies (Albers et al. 2008; Ricciuto and Tarasuk 2005). It is likely that this price differential could be attributed to alternative oil ingredients being more expensive than PHVOs as highlighted by producer price index data. This points to the need for complementary policies and approaches to reducing *trans* fat in food products and promoting the consumption of healthier oils, given that price conscious consumers may be more likely to buy lower priced products that contain *trans* fat. Interestingly, we found that nearly double the proportion of private label cookies contained *trans* fat as compared to branded cookies in Canada. It is likely that these cookies cater to price conscious consumers providing additional support for policies that go beyond nutrition labeling (e.g., *trans* fat bans) to reduce *trans* fat levels in processed food.

In addition to price, the way products are positioned can influence consumer-purchasing patterns. A substantial proportion of cookies in both Canada and US contained front of pack nutrition claims related to fat. Managers use front of pack nutrition claims as a marketing tool to promote sales (Nestle and Ludwig 2010; Van Camp et al. 2013b). They also often highlight multiple attributes and can provide a "health halo" which reduces the probability consumers explore traditional side of pack (Nutrition Facts) information for more detail. Applying our DAAAM approach to food innovation, it appears clear that various diffusion-adoption-assimilation-adherence decisions can be supported by a range of marketing strategies, including the price, product and promotion. Further firm and brand-level analysis would be useful to determine if front of pack nutrition marketing claims such as these are associated with higher quality products or not.

The conceptual model is part of a broader process of change that remains under studied. We don't consider the motivation for starting the food innovation process by policy makers for example through industry outreach and education to promote awareness. Neither do we extend the model to consider the ***impact*** of these changes in supply on nutrient intake, diet quality and wellness (which may need to accommodate lifestyle changes such as exercise, smoking, etc.). A fully integrated approach would also include feedback loops encouraging subsequent policy changes, managerial decisions and consumer reactions. The empirical case provides a perspective over time in one product category focusing (mostly) on one food component – fat.

In addition to the aforementioned limitations related to the conceptual model, there are also limitations in the data used to conduct these analyses. Although the Mintel data provides us with an understanding of the nutrient quality of new products launched, it does not provide information on market share. Moreover, we do not have information on consumption patterns, thereby limiting the analyses to the foods that are available for consumers to purchase rather than those actually purchased and consumed. Nevertheless, these findings still provide important information which have the potential to inform the policy making process. One of the implications of these study findings for policy makers is that mandatory nutrition labeling can influence the quality of food available in the market, as it becomes an impetus for product reformulation. In this context such a role was likely aided by increased consumer awareness for low *trans* products and subsequent changes in demand. The labeling regulation in both countries was likely the impetus of these changes but this study does not evaluate the direct impact of the policy on new product launches. However, the distinct implementation approaches used in the US and Canada appeared to have some role on the DAAAM food innovation process.

It is important to acknowledge that diet and wellness isn't simply a discussion of one product, one attribute or one eating occasion! Product reformulation of processed foods is only one component of a multipronged approach to improving the quality of the food supply leading to improved diets and reduced risk of non-communicable disease. Nutrition labeling of packaged foods should be complemented with broader initiatives aimed at improving access to affordable healthy foods. The national diets of the US and Canada include contributions from manufacturers and food service companies alike, so innovations from a range of food firms need to be considered when determining how to improve diet quality.

References

Albers, M.J., L.J. Harnack, L. M. Steffen and D.R. Jacobs. 2006. Marketplace survey of trans-fatty acid content of margarines and butters, cookies and snack cakes, and savory snacks. *Journal of the American Dietetic Association* 2008;108:367–70. doi:10.1016/j.jada.2007.10.045 PMID:18237584

Cohen, D.A., R.A. Scribner and T.A. Farley. 2000. A Structural Model of Health Behavior: A Pragmatic Approach to Explain and Influence Health Behaviors at the Population Level. *Preventative Medicine* 30: 146-154.

Cooper, R.B. and R.W. Zmud. 1990. Information Technology implementation research: A technological diffusion approach. *Management Science* 36(2):123-139.

Davis, FD, RP Bagozzi, and PR Warshaw. 1989. User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. *Management Science* 35(8): 982–1003

Downs S.M., A.M. Thow, and S.R. Leeder. 2013. The effectiveness of policies for reducing dietary *trans* fat: a systematic review of the evidence. *Bulletin World Health Organization.* 1-91(4):262-269.

Eckel, R. H., S. Borra, A. H. Lichtenstein and S. Y. Yin-Piazza. 2007. Understanding the Complexity of Trans Fatty Acid Reduction in the American Diet American Heart Association Trans Fat Conference 2006: Report of the Trans Fat Conference Planning Group. *Circulation* 115(16): 2231-2246.

Eckel, R. H., P. Kris-Etherton, A. H. Lichtenstein, J. Wylie-Rosett, A. Groom, K. F. Stitzel, and S. Yin-Piazza. 2009. Americans' awareness, knowledge, and behaviors regarding fats: 2006-2007. *Journal of the American Dietetic Association* 109(2): 288-296.

Flickinger, B.D. and P. J. Huth. 2004. Dietary fats and oils: technologies for improving cardiovascular health. *Current Atherosclerosis Reports* 6:468-476.

Food and Drug Administration. 2003. Guidance for Industry: *Trans* Fatty Acids in Nutrition Labeling, Nutrient Content Claims, Health Claims; Small Entity Compliance Guide. http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/LabelingNutrition/ucm053479.htm.

Food and Drug Administration. 2013. Tentative Determination Regarding Partially Hydrogenated Oils; Request for Comments and for Scientific Data and Information. *Federal Register* 78(217): 67169-75.

Health Canada. 2006. *TRANS*forming the food supply. Report of the *trans* Fat Task Force. http://www.hc-sc.gc.ca/fn-an/nutrition/gras-*trans*-fats/tf-ge/tf-gt_rep-rap-eng.php

Henson S. and M Heasman. 1998. Food Safety, Regulation and the Firm: Understanding the Compliance Process. *Food Policy* 23(1): 9-23.

Lewin, K. 1951. *Field Theory in Social Science* Harper and Row. New York.

Marion BW. 1976. Application of the Structure, Condict, Performance Paradigm to Subsector Analysis. WP-7 Dept. of Ag and Applied Econ, University of Wisconsin. www.aae.wisc.edu/fsrg/publications/archived/wp-7.pdf

Mozaffarian D., M.B. Katan, A. Ascherio, M. J. Stampfer, W.C. Willett. 2006. Trans fatty acids and cardiovascular disease. *New England Journal of Medicine* 354(15):1601-13.

Mozaffarian, D, MF Jacobson and JS Greenstein. 2010. Food Reformulations to Reduce Trans Fatty Acids. *New England Journal of Medicine*. 362(21): 2037-2039

Nestle, M., and Ludwig, D. S. 2010. Front-of-package food labels. *JAMA: The Journal of the American Medical Association* 303(8): 771-772.

Niederdeppe, J. and D.L. Frosch. 2009. News Coverage and Sales of Products with *Trans* Fat: Effects Before and After Changes in Federal Labeling Policy. *American Journal of Preventative Medicine*. 36(5): 395-401.

Porter, M.E. 1983. Industrial organization and the evolution of concepts for strategic planning: The new learning. *Managerial and Decision Economics* 4(3): 172–180.

Rahkovsky, I., S. Martinez and F. Kuchler. 2012. New Food Choices Free of Trans Fats Better Align U.S. Diets with Health Recommendations. *Economic Information Bulletin* Number 95, Economic Research Service, U.S. Department of Agriculture.

Ratnayake, W.M.N., M.R. L'Abbe and D. Mozaffarian. 2009. Nationwide Product Reformulation to Reduce *Trans* Fatty Acids in Canada: When *Trans* Fat goes out, what goes in? *European Journal of Clinical Nutrition* 63: 808-811.

Ricciuto, L., K. Lin and V. Tarasuk. 2008. A Comparison of the Fat Composition and Prices of Margarines between 2002 and 2006, When New Canadian Labelling Regulations Came into Effect. *Public Health Nutrition* 12(8): 1270-1275.

Ricciuto L., H. Ip, and V. Tarasuk. 2005. The relationship between price, amounts of saturated and trans fats, and nutrient content claims on margarines and oils. *Canadian Journal Dietetic Practice and Research* 66:252–5. doi:10.3148/66.4.2005.252 PMID:16332300.

Rogers, E.M. 2003. *Diffusion of Innovations* (5th ed.). New York: Free Press.

Schleifer, D. 2013. Categories Count: Trans Fat Labeling as a Technique of Corporate Governance. *Social Studies of Science* 43(1): 54-77.

Schleifer, D. 2012. The Perfect Solution: How Trans Fats Became the Healthy Replacement for Saturated Fats. *Technology and Culture* 53(1): 94-119.

Schleifer, D. 2011. We Spent a Million Bucks and Then We Had To Do Something: The Unexpected Implications of Industry Involvement in Trans Fats Research. *Bulletin of Science, Technology and Society*. 31 (6): 460-471.

Shanahan, C.J., N.H. Hooker and T.L. Sporleder. 2008. The Diffusion of Organic Food Products: Toward a Theory of Adoption. *Agribusiness: An International Journal* 24(3): 369-387.

Sporleder, T.L., N.H. Hooker, C.J. Shanahan and S. Bröring. 2008. Innovation in Food Products: First-Mover Strategy and Entropy Metrics. *International Food and Agribusiness Management Review* 11(3): 49-65.

Teegala S.M., W.C.Willett, D. Mozaffarian. 2009. Consumption and Health Effects of Trans Fatty Acids: A Review. *Journal of AOAC International* 92(5):1250-1257.

Uauy R., A. Aro, R. Clarke et al. 2009. WHO Scientific Update on trans fatty acids: summary and conclusions. *European Journal of Clinical Nutrition* 63:S68-S75.

Unnevehr, L.J., and E. Jagmanaite. 2008. Getting Rid of *Trans* Fats in the US Diet: Policies, Incentives and Progress. *Food Policy* 33: 497-503.

Van Camp, D., N.H. Hooker and C-T Lin. 2012a. Impact of Mandatory *Trans* Fat Labeling on the Fat Content and Composition of New Chip and Cookie Products in the United States. *Public Health Nutrition* 15(6): 1130-1137.

Van Camp, D., D.M. Souza Monteiro and N.H. Hooker. 2012b. Stop or Go? How is the UK Food Industry Responding to Front of Pack Nutrition Labeling? *European Review of Agricultural Economics* 39(5): 821-842.

World Health Organization. 2004. Global Strategy on Diet, Physical Activity and Health. http://www.who.int/dietphysicalactivity/strategy/eb11344/strategy_english_web.pdf

World Health Organization. 2013. WHO. Global Nutrition Policy Review. Geneva: WHO. http://apps.who.int/iris/bitstream/10665/84408/1/9789241505529_eng.pdf

Appendix

Table 1. Energy and nutrient composition of cookies in the US and Canada from 2006 to 2012

Energy and Nutrients	2006 (n=409)	2007 (n=438)	2008 (n=340)	2009 (n=265)	2010 (n=423)	2011 (n=416)	2012 (n=410)	p-value
				US (n=2,701)				
Energy (kcal/100g)	463 ± 78	463± 77	461± 61	452 ± 69	469 ± 104	459 ± 66	470 ± 57	.058
Fat (g/100g)	20.4 ± 7.7	19.6 ± 8.7	20.1 ± 7.8	19.9 ± 7.0	20.1 ± 7.6	19.6 ± 7.6	20.5 ± 7.4	.636
Saturated fat (g/100g)	8.4 ± 5.6[a]	8.4 ± 6.1[a]	8.7 ± 5.5	9.0 ± 5.6	9.2 ± 5.8	9.3 ± 6.9	9.9 ± 5.9[b]	.012*
Trans fat (g/100g)[§]	1.2 ± 2.5	1.1 ± 2.5	0.6 ± 1.9	0.3 ± 1.3	0.5 ± 1.5	0.3 ± 1.1	0.2 ± 0.9	.000*
Carbohydrate (g/100g)	65.8± 12.0	68.1 ± 13.1[a]	66.5± 9.1	65.2 ± 9.3[b]	66.2± 10.8	66.5 ± 10.1	66.8 ± 8.8	.049*
Protein (g/100g)	5.8 ± 5.0	5.7± 2.4	5.8 ± 2.6	5.8 ± 2.7	5.7± 2.5	5.6 ± 2.3	5.6± 2.7	.873
Fibre (g/100g)[§]	2.9 ± 4.8	2.4 ± 2.4	3.1 ± 3.6	3.3 ± 4.1	3.0 ± 5.0	2.7 ± 3.2	2.6 ± 2.9	.504
Sodium (mg/100g)	298± 154	317± 160	321± 150	308 ± 142	287± 158	287± 143	288 ± 198	.015*

Energy and Nutrients	2006 (n=141)	2007 (n=150)	2008 (n=102)	2009 (n=118)	2010 (n=124)	2011 (n=167)	2012 (n=163)	p-value
				CANADA (n=965)				
Energy (kcal/100g)	460 ± 62	468± 60	462 ± 56	470 ± 64	478 ± 62	477± 106	468 ± 67	.363
Fat (g/100g)	19.1 ± 7.0	21.2± 6.6	20.2± 6.4	21.5± 7.8	21.2 ± 7.3	21.3 ± 7.4	20.7± 7.4	.110
Saturated fat (g/100g)	8.6 ± 5.8	9.5 ± 6.3	9.5 ± 5.7	10.7 ± 6.5	9.7 ± 5.6	9.7 ± 6.1	10.0± 6.2	.247
Trans fat (g/100g)[§]	1.1 ± 1.9	0.8 ± 2.1	0.5 ± 1.2	0.5 ± 2.3	0.2 ± 1.1	0.2± 0.9	0.3 ± 1.5	.000*
Carbohydrate (g/100g)	66.4 ± 10.7	66.0 ± 11.0	63.3 ± 10.7	63.8 ± 10.7	65.7± 7.6	65.1 ± 12.5	64.5± 9.7	.261
Protein (g/100g)	6.0 ± 2.9	6.5 ± 3.3	6.3 ± 2.2	5.7± 2.1	6.3 ± 3.1	6.6 ± 3.3	6.1 ± 2.2	.148
Fibre (g/100g) [§]	3.2± 5.4	2.7± 2.3	3.1± 2.6	2.6 ± 2.7	3.4 ± 3.2	2.6 ± 2.4	2.6± 2.7	.279
Sodium (mg/100g)	280± 156	258 ± 155	276± 181	256± 146	250± 152	276 ± 159	265± 143	.687

[§]Kruskal Wallis test used for abnormally distributed data
*Statistically significant a p<.05

Table 2. The energy and nutrient composition of cookies containing *trans* fat as compared to those without trans fat in the US and Canada

Energy and Nutrients	No *trans* fat (n=1928)	Contains *trans* fat (n=268)	p-value	No *trans* fat (n=601)	Contains *trans* fat (n=255)	p-value
		US			**CANADA**	
Energy (kcal/100g)	462 ± 68	471 ±79	.042*	461 ± 79	485 ±47	.000*
Fat (g/100g)	20.0 ±7.7	20.9 ±7.4	.063	19.9 ± 7.4	22.7 ±6.0	.000*
Saturated fat (g/100g)	9.2 ± 6.0	7.9 ±5.6	.000*	8.8 ± 6.2	11.5 ± 5.3	.000*
Carbohydrate (g/100g)	66.6 ± 10.5	66.4 ± 10.5	.765	65.4 ±11.2	65.0 ±6.8	.554
Protein (g/100g)	5.8 ±3.1	5.3 ±2.2	.025*	6.4 ± 2.8	5.8 ±2.4	.001*
Fibre (g/100g) [§]	2.9 ± 3.8	1.9 ±1.9	.002*	3.1 ±3.6	2.2 ± 1.9	.000*
Sodium (mg/100g)	299 ±161	318 ±145	.074	270 ± 163	259 ± 129	.283

[§] Mann-Whitney U test used for abnormally distributed data
*Statistically significant a p<.05

International Food and Agribusiness Management Review
Volume 17 Special Issue A, 2014

Fast Food Restaurant Pricing Strategies in Michigan Food Deserts

Andrea Marie Leschewski[ⓘa] and Dave D. Weatherspoon[b]

[a] *PhD. Candidate, Agricultural, Food & Resource Economics, Michigan State University, 208 Cook Hall, Justin S. Morrill Hall of Agriculture, East Lansing, Michigan, 48824-1039, USA*

[b]*Professor, Agricultural, Food & Resource Economics, Michigan State University, 213C Agriculture Hall, Justin S. Morrill Hall of Agriculture, East Lansing, Michigan, 48824-1039, USA*

Abstract

The academic literature primarily focuses on the lack of access to affordable, healthy food in food deserts. However, the behavior of the fast food firms in terms of promotions and pricing within food deserts is not well understood. This study uses food desert – non-food desert match design of census blocks to determine how the pricing strategies of fast food restaurant managers in Michigan food deserts differ by location, ownership, and restaurant characteristics. Results show that while restaurants located in food deserts and non-food deserts offer similar amenities, have similar ownership structures, and have similar business approaches, higher prices are charged for select food items at restaurants located in food deserts.

Keywords: fast food, food desert, pricing strategies, cobranding

ⓘCorresponding author: Tel: + 1. 517.353.9850
Email: A. M. Leschewski: leschews@msu.edu
D. D. Weatherspoon: weathe42@msu.edu

Introduction

From 1980 to 2011, fast food consumption in the United States increased from $6 billion to $219 billion per year (Schlosser 2001; Sales 2012). Accounting for nearly 17.6% of an individual's total food expenditures, fast food has established itself as a main component of the American diet (Food 2012). Concurrently with the increase in fast food consumption, obesity in the United States has increased from 22.9% in 1988 to 35.7% in 2011 (Flegal et al. 2002; Ogden et al. 2012). Several studies have linked the consumption of fast food to obesity (Anderson et al. 2011; Jeffery et al. 2006; Thompson et al. 2004; Maddock 2004). More specifically, Spence et al. (2009) found that an increase in the ratio of fast food restaurants and convenience stores to supermarkets increased the prevalence of obesity.

Particular areas where fast food restaurants and convenience stores out number supermarkets are food deserts [a low-income census tract where a substantial share of residents have low access to supermarkets (Food 2008)]. In the absence of supermarkets, food desert residents must find alternative food suppliers, such as fast food restaurants and convenience stores.

The pricing strategies of fast food restaurants in food deserts are important for two reasons: price exploitation and health impacts. Within food deserts, Ver Ploeg (2010) shows that convenience stores often charge higher than normal prices. This study focuses on managerial pricing decisions to determine if fast food restaurants charge higher prices in the absence of competition from supermarkets. Several studies have focused on the pricing strategies of fast food restaurants (Ater et al. 2010; Stewart and Davis 2005; Kalnins 2003; Thomadsen 2002; Jekanowski 1998; Graddy 1997; and LaFontaine 1995), but not specifically on fast food restaurants in food deserts. In addition to those prior studies, this study will also estimate the effect three independent variables have on fast food price: food desert location, whether or not the restaurant is freestanding, and whether or not the restaurant is cobranded.

This research seeks to inform fast food firms about the impact their pricing strategies have on poor, inner-city consumers with low access to supermarkets. This study will address common concepts about food desert policy and initiatives aimed at improving the diet quality and health of food desert residents.

This study compares food desert – non-food desert census blocks to determine how the pricing strategies of fast food restaurant managers in Michigan food deserts differ by location, ownership, and restaurant characteristics. In the remainder of the paper a review of prior literature is presented, followed by the data, methods, results and conclusions.

Fast Food Pricing in Context

According to the 2008 Farm Bill, a food desert is defined as a low-income census tract where a substantial number or share of residents has low access to a supermarket or large grocery store (Food 2008). The ERS' Food Access Research Atlas further defines low access as a census tract with at least 500 people and/or at least 33% of the population is at least a mile from a supermarket or large grocery store and defines low income as a census tract with a poverty rate

of 20% or higher or a median family income at or below 80% of the area's median family income (ERS 2010).

While the effect the absence of supermarkets has on food deserts has been explored in numerous studies, other factors that affect individual's dining choices are not well understood. To address what food desert residents choose to consume and why, it is essential to characterize the entire built food environment (i.e. buildings, stores, roads and natural elements, (Sallis and Glanz 2006)).

To further characterize the entire built food environment, several recent studies have considered 'food swamps' or 'fast food oases'. The term "food swamp" was first proposed by Rose et al. (2009), who conjectured that while a lack of access to healthy food options is detrimental to food desert residents, an abundance of unhealthy dining options such as fast food and convenience stores may pose an even larger problem. Ver Ploeg (2009) further defined the term 'food swamp' as neighborhoods that have relatively easy access to less healthy foods compared with access to healthy foods.

Irrespective of location, there is extensive literature supporting that fast food restaurants strategically set prices. Carmin et al. (1990), Liang and Kanetkar (2006), and Naipaul and Parsa (2001) found evidence that fast food restaurants practice *odds and cents pricing*. Under this pricing strategy, fast food restaurants prefer prices that end in odd digits, particularly '5' and '9', which is commonly referred to as *just below pricing*. Under this strategy, Stiving (2000) found that fast food restaurants are more likely to set prices just below a round dollar amount (e.g. $1.99) because consumers tend to round down when viewing prices. Fast food restaurants also use prices to signal quality to consumers. Carmin et al. (1990) explains that under the *perceived value* strategy, customers view items that are priced higher as higher quality.

In addition to psychological pricing strategies, studies have found that fast food restaurants' prices are linked with the restaurants' costs, characteristics, location, and competition. Common costs associated with the price of fast food are employee payroll, rent, insurance costs, and real estate costs. As each of these costs increases, fast food prices are expected to increase (Stewart and Davis 2005; Graddy 1997; Jekanowski 1998). Stewart and Davis (2005) and Graddy (1997) found a significant positive relationship between the price of fast food and real estate costs. Evidence of a positive relationship between fast food price and rent was also found by Jekanowski (1998). Graddy tested the relationship between price and both insurance costs and employee payroll, but found no significant relationship.

The characteristics of the restaurants themselves have also been found to affect the prices fast food restaurants charge. A fast food restaurant's status as either corporate or franchisee owned, has been found to impact prices. LaFontaine (1995) reported that there is greater price dispersion among franchises than corporate fast food outlets, while Graddy (1999), Ater et al. (2010), and Kalnins (2003) found that franchised fast food outlets tend to charge higher prices than corporate fast food outlets. Unlike company-owned restaurants whose goal is to maximize sales volume, Kalnins (2003) explains that franchises seek to maximize profits because franchisees are residual claimants (i.e. they receive the restaurant's profits, less royalty fees and operating costs). Thus, franchises tend to charge higher prices than company owned stores in order to maximize their profits.

Demographics of the area in which a fast food restaurant is located has also been identified as a factor that influences pricing. Both Graddy (1997) and Stewart and Davis (2005) found that prices charged by fast food restaurants were higher in low income areas. Graddy (1997) explains that income can either be viewed as a competition variable or a discrimination variable. In lower-income areas, there may be less competition from other restaurants, leading to higher prices. Under the discrimination argument, fast food restaurants may be taking advantage of low-income individuals with few other dining alternatives by charging higher prices. In both cases, income is expected to be inversely related to fast food prices.

Stewart and Davis further found that fast food prices are positively related with population and that there was no significant link between price and age (2005). Population is likely positively correlated with fast food prices because as the population in an area increases, total demand for fast food is also likely to increase. A common response to increased demand for a product is to increase prices. Despite Stewart and Davis' (2005) finding that there is no significant link between age and price, age is expected to have an inverse relationship with price because it also affects demand for fast food. Stewart, Blisard, Jolliffe, and Bhuyan (2005) found that age is inversely related to the demand for fast food. Thus, because of lower demand, fast food price is expected to be lower in areas with an older population.

Several studies have found conflicting results on the effect racial composition of an area has on price. Jekanowski (1998) found that fast food prices tended to be lower in areas with higher proportions of African Americans, while Graddy found that fast food prices were positively related to the proportion of African Americans. Stewart and Davis found no significant relationship between fast food price and the proportion of African Americans (2005). Both Stewart and Davis (2005) and Graddy (1997) found no significant relationship between fast food price and the proportion of Hispanics. Differences in fast food prices based on the proportion of the population that is African-American or Hispanic can be explained by a demand approach or a discrimination approach. Under the demand approach, African-Americans and Hispanics are said to have different taste preferences, which affect their demand for fast food; demand in turn affects fast food price. The discrimination approach posits that fast food restaurants use discriminatory pricing strategies under which they charge higher prices in African-American and Hispanic communities. With mixed results on races' effect on fast food price, this study hopes to further characterize the relationship.

Several studies have examined the effect competition from other fast food restaurants, sit-down restaurants, and supermarkets have on fast food prices. Increased competition from other fast food outlets, sit-down restaurants, and supermarkets is likely inversely related with price; increased competition tends to put downward pressure on prices. Graddy (1997), Jekanowski (1998), and Thomadsen (2002) all conclude that increased fast food outlet density in an area leads to lower prices. Jekanowski further found no significant link between fast food price and the density of sit-down restaurants and supermarkets (1998). Binkley and Connor, however, found that there is price competition between fast food outlets and supermarkets, but were unable to determine the specific nature of the competition (1996).

Data

Eight Michigan cities comprise the focus area of this study: Detroit, Flint, Grand Rapids, Lansing, Livonia, Warren, Sterling Heights, and Dearborn. The first four cities are the four largest cities by population in Michigan with areas characterized as food deserts[1] (Food 2008). The latter four cities are the four largest cities in Michigan with no areas characterized as food deserts.

Within these eight cities, this study analyzes the prices charged by McDonald's, Burger King, and Subway outlets. These three fast food chains were selected because they were the only three chains to appear in the eight-firm concentration ratio (CR-8)[2].

Prices were collected via a phone survey for the three top-selling items at each of the restaurants; three items from each restaurant were chosen because restaurants tend to report their top three selling items in their annual reports. According to the McDonald's 2011 Annual Report, these items are the Big Mac, Chicken Nuggets, and Medium French Fries (McDonald's Annual Report 2011). Information on Burger King's top selling items was not available, so the prices of the Whopper, Chicken Nuggets, and Medium French Fries were collected, analogous to McDonald's top three items. Subway's most popular items, the Italian BMT, Tuna, and Subway Club 6-inch sandwiches were listed on the corporate website (Subway FAQS 2012). 6-inch subs were chosen, as opposed to foot-long subs, because of Subway's national pricing campaign for $5 foot long sandwiches.

In order to conduct the survey, the addresses and phone numbers of all McDonald's, Subway, and Burger King restaurants were collected from their respective corporate websites. Every McDonald's (90 restaurants), Burger King (50 restaurants) and Subway (155 restaurants) was surveyed. All of the restaurants were contacted during March of 2013. Three phone call attempts were made to contact each restaurant. During the phone survey, the restaurant's manager was asked the prices of their three top selling items and whether the prices were promotional. Of the total restaurants in the eight cities, price data was collected from 74% of McDonald's, 80% of Burger Kings, and 54% of Subway restaurants and none of the prices collected were promotional. The responding restaurants were a representative sample of fast food restaurants in food deserts, with 55% of McDonald's, 60% of Burger Kings and 47% of Subways being located in food deserts.

The price data collected from the phone survey was supplemented by data from GIS Business Analyst 2011. Derived from the 2010 US Census, Business Analyst provides data on the sales and characteristics of all businesses within the United States. In addition to the fast food restaurants' sales and characteristics, demographic data on the block group where the restaurant is located was obtained from Business Analyst. Block groups are statistical divisions of census tracts, which generally contain 600 to 3,000 people (Geographic 2010). Raja et al. (2008) explain that often, census tracts are often too large to represent a neighborhood and thus a finer

[1] The ERS' Food Access Research Atlas was used to identify food deserts as defined in the 2008 Farm Bill.
[2] The eight-firm concentration ratio (CR-8) refers to the market share of the eight largest fast food firms.

level of geographic scale is needed to analyze food disparities. Thus, the block group level is used because it is the geographic unit that most accurately represents the neighborhood in which food desert residents shop and dine.

Table 1 lists and provides a description of the variables collected from the price survey and GIS Business Analyst 2011. The dependent variables in this study are the prices of each of McDonald's', Burger King's, and Subway's top-selling items. The independent variables are grouped into six categories: location, restaurant characteristics, prices, costs, demographics, and competition.

The expected sign, name, description and data source for of each of the independent variables is shown in Table 1. The primary variable of interest in this study is the food desert dummy. The food desert dummy variable is expected to have a positive relationship with the price of fast food. A positive relationship is expected due to the fact that other food retailers located in food deserts, such as small, independent grocers and convenience stores, have been found to charge higher prices (Chung et al. 1999; Kaufman et al. 1997; MacDonald et al. 1991). Like these smaller food retailers, fast food restaurants are expected to take advantage of the fact that food desert residents have few alternative food sources by charging higher prices at restaurants in food deserts.

Table 1. Description of Independent Variables

Variable	Expected Sign	Abbrev.	Value Description
Dependent			
Price ($)[a]	---	price	Price per food item
Location			
Food Desert (dummy)[b]	+	fdes	1 if food desert, 0 else
Eight City Dummies [b]	+/-	city	1 if in city, 0 else
Restaurant Characteristics			
Franchise (dummy)[b]	+	fran	1 if franchise, 0 else
Cobranded (dummy)[b]	+	co	1 if cobranded, 0 else
Freestanding (dummy)[b]	-	free	1 if freestanding, 0 else
Playplace (dummy)[a]	+	play	1 if playplace, 0 else
Cost			
Median Home Price ($)[b]	+	home	Mean home price in block group
Sales Volume ($1,000)[b]	-	sales	Restaurant's sales volume
Demographics			
Per Capita Income ($)[b]	-	inc	Mean pci in block group
Population (#)[b]	+	pop	Population of block group
Median Age (#)[b]	-	age	Median age in block group
African-American (%)[b]	+/-	afr	% of the block group that is Afr.-Am
Hispanic (%)[b]	+/-	his	% of the block group that is Hispanic
Competition			
Other Fast Food (#)[b]	-	ffres	#of other fast food within 1 mile
Sit-Down Restaurants (#)[b]	-	sdres	# of sit-down restaurants within 1 mile
Supermarkets (#)[b]	-	smrkt	# of supermarkets within 1 mile

[a] Denotes data collected from the pricing survey
[b] Denotes data collected from GIS Business Analyst 2011

The independent variables unique to the food desert research are whether the fast food restaurant is: cobranded, freestanding, and/or has a playplace. Restaurants that are cobranded, i.e. combined with at least one other brand, are expected to have higher prices. This is because cobranded restaurants often have to pay higher franchise fees and royalty fees than non-cobranded units (Abcede 1994). These higher fees likely translate into higher prices. Non-freestanding restaurants, such as those in malls and airports, are expected to charge higher prices because of their convenient locations. Similarly, fast food restaurants with playplaces are expected to charge higher prices because of the additional entertainment value the playplaces provides.

The expected signs of the remaining independent variables were discussed in the overview of prior studies' findings in the literature review.

Methods

Using the phone survey and GIS data described in Table 1, descriptive statistics are used to compare fast food price, restaurant characteristics, costs, demographics, and competition variables between food deserts and non-food desert block groups. Mean comparison tests are also used to determine whether there is a statistically significant difference in the prices charged for each of the restaurants' top-three best-selling items in food deserts compared to non-food deserts.

The findings from the descriptive statistics and mean comparison tests are used to inform the multivariate regression analysis. OLS regression techniques are used to analyze the pricing strategies of the fast food restaurant managers in food deserts. The general form of the model being estimated is detailed in Equation 1.

(1) $price_{1\text{-}9}$ = (*home, sales, inc, pop, age, afr, his, free, co, fran, play, ffres, sdres,, city, fdes*) [3].

The models dependent variable is the price of the fast food item. A total of nine regressions are estimated, one for each of the prices of the top three selling items at McDonald's, Burger King, and Subway.

Results

Descriptive statistics, mean comparison tests, and regression results are presented for each fast food firm separately in order to determine if they use different pricing strategies in food desert versus non-food desert markets.

McDonald's

Descriptive statistics of the data collected on McDonald's restaurants in both the non-food desert and food desert block groups are shown in Table 2. The McDonald's restaurants are relatively

[3] Independent variable abbreviations are detailed in Table 1.

evenly dispersed among food desert and non-food desert block groups, with 37 restaurants located in food deserts and 30 restaurants located in non-food deserts.

Table 2. McDonalds Descriptive Statistics

	Food Desert (N=37)				Non-Food Desert (N=30)			
Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Restaurant Characteristics								
Franchise (dummy)	0.75	0.43	0.00	1.00	0.77	0.43	0.00	1.00
Cobranded (dummy)	0.05	0.23	0.00	1.00	0.06	0.25	0.00	1.00
Freestanding (dummy)	0.95	0.22	0.00	1.00	0.90	0.31	0.00	1.00
Playplace (dummy)	0.30	0.46	0.00	1.00	0.20	0.41	0.00	1.00
Prices								
Price McNuggets ($)	3.44	0.44	1.99	3.99	3.62	0.19	3.17	3.99
Price Big Mac ($)	3.66	0.27	2.96	4.09	3.66	0.23	3.09	4.15
Price Med. Fry ($)	1.63	0.12	1.39	1.9	1.63	0.15	1.00	1.94
Costs								
Median Home Price ($)	70,528	33,072	0	135,859	110,124	55,983	17,500	250,000
Sales Volume ($1,000)	2,127	454	1,040	3,000	1,948	686	1,000	3,360
Demographics								
Per Capita Income ($)	19,158	6,360	1,667	29,416	24,737	7,445	10,221	36,434
Population (#)	1,183	727	18	3,414	1,575	1,095	178	4,610
Median Age (#)	34.21	6.55	23.60	51.70	39.31	9.99	26.50	68.60
African-American (%)	43.00	41.00	0.00	99.00	24.00	36.00	0.00	98.00
Hispanic (%)	7.00	10.00	0.00	46.00	6.00	13.00	0.00	71.00
Competition								
Other Fast Food (#)	2.62	2.42	0.00	14.00	2.63	1.79	0.00	7.00
Sit-Down Restaurants (#)	3.70	3.04	0.00	17.00	5.53	4.38	1.00	24.00
Supermarkets (#)	0.00	0.00	0.00	0.00	0.53	0.57	1.00	2.00

Source. 2010 US Census and Original Price Survey

The descriptive statistics for the price variables suggests that there is price variation among McDonald's restaurants located in food deserts versus non-food deserts. For McNuggets, the mean price is lower in food desert restaurants than in non-food desert restaurants, with mean prices of $3.44 and $3.62 and a standard deviation of $.44 and $0.19 respectively. The mean prices for a Big Mac and Medium Fries are the same for both food desert and non-food desert locations. However, Big Mac price and Medium Fries price have standard deviations that differ between food desert and non-food desert locations. The price of a Big Mac has a mean of $3.66 with standard deviations of $0.27 in food deserts and $0.23 in non-food deserts. Similarly, Medium Fries has a mean of $1.63 and standard deviations of $0.12 in food deserts and $0.15 in non-food deserts.

Table 3. Mean Comparison of McDonald's Prices by Product in Food Deserts vs Non-Food Deserts

Big Mac Price	**Observations**	**Mean**	**Std. Err.**	**Std. Dev.**
Food Desert	37	3.66	0.04	0.27
Non-Food Desert	30	3.66	0.04	0.23
Combined	67	3.66	0.03	0.25
t-statistic: 0.00			Pr(|T|>|t|): 1.00	
McNuggets Price				
Food Desert	37	3.44	0.07	0.44
Non-Food Desert	30	3.62	0.03	0.19
Combined	67	3.52	0.04	0.36
t-statistic: 2.21			Pr(|T|>|t|): .03	
Medium Fries Price				
Food Desert	37	1.63	0.02	0.12
Non-Food Desert	30	1.63	0.03	0.15
Combined	67	1.63	0.02	0.13
t-statistic: -.12			Pr(|T|>|t|): .91	

Source. 2010 US Census and Original Price Survey

Mean comparison tests of Big Mac, McNuggets, and Medium Fries prices, shown in Table 3 confirm that only the price of McNuggets varies between food deserts and non-food deserts. The mean comparison test for McNuggets price has a t-statistic of 2.21, implying that McNuggets price differs between food deserts and non-food deserts at the 5% significance level.

Although there is price variation for McNuggets, Table 2 shows that all McDonald's restaurants offer similar amenities, have similar ownership structure, and have similar business approaches. Of the 37 McDonald's restaurants located in food deserts (non-food deserts), 75% (77%) are franchised, 5% (6%) are cobranded, 95% (90%) are freestanding, and 30% (20%) have a playplace.

In contrast, as expected the cost and demographic variables show differences between the two types of locations. Considering the cost variables, the median home price is lower in food desert block groups at $70,528 compared to $110,124 in non-food desert block groups. Inversely, the sales volume at McDonald's restaurants in food desert block groups is higher at $2,127,000 compared to those in non-food desert block groups, $1,948,000 in 2010. The demographic variables show that per capita income, population, and median age are lower for McDonald's in food desert block groups versus non-food desert block groups. Conversely, the proportion of the population that is either African-American or Hispanic is higher in food desert block groups compared to non-food desert block groups.

The competition variables reveal major differences in the market environment as well with there being more supermarkets, other fast food restaurants, and sit-down restaurants in non-food desert block groups compared to food desert block groups. This is consistent with the definition of a food desert.

Table 4. McDonald's OLS Regression Results by Product (N=67)

Independent Variables	Big Mac Price	Chicken Nuggets Price	Medium Fry Price
Location			
Food Desert	0.118*	-0.066	-0.017
Restaurant Characteristics			
Franchise	0.028	-0.087	-0.079
Cobranded	-0.097	0.183	0.007
Playplace	-0.078	-0.003	0.057*
Costs			
Sales Volume	-0.001**	-0.000	0.000
Demographics			
Per Capita Income	4.02e-06	8.68e-06	6.06e-06*
Population	-0.000	-0.000	-0.000
Median Age	0.008*	0.011**	-0.001
African-American	.042	0.122	0.167**
Hispanic	.018	0.570	0.358**
Competition			
Other Fast Food	.017	0.026	0.013**
Sit-Down Restaurants	.003	0.006	-0.008**
City Dummies			
Lansing	.181*	0.357**	-0.046
Flint	-0.240***	0.006	-0.071*
Grand Rapids	0.032	0.109	-0.122*
Dearborn	-0.249*	0.014	0.172*
Warren	0.236*	0.100	0.005
Livonia	0..246*	0.282	0.007
R-Squared	0.544	0.309	0.461

Significant at the 90% level, ** Significant at the 95% level, *** Significant at the 99% level

The ordinary least squares estimates for Equation 1 with the prices of McDonald's three most popular food items as dependent variables are shown in Table 4. Variance inflation factors were calculated in order to determine if a multicollinearity problem was present. Three of the independent variables (freestanding, median home price, and supermarkets) had variance inflation factors greater than 10. These variables were removed from the model as they were indicative of a multicollinearity problem (Greene 2003). The Breusch-Pagan test for heteroskedasticity was then used to determine if heteroskedasticity was present in each of the three price models. The test results showed that heteroskedasticity was present in the regression with McNuggets price and Medium Fry price as dependent variables. Robust standard errors were then calculated for all three regressions in order to correct for the presence of heteroskedasticity. The r-squared values of 0.544, 0.309, and 0.461 for the Big Mac price, McNuggets price, and Medium Fries price regressions respectively, show that a significant proportion of the price variation is explained by the independent variables.

Because the primary concern of this paper is to determine if fast food restaurants charge different prices in food deserts, the food desert coefficient is discussed first. Of the three food items, the food desert dummy variable is only significantly related to Big Mac price. The multivariate results suggest that, at the 10% significance level, McDonald's restaurants located in food deserts charge $0.118 more for Big Macs holding all other variables constant. This positive relationship supports the hypothesis that McDonald's restaurants are taking advantage of the fact that food desert residents have few other food alternatives by charging higher prices in food deserts. Why Big Macs cost more in food deserts, but McNuggets and Medium Fries do not, is unclear. Big Mac price differences in food deserts may be attributed to the fact that McDonald's views the Big Mac as its "classic" menu item (McDonald's 2009). Within the 2009 McDonald's Annual Report, McDonald's explains that they are focusing on the sales performance and emphasizing the affordability of their classic menu items such as the Big Mac and the Quarter Pounder with Cheese (McDonald's 2009). The fact that McDonald's specifically focuses on Big Mac sales and affordability may explain why they vary its price in food deserts, but do not vary the price of McNuggets and Medium Fries.

The regression result that Big Macs price is higher in food deserts contrasts with the bivariate mean comparison tests, which showed that there was a significant difference in the price of McNuggets between food desert and non-food desert restaurants, but Big Mac price and Medium Fry price did not differ. These contrasting results arise because the multivariate regression analysis takes into account other location, restaurant characteristics, demographics, costs, and competition variables when determining whether prices differ in food deserts.

Of the three restaurant characteristics variables unique to this study, only the presence of a playplace was found to affect price at the 10% significance level, suggesting that McDonald's restaurants charge $0.057 more for Medium Fries at restaurants that have a playplace. This result supports the hypothesis that restaurants can charge higher prices because of the extra entertainment value that a playplace provides.

Unlike prior studies by Graddy (1999), Ater et al. (2010), and Kalnins (2003), this study finds no significant pricing differences among corporate and franchisee owned McDonald's restaurants.

Looking at the cost variables, the regression results show that there is a negative relationship between sales volume and the price of a Big Mac. At the 5% significance level, a $1,000 increase in sales volume decreases the price of a Big Mac by $0.001. This finding supports the economies of scale view that increased sales can lead to decreased per unit costs, which can then translate into lower prices.

Considering the demographic variables, the regression results show that per capita income, median age, the proportion of the population that is African-American, and the proportion of the population that is Hispanic affect fast food price. Per capita income has a positive relationship with the price of a Medium Fry. Although the per capita income coefficient is significant at the 10% level, its value is close to zero. This implies that, like the Big Mac price and the McNuggets price, the price of Medium Fries is not affected by per capita income. Population is found to have no effect on fast food price. This is contrary to the findings of Stewart and Davis (2005) who found a positive relationship between population and fast food price. This difference in findings

is likely a result of the differing study areas. Median age is positively related to both Big Mac price and McNuggets price. This positive relationship is opposite of what was expected. Prior findings by Stewart, Blisard, Jolliffe, and Bhuyan (2005), showed that fast food demand decreased with age. A typical response to an increase in demand is to increase prices. Thus age was expected to be inversely related to price. The positive relationship between median age and fast food price may result from age groups having different food preferences and dining habits in this paper's study area.

Both the proportion of the population that is African-American and the proportion of the population that is Hispanic are positively related to the price of Medium Fries. At the 5% significance level, a 1% increase in the proportion of the population that is African-American (Hispanic) leads to a $0.167 ($0.358) increase in the price of a Medium Fry. For the Big Mac price and McNuggets price regressions, the coefficients on race variables are nearly significant. This finding is identical to that of Graddy (1997) who found that fast food restaurants charge more for fries in areas with higher proportions of African-Americans. This finding suggests that McDonald's may be using discriminatory pricing strategies under which they charge higher prices in areas with higher proportions of minorities. An alternative explanation is that African-Americans and Hispanics may have different tastes and food preferences which affect their demand for fries. This difference in demand could in turn affect the price of fries in African-American and Hispanic communities.

Of the competition variables, the presence of other fast food restaurants and sit-down restaurants has an effect on the Medium Fry price. At the 5% significance level, an additional fast food restaurant (sit-down restaurant) leads to a $0.013 increase ($0.008 decrease) in the price of a Medium Fry. The positive relationship between the number of other fast food restaurants and Medium Fry price is opposite of what was expected. Additional competition from other fast food restaurants was expected to cause restaurants to lower prices. Muller (1997) offers a possible explanation why the number of food restaurants is positively related to Medium Fry price, but not Big Mac price or McNuggets price. Muller (1997) explains that small changes in the price of a fast food item will lead customers to substitute the item with a competitor's product. Following this argument, McDonald's may not charge higher prices for the Big Mac and McNuggets when faced with competition from other fast food outlets because the Whopper and Burger King Chicken Nuggets act as close substitutes. Because McDonald's french fries are perceived superior in the fast food industry, consumers are likely less sensitive to the Medium Fry price (America's 2012). Thus McDonald's can charge higher prices for Medium Fries despite the added competition from other fast food restaurants.

The inverse relationship between the number of sit-down restaurants and the price of a Medium Fry supports the idea that increased competition leads to lower prices. This finding also supports prior findings that sit-down restaurants have recently been lowering prices in order to compete with fast food restaurants (Senauer et al. 2010). If fast food restaurants charge high prices for additional items such as fries and soda, alternative dining options such as sit-down restaurants may become more appealing.

The regression results show that McDonald's prices vary with the city that the restaurant is located in. The varying prices for the three food items are due to differences in costs of living and consumer preferences amongst the seven cities[4].

Burger King

Descriptive statistics of the data collected on Burger King restaurants in both non-food desert and food desert block groups are shown in Table 5. Similar to McDonald's, the Burger King restaurants are relatively evenly dispersed in food desert and non-food desert block groups, with 24 restaurants located in food deserts and 16 restaurants located in non-food deserts.

Table 5. Burger King Descriptive Statistics

	Food Desert (N=24)				Non-Food Desert (N=16)			
Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Restaurant Characteristics								
Cobranded (dummy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Freestanding (dummy)	1.00	0.00	1.00	1.00	1.00	0.00	1.00	1.00
Playplace (dummy)	0.17	0.38	0.00	1.00	0.19	0.40	0.00	1.00
Prices								
Price Nuggets ($)	2.83	0.36	2.49	3.69	2.82	0.47	2.02	3.69
Price Whopper ($)	3.59	0.18	3.29	3.95	3.64	0.18	3.29	3.81
Price Med. Fry ($)	2.01	0.19	1.79	2.43	2.00	0.13	1.79	2.29
Costs								
Median Home Price ($)	60,098	33,444	0	112,500	109,220	35,255	47,424	188,996
Sales Volume ($1,000)	1,085	345	600	1,960	1,060	305	640	1,600
Demographics								
Per Capita Income ($)	19,939	7,244	8,579	32,108	24,599	6,030	10,411	33,268
Population (#)	1,143	669	136	2,713	1,533	1,066	411	4,610
Median Age (#)	33.26	6.08	22.80	46.00	37.75	5.07	31.60	51.70
African-American (%)	46.00	39.00	1.00	98.00	10.00	24.00	0.00	98.00
Hispanic (%)	11.00	16.00	0.00	71.00	6.00	13.00	0.00	53.00
Competition								
Other Fast Food (#)	1.50	1.64	0.00	6.00	2.56	1.41	1.00	5.00
Sit-Down Restaurants (#)	3.95	4.17	0.00	15.00	6.25	7.17	2.00	32.00
Supermarkets (#)	0.00	0.00	0.00	0.00	0.44	0.63	0.00	2.00

Source. 2010 US Census and Original Price Survey

The descriptive statistics suggest that there is price variation in all three of Burger King's top-selling items in food desert versus non-food desert locations. The price of Chicken Nuggets has a mean of $2.83 ($2.82) and a standard deviation of $0.36 ($0.47) in food desert (non-food

[4] None of the McDonald's restaurants were located in Sterling Heights

desert) locations. The price of a Whopper has a mean of $3.59 ($3.64) and a standard deviation of $0.18 ($0.18) in food desert (non-food desert) locations. Similarly, the mean price of Medium Fries is $2.01 ($2.00), with a standard deviation of $0.19 ($0.13) in food desert (non-food desert) locations.

Mean comparison tests for the price of each of the three food items in two location types are shown in Table 6. The t-statistics for Whopper price and Chicken Nuggets price are 0.91 and -0.11. This implies that there is no significant price difference for Whoppers and Chicken Nuggets in food deserts compared to non-food deserts. The mean comparison test for Medium Fries, however, has a t-statistic of -1.93. This indicates that medium fry price differs in food deserts compared to non-food deserts at the 10% level.

Table 6. Mean Comparison of Burger King Prices by Product in Food Deserts vs Non-Food Deserts

Whopper Price	**Observations (#)**	**Mean ($)**	**Std. Err. ($)**	**Std. Dev. ($)**
Food Desert	24	3.59	0.04	0.18
Non-Food Desert	16	3.64	0.05	0.18
Combined	40	3.61	0.03	0.18
t-statistic: .91			**Pr(|T|>|t|): .3714**	
Nuggets Price				
Food Desert	24	2.83	0.07	0.36
Non-Food Desert	16	2.82	0.12	0.47
Combined	40	2.83	0.06	0.4
t-statistic: -.11			**Pr(|T|>|t|): .91**	
Medium Fries Price				
Food Desert	24	2.1	0.04	0.19
Non-Food Desert	16	2	0.03	0.13
Combined	40	2.06	0.03	0.17
t-statistic: -1.93			**Pr(|T|>|t|): .06**	

Unlike McDonald's, the descriptive statistics in Table 5 show that there is no variation present in the cobranding and freestanding restaurant dummy variables. All of the Burger King restaurants in this sample are non-cobranded and are freestanding. Information on whether the Burger King restaurant is a franchise was not available and is thus not included in Table 5. There is, however, a small difference in the percentage of Burger King restaurants that have a playplace, 17% (19%) of Burger King restaurants located in food deserts (non-food desert).

The descriptive statistics for the cost variables show that median home price is higher in non-food desert block groups and that the sales at Burger King restaurants in food deserts are higher than the sales of those in non-food deserts. Similar to McDonald's, the demographic variables, per capita income, population, and median age are higher in non-food desert block groups. Also like McDonald's, the proportion of the population that is African-American and the proportion of the population that is Hispanic are higher in food desert block groups.

In the competition variable category, there are more sit-down restaurants, supermarkets, and other fast food restaurants in non-food desert block groups.

The ordinary least squares estimates for Equation 1 with the prices of Burger King's three food items as dependent variables are shown in Table 7. Because of the small number of observations (N=40), bootstrapping, using 200 replications, was used to estimate the standard errors of the regression coefficients. The city dummy variables were not included in the regression in order to increase the degrees of freedom. Variance inflation factors were calculated in order to determine if a multicollinearity problem was present. None of the variables had a variance inflation factor greater than 10, suggesting that multicollinearity was not present in the model. The Breusch-Pagan test for heteroskedasticity was then used to determine if heteroskedasticity was present in each of the three price models. The test results showed that heteroskedasticity was present in the regression with Chicken Nuggets price as the dependent variable. Robust standard errors were then calculated for all three regressions in order to correct for the presence of heteroskedasticity.

Table 7. Burger King's OLS Regression with Bootstrapped SEs Results (N=40)

Independent Variables	Whopper Price	Chicken Nuggets Price	Medium Fry Price
Location			
Food Desert	-0.040	-0.110	0.064
Restaurant Characteristics			
Playplace	-0.003	-0.144	-0.066
Costs			
Sales Volume	-0.000	0.000	0.000
Median Home Value	-2.36 E-07	-7.31 E-07	7.44 E-07
Demographics			
Per Capita Income	3.51 E-06	-3.68 E-06	-4.62 E-06
Population	-0.000	0.000	-0.000
Median Age	-0.018	-0.027	-0.009
African-American	-0.240	-0.287	0.044
Hispanic	-0.331	0.292	-0.810***
Competition			
Other Fast Food	-0.031	0.007	-0.019
Sit-Down Restaurants	0.004	0.013	0.007
Supermarkets	0.061	-0.028	0.046
R-Squared	0.217	0.361	0.401

Significant at the 90% level, ** Significant at the 95% level, *** Significant at the 99% level

The Burger King regression results with bootstrapped standard errors are shown in Table 7. Unlike the mean comparison test results in Table 6, which show that Medium Fry price differs between food deserts and non-food deserts, the regressions results show that being located in a food desert does not significantly affect the price of a Whopper, Chicken Nuggets, or a Medium Fry. This finding suggests that, after accounting for other factors, Burger King does not use different pricing strategies in restaurants located in food deserts versus non-food deserts.

In addition to the food desert variable, only one of the other independent variables significantly affects the food item prices. At the 1% significance level, a 1% increase in the proportion of the population that is Hispanic leads to a $0.81 decrease in the price of a Medium Fry. Within the regressions for each of the three food items, the constant term was significant at the 1% level. This suggests that variables, other than those included in this study and prior literature, likely have an effect on the prices Burger King charges at its restaurants. These finding suggests that the pricing strategies of Burger King differ greatly from those employed by McDonald's and the fast food industry as a whole.

Subway

Descriptive statistics of the data collected on Subway restaurants for both block groups are shown in Table 8. The Subway restaurants are evenly distributed, with 39 restaurants in food deserts and 44 restaurants in non-food deserts.

Table 8. Subway Descriptive Statistics

	Food Desert (N=39)				Non-Food Desert (N=44)			
Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Restaurant Characteristics								
Cobranded (dummy)	0.36	0.49	0.00	1.00	0.39	0.49	0.00	1.00
Freestanding (dummy)	0.64	0.49	0.00	1.00	0.61	0.49	0.00	1.00
Prices								
Price Italian BMT ($)	4.03	0.09	4	4.25	4.01	0.05	4	4.25
Price Tuna ($)	4.08	0.17	4	4.5	3.89	0.3	3.5	4.5
Price Subway Club ($)	4.55	0.1	4.5	4.75	4.46	0.17	4.00	4.75
Costs								
Median Home Price ($)	81,924	54,166	0	198,077	126,857	71,725	0	265,909
Sales Volume ($1,000)	268	125	40	720	318	160	80	800
Demographics								
Per Capita Income ($)	23,580	10,328	11,370	49,343	26,510	10,479	2,424	53,902
Population (#)	1,239	759	38	3,847	1,441	890	33	4,085
Median Age (#)	37.87	6.51	25.50	50.50	39.59	8.13	23.90	57.70
African-American (%)	45.00	39.00	0.00	99.00	15.50	27.76	0.00	98.25
Hispanic (%)	7.50	13.10	0.00	62.70	2.69	3.10	0.00	17.52
Competition								
Other Fast Food (#)	2.51	1.73	0.00	7.00	2.48	1.55	0.00	6.00
Sit-Down Restaurants (#)	6.77	10.84	0.00	51.00	7.11	5.97	0.00	24.00
Supermarkets (#)	0.00	0.00	0.00	0.00	0.75	0.62	0.00	2.00

Source. 2010 US Census and Original Price Survey

The descriptive statistics suggest that there is price variation in all three Subway sandwiches in food desert versus non-food desert restaurants. The 6-inch Italian BMT price has a mean of

$4.03 ($4.01) and a standard deviation of $0.09($0.05), the 6-inch Tuna price has a mean of $4.08($3.89) and standard deviation of $0.17($0.3), and the 6-inch Subway Club price has a mean of $4.55($4.46) and a standard deviation of $0.10($0.17) in food desert (non-food desert) locations.

Mean comparison tests for sandwich prices in food deserts compared to non-food deserts are shown in Table 9. The t-statistic for the Italian BMT price is -1.32, suggesting that its price does not differ in food deserts versus non-food deserts. The t-statistics for the Tuna and Subway Club however are -3.78 and -2.98 respectively. This implies that at the 1% significance level, the 6-inch Tuna sandwich and the 6-inch Subway Club cost more at restaurants in food deserts.

Like McDonald's, Table 8 shows Subway restaurants located in food deserts and non-food deserts have similar ownership structure and have similar business approaches. Of the 39 (44) Subway restaurants located in food deserts (non-food deserts), 36% (39%) are cobranded and 64% (61%) are freestanding. The franchise variable was not included in Table 8 due to the fact that all Subway restaurants are franchised. Further, the playplace variable was excluded because no Subway restaurant in the sample had a playplace.

Considering the cost variables, median home price is higher in food desert block groups. Unlike McDonald's and Burger King, sales volume is higher at Subway restaurants located in non-food desert block groups. This difference suggests that food desert residents are more likely to dine at burger restaurants and less likely to dine at Subway than non-food desert residents.

Table 9. Mean Comparison of Subway Prices by Product in Food Deserts vs Non-Food Deserts

Italian BMT Price	**Observations (#)**	**Mean ($)**	**Std. Err. ($)**	**Std. Dev. ($)**
Food Desert	39	4.03	0.01	0.09
Non-Food Desert	44	4.01	0.01	0.05
Combined	83	4.02	0.01	0.07
t-statistic: -1.32			**Pr(|T|>|t|): .19**	
Tuna Price				
Food Desert	39	4.08	0.03	0.17
Non-Food Desert	44	3.89	0.05	0.3
Combined	83	3.98	0.03	0.26
t-statistic: -3.78			**Pr(|T|>|t|): .0003**	
Subway Club Price				
Food Desert	44	4.55	0.02	0.1
Non-Food Desert	39	4.46	0.03	0.17
Combined	83	4.5	0.02	0.15
t-statistic: -2.98			**Pr(|T|>|t|): .004**	

Source. GIS Business Analyst and Price Survey

As with McDonald's and Burger King, per capita income, population, and median age are higher in non-food desert block groups, while the proportions of the population that are African American and Hispanic are higher in food desert block groups.

Descriptive statistics for the competition variables show that there are more sit-down restaurants and supermarkets in non-food desert block groups. However, there are more other fast food restaurants in food desert block groups compared to non-food desert block groups.

The OLS regression results for the three Subway sandwiches are presented in Table 10. Variance inflation factors were calculated in order to determine if a multicollinearity problem was present. Three of the independent variables (freestanding, median home price, and supermarkets) had variance inflation factors greater than 10. These variables were removed from the model as they were indicative of a multicollinearity problem (Greene 2003). The Breusch-Pagan test was then used to determine if heteroskedasticity was present in each of the three price models. The test results showed that heteroskedasticity was present in the regression with Italian BMT price and Subway Club price as dependent variables. Robust standard errors were then calculated for all three regressions in order to correct for the presence of heteroskedasticity. The r-squared values of 0.115, 0.455, and 0.216 for the Italian BMT, Tuna, and Subway Club price regressions respectively, show the percent of the price variation explained by the independent variables.

Within the OLS regression for each Subway sandwich, city dummy variables are omitted. Upon analyzing the data collected from the pricing survey, it was found that Subway appears to charge uniform prices for their menu items within each city. For example, in all but 2 Subway restaurants in the sample from Grand Rapids, the 6-inch Subway Club costs the same price, $4.50. In order to determine whether Subway's prices are affected by the food desert dummy, restaurant characteristics, costs, demographics, and competition, it was necessary to exclude the city dummy variables.

The regression results in Table 10 show that Subway restaurants located in food deserts charge higher prices for 6-inch Tuna sandwiches and 6-inch Subway club sandwiches. At the 10% significance level, Subway restaurants charge $0.091 more for 6-inch Tuna sandwiches in food deserts. Similarly, at the 1% significance level, Subway restaurants located in food deserts charge $0.137 more for 6-inch Subway Club sandwiches. These results confirm the bivariate mean comparison test findings that the prices of the 6-inch Tuna and 6-inch Subway Club were higher in food desert versus non-food desert block groups. This positive relationship between price and food deserts supports that Subway restaurants are taking advantage of the fact that food desert residents have few other food alternatives by charging higher prices in food deserts. Why the price of a 6-inch Italian BMT does not vary between Subways located in food deserts versus non-food deserts requires further study outside the scope of this paper.

As with McDonald's, cobranding has no effect on the prices charged for each of the three Subway sandwiches. This suggests that the extra value added from combining two or more brands, does not allow fast food restaurant managers to charge higher prices.

Table 10. Subway's OLS Regression Results (N=83)

Independent Variables	Italian BMT Price	Tuna Price	Subway Club Price
Location			
Food Desert	0.026	0.091*	0.137***
Restaurant Characteristics			
Cobranded	-0.003	-0.001	0.048
Costs			
Sales Volume	0.000	0.001*	-0.000
Demographics			
Per Capita Income	-8.01 E -07	-4.14 E-06	-2.21 E-06
Population	-0.000**	3.78 E -06	8.47 E-06
Median Age	0.001	0.009**	0.001
African-American	-0.017	0.372***	-0.019**
Hispanic	-0.053	0.423*	-0.310**
Competition			
Other Fast Food	0.007	0.034*	-0.019
Sit-Down Restaurants	0.002	-0.003	-0.000

The cost variable, sales volume is found to have a positive relationship with the price of a 6-inch Tuna sandwich. The regression results imply that at the 10% significance level, a $1,000 increase in restaurant sales leads to a $0.001 increase in the price of a 6-inch Tuna sandwich. This finding supports the idea of economies of scale, under which increased sales leads to lower per unit costs, which in turn translate into lower prices.

Four of the demographic variables were found to affect the prices of Subway's sandwiches. The population of the block group in which the Subway is located is inversely related to the price of the 6-inch Italian BMT. However, the coefficient for population in the Italian BMT regression is close to zero. This suggests that like the Tuna price and Subway Club price, the population does not affect the price of the Italian BMT. Median age has a positive relationship with the price of the 6-inch Tuna sandwich. This positive relationship is opposite of what was expected based on the findings by Stewart, Blisard, Jolliffe, and Bhuyan (2005), who showed that fast food demand decreased with age. A typical response to an increase in demand is to increase prices. Thus age was expected to be inversely related to price. The positive relationship between median age and fast food price may result from age groups having different food preferences, which affect their demand for fast food, in this paper's study area.

Both the proportion of the population that is African-American and the proportion of the population that is Hispanic affect the price of Subway sandwiches. A 1% increase in the proportion of the population that is African-American leads to a $0.372 increase in the price of a 6-inch Tuna sandwich at the 1% significance level. Conversely, a 1% increase in the proportion of the population that is African-American leads to a $0.019 decrease in the price of the Subway Club. Similarly, a 1% increase in the proportion of the population that is Hispanic leads to a $0.423 increase ($0.310 decrease) in the price of a 6-inch Tuna (6-inch Subway club) sandwich.

Why Subway charges higher prices for Tuna sandwiches, lower prices for Subway Club sandwiches, and the same prices for Italian BMT sandwiches in communities with a higher proportion of minorities is unclear. It may be the case that African-American's and Hispanic's have higher demand for Tuna sandwiches and lower demand for Subway Club sandwiches compared to population demand as a whole. These differences in demand may translate into different prices for the sandwiches.

The regression results show that per capita income does not affect the price of the three Subway sandwiches. This result differs from both Graddy (1997) and Stewart and Davis (2005) who found that fast food prices were higher in lower-income areas.

Considering the competition variables, only the number of other fast food restaurants affect the price of Subway sandwiches. At the 10% significance level, an additional fast food restaurant causes Subway to charge $0.034 more for a 6-inch Tuna sandwich. Muller's (1997) finding that small changes in the price of a fast food item will lead customers to substitute the item with a competitor's product, can again be used to support this positive relationship. The Italian BMT sandwich and Subway Club sandwich both contain meat and can be viewed as substitutes to the Big Mac and Whopper. The Tuna sandwich however does not have a close substitute at McDonald's and Burger King, whose only seafood offering is a fried fish sandwich. Thus, Subway can likely charge higher prices for the Tuna sandwich despite the added competition from other fast food restaurants.

Conclusions

The results of this study indicate that despite having similar ownership structure, offering similar amenities, and having similar business approaches, some fast food restaurants charge higher prices for select food items at restaurants located in food deserts. Regression results indicate that the McDonald's Big Mac and Subway's 6-inch Tuna and 6-inch Subway Club sandwiches are more expensive in food desert versus non-food desert restaurants. Unlike McDonald's and Subway, Burger King does not appear to charge different prices at food desert versus non-food desert restaurants.

The conclusion that fast food restaurants such as McDonald's and Subway are charging higher prices in food deserts, combined with prior findings that small grocers and convenience stores charge higher prices in food deserts (Chung et al. 1999, Kaufman et al. 1997, MacDonald et al. 1991), suggests the food industry needs to reevaluate their approach to marketing to poor underserved markets. Policymakers may also need to investigate the overall higher food costs in food desert locations.

In addition to evidence of higher fast food prices in food deserts, this study finds that sales at McDonald's and Burger King are higher at restaurants located in food deserts, while sales at Subway are lower at restaurants located in food deserts. This finding suggests that food desert residents are more likely to dine at burger style restaurants than at Subway. With Subway often viewed as a healthier option than burger style restaurants, this finding supports the need for continued food education programs in food deserts. Continued funding of programs such as The Supplemental Nutrition Assistance Program (SNAP-Ed) and The Expanded Food Nutrition

Education Program (EFNEP) is essential in that they are helping individual's with limited means gain the knowledge, skills, and attitudes necessary to have a nutritionally sound diet (Expanded 2013).

This study is the first to analyze fast food restaurant pricing strategies in food deserts. Additional research and data is needed to further understand the role fast food restaurant pricing plays in food deserts. Questions of particular interest include:

- How do fast food restaurants decide which items to charge higher prices for in food deserts?
- Do fast food restaurants charge higher prices for menu items with higher nutritional value at restaurants located in food deserts?
- How are fast food pricing and consumer preferences associated in food desert locations?

References

Abcede, A., S. Dwyer, P. Shook, and D. Smith. 1994. From Car Hops to Co-Branding. *National Petroleum News* 86(5): 34-45.

Zagat. 2012. America's Best Burgers, Fries, Coffee and More. http://blog.zagat.com/2012/09/americas-best-burgers-fries-coffee-and.html

Anderson, B., S. Lyon-Callo, C. Fussman, G. Imes, and A. Rafferty. 2011. Fast-Food Consumption and Obesity Among Michigan Adults. *Preventing Chronic Disease* 8(4): A71.

Ater, I. and O. Rigbi. 2010. Price Control in Franchised Chains: The Case of McDonald's Dollar Menu. *SIEPR Discussion Paper*. No. 0622.

Batis, C., L. Hernandez-Barrera, S. Barquera, J. Rivera, and B. M. Popkin. 2011. Food Acculturation Drives Dietary Differences among Mexicans, Mexican Americans, and Non-Hispanic Whites. *The Journal of Nutrition* 141(10): 1898-1906.

Binkley, J. and J. Connor. 1996. Market Competition and Metropolitan-Area Grocery Prices. Working Paper. Food Marketing Policy Center. University of Connecticut.

Carmin, J. and G. Norkus. 1990. Pricing Strategies for Menus: Magic or Myth. *Cornell Hotel and Restaurant Administration Quarterly* 31(3): 44-50.

Chung, C. and S.L. Myers. 1999. Do the Poor Pay More for Food? An Analysis of Grocery Store Availability and Food Price Disparities. *Journal of Consumer Affairs* 33:276-96.

ERS Food Access Research Atlas. *ERS.* 2010. http://www.ers.usda.gov/data-products/food-access-research-atlas/go-to-the-atlas.aspx#.UkobSDlXLzJ.

Expanded Food and Nutrition Education Program (EFNEP). 2013. *National Institute of Food and Agriculture*. http://www.csrees.usda.gov/nea/food/efnep/efnep.html.

Flegal, K., M. Carroll, C. Ogden, and C. Johnson. 2002. Prevalence and Trends in Obesity Among US Adults 1999-2000. *Journal of the American Medical Association* 288(14): 1723-1727.

Food and Alcoholic Beverages: Total Expenditures. *ERS*. October 1, 2012. http://www.ers.usda.gov/data-products/food-expenditures.aspx#26636.

Food, Conservation, and Energy Act of 2008. 2008. Public Law No. 110-246, 112 Stat. 165.

Geographic Terms and Concepts-Block Groups. *United States Census Bureau*. 2010. http://www.census.gov/geo/reference/gtc/gtc_bg.html.

Graddy, Kathryn. 1997. Do Fast-Food Chains Price Discriminate on the Race and Income Characteristics of an Area. *Journal of Economic and Business Statistics* 15: 391-401.

Graddy, K., and D. Robertson. 1999. Fairness of Pricing Decisions. *Business Ethics Quarterly* 9(2): 225-243.

Greene, William H. 2003. Econometric Analysis. 5th Ed. *Upper Saddle River*, NJ.

Jeffery, R., J. Baxter, M. McGuire, and J. Linde. 2006. Are Fast Food Restaurants an Environmental Risk Factor For Obesity. *International Journal of Behavioral Nutrition and Physical Activity* 3(2): 1- 6.

Jekanowski, Mark David. 1998. An Econometric Analysis of the Demand for Fast Food Across Metropolitan Areas with an Emphasis on the Role of Availability. PhD Dissertation, Purdue University, West Lafayette, IN.

Kalnins, Arturs. 2003. Hamburger Prices and Spatial Econometrics. *Journal of Economics and Management Strategy* 12(4): 591-616.

Kaufman, P.R., J.M. MacDonald, S.M. Lutz, and D.M. Smallwood. 1997. Do the Poor Pay More for Food? Item Selection and Price Differences Affects Low-Income Household Food Costs. *Economic Research Service* No. 34065.

LaFontaine, Francine. 1995. Pricing Decisions in Franchised Chains: A Look at the Restaurant and Fast-Food Industry. *NBER* Working Paper 5247.

Liang, J., and V. Kanetkar. 2006. Price Endings: Magic and Math. *Journal of Product and Brand Management* 15(6): 377-385.

MacDonald, J.M. and P.E. Nelson. 1991. Do the Poor Still Pay More? Food Price Variations in Large Metropolitan Areas. *Journal of Urban Economics* 30: 344-59.

Maddock, Jay. 2004. The Relationship Between Obesity and Prevalence of Fast Food Restaurants: State-Level Analysis. *American Journal of Health Promotion* 19(2): 137-143.

McDonald's Annual Report 2010. 2009. *McDonald's*. http://www.aboutmcdonalds.com/mcd/investors/annual_reports.html

McDonald's Annual Report 2011. 2011. *McDonald's* http://www.aboutmcdonalds.com/mcd/investors/annual_reports.html

Morland, K., S.Wing, A. Diez Roux, and C. Poole. 2002. Neighborhood Characteristics Associated with the Location of Food Stores and Food Service Places. *American Journal of Preventive Medicine* 22(1): 23-29.

Muller, Christopher. (1997). Redefining Value: The Hamburger Price War. *Cornell Hospitality Quarterly*. 38(3): 62-73.

Naipaul, Sandra, and H.G. Parsa. 2001. Menu Price Endings that Communicate Value and Quality. *Cornell Hotel and Restaurant Administration Quarterly* 42(1): 26-37.

Ogden, C., M. D. Carroll, B. Kit, and K. Flegal. 2012. Prevalence of Obesity in the United States 2009-2010. *NCHS DATA Brief* 82: 1-8**.**

Raja, S., Changxing M., and P. Yadav**.** 2008. Beyond Food Deserts: Measuring and Mapping Racial Disparities in Neighborhood Food Environments. *Journal of Planning Education and Research* 27(4): 469-482.

Rose, D., Bodor, N., Swalm, C., Rice, J., Farley, T., & Hutchinson, P. 2009. Deserts in New Orleans? Illustrations of urban food access and implications for policy. *Ann Arbor, MI: University of Michigan National Poverty Center/USDA Economic Research Service Research*.

Sales of Meals and Snacks Away from Home by Type of Outlet. *ERS*. October 1, 2012. http://www.ers.usda.gov/data-products/food-expenditures.aspx#26636.

Sallis, James and Karen Glanz. 2006. The Role of Built Environment in Physical Activity, Eating, and Obesity in Childhood. *The Future of Children* 16(1): 89-108.

Schlosser, Eric. 2002. *Fast Food Nation: The Dark-Side of the All-American Meal.* New York, NY: Perennial.

Senauer, Beb and Jon Seltzer. 2010. The Changing Face of Food Retailing. *Choices* 25(4).

Spence, J., N. Cutumisu, J. Edwards, K. Raine, and K. Smoyer- Tomic. 2009. Relation Between Local Food Environments and Obesity Among Adults. *BMC Public Health* 9(192): 1-6.

Stewart, H., N. Blisard, S. Bhuyan, and R. Nayga Jr. 2004. The Demand for Food Away From Home: Full-Service or Fast Food. *USDA ERS,* Agricultural Economic Report Number 829.

Stewart, H., N. Blisard, D. Jollifee, and S. Bhuyan. 2005. The Demand for Food Away from Home: Do Other Preferences Compete with Our Desire to Eat Healthfully? *Journal of Agricultural and Resource Economics* 30(3): 520-536.

Stewart, H., and D. Davis. 2005. Price Dispersion and Accessibility: A Case Study of Fast Food. *Southern Economic Journal* 71(4): 784-799.

Stiving, Mark. 2000. When Price Signals Quality. *Management Science* 46(12): 1617-1629.

Subway FAQS. (2012). *Subway* www.subway.com/ContactUS /CustServFAQS .aspx.

Thomadsen, Raphael. 2002. Price Competition in Industries with Geographic Differentiation: Measuring the Effect of Location on Price in the Fast Food Industry. Columbia University, unpublished manuscript.

Thompson, O.M., C. Ballew, K. Renicow, A. Must, L.G. Bandini, H. Cyr, and W.H. Dietz. 2004. Food Purchased Away From Home as a Predictor of Change in BMI Z-Score Among Girls. *International Journal of Obesity* 28: 282-289.

Ver Ploeg, Michele. 2009. Access to Affordable Nutritious Food is Limited in Food Deserts. *Amber Waves: Economic Research Service* 8(1): 1-9.

International Food and Agribusiness Management Review
Volume 17 Special Issue A, 2014

Population Density, Poverty, and Food Retail Access in the United States: An Empirical Approach[1]

Parke Wilde[Ⓘa], Joseph Llobrera[b] and Michele Ver Ploeg[c]

[a]*Associate Professor, Friedman School of Nutrition Science and Policy, Tufts University*
150 Harrison Ave., Boston, Massachusetts, 02111, USA

[b]*Postdoctoral Scholar, Friedman School of Nutrition Science and Policy, Tufts University*
150 Harrison Ave., Boston, Massachusetts, 02111, USA

[c]*Economist, ERS/USDA, 355 E Street, SW, Washington, DC, 20024-3221, USA*

Abstract

This article uses a random sample of census block groups to describe the adequacy of the local food retail environment in the continental United States. It builds upon simple empirical relationships between population density, poverty rates, vehicle access, and proximity to the nearest supermarket. In contrast with the conventional wisdom, the results show that high-poverty block groups had closer proximity to the nearest supermarket than other block groups did, on average: 85.6% of high-poverty block groups had a supermarket within 1 mile, while 76.8% of lower-poverty block groups had a supermarket within this distance. Population density is a strong predictor of proximity to the nearest supermarket. Block groups with very high population density generally had very close proximity to a nearest supermarket. In block groups lacking a nearby supermarket, rates of automobile access generally were quite high (more than 95%), although this still leaves almost 5% of the population in these areas lacking both an automobile and a nearby supermarket.

Keywords: food retail, food access, food deserts, poverty, community food security

Ⓘ Corresponding author: Tel: + 1.617.636.3495
Email: P. Wilde: parke.wilde@tufts.edu
J. Llobrera: joseph.llobrera@tufts.edu
M. V. Ploeg: sverploeg@ers.usda.gov

[1] The analysis and conclusions provided herein reflect those of the authors and not necessarily those of the Economic Research Service or the U.S. Department of Agriculture.

Introduction

The United States in recent years has faced public concerns about unhealthy eating patterns, low consumption of fruits and vegetables, high rates of overweight and obesity, and household food insecurity. These concerns have generated a lively policy debate about the adequacy of the food retail environment, especially in low-income areas, and whether and how public policy could intervene to improve the retail environment in underserved areas (USDA Economic Research Service 2009; Rose 2010; Gittelsohn and Lee 2013).

These policy discussions have led to research that has attempted to define which areas may be underserved and have inadequate food retail. Such areas sometimes have been called "food deserts," although use of this term may be declining. Informally, the term "food desert" may be used to describe neighborhoods that lack healthy food resources. More formally, USDA's Economic Research Service classifies a census tract that meets a particular definition of low income and distance from the nearest supermarket as a "food desert" (Economic Research Service 2013). To understand the implications of alternative definitions, this article describes and compares three approaches that have been used to identify geographic areas with inadequate food retail:

- a low-income low-access approach, which identifies geographic areas that are low-income and lack a supermarket within a specified distance;
- a low-vehicle low-access approach, which identifies geographic areas that have low rates of vehicle access and lack a supermarket within a specified distance;
- a relative distance approach, which identifies geographic areas that have worse-than-usual proximity to a supermarket, compared with other neighborhoods that have similar population density and vehicle access rates.

These three approaches have been used in research applications and widely-circulated online tools. A low-income low-access approach was the primary approach used in USDA's online food desert atlas and still is one approach used in an updated version of this online tool, called the Food Access Research Atlas (FARA) (Economic Research Service 2013). A newer low-vehicle low-access approach also is used in the updated online FARA tool (Economic Research Service 2013). A relative distance approach has been used in the definition of areas with limited supermarket access (LSA) by The Reinvestment Fund, one of several notable non-governmental research initiatives using alternative definitions of adequacy (The Reinvestment Fund 2011).

These tools are important because they may be used as inputs to policy decisions about subsidies or tax breaks to encourage retailers to locate in underserved locations or zoning rules to guide retailer location choices. However, retailers' location decisions respond primarily to market incentives rather than policy initiatives. Food retailers choose locations that they judge will be profitable. The profitability of a particular location depends on (a) the number and buying power of potential customers in nearby residential neighborhoods, (b) the nature of competition from other retailers, and (c) land, labor, and capital costs, which vary from place to place. Retailers cannot afford to build supermarkets in locations with too few customers or too many competitors.

The three research approaches lead to distinct conclusions about the adequacy of food retail conditions nationally and about which particular geographic areas lack adequate retail. Although they have similar purposes, the approaches differ in the underlying household-level circumstance or condition that motivates the methodology; they differ in implicit assumptions about the relationships between poverty, vehicle access, population density, and proximity to supermarkets; and they differ in their method for aggregating data from basic units (such as a census block group) to larger geographic units (such as a census tract).This article compares and contrasts the three approaches using a common data source, a random sample of more than 33,000 census block groups in the continental United States.

Using this data source, this article addresses four empirical questions about characteristics of small geographic areas (census block groups):

1. What is the empirical relationship between poverty and proximity to supermarkets?
2. What is the empirical relationship between population density and proximity to supermarkets?
3. What is the empirical relationship between vehicle access and proximity to supermarkets?
4. What is the average proximity to a supermarket for geographic areas with particular levels of population density and vehicle access rates?

These concrete empirical questions are important for two reasons. First, the basic relationships among poverty, population density, vehicle access, and proximity to supermarkets are interesting in their own right; in some cases, these relationships are surprising and contradict the conventional wisdom. Second, these empirical questions help in making choices among the three research approaches and in developing improved methods for identifying areas with inadequate food retail access.

This article contributes to a research literature that also includes several other important lines of work. The three approaches here focus on proximity to supermarkets, using retailer data that are available at the national level. Other research addresses different retail formats, including healthy food initiatives in smaller stores, using retailer data that are only available in particular locations (Gittelsohn, Rowan, and Gadhoke 2012). The three approaches here focus on the nearest supermarket, while other research measures distances to potentially more distant retailers patronized by food consumers (USDA Economic Research Service 2012; Apparicio, Cloutier, and Shearmur 2007; Cole 1997).The three approaches here merely describe food retail conditions, while other research seeks to measure the relationship of these conditions to diet and health outcomes (Gibson 2011; Leung et al. 2011; Chen, Florax, and Snyder 2010). For this article, it was sufficient to better understand the geographic conditions and computational methods in high-profile online tools that are used to identify areas with inadequate proximity to the nearest supermarket.

Background

USDA has published two reports measuring access to affordable and nutritious food nationwide (USDA Economic Research Service 2009; USDA Economic Research Service 2012). Retail access conditions depend to a large extent on competition in economic markets. An earlier

literature in economics paid close attention to the relationship between the number of retailers in a particular area and their degree of market power (Fik 1988, Benson and Faminow 1985, Cotterill 1986). A line of research tracing back to Huff (1964) considered the question of how large each retailer's catchment area would be if consumers sought to shop at the closest retailer. In part responding to changes in the diversity of retail formats, some more recent research has focused on the relationship between market power and the mix of services that retailers offer (Bonanno and Lopez 2009).

This type of economic analysis adds new insight to existing lines of research on inadequate food retail access. For example, Broda, Leibtag, and Weinstein (2009) note that low-income consumers differ from other consumers not only in their more frequent use of small retailers (which may have higher food prices and locations close to home) but also in their more frequent use of superstores or supercenters (which may have lower food prices and locations farther from home). Bitler and Haider (2011) discuss both the supply and demand for food retail services, recognizing that in some cases it is a market equilibrium outcome to have only a small number of retailers in a particular geographic area.

This study focuses on three high-profile existing approaches to identifying geographic locations with inadequate supermarket access. The three approaches differ in their implicit assumption about the underlying household-level condition that is most important.

The Low-Income Low-Access Approach. In an online mapping tool and accompanying data resources, USDA's Food Access Research Atlas (FARA) identifies census tracts as having inadequate food retail if they meet both a low-income definition and a low-access definition (Economic Research Service 2013).

- Low-income tracts satisfy an absolute poverty standard or a relative income standard. The absolute standard is having a poverty rate of at least 20%, based on the federal government's poverty thresholds. The relative standard is having census-tract median income at or below 80% of the median income in the corresponding metropolitan area or (for non-metropolitan areas) the entire state. This second standard varies across geographic locations.
- Low-access tracts have at least a third of the population or at least 500 people with low access. Low-access, for ERS, means low proximity to the nearest supermarket, defined using a different distance threshold in urban areas (at least 1 mile from a supermarket) and rural areas (at least 10 miles from a supermarket). Estimates are also given for alternative distance thresholds, but we focus on the 1- and 10-mile thresholds.

In this approach to classifying census tracts, some complexity arises from the need to aggregate up to the census-tract level, but the implicit underlying concept is clear. A person qualifies as having inadequate food retail access if he or she is low-income (based on having income below either the poverty line or 80% of area median income) and lives farther than the threshold distance from the nearest supermarket (where the threshold distance is 1 mile in urban areas and 10 miles in rural areas). This approach does not explicitly refer to vehicle access, but both the low-income standard and the distinction between urban and rural areas may be motivated by concern for those who lack vehicles.

The Low-Vehicle Low-Access Approach. USDA's FARA tool recently has added more information so that a vehicle-based measure can be constructed. A tract is identified as having low vehicle availability "if more than 100 households in the tract have no vehicle available and are more than 0.5 miles from the nearest supermarket" (Economic Research Service 2013).

The Relative Distance Approach. The Reinvestment Fund (TRF), a non-governmental organization prominent in community food security research, identifies areas with limited supermarket access (LSA). Like USDA, TRF makes the results available in a popular online mapping tool. TRF uses a relative distance-to-supermarket concept somewhat akin to a relative income threshold in poverty measurement. A particular block group has low relative access if its distance to the nearest supermarket is longer than a threshold distance, which varies across 13 comparison-group strata, defined by combinations of population density and vehicle access rates.

For each comparison-group stratum, the threshold distance for determining whether the block group has limited access is based on the distance to the nearest supermarket for higher income block groups in the stratum that are presumably not deprived. TRF computes the benchmark distance as the median distance to the nearest supermarket for those block groups with higher income (based on area median income above 120% of median income for the metropolitan area or state). Several findings are useful for understanding TRF's concept of inadequacy:

- The 4 rural strata with the lowest population density have 11.7% of the U.S. population. All of these strata have high vehicle access in TRF's classification. In these strata, the adequate benchmark distance ranges from 5.5 miles to 17.5 miles. This distance is roughly comparable to the 10-mile threshold used by USDA's FARA in rural areas.
- The 5 urban strata with the highest population density have 50.3% of the U.S. population. All but one of these strata have medium or high vehicle access in TRF's classification. In these strata, the adequate benchmark distance ranges from 0.15 miles to 1 mile.
- Only 1 of the 13 strata has low vehicle access in TRF's classification. It has a high population density and represents 6.6% of the U.S. population. Its adequate benchmark distance is just 0.29 miles.

In TRF's approach, the threshold distance varies across the comparison-group strata. For some locations, the threshold distance is larger than five miles, recognizing that many residents have vehicles. In other locations, the threshold for inadequate retail access may be as small as 0.15 miles or 0.29 miles, which is shorter than the threshold distance to supermarket used in other approaches with which we are familiar. With such small threshold distances, many locations may be classified as having inadequate access.

Conclusions about retail adequacy for census tracts necessarily build on conclusions about retail adequacy for smaller geographic units. In small areas, such as a census block group or a 1-km or 0.5-km grid square, the research literature generally treats resident households as if they share the same food retail environment. Building on the identification of small geographic units where households have inadequate access, one can determine which larger geographic areas (such as census tracts or counties) have sufficient numbers of such households or individuals to qualify as areas with limited supermarket access. For these larger geographic units, it is clear that research methods must acknowledge the internal heterogeneity in food retail access.

Conclusions about retail adequacy in small geographic units necessarily build on a concept of adequacy at the household level. It is useful to make this household-level concept explicit rather than having readers derive it implicitly from definitions of adequacy for geographic areas. To define adequacy at the level of the household, much of the literature focuses on the presence of supermarkets within a specified threshold distance from home. A sensible threshold distance may depend on whether a household has a vehicle. A common threshold distance is 0.5 miles or 1 mile for people who lack a vehicle and a longer distance for people who have a vehicle. As an illustrative example, one could say a household has inadequate access if (a) it lacks a vehicle and lives more than 0.5 miles from the nearest supermarket or (b) it has a vehicle and lives more than 10 miles from the nearest supermarket (Figure 1). This framework easily may be adapted for other threshold distances, such as 1 mile for households that lack a vehicle.

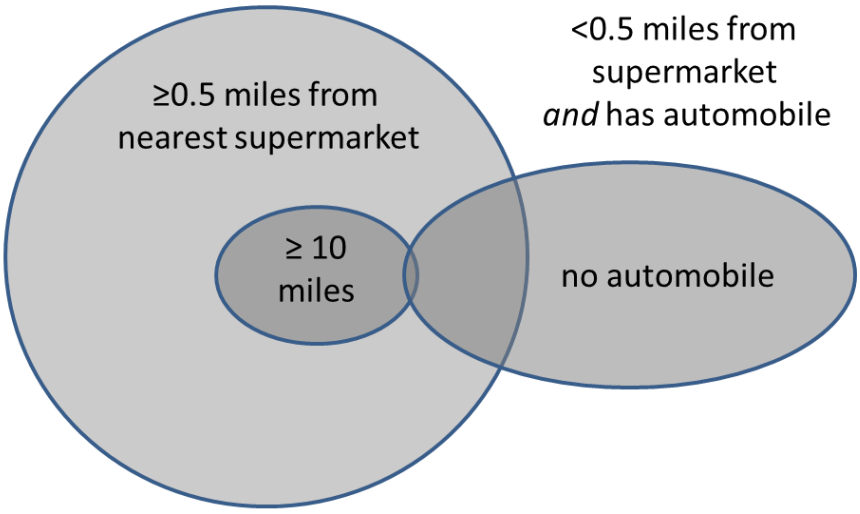


Figure 1. A Concept of Inadequate Food Retail Access at the Household Level.

Note. The circle at left represents households located at least 0.5 miles from a supermarket. A subset of these households are located at least 10 miles from a supermarket. The oval at right represents households with no vehicle. Darker shading in the intersection represents inadequate food retail access.

Data and Methods

This study used geographic information for all census block groups within 91 counties in 27 States. The counties were chosen by USDA's Economic Research Service in connection with the Food Acquisition and Purchase Survey (FoodAPS), a new national food expenditure survey (Kirlin and Denbaly 2013). For FoodAPS, Mathematica Policy Research, Inc., selected a slightly different list of 108 counties within 50 primary sampling units (PSUs) in the same 27 States. Within the PSUs, the FoodAPS survey sampled approximately 5,000 households in 400 secondary sampling units (SSUs). None of the FoodAPS household data or SSU identifiers were used in this article, which only needed geographic-level data.

The sample size was 33,604 block groups (after excluding 3 block groups that had implausibly high population densities, which we attributed to incorrect land area estimates). The analysis block groups belonged to 11,747 census tracts in 91 counties in the 50 PSUs. The block-group analysis file included two types of variables: (a) variables that were originally acquired at the block-group level (such as Census Bureau demographic characteristics for block groups) and (b) variables that describe the retail environment at varying distances from the population-weighted centroid of the block group.

This study used the same 2010 retailer location data that USDA/ERS used in FARA, combining information from TDLinx and USDA/FNS Store Tracking and Redemption System (STARS). Nielsen TDLinx is a commercial database of retailers selling consumer packaged goods (including food). FNS uses STARS to monitor and manage SNAP-authorized retailers. Our analysis is based on counts of retailers located within a specified distance from the population-weighted block-group centroid. FARA, by contrast, is based on 0.5-km square grids rather than concentric circles. In FARA, the entire country was divided into 0.5-km square grids and then population data was allocated to these grids. The distance to the nearest supermarket was measured for each grid cell by calculating the distance between the geographic center of the 0.5-km square grid that contains estimates of the population and the center of the grid with the nearest supermarket. This study used block groups rather than 0.5-km square grids, because we lacked access to 0.5-km grid data, and block groups were judged to be adequately disaggregated.

At the block-group level, this study made no assumption that residents shopped within the block group itself. Instead, residents were assumed to shop anywhere in the retail environment that surrounded the block-group centroid. We estimated counts for supermarkets and superstores at linear distances of 0.5 miles, 1 mile, 5 miles, 10 miles, and 20 miles from the population-weighted centroid of the block group. The commonly-used conventions (such as a 0.5-mile or 1-mile radius in urban areas or a 10-mile radius in rural areas) are special cases that can be analyzed using this data source.

For clarity, in the initial analysis of underlying relationships across block-group variables, this study used an absolute poverty standard for defining high-poverty areas. A high-poverty block group was defined as one with $\geq$ 20% of the population in poverty. The analysis used 4 population density levels, ranked from least to most dense: low, 0-1k persons per square mile; medium, 1k-5k persons per square mile; high, 5k-10k persons per square mile; very high, 10k+ persons per square mile. We removed from the analysis 3 outlier block groups with implausible population density greater than 300k persons per square mile (a density much greater than that of Manhattan). Block groups in rural census tracts are predominantly in density level 1. Block groups in urban census tracts are more numerous, and they are split evenly between density levels 2, 3, and 4.

The first four sections of the analysis address the four empirical questions noted in the introduction, describing the relationships among variables related to food access at the block-group level. The final section of analysis discusses issues of aggregation from a detailed geographic level (block group) to a broader geographic level (census tract).

Results

Poverty and Proximity to Supermarkets

First, consider the relationship between poverty and proximity to supermarkets. 26.1% of block groups were high-poverty, and these block groups contained 25.4% of the population. Because census block groups by design have roughly similar population sizes, weighting block groups by population made only small differences to the empirical results, so this article reports unweighted counts of block groups. High-poverty block groups (one quarter of all block groups) contained 60.6% of poor people. Lower-poverty block groups (three quarters of all block groups) contained the remaining 39.4% of poor people.

Fewer than 1 out of each 2,000 block groups (0.03%) lacked a supermarket within 20 miles, and another 1 out of 300 block groups (0.32%) lacked a supermarket within 10 miles (Table 1). At the other end of the spectrum, 43.9% of block groups had a supermarket within 0.5 miles, and another 35.2% of block groups had a supermarket between 0.5 miles and 1 mile away. In between the two extremes, 20.6% of block groups had a nearest supermarket between 1 and 10 miles away.

The high-poverty block groups had better access to supermarkets than other block groups did, on average, 85.6% of high-poverty block groups had a supermarket within 1 mile. By contrast, only 76.8% of lower-poverty block groups had a supermarket within this distance. Thus, most block groups had fairly good proximity to a nearest supermarket. Surprisingly, low-income block groups on average had better proximity than high-income block groups did.

Table 1. Frequency of Having a Nearest Supermarket at Each Distance (in Miles) for Block Groups with and without a High Poverty Rate.

	Distance to Nearest Supermarket (in miles)					
Block Group Poverty	0 to 0.5	0.5 to 1	1 to 10	10 to 20	>20	Total
			# Block groups *(row %)*			
Not high poverty	10,029	8,968	5,659	88	6	24,750
	(40.52)	*(36.23)*	*(22.86)*	*(0.36)*	*(0.02)*	*(100.00)*
High poverty	4,655	2,817	1,230	18	5	8,725
	(53.35)	*(32.29)*	*(14.10)*	*(0.21)*	*(0.06)*	*(100.00)*
Total	14,684	11,785	6,889	106	11	33,475
	(43.87)	*(35.21)*	*(20.58)*	*(0.32)*	*(0.03)*	*(100.00)*

Note. High-poverty block groups have a poverty rate greater than or equal to 20

Population Density and Proximity to Supermarkets

Second, consider the relationship between population density and proximity to the nearest supermarket. Among block groups in the lowest-density level, only 6.1% are within 0.5 miles of a supermarket and another 15.8% are between 0.5 and 1 miles of a supermarket (Table 2). By contrast, among block groups in the highest-density level, 72.5% are within 0.5 miles of a supermarket.

Table 2. Frequency of Having a Nearest Supermarket at Each Distance (in Miles) at Each of Four Population Density Levels.

	Distance to Nearest Supermarket (in miles)					
Population Density	0 to 0.5	0.5 to 1	1 to 10	10 to 20	>20	Total
			# Block groups *(row %)*			
Low	229	592	2,821	106	11	3,759
	(6.09)	*(15.75)*	*(75.05)*	*(2.82)*	*(0.29)*	*(100.00)*
Medium	2,567	4,388	2,805	1	0	9.761
	(26.30)	(44.95)	(28.74)	(0.01)	(0.00)	(100.00)
High	4,408	4,255	1,026	0	0	9689
	(45.49)	*(43.92)*	*(10.59)*	*(0.00)*	*(0.00)*	*(100.00)*
Very high	7,495	2,570	268	0	0	10,333
	(72.53)	*(24.87)*	*(2.59)*	*(0.00)*	*(0.00)*	*(100.00)*
Total	14,699	11,805	6,920	107	11	33,542
	(43.82)	*(35.19)*	*(20.63)*	*(0.32)*	*(0.03)*	*(100.00)*

For urban areas, Figure 2 shows block-group poverty rates on the horizontal axis and the natural logarithm of block-group miles to the nearest supermarket, ln(distance), on the vertical axis.

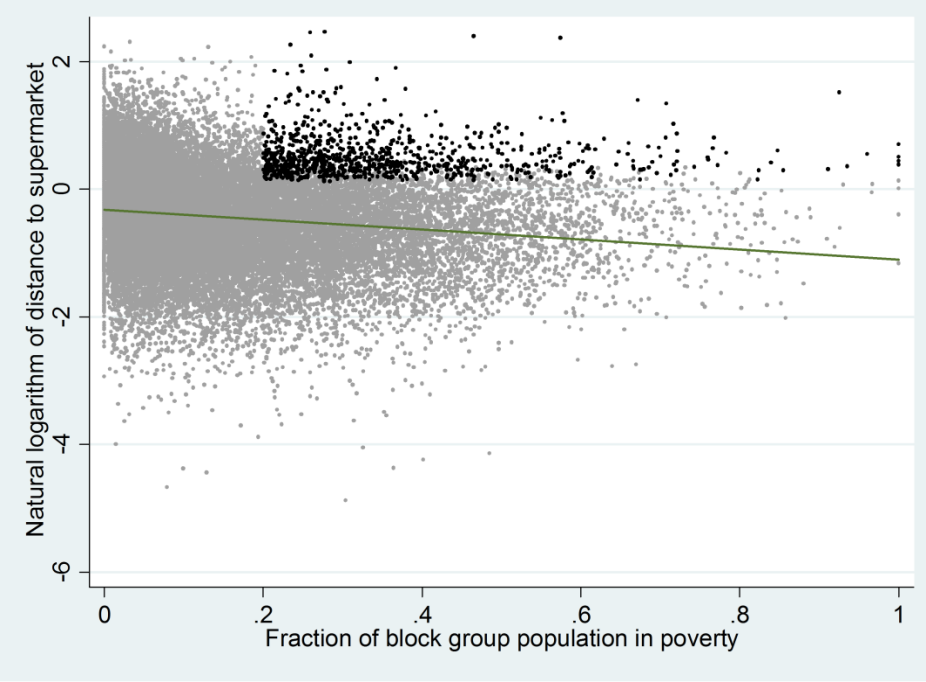


Figure 2. The Natural Logarithm of Distance to the Nearest Supermarket, as a Function of the Poverty Rate, in Urban Areas.

Note. black color indicates the poverty rate is high (greater than 20%) and the nearest supermarket is 1 mile away or farther; the vertical axis shows the natural logarithm of the distance to the nearest supermarket in miles (the logarithmic scale is used for display, because the dependent variable is highly right-skewed).

Block groups further than a mile from a supermarket have ln(distance) greater than zero. In the figure, there is not much correlation between ln(distance) and the poverty rate, and what little correlation exists is negative. The block groups that are both high-poverty and greater than one mile from the nearest supermarket are in the top right quadrant, marked in black. This figure shows that definitional thresholds strongly influence descriptions of supermarket access that are based on distance and poverty rates.

The block groups marked in black are not a separate cluster in this two-dimensional space. On the contrary, an analyst using a distance threshold slightly different than one mile, or a poverty rate threshold slightly different than 20%, would have generated a much different estimate of the fraction of block groups that suffers from poor supermarket access. Moreover, the block groups illustrated in black are overshadowed by the larger number of block groups in the top left and bottom right quadrants. The block groups in the top left quadrant have poverty rates below 20%, but they are far from the nearest supermarket and they include large numbers of poor people (we noted earlier that almost two fifths of poor people live in block groups with poverty rates below 20%). The block groups in the bottom right quadrant have exceptionally high rates of poverty, and they may face serious problems with the quality of the food environment, but they do enjoy close proximity to the nearest supermarket.

Thus, much more than poverty, population density was a powerful predictor of proximity to a nearest supermarket. Nearly all block groups with very high population density had a nearest supermarket no more than 1 mile away.

Vehicle Access and Proximity to Supermarkets

Third, consider the relationship between vehicle availability and supermarket access. In block groups with a supermarket less than 0.5 miles away, 15.3% of households lacked a vehicle (Table 3). For in-between block groups, with a nearest supermarket between 1 and 10 miles away, 4.7% of households lacked a vehicle. In block groups with a nearest supermarket between 10 and 20 miles away, 4.6% of households lacked a vehicle.

Table 3. Percentage of Households Having No Vehicle, for Block Groups with Nearest Supermarket in Each Distance Category.

	Distance to Nearest Supermarket (in miles)				
	0 to 0.5	0.5 to 1	1 to 10	10 to 20	>20
Mean % with No Vehicle	15.34	8.04	4.71	4.55	5.71

Thus, vehicle availability is highest in the areas where vehicles are most needed. Yet, lack of a vehicle may be a problem for a small but non-negligible fraction (almost 5%) of those households that are at least 1 mile from the nearest supermarket.

Proximity to Supermarkets Based on Area Characteristics

Fourth, consider the proximity to supermarkets in block groups with particular levels of population density and vehicle access. This fourth empirical question helps us to understand relative distance methods, such as TRF's approach to identifying LSAs, which was described in the background section.

This article's relative distance analysis, loosely motivated by TRF's approach, used the same 4 population density levels as in our earlier results. We defined a block group as "high vehicle" if the rate of vehicle access was greater than 80%, and "low vehicle" otherwise. We stratified all block groups into low-income (having a high poverty rate or low relative income or both) and not-low-income categories. TRF uses only higher-income areas (defined as having median income above 120% of the poverty guideline) to establish adequate benchmark distances.

In our analysis, as in TRF (2011), the low-density block groups had high vehicle access rates (Table 4). The mean distance to the nearest supermarket among these predominantly low-density block groups was about 4 miles (4.18 miles in low-income block groups and 3.93 miles in other block groups). By contrast, for block groups with the highest population density level, the mean distance to the nearest supermarket was much smaller, ranging from 0.37 to 0.57 miles depending on vehicle access and low-income status. These benchmark distances are similar to the results TRF (2011) found for high-density areas.

Table 4. Benchmark Distances for Several Population Density and Vehicle Access Categories.

Population Density	**Mean Distance in Miles** ***(% of all block groups)***			
	Not Lower Income		Lower Income	
	High Vehicle	Low Vehicle	High Vehicle	Low Vehicle
1 (lowest density)	3.93 *(13.0)*	-	4.18 *(7.5)*	-
2	1.13 *(35.4)*	-	0.97 *(15.7)*	0.87 *(4.6)*
3	0.76 *(30.3)*	-	0.75 *(19.8)*	0.71 *(6.3)*
4 (highest density)	0.57 *(15.4)*	0.37 *(4.3)*	0.57 *(25.1)*	0.42 *(20.1)*

Note. Empty cells indicate that few people live in areas with that combination of population density and vehicle access.

Thus, although our relative distance approach did not seek exactly to replicate the TRF approach, we observed the same patterns that TRF observed. High-population-density areas tend to have short benchmark distances of much less than 1 mile, which means that such block groups generally are within one mile of a supermarket.

Aggregating to the Census Tract

In urban areas, a block group generally is sufficiently small that the population-weighted centroid can be treated as the location where people live. We recognize that rural block groups are larger, but, in this study, we nonetheless use the population-weighted block group centroid as an approximation of the location where residents live. In yet larger geographic units such as census tracts, one always must recognize that the food environment is different for residents of different neighborhoods within the unit. Building on the basic block-group level results in the previous section, we next investigate issues of aggregating to the census-tract level in the low-income low-access approach. Some of the lessons from this analysis may apply to other approaches as well.

FARA identifies census tracts that are both (1) a low-income tract and (2) a low-access tract (meaning that the households have poor proximity to the nearest supermarket). It is comparatively straightforward to define a low-income census tract, using the same approach as was used previously to define a low-income block group. Low income, in FARA, means having a poverty rate of at least 20% (as in the previous section) or having low median income relative to other parts of the same metropolitan area or state. While the previous section showed that 26% of block groups had high poverty, 42.2% of census tracts qualify as low-income using this more expansive definition (Table 5).

Table 5. Joint Frequency for Census Tracts Having Low Income and Low Access.

	Access Status		
	Not Low	Low	Total
Income Status			
		# Census Tracts	
		(row %)	
Not Low Income	4,672	2,111	6,783
	(68.88)	*(31.12)*	*(100.00)*
Low Income	4,073	879	4,952
	(82.25)	*(17.75)*	*(100.00)*
Total	8,745	2,990	11,735
	(74.52)	*(25.48)*	*(100.00)*

Note. The ERS Food Access Research Atlas (FARA) classifies a tract with both low income and low access as a "food desert."

It is more difficult to define low access at the census-tract level than at the block-group level. The issue is that supermarket access is an attribute of a very specific geographic location, such as a block-group centroid (in the previous section) or a small 0.5-km square grid cell (in USDA's FARA estimates). In contrast with a block group, a census tract is too large an area for the distance from the census-tract centroid to be a useful concept. Hence, FARA based its tract-level definition of low-access on a particular aggregation: a low-access census tract is one in which at least 500 people reside in low-access grid cells, or 33% of the tract population resides in low-access grid cells, or both. While the previous section showed that 20.9% of block groups had no supermarket within 1 mile, this census-tract analysis found that 25.5% of census tracts qualify as low access using this approach (Table 5). It is common to have low-access census tracts that include some neighborhoods with adequate food retail access.

Overall, 879 out of 11,735 census tracts (7.5% of all census tracts) met both the low-access and low-income criteria. Low-income census tracts are less likely than other census tracts to be classified as low-access tracts. Of those census tracts classified as having low income, 17.8% had low access. Of census tracts that were not low-income, 31.1% had low access (Table 5). To summarize, the census-tract level analysis was more likely than the earlier block-group level analysis to classify a geographical area as an area with inadequate food retail. Yet, the basic relationship between income status and food retail access status remained the same. Low-income census tracts have comparatively good access to supermarkets.

Discussion

There is substantial policy interest in classifying geographic areas according to the adequacy of the local food retail environment and in measuring the prevalence of poor access conditions. Three leading approaches share some similarities in methods and motivation, but they differ in key respects and lead to substantially different conclusions about food retail adequacy.

The approaches studied here each measure the distance to the nearest supermarket and compare it to a threshold distance thought to indicate an acceptable burden for grocery shopping. In the low-income low-access approach, USDA Economic Research Service (2009) used time-based measures for walking and driving to develop estimates of walkable and drivable distances. For walking, the authors assumed a walking speed of 2 miles per hour and a 15-minute walking time to arrive at a 0.5 mile radius for "high" access (in urban areas). Others (Algert, Agrawal, and Lewis 2006, Apparicio, Cloutier, and Shearmur 2007, California Center for Public Health Advocacy, PolicyLink, and UCLA Center for Health Policy Research 2008) have used similar definitions of walkability. For driving, USDA's Economic Research Service assumed a driving speed of 40 miles per hour and a 15-minute drive to arrive at a 10 mile radius for "high" access in rural areas. Clearly, if one uses a smaller threshold distance, one is systematically more likely to classify a particular location as having inadequate food retail conditions. Conversely, if one uses a larger threshold distance, one finds fewer such areas. Hence, a lot depends on the choice of threshold distance. The findings show that the choice of the threshold point could make a sizable difference in the number of locations that are designated as limited access.

Each approach implicitly sought to take account of the fact that a reasonable threshold distance may be different for households with and without vehicles, but the methods for taking account of vehicle availability differed considerably. If the population of concern is people who live further than a threshold distance and lack a vehicle, then FARA's vehicle-based measure seems to be the most direct approach.

Using low-income status at the census-tract level has some shortcomings as a method for identifying this population. Because low-income areas are more likely than other areas to have a supermarket nearby, the low-income low-access approach actually excludes many areas that are not low-income, but which have particularly long distances to the nearest supermarket. Recall from the first section of results that almost 40% of poor people live in neighborhoods that are not high-poverty neighborhoods. One could argue that the low-income low-access approach excludes one of the most commonly deprived populations, which is poor people in non-poor neighborhoods that lack a supermarket.

Similarly, the relative distance approach would be an indirect way of identifying areas where people lack a vehicle and live too far from a supermarket. In some areas with large threshold distances, it seems possible that households without a vehicle would face great hardship. In other areas, a threshold distance of less than 0.5 miles may be too short. In such areas, many residents without vehicles may be classified as having limited supermarket access even if they are well-satisfied with nearby supermarkets at distances of between 0.5 miles and 1 mile.

We conclude that neither the low-income low-access approach (with access based only on distance) nor the relative distance approach serves well as a method for accounting for vehicle access, but we recognize that there may be other motivations for these approaches. It could be that low income is not intended as a proxy for low vehicle availability, but instead there is a more direct reason why people in low-income neighborhoods without a supermarket should be at greater disadvantage than people in other neighborhoods without a supermarket. For example, community development in low-income neighborhoods could be the policy goal. Likewise, there could be a more direct motivation for the relative distance approach, such as concerns over equity of access.

Our results suggest some recommendations for future work in measuring food retail adequacy. First, it is good to state explicitly the household-level or individual-level condition that represents inadequate food retail access. For example, the underlying household-level condition might be one of the three conditions studied in this article: (1) poverty plus lack of a nearby supermarket, or (2) lack of a vehicle plus lack of a nearby supermarket, or (3) lack of a supermarket as close as one typically expects in neighborhoods with similar population density. Alternatively, the household-level condition might address issues beyond those covered here, such as lack of fresh fruits and vegetables at a particular price point. Second, when it is necessary to aggregate from granular geographic data to larger areas such as census tracts or counties, it is good to do so in a fashion that preserves the underlying information about the extent of hardship. Current methods of aggregation may cautiously classify some census tracts as having inadequate access even if many block groups or smaller geographic units contained in the census tracts have adequate food retail access.

The research literature on food retail adequacy may have policy implications. In particular, policy-makers may choose to target areas for subsidies or tax incentives to attract additional commercial supermarkets, or they may use zoning rules to guide retailer location decisions. When research on food retail adequacy is used in this fashion, it is especially important that the choice of threshold distance and assumptions about vehicle adequacy match actual consumer behavior. For example, if one assumed that low-income households in a particular community seek to shop for groceries within a 0.5-mile radius, when in fact vehicle availability rates are high and households in this community usually patronize lower-priced retailers at greater distances, then it could be a substantial policy error to subsidize the introduction of a new supermarket. To determine locations where market outcomes have been unsatisfactory and where a new supermarket may be encouraged, it is good first to recognize and assess population density, vehicle availability, and the proximity of other supermarkets.

References

Algert, S. J., A. Agrawal and D. S. Lewis. 2006. Disparities in access to fresh produce in low-income neighborhoods in Los Angeles. *American Journal of Preventive Medicine* 30(5): 365-370.

Apparicio, P., M. S. Cloutier and R. Shearmur. 2007. The case of Montreal's missing food deserts: Evaluation of accessibility to food supermarkets. *International Journal of Health Geographies* 6(4).

Benson, B. L., and M. D. Faminow. 1985. An alternative view of pricing in retail food markets. *American Journal of Agricultural Economics* 67(2): 296–306.

Bitler, M., and S. J. Haider. 2011. An economic view of food deserts in the United States. *Journal of Policy Analysis and Management* 30(1): 153–176.

Bonanno, A. and R. A. Lopez. 2009. Competition effects of supermarket services. *American Journal of Agricultural Economics* 91 (3): 555–568.

Broda, C., E. Leibtag and D. E. Weinstein. 2009. The role of prices in measuring the poor's living standards. *The Journal of Economic Perspectives* 23 (2): 77–97.

California Center for Public Health Advocacy, PolicyLink, and UCLA Center for Health Policy Research. 2008. *Designed for Disease: The Link Between Local Food Environments and Obesity and Diabetes*.

Chen, S., Florax, R. J. G. M., and S. D. Snyder. 2010. Does where you live make you fat? Obesity and access to chain grocers. *Economic Geography* 86: 431–452.

Cole, N. 1997. *Evaluation of the Expanded EBT Demonstration in Maryland: Patterns of Food Stamp and Cash Welfare Benefit Redemption,* Report submitted to U.S. Department of Agriculture, Food and Nutrition Service, by Abt Associates, Inc.

Cotterill, R. W. 1986. Market power in the retail food industry: Evidence from Vermont. *The Review of Economics and Statistics* 68(3): 379–386.

Economic Research Service (ERS). 2013. U.S. Department of Agriculture (USDA). Food Access Research Atlas (FARA). http://www.ers.usda.gov/data-products/food-access-research-atlas.aspx [accessed August 2, 2013].

Fik, T. J. 1988. Spatial competition and price reporting in retail food markets. *Economic Geography* 64(4): 29–44.

Gibson, D. M. 2011. The neighborhood food environment and adult weight status: estimates from longitudinal data. *American Journal of Public Health* 101: 71–78.

Gittelsohn, J., M. Rowan and P. Gadhoke. 2012. Interventions in small food stores to change the food environment, improve diet, and reduce risk of chronic disease. *Preventing Chronic Disease* 9: E59.

Gittelsohn, J., and K. Lee. 2013. Integrating educational, environmental, and behavioral economic strategies may improve the effectiveness of obesity interventions. *Applied Economic Perspectives and Policy* 35(1): 52–68.

Huff, D. L. 1964. Defining and estimating a trading area. *The Journal of Marketing* 28: 34–38.

Kirlin, J. A. and M. Denbaly. 2013. FoodAPS National Household Food Acquisition and Purchase Survey, U.S. Department of Agriculture, Economic Research Service, July 2013. http://www.ers.usda.gov/data-products/foodaps-national-household-food-acquisition-and-purchase-survey.aspx [accessed August 2, 2013].

Leung, C. W., B. A. Laraia, M. Kelly, D. Nickleach, N.E. Adler, L.H. Kushi and I. H. Yen. 2011. The influence of neighborhood food stores on change in young girls' body mass index. *American Journal of Preventive Medicine* 41: 43–51.

Rose, D. 2010. Access to healthy food: A key focus for research on domestic food insecurity. *Journal of Nutrition* 140: 1167–1169.

The Reinvestment Fund (TRF). 2011. *Limited Supermarket Access Analysis: Summary of TRF's Methodology*. http://www.trfund.com/resource/downloads/policypubs/LSAMethodology2011.pdf [accessed August 14, 2012].

USDA Economic Research Service. 2009. *Access to Affordable and Nutritious Food—Measuring and Understanding Food Deserts and Their Consequences: Report to Congress*. Contributors: Ver Ploeg, M., V. Breneman, T. Farrigan, K. Hamrick, D. Hopkins, P. Kaufman, B.H. Lin, M. Nord, T. A. Smith, R. Williams, R. Kinnison, C. Olander, A. Singh, and E. Tuckermanty. Washington, DC: U.S. Department of Agriculture, Economic Research Service.

USDA Economic Research Service. 2012. *Access to Affordable and Nutritious Food: Updated Estimates of Distance to Economic Supermarkets Using 2010 Data*. Contributors: Ver Ploeg, M., Breneman, V., Dutko, P., Williams, R., Snyder, S., C. Dicken and P. Kaufman. Washington, DC: U.S. Department of Agriculture, Economic Research Service.

International Food and Agribusiness Management Review
Volume 17 Special Issue A, 2014

Behavioral Economics in the School Lunchroom: Can it Affect Food Supplier Decisions? A Systematic Review

Janani R. Thapa[a] and Conrad P. Lyford[Ⓘb]

[a]*Graduate Research Assistant, Department of Agricultural and Applied Economics, Texas Tech University, Box 42132 Lubbock, Texas, 79409-2132, USA*

[b] *Associate Professor, Department of Agricultural and Applied Economics, Texas Tech University, Box 42132 Lubbock, Texas, 79409-2132, USA*

Abstract

A systematic review was conducted to provide a comprehensive overview on the emerging success of applying behavioral economics tools to promote healthy food choice decisions in school lunchrooms. This paper summarizes the current knowledge on the topic and facilitates meeting the recommendations of the White House Task Force on Obesity, and the Institute of Medicine (IOM). Further, the paper contributes to the White House Task Force's appeal on comprehensive research that target both consumers and producers. It extends the literature to assess evidence if food supplier decisions have been affected. This review suggests that there is an emerging best practice in applying choice architecture and nudging in school lunchroom that improves food choice. However, this information does not appear to have been utilized extensively in food supplier decisions. There is a need for research to include food supplier decisions in promoting healthy food choice.

Keywords: childhood obesity, food supply, National School Lunch Program, nudging, systematic review, lunchroom, choice architecture

[Ⓘ]Corresponding author: Tel: + 1.806.742.1921 ext. 236
Email: C. Lyford: conrad.lyford@ttu.edu
J. R. Thapa: janani.thapa@ttu.edu

Introduction

There is a pressing and growing interest in addressing childhood obesity in the school lunchroom setting. The CDC reports more than one third of children and adolescents were overweight or obese (CDC 2010). Researchers have also observed that obese children are more likely to be obese adults (CDC 2010; Serdula et al. 1993, and Garn and LaVelle 1985). Clearly, children should be considered a priority population for obesity prevention strategies (Dehghan et al. 2005). As part of the response to this, the National School Lunch Program (NSLP) as directed by United States Department of Agriculture (USDA) in The Healthy, Hunger-Free Kids Act of 2010 seeks to ensure that meal patterns and nutrition standards be updated based on the latest Dietary Guidelines for Americans (FNS 2012); this legislation guarantees the increased availability of fruits, vegetables, and whole grains in the school menu. However, the USDA has reported very high "plate waste" and students "turning up their noses" at fruits and vegetables (Ralston et al. 2008). Healthy foods, such as fruits and vegetables, are often not chosen by children and frequently not eaten even when served.

The NSLP faces a trio of challenges: 1) increasing the healthfulness of food served in school lunchrooms, 2) staying financially solvent (Just and Wansink 2009, Ralston et al. 2008), and 3) competing with "competitive foods." The term "competitive foods" refers to all foods and beverages available or sold in schools with the exception of items served through the NSLP that compete with the NSLP meal for student purchases (Guthrie and Newman 2012). Several researchers like Bhatia et al. (2011), Fox et al. (2005), Snelling et al. (2007), and Story et al. (2009) have reported that the availability of "competitive foods" is associated with a high caloric intake among children. A question in the area of obesity prevention is if the competitive food producers can instead start supplying healthy foods to better address the Healthy, Hunger-Free Kids Act of 2010. Is there sufficient legislative push and demand pull to create a new demand channel for healthy food options? A push in this direction is contained in the "Smart Snack in School" nutrition standards announcement for competitive foods in a USDA[1] news release.

Within these challenges, increasing demand for healthy food by changing food behavior is possible and researchers have shown promising results (Aldridge et al. 2009 and Esposito et al. 2009). Success has been reported in applying behavioral economics to increase healthy food choice and consumption in school lunchrooms at low cost. Tools of behavioral economics like nudging and choice architecture can be low cost and provide distraction while preserving self-attribution. Self-attribution is when people feel that they have made their own decisions. Self-attribution has been recorded to provide greater satisfaction to the consumer (Just and Wansink 2009) and distraction as an external cue is reported to have a major effect on the food selected, the amount consumed and the eater's perception (Just et al. 2007). Choice architecture and nudging (where-in choices are affected without letting the decision makers know that their decisions have been influenced) has been shown to work with children (Hanks et al. 2012a; Just et al. 2007; Just and Wansink 2009; Roberto et al. 2010; Van Kleef et al. 2013 and Wansink et al. 2012 a,b). For example, Roberto et al. (2010) showed that children significantly preferred the taste of foods that had popular cartoon characters on the packaging compared with the same food without characters.

[1] USDA Release No. 0134.13

This suggests that the application of behavioral economics' tools such as choice architecture and nudging in school lunchroom have shown very positive results in promoting healthy food choice decision. However, the literature also suggests that it has not received the attention it should have; considering its potential to instill healthy food habits in children and its' overall potential to reduce childhood obesity. The increased consumption of fruits and vegetables in school lunchrooms may have a dual impact by first, preventing childhood obesity and second, by benefiting local fruits and vegetable producers and other lunchroom stakeholders like the local agribusiness entrepreneurs and lunchroom food suppliers. Despite promising results of ingenious yet subtle and low cost choice architecture modification, no reviews have been conducted on the effectiveness of specifically applying choice architecture in school lunchroom setting. No paper was found to consider nudging intervention in school lunchrooms in a comprehensive manner to include both consumers and producers. Related reviews in the area are: Skov et al. (2012),Thomson and Ravia (2011), Hernández-Garbanzo et al. (2013), Delgado-Noguera et al. (2011), and Khambalia et al. (2012).

This paper will report on the findings of applying choice architecture and nudging in school lunchrooms, and analyze the findings to see if food supplier decisions have been affected. An important contribution of this paper will be to consider whether businesses that supply foods to school lunchrooms have responded to nutrition improvement efforts by changing their products. A systematic review will be used to find research that have applied choice architecture and nudging to promote healthy food choice decision. As a second step, the results of the systematic review will be analyzed to identify if any alteration in food supplier decisions have been reported as a result of nudging and choice architecture intervention in school lunchroom. This research paper will provide a comprehensive overview of the emerging success of applying choice architecture and nudging in school lunchrooms with attention to school lunchroom food suppliers.

Methodology

Search Strategy

A systematic review was carried out in two steps: 1) a primary search to establish appropriate search terms, and 2) a systematic search in six relevant electronic databases: PubMed/Medline, Embase, PsychInfo and Cochrane Review, Web of Science, and Google Scholar. The search was conducted in three stages: the first two stages search were done in March 2013 and June 2013 for the search terms 'nudge(ing)' 'lunchroom' and 'choice architecture' 'lunchroom'. The search was revised in November 2013 to include 'food supplier decision(s)' and 'behavioral economics' in the third stage. This was done to ensure that the most recent studies were included and the search strategy fulfilled the objective of this paper.

Language and Data Restrictions

No language restriction and publication year restrictions were applied during the search. The searches include publications from earliest records available to the mid of November, 2013. However, most of the articles on the research topic were found to be published after the year 2005.

Selection Criteria

Inclusion criteria were developed to address the problem of heterogeneity in intervention type and outcome measures as suggested by Mulrow et al. (1997). The research question was specific. The inclusion criteria ensure that the research was conducted in a consistent manner and that the research participants were always the school students (ranging from age 4 to 18), and the outcome measure was the change in food intake. The applied selection criteria for the study were: 1) it must have a predetermined behavioral economics component-choice architecture or nudging, 2) it must be carried out in a school lunchroom setting, or report findings of research being carried out in school lunchroom setting, and 3) it must have a food consumption related outcome measures. All types of publication available in the databases were included. The exclusion criteria are: nudging in clinical trials, research conducted outside the school lunchroom setting, research that modifies food selection and/or prices. The researchers are specifically interested in the success of applying nudging and choice architecture modification in school lunchrooms without the potential interference from other factors, and its effect in food supplier decisions. A systematic review on economic incentives and nutritional behavior of children in the school setting has been done by Jensen et al. (2011).

Data Extraction and Synthesis

Following the systematic search, a screening of titles and abstracts was done to identify their potential inclusion in the review. The following data were extracted into Tables in the first screening: authors, publication year, research objectives, methodology and major results. The extracted data file was checked for completeness and accuracy and a final data file was made. A method of narrative synthesis adapted and developed by Popay et al. (2007) was followed for this review. This method has been followed by several researchers in the context of behavior change including: McMahon and Fleury (2012), Everson-Hock et al. (2013), Chisholm et al. (2012), Gordon et al. (2011) and Skov et al. (2013). The findings that made it through the final selection were grouped, and narrative synthesis was applied to each group. This systematic review process is shown in Figure 1.

Search Modification

The established search terms for this systematic review gave very few or no hits in PubMed, Embase, PsychInfo and Cochrane Review. The search term ‘choice architecture’ ‘lunchroom’ and ‘choice architecture’ ‘lunchroom’ ‘behavioral economics’ ‘food supplier decision(s)’ had zero hits in PubMed, Embase, PsychInfo and Cochrane Review. The search term ‘food supplier decision(s)’ had zero hits in all the databases. To address this problem in the systematic review process, the search terms ‘nudge(ing)’ and ‘choice architecture’ were used without combining them with rest of the search terms. A separate search for search terms: ‘lunchroom’ and ‘behavioral economics’ were done in PubMed, Embase, PsychInfo and Cochrane Review databases. However, the search terms ‘nudge(ing)’ and ‘choice architecture’ without combining with ‘lunchroom’ in Google Scholar and Web of Science resulted in many (1573 to >2 million) hits and thus were not included in the systematic search. A systematic search for ‘lunchroom’ was done only in Web of Science (58 hits) and not in Google Scholar (25200 hits). Similarly a systematic search for ‘behavioral economics’ and ‘lunchroom’ was done in Google Scholar (65 hits) but in Web of Science, PubMed, Cochrane Review, Embase, PsychInfo it resulted zero hits.

Results

From the 1889 searches (1615 hits in Google Scholar excluding patents and citations, 61 hits in Web of Science(WoS), 149 hits in PubMed, 21 hits in Embase, 16 hits in PsychInfo and 27 hits in Cochrane) only 31 (unduplicated) searches met the inclusion criteria (Figure 1). Of the 31(listed in Table 1, see Appendix), 24 were published and from the rest of the 31, three were dissertation theses, and four were works in progress. Dissertation theses and works in progress are not included in the narrative synthesis to preserve the credibility of the review; these unpublished research work also report positive results from applying behavioral economics' tool in school lunchroom. Among the 24 published reports, 18 were full text articles and six were published abstracts (marked * in Table 1). The narrative analysis was conducted for the eighteen publications by grouping them into, 1) Experimental research reports, and 2) Non-Experimental reports. The published abstracts also report positive results from nudging and choice architecture.

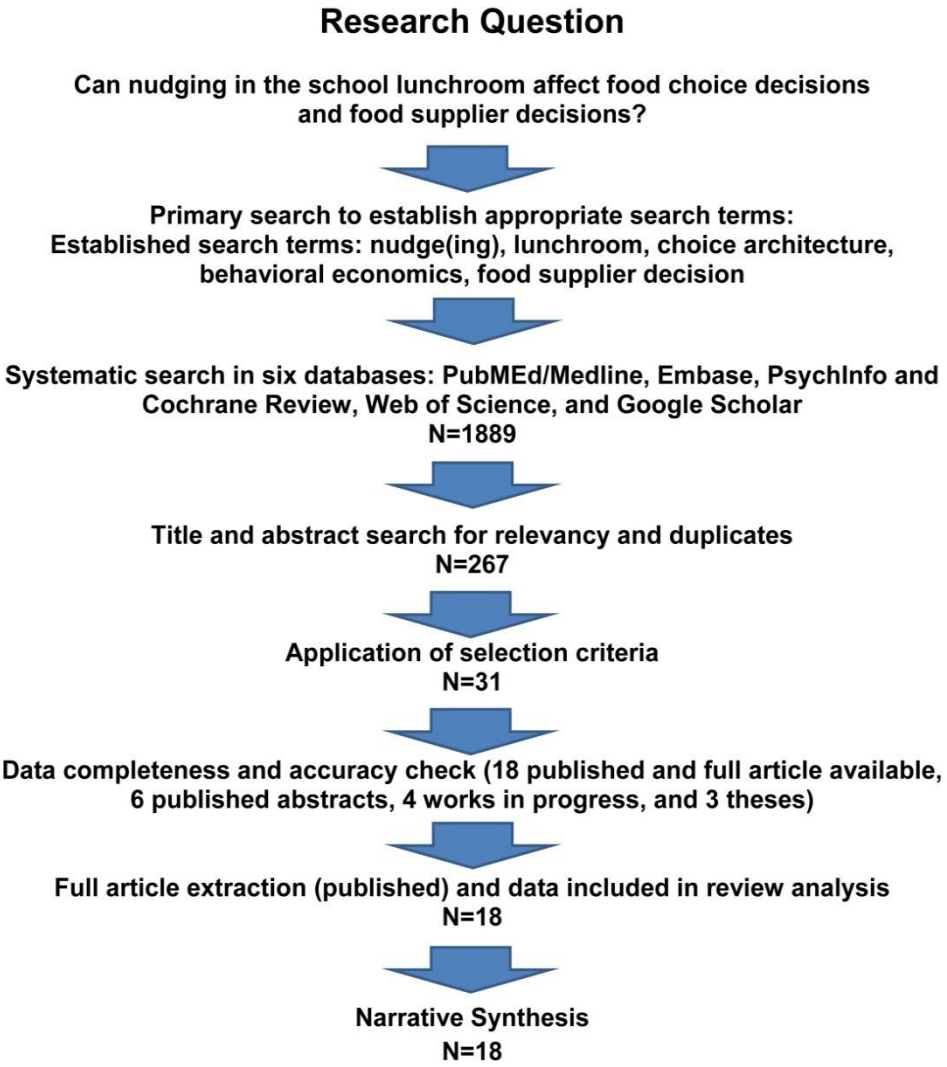


Figure 1. The Systematic Review Process Used

Narrative Synthesis

This narrative synthesis will report on the findings of applying behavioral economics' tools such as choice architecture and nudging in school lunchroom from the included research articles in two groups. The review about food supplier decisions being affected is presented in a different subsection at the end of this section.

Experimental Research Reports

Within the experimental research group, researchers have nudged healthy eating by different techniques like trigger foods, serving styles, pre-sliced food, attractive names, healthy convenience and active choice. However, regardless of the type of nudging or choice architecture modification technique being used, all of these strategies have had some successes. Within this group of literature nudges are the uses of subtle choice architecture modification to prompt healthy food choice decisions. The nine papers in this group were based on outcomes of eight experiments. The experiments were set up consistently with data collection before and during the intervention, but were based in numerous locations: Copenhagen Denmark, rural northern California, four in several locations in western New York and in a Midwestern city school. In the experiment conducted in Denmark (Olsen et al. 2012) it is not clear if the experiment was conducted in the local school lunchroom, however the recruited participants were from local schools. Therefore, this study has been dealt with very briefly in the narrative synthesis and is not listed in Table 2 (see Appendix). One experiment did not have a control population (Hakim and Meissen 2013).

Table 2 provides a concise extraction of the research action, nudges being used, research outcome, outcome measure, results and conclusion of the searches in the experimental research reports group for the narrative synthesis. As shown in this Table, different types of nudging were used to accomplish similar outcomes: increased sales of healthier food options or increased consumption of healthier food options. The target outcome was achieved in each of the reported studies. Also, increased fruit consumption following enhanced fruit accessibility has been supported by Cullen et al. (2003). Altering the shape and size of fruits and vegetables and providing visual cues usually have worked but not in all cases (Table 2). Interestingly, the shape of the fruits and vegetables served matters (Liem and Zandstra 2009 and Olsen et al. 2012).
The five studies: 1) Hanks et al. (2012a), 2) Wansink et al. (2013), 3) Wansink et al. (2012b), 4) Hanks et al. (2012b) and Hanks et al. (2013a), and 5) Hanks et al. (2013b) conducted under the Behavioral Economics in Child Nutrition Program, Cornell University point to the prospect of the interventions having a low cost. The experiment by Hakim and Meissen (2013) reported on the effectiveness of nudging in both an offer and serve NSLP model. Goto et al. (2013) suggests an implication for school policies.

Overall, this review shows that there is only a limited amount of published research that has been conducted to date in applying tools of behavioral economics in school lunchroom setting. Further, the majority of available research is done by a small number of researchers working in the area. The trend of literature suggests that more work is being done (23 of the 31 searches were published in 2012 and 2013), and there are pipeline works that could be published within the next year. However, the authors suggest that there is value of more researchers working in

this area because nudging and choice architecture modification has potential to promote healthy food habit at low cost.

Non-Experimental Reports

Nine research papers that report on the success in promoting healthy food choice decision by applying behavioral economics' tools including nudging and choice architecture in school lunchroom are included in this group (marked ** in Table 1). Wallace (2011) reiterates the effectiveness of using schools to reach children with information and intervention strategies to improve health and quality of life behaviors. Removing the less healthy option is not the best solution because sooner or later, the children will face food selection decisions in an environment that is not necessarily healthy. This paper also reports on how a catchy, fun and cool name like "Spiderman Spinach Salad" gets the children's attention. The second paper is a theme overview for Choices magazine by Jensen (2009). This paper highlights the recommendations made to the meal programs by the IOM to include a new focus on increasing fruits and vegetables and whole-grain-rich foods and reducing the amount of saturated fat and sodium. The third paper (Just and Wansink 2009) is a collection of case studies that have shown success. The paper concludes "through careful thought and simple innovations great changes can be made even in the school lunchroom". The fourth paper is a CDC publication (Huang et al. 2013). It provides a practical set of spatially organized and theory based strategies for making school environments more conducive to learning about and practicing healthy eating by optimizing the physical resources and learning spaces. The target population is practitioners in architecture and public health. The fifth paper (Gittelsohn and Lee 2013) has provided case studies of three multilevel, integrated interventions implemented by Johns Hopkins University between 2004-2011 in an effort to develop and integrate interventions that change the food environment, nutrition education, and employment of behavioral economics strategies into the same conceptual framework to potentially contribute to healthier diets and reduce the risk of chronic disease. The sixth paper (Liu et al. 2013) has highlighted several phenomena from the behavioral economics literature to explain how awareness of these phenomena can help regulate public school cafeterias beyond information to nudge people towards healthier food choices. This paper has suggested that leveraging the behavioral economics insight at the policy making level can fulfill the needed supplementary approaches to promote healthy eating, also suggested by (Gittelsohn and Lee 2013). The seventh paper (Wansink 2013) has summarized the tested nudges into convenient, attractive and normative approach (CAN). This paper reports the CAN approach as an evolutionary approach in changing how children eat. The eighth paper (Guthrie and Newman 2013) has reported that nudging can increase food acceptance in children and that nudging can further pay dividends in the context of raising food costs to the USDA in compliance with the changed USDA food standards for school lunchroom. The final paper (Godfrey 2013) in this sub-group is very important because it reports the perspective of using behavioral economics' tools from the food service director of the school where one of the experiments in the experimental research reports group was conducted. Other reports such as these and other articles reviewed in this paper have potential to reach lunchroom food suppliers.

Have food supplier decisions been affected?

The included publications in both the experimental research report and non-experimental report group were analyzed to see if any alteration in food supplier decisions was reported as a result of school lunchroom nudges and choice architecture intervention. In the experimental research report group, Goto et al. (2012) have linked the research implication to school policies, while the rest of the eight papers have discussed the cost component of intervention. However, none of the studies in both experimental and non-experimental group have looked at the changes in food supplier decisions or choices as a result of an overall push in making school lunchroom healthier. There is no evidence in the nudging literature of efforts by food companies to offer improved products. However, what can be adopted by food suppliers from this body of literature are reported in Godfrey (2013), Just and Wansink (2009), Guthri and Newman (2013), and Wansink (2013). Just and Wansink (2009) have reported examples from lunchroom innovators that provide big bang for the buck; some examples are as simple as replacing the grain based snacks being offered while student waited to pay by fruits. These are easily replicable ways of increasing sales of healthy food options. In addition, the successes of behavioral economics' tools in school lunchroom do provide opportunities for food suppliers to adopt nudging strategies to increase student acceptance of healthy foods (Guthrie and Newman 2013). There is also some evidence of independent actions done by private food companies that can be adopted by lunchroom food suppliers. For example, efforts done by foundations like Produce for Better Health Foundation on creating demand for fruits and vegetables reported in its State of the Plate report (PBH 2010). A recent evidence of nudging efforts from private companies is the partnership of the Sesame Workshop and the Produce Marketing Association with Partnership for a Healthier America (PHA) in a two year agreement to help promote fresh fruit and vegetable consumption to kids (Cohen 2013).

The new regulations on school lunches as encapsulated in the "Smart Snack in School" nutrition standards announcement for competitive foods (USDA news release, June 27, 2013) will undoubtedly provide a necessity that food suppliers will need to meet. It might be useful for the food suppliers and government policymakers to actively collaborate in developing improved market offerings which include appropriate and tested tools of behavioral economics like nudging and choice architecture. Similar recommendations have been made by Byker et al. (2013).The findings of this paper are in line to the strong interest in healthier foods in the lunchroom as emphasized by the White House Taskforce on Obesity (2010). This Taskforce appealed for a more comprehensive research and evaluation of policies that target both consumers and producers. Similar suggestions have been made by National Research Council (2010). The need for an environmental component, in addition to successes in applying behavioral economics to change food behavior, where in interventions are designed with policymakers and other stakeholders to promote environmental support for action has been identified by Contento (2008). Following the recommendations from Brownson et al. (2006), and National Research Council (2010), Borys et al. (2012) has listed identifying obesity prevention stakeholders as a strategy to prevent childhood obesity. Additionally, critical participation from the business community to effectively address the problem of obesity is highlighted by Bleich (2013).

This paper leads to a needed research in addressing the effect of nudging and choice architecture on food supplier decisions towards a collaborative effort to promote healthy food choice decision. It should be clear that when more fruits and vegetables are consumed there is an increased demand for fruits and vegetables to be met by suppliers; hence future studies should look at the effect of lunchroom success of applying behavioral economics' tools on lunchroom food suppliers. The success of behavioral economics suggests a win-win strategy of improving school children's health without compromising food suppliers' revenue. Food suppliers thus need to be encouraged to innovate and be rewarded for applying tested behavioral economics' tools like nudging and choice architecture to make fruits and vegetables more appealing. The "Smart Snack in School" mandate may not accomplish this desirable outcome by itself. However, a complementary effort of applying behavioral economics' tools to promote sale and consumption of healthy food options while complying with the competitive food regulations shows promise. More research is needed which incorporates food supplier decisions as a major component of the research.

Conclusion

A systematic review was conducted to provide a comprehensive overview of the emerging success of applying choice architecture and nudging in school lunchroom and analyze the findings to see if lunchroom food supplier decisions have been affected. This review suggests that when strict inclusion criteria are used to do an electronic search, all the studies show that nudging in the lunchroom leads to healthier food choice decision. None of the studies found that nudging is not effective. Addressing the childhood obesity epidemic by applying behavioral economics is relatively new and most of the research in this area conducted so far has often focused on increasing healthy food consumption, including fruits and vegetables. An interesting outcome is that the effect on major lunchroom stakeholder-the food supplier decisions was not documented. There is some evidence of efforts by private companies to increase the demand for fruits and vegetables but overall there appears to be a reliance on regulations, such as, most recently the "Smart Snack in School" mandate, and efforts to improve the system often view food suppliers as the problem (For e.g. Hirsch 2006) or they are more commonly not mentioned (APHA, n.d.). Moreover, it is important to note that none of the studies included in this study refers to the impact that changes in lunchroom choice architecture might have on food supplier decisions. This paper identifies the need and suggests that, for the next wave of studies, emphasis should be placed on studying ways of using choice architecture and nudging by food suppliers. In this line, first parents, school administrators and school district officials need to be convinced of the reliability of the results summarized in this paper. Second, they need to enlist the help of politicians and local business organizations in working with food suppliers to improve their marketing and production practices. Without such a change, a vision of children trashing tasteless but nutritious food comes to mind.

This paper helps by providing a synthesis of current emerging knowledge about using nudges and shows their common effectiveness. The larger challenge of incorporating these changes and changing school lunch policies to use nudges has received relatively little attention. There are more than 31 million children participating in the NSLP and using nudges to make the lunchroom a healthier food environment while ensuring increased healthy foods, fruits and vegetables consumption shows promise in offsetting childhood obesity trends while working

hand-in-hand with lunchroom food suppliers. Thus, amidst a comprehensive research effort and alarming childhood obesity statistics, it is apparent that a holistic low cost intervention that increases healthy food consumption and increases demand for healthy food at local and national level is much needed. Such an approach would be most effective if it engages rather than ignores the potential role of food suppliers.

References

Aldridge, V., T. M. Dovey, and J. C. G. Halford. 2009. The role of familiarity in dietary development. *Developmental Review* 29(1): 32-44.

Alexandra, W., G. Keiko, C. Kenny, G. Maria, and W. Cindy. 2012. Do Environmental Interventions Impact Elementary School Students' Lunchtime Milk Selection? In: 2012 AAEA/EAAE Food Environment Symposium, May. Boston. RePEc:ags:aaeafe:123513.

APHA, n.d. Detailed ACTION Plan: Recommendations for Action by Families Schools, Communities and Policy Makers. [accessed November 15, 2013] http://www.apha.org/programs/resources/obesity/obesitydetailedaction.html

Bhatia, R., P. Jones, and Z. Reicker. 2011. Competitive foods, discrimination, and participation in the National School Lunch Program. *The Journal of School Health* 79(10): 485–494. Online: http://www.ncbi.nlm.nih.gov/pubmed/19751310

Bleich, S. N. 2013. Generating better evidence to engage local food outlets in obesity prevention research. *Preventive Medicine* 57(4): 265–7. doi:10.1016/j.ypmed.2013.07.015

Borys, J-M., Y. Le Bodo, S. A. Jebb, J. C. Seidell, C. Summerbell, D. Richard, and et al. 2012. EPODE approach for childhood obesity prevention: Methods, progress and international development. *Obesity Reviews* 13(4):299–315.

Brownson, R. C., C. Royer, R. Ewing and T. D. McBride. 2006. Researchers and policymakers: travelers in parallel universes. *American Journal of Preventive Medicine* 30(2): 164–172. Online: http://www.ncbi.nlm.nih.gov/pubmed/16459216

Byker, C. J., C. a. Pinard, A. L. Yaroch and E. L. Serrano. 2013. New NSLP Guidelines: Challenges and Opportunities for Nutrition Education Practitioners and Researchers. *Journal of Nutrition Education and Behavior* 45(6):683–689. doi:10.1016/j.jneb.2013.06.004

Castellari, E., J. P. Berning and R. Huang. 2013. Hunger-driven food choices: An experiment to test the effect of providing pre-lunch snacks on school lunch choices. No. 150354. Annual Meeting, August, Washington, D.C.

CDC. 2010.Obesity Fact Sheet. Accessed online [http://www.cdc.gov/healthyyouth/obesity/facts.htm]

Chisholm, A., J. Hart, K. V. Mann, E. Harkness and S. Peters. 2012. Preparing Medical Students to Facilitate Lifestyle Changes With Obese Patients: A Systematic Review of the Literature. *AcadMed* 87(1938-808X (Electronic)): 912–923. doi:10.1097/ACM.0b013e3182580648

Cohen. 2013. Elmo and Rosita Join First Lady Michelle Obama to Promote Fresh Food Choices for Kids. *The White House*. [accessed November 1, 2013] http://www.whitehouse.gov/blog/2013/10/31/elmo-and-rosita-join-first-lady-michelle-obama-promote-fresh-food-choices-kids.

Contento, I. R. 2008. Nutrition education: linking research, theory, and practice. *Asia Pacific Journal of Clinical Nutrition* 17 (1): 176–179. http://www.ncbi.nlm.nih.gov/pubmed/18296331

Cullen, K. W., T. Baranowski, E. Owens and et al. 2003. Availability, accessibility, and preferences for fruit, 100% fruit juice, and vegetables influence children's dietary behavior. *Health Education Behavior* 30(5): 615–626.

Dehghan, M., N. Akhtar-Danesh, and A. T. Merchant. 2005. Childhood obesity, prevalence and prevention. *Nutrition Journal* 4(24): http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1208949andtool=pmcentrezandrendertype=abstract

Delgado-Noguera, M., S. Tort, M. J. Martínez-Zapata, and X. Bonfill. 2011. Primary school interventions to promote fruit and vegetable consumption: a systematic review and meta-analysis. *Preventive Medicine* 53(1-2): 3–9. doi:10.1016/j.ypmed.2011.04.016

Devine, C.M, M. Connors, C.A. Bisogni, and J. Sobal. 1998. Life-course influences on fruit and vegetable trajectories.Qualitative analysis of food choices. *Journal of Nutrition Education* 30: 361-370.

Everson-Hock, E. S., M. Johnson, R. Jones, H. B. Woods, E. Goyder, N. Payne, & J. Chilcott. 2013. Community-based dietary and physical activity interventions in low socioeconomic groups in the UK: A mixed methods systematic review. *Preventive Medicine* 56(5):265–72. doi:10.1016/j.ypmed.2013.02.023

Esposito, L., J. O. Fisher, J. A. Mennella, D. M. Hoelscher, and T. T. Huang. 2009. Developmental Perspectives on Nutrition and Obesity From Gestation to Adolescence. *Preventing Chronic Disease* 6(3): 11.

Ferro, G., S. Gupta, and J. Kropp. 2013. The Effect of Pre-Selection and Visual Cues on Food Item Selection by Middle School Children, Annual Meeting, Washington, D.C., Agricultural and Applied Economics Association, August.

FNS. 2012. National School Lunch Program. Child Nutrition Programs, USDA. Online: [http://www.fns.usda.gov/slp]

Everson-Hock, E. S., M. Johnson, R. Jones, H.B. Woods, E. Goyder, N. Payne, and J. Chilcott. 2013. Community-based dietary and physical activity interventions in low socioeconomic groups in the UK: A mixed methods systematic review. *Preventive Medicine* 56(5): 265–72. doi:10.1016/j.ypmed.2013.02.023

Fox, S., A. Meinen, M. Pesik, M. Landis and P. L. Remington. 2005. Competitive food initiatives in schools and overweight in children: a review of the evidence. *Wisconsin Medical Journal* 104(5): 38–43. http://www.ncbi.nlm.nih.gov/pubmed/16138514.

Garn, S. M., and M. LaVelle. 1985. Two-decade follow-up of fatness in early childhood. *American Journal of Diseases of Children* 139(2): 181–185.

Gittelsohn, J., and K. Lee. 2013. Integrating Educational, Environmental, and Behavioral Economic Strategies May Improve the Effectiveness of Obesity Interventions. *Applied Economic Perspective and Policy* 35(1):52–68.

Godfrey, J. R. 2012. Making Lunchrooms Smarter in the Ithaca City School District. 8(6): 588–590. doi:10.1089/chi.2012.0086.lunc

Gordon, J., M. Watson and A. Avenell. 2011. Lightening the load? A systematic review of community pharmacy-based weight management interventions. *Obesity Reviews* 12(11):897–911. doi:10.1111/j.1467-789X.2011.00913.x

Goto, K., A. Waite, C. Wolff, K. Chan and M. Giovanni. 2013. Do Environmental Interventions Impact Elementary School Students' Lunchtime Milk Selection? *Applied Economic Perspectives and Policy* 35(2): 360–376. doi:10.1093/aepp/ppt004

Guthrie, J., and C. Newman. 2013. Eating Better at School: Can New Policies Improve Children's Food Choices? USDA/ERS *Amber Waves.* http://www.ers.usda.gov/amber-waves/2013-september/eating-better-at-school-can-new-policies-improve-children%92s-food-choices.aspx#.UoayrhpeapI

Hakim, S. M., and G. Meissen. 2013. Increasing consumption of fruits and vegetables in the school cafeteria: the influence of active choice. *Journal of Health Care for the Poor and Underserved* 24(2): 145–57. doi:10.1353/hpu.2013.0109

Hanks, A. S., D. R. Just, L. E. Smith and B. Wansink. 2012a. Healthy convenience: nudging students toward healthier choices in the lunchroom. *Journal of Public Health* 34(3): 370–6. doi:10.1093/pubmed/fds003

Hanks, A. S., D. R. Just and B. Wansink. 2012b. Trigger Foods: The Influence of "Irrelevant" Alternatives in School Lunchrooms *Agricultural and Resource Economics Review* 41(1): 114–123.

Hanks, A. S., Just, D. R., and Wansink, B. 2012c. A Source of Contention or Nutrition: An assessment of Removement Flavored Milk from School Lunchrooms. *Journal of Nutrition Education and Behavior* 44(4):S21. Supplement, Oral Abstracts. SNEB 2012 Annual Conference Proceedings 45th Annual Conference, Nutrition Education: Energy from Synergy. Washington, DC.

Hanks, A. S., D. R. Just and B. Wansink. 2013a. Smarter Lunchrooms Can Address New School Lunchroom Guidelines and Childhood Obesity. *The Journal of Pediatrics* 162(4): 867-869. doi:10.1016/j.jpeds.2012.12.031

Hanks, A. S., D. R. Just and B. Wansink. 2013b. Preordering School Lunch Encourages Better Food Choices by Children. *JAMA Pediatrics*167(7): 673–674. doi:10.1001/jamapediatrics.2013.82.

Hernández-Garbanzo, Y., J. Brosh, E. L. Serrano, K. L. Cason and R. Bhattarai. 2013. Psychosocial Measures Used to Assess the Effectiveness of School-based Nutrition Education Programs: Review and Analysis of Self-report Instruments for Children 8 to 12 Years Old. *Journal of Nutrition Education and Behavior* doi:10.1016/j.jneb.2013.01.007

Hirsch, J. M. 2006. Food companies a target in obesity fight. USA Today. [accessed November 15, 2013] http://usatoday30.usatoday.com/news/health/2006-03-18-obesity-blame_x.htm

Huang, T.T., D. Sorensen, S. Davis, L. Frerichs, J. Brittin, J. Celentano, et al. 2013. Healthy Eating Design Guidelines for School Architecture. *Preventing Chronic Disease.*10:120084. DOI: http://dx.doi.org/10.5888/pcd10.120084

Hubbard, K., L. Bandini, S. Folta, B. Wansink, M. Eliaswiz and A. Must. 2013. Impact of a smarter lunchroom intervention on food selection and consumption among adolescents and young adults with intellectual and developmental disabilities in a residential school setting. 141st APHA Annual Meeting. Boston. November. https://apha.confex.com/apha/141am/webprogramadapt/Paper275953.html

Jensen, H. H. 2009. Theme Overview: Weighing Healthy Choices for the School Meals Program. *Choices*. 24 (3).

Jensen, J. D., H. Hartmann, A. De Mul, A. Schuit, and J. Brug. 2011. Economic incentives and nutritional behavior of children in the school setting: a systematic review. *Nutrition Reviews* 69(11). [660–74. doi:10.1111/j.1753-4887.2011.00422.x]

Just, D. R., L. Mancino, and B. Wansink. 2007. Could behavioral economics help improve diet quality for nutrition assistance program participants? *Economic Research Report No 43*. U.S. Dept. of Agriculture, Economic Research Service.

Wansink, B., D. R. Just and C. Payne. 2008. Constrained Volition and Healthier School Lunches. http://www.agecon.purdue.edu/news/seminarfiles/HotLunch.pdf

Just, D., and B. Wansink. 2009. Smarter Lunchrooms: Using Behavioral Economics to Improve Meal Selection. *Choices: Magazine of Food Farm and Resource Issues* http://www.choicesmagazine.org/magazine/article.php?article=87

Khambalia, A. Z., S. Dickinson, L. L. Hardy, T. Gill, and L. A. Baur. 2012. A synthesis of existing systematic reviews and meta-analyses of school-based behavioural interventions for controlling and preventing obesity. *Obesity Reviews* 13(3): 214–33. doi:10.1111/j.1467-789X.2011.00947.x

Liem, D. G., and Zandstra, L. H. 2009. Children's liking and wanting of snack products: Influence of shape and flavour. *The International Journal of Behavioral Nutrition and Physical Activity* 6(1): 38. http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2716294andtool=pmcentrezandrendertype=abstract

Liu, P. J., J. Wisdom, C. A. Roberto, L. J. Liu and P.A. Ubel. 2013. Using Behavioral Economics to Design More Effective Food Policies to Address Obesity. *Applied Economic Perspectives and Policy* 35(1): 1–6. doi:10.1093/aepp/ppt027

McDowell, K. 2013. *Determining the Effectiveness of a Behavioral Economics Cafeteria Intervention at Big Walnut High School Designed to Improve Healthfulness of Student Purchases*. The Ohio State University. http://kb.osu.edu/dspace/handle/1811/54678

McMahon, S., and J. Fleury. 2012. External validity of physical activity interventions for community-dwelling older adults with fall risk: a quantitative systematic literature review. *Journal of Advanced Nursing* 68(10):2140-54.

Miller, N. 2013. *Increasing portion sizes of fruits and vegetables in an elementary school lunch program can increase fruit and vegetable consumption*. The University of Minnesota. http://conservancy.umn.edu/bitstream/157503/1/Miller_umn_0130M_13903.pdf

Mulrow, C., P. Langhorne and J. Grimshaw. 1997. Integrating heterogeneous pieces of evidence in systematic reviews. *Annals of Internal Medicine* 127(11): 989–995. http://www.ncbi.nlm.nih.gov/pubmed/9412305

National Research Council. *Bridging the Evidence Gap in Obesity Prevention: A Framework to Inform Decision Making*. Washington, DC: The National Academies Press, 2010.

Newman, C., J. Guthrie, L. Mancino, and A. Snelling. 2013. School Meals Experiment: Can a Taste Test Increase Vegetable Acceptance? Annual Meeting.Washington, D.C., August.

Newman, C. 2012. The Food Costs of Healthier School Lunches, Agricultural and Resource *Economics Review* 41(1):12-28.

Olsen, A., C. Ritz, L. Kramer, and P. Møller. 2012. Serving styles of raw snack vegetables. What do children want? *Appetite, 59*(2): 556-62 doi:10.1016/j.appet.2012.07.002

PBH. 2010. *State of the Plate 2010 Study on America's Consumption of Fruits and Vegetables*. [accessed onNovember16, 2013] http://www.pbhfoundation.org.

Popay, J., Roberts, H., Sowden, A., Petticrew, M., Arai, L., Rodgers, M. and Britten, N. with Roen, K. & Duffy, S. 2006. Guidance on the conduct of narrative synthesis in systematic reviews. Final report, Institute of Health Research, Lancaster: ESRC Methods Programme.

Ralston, K., C. Newman, A. Clauson, J. Guthrie, and J. Buzby. 2008. The National School Lunch Program: Background, Trends, and Issues. edited by Economic Research Service. *Economic Research Report.*

Roberto, C. A., J. Baik, J. L. Harris, and K. D. Brownell. 2010. Influence of Licensed Characters on Children's Taste and Snack Preferences. *Pediatrics* 126(1): 88-93.

Serdula, M. K., D. Ivery, R. J. Coates, D. S. Freedman, D. F. Williamson and T. Byers.1993. Do obese children become obese adults? A review of the literature. *Preventive Medicine*, 22(2):167–177. [July 24, 2013] http://www.ncbi.nlm.nih.gov/pubmed/8483856

Skov, L. R., S. Lourenço, G. L. Hansen, B. E. Mikkelsen and C. Schofield. 2013. Choice architecture as a means to change eating behaviour in self-service settings: a systematic review. *Obesity Reviews* 14(3): 187–96. doi:10.1111/j.1467-789X.2012.01054.x

Smith L.E., D. R. Just, B. Wansink, C.E. Wallace and H. P. Chua. 2011(a). Healthy Convenience: Nudging Students to Make Healthier Choices in the Lunchroom. *Journal of American Society for Experimental Biology* 25 (781.25): Abstract

Smith L.E., D. R. Just, B.Wansink. 2011(b). Convenience Drives Choice in School Lunch Rooms: A Salad Bar Success Story. *Journal of American Society for Experimental Biology*. 24(732.11): Abstract

Snelling, A. M., C. Korba and A. Burkey. 2007. The national school lunch and competitive food offerings and purchasing behaviors of high school students. *The Journal of School Health* 77(10): 701–705.[July 24, 2013] http://www.ncbi.nlm.nih.gov/pubmed/18076416

Thomson, C. A., and J. Ravia. 2011. A systematic review of behavioral interventions to promote intake of fruit and vegetables. *Journal of the American Dietetic Association* 111(10):1523–35. doi:10.1016/j.jada.2011.07.013

USDA. 2013. Agriculture Secretary Vilsack Highlights New "Smart Snacks in School" Standards; Will Ensure School Vending Machines, Snack Bars Include Healthy Choices.

Release No. 0134.13. http://www.usda.gov/wps/portal/usda/usdahome?contentid=2013/06/0134.xml [July 29, 2013]

Van Kleef, E., M. Shimizu, and B. Wansink. 2013. Just a bite: Considerably smaller snack portions satisfy delayed hunger and craving. *Food Quality and Preference* 27(1): 96-100.

Wallace, C. E. 2011. BEN and the Smarter Lunchroom: Nudging Children to Healthy Choices. *Childhood Obesity (Formerly Obesity and Weight Management)* 7(3): 245–246. [doi:10.1089/chi.2011.0300.wall]

Wansink B, D. R. Just, and C.R. Payne. 2010. Smarter Lunchrooms: Payment Systems that Nudge Healthier School Lunch Choices. *Journal of American Society for Experimental Biology* 24(322.1): Abstract

Wansink B, D. R. Just, L.E. Smith, and C.E. Wallace. 2011. Lunch Line Redesign: Making School Lunchrooms Smarter. *Journal of American Society for Experimental Biology* 25(342.8): Abstract

Wansink, B., D. R. Just, and C. R. Payne. 2012a. Can Branding Improve School Lunches? *Archives of Pediatrics and Adolescent Medicine* 166(10): 967-968.

Wansink, B., D. R. Just, C. R. Payne, and M. Z. Klinger. 2012b. Attractive names sustain increased vegetable intake in schools. *Preventive Medicine* 55(4): 330-332.

Wansink, B., D. R. Just, A. S.Hanks and L. E. Smith. 2013. Pre-sliced fruit in school cafeterias: children's selection and intake. *American journal of preventive medicine* 44(5): 477–80. [doi:10.1016/j.amepre.2013.02.003]

White House Task Force on Childhood Obesity. 2010. Solving the Problem of Childhood Obesity Within a Generation - White House Task Force on Childhood Obesity Report to the President. Washington, DC: 2010.[www.letsmove.gov/white-house-task-force-childhood-obesity-report-president]

Young, K. D. 2012. School Health Policy: School Lunch Consumption Patterns of Middle School Students. Masters Thesis. American University. Washington, D.C.

Appendix

Table 1. Summary of searches that have choice architecture component in a school lunchroom setting with food choice decision outcome variable

SN	Search terms	Database	Reference	Title
Published work				
1	Nudge(ing) and lunchroom and lunchroom	WoS, PubMed	Hanks et al. (2012a)	Healthy Convenience: Nudging Students Toward Healthier Choices in the Lunchroom
	Nudge and lunchroom	Google Scholar		
2	Nudge(ing) and lunchroom and lunchroom	WoS	Smith et al. (2011a)*	Healthy Convenience: Nudging Students to Make Healthier Choices in the Lunchroom
3	Nudge(ing) and lunchroom and lunchroom	WoS	Wansink et al. (2010) *	Smarter Lunchrooms: Payment Systems that Nudge Healthier School Lunch Choices
4	Lunchroom	WoS	Wansink et al. (2013)	Pre-sliced Fruit in School Cafeterias Children's Selection and Intake
5	Lunchroom	WoS PubMed	Hanks et al. (2013a)	Smarter Lunchrooms Can Address New School Lunchroom Guidelines and Childhood Obesity
6	Lunchroom	WoS	Wansink et al. (2012b)	Attractive Names Sustain Increased Vegetable Intake in Schools
7	Lunchroom	WoS	Wansink et al. 2011*	Lunch Line Redesign: Making School Lunchrooms Smarter
8	Lunchroom	WoS	Smith et al. (2011b) *	Convenience Drives Choice in School Lunch Rooms: A Salad Bar Success Story
9	Choice architecture	PubMed	Hakim and Meissen (2013)	Increasing Consumption of Fruits and Vegetables in the School Cafeteria: the Influence of Active Choice.
	Choice architecture and lunchroom	Google Scholar		
10	Nudging and lunchroom	Google Scholar	Huang et al. (2013) **	Healthy Eating Design Guidelines for School Architecture
11	Nudge and lunchroom	Google Scholar	Hanks et al. (2012c) *	A Source of Contention or Nutrition: An Assessment of Removing Flavored Milk from School Lunchrooms
12	Nudge and lunchroom	Google Scholar	Just and Wansink (2009) **	Smarter Lunchrooms: Using Behavioral Economics To Improve Meal Selection

Table 1. *Continued*

SN	Search term	Database	Reference	Title
13	Nudge and lunchroom	Google Scholar	Hanks et al. (2012b)	Trigger Foods: The Influence of 'Irrelevant' Alternatives in School Lunchrooms
14	Nudge and lunchroom	Google Scholar	Goto et al. (2012)	Do Environmental Interventions Impact Elementary School Students' Lunchtime Milk Selection?
15	Nudging and lunchroom	Google Scholar	Wallace (2011) **	BEN and the Smarter Lunchroom: Nudging Children to Healthy Choices
16	Nudging and lunchroom	Google Scholar	Olsen et al. (2012)	Serving Styles of Raw Snack Vegetables. What do Children Want?
17	Nudge and lunchroom	Google Scholar	Jensen (2009) **	Theme Overview: Weighing Healthy Choices For The School Meals Program
18	Behavioral Economics and lunchroom	Google Scholar	Gittelsohn and Lee (2013)**	Integrating Educational, Environmental, and Behavioral Economic Strategies May Improve the Effectiveness of Obesity Interventions
19	Behavioral Economics and lunchroom	Google Scholar	Hubbard et al. (2013) *	Impact of A Smarter Lunchroom Intervention on Food Selection and Consumption Among Adolescents and Young Adults With Intellectual and Developmental Disabilities in a Residential School Setting
20	Behavioral Economics and lunchroom	Google Scholar	Liu et al. (2013)**	Using Behavioral Economics to Design More Effective Food Policies to Address Obesity
21	Behavioral Economics and lunchroom	Google Scholar	Wansink (2013)**	Convenient, Attractive, and Normative: The CAN Approach to Making Children Slim by Design
22	Behavioral Economics and lunchroom	Google Scholar	Hanks et al. (2013b)	Preordering School Lunch Encourages Better Food Choices by Children
23	Behavioral Economics and lunchroom	Google Scholar	Guthrie and Newman (2013)**	Eating Better at School: Can New Policies Improve Children's Food Choices?
24	Behavioral Economics and lunchroom	Google Scholar	Godfrey (2012)**	Making Lunchroom Smarter in Ithaca City School District
Work in Progress				
25	Nudge and lunchroom	Google Scholar	Just et al. (2008)	Constrained Volition and Healthier School Lunches
26	Nudge and lunchroom	Google Scholar	Ferro et al. (2013)	The Effect of Pre Selection and Visual Cues on Food Item Selection by Middle School Children
27	Nudge and lunchroom	Google Scholar	Castellari et al. (2013)	Hunger Driven Food Choices: An Experiment to Test The Effect of Providing Pre-Lunch Snacks on School Lunch Choices

Table 1. *Continued*

SN	Search term	Database	Reference	Title
28	Nudge and lunchroom	Google Scholar	Newman et al. (2013)	School Meals Experiment: Can a Taste Test Increase Vegetable Acceptance?
Theses				
29	Nudge and lunchroom	Google Scholar	Young (2012)	School Health Policy: School Lunch Consumption Patterns of Middle School Students
30	Behavioral Economics and lunchroom	Google Scholar	McDowell (2013)	Determining the Effectiveness of a Behavioral Economics Cafeteria Intervention in Big Walnut High School Designed to Improve Healthfulness of Student Purchases
31	Behavioral Economics and lunchroom	Google Scholar	Miller (2013)	Increasing Portion Sizes of Fruits and Vegetables in an Elementary School Lunchroom Can Increase Fruits and Vegetable Consumption

*full article not available ** Non-Experimental

Table 2. Research Summary for Narrative Synthesis

Healthy convenience - high school lunchroom, Hanks et al. (2012a).	
Action	Introduced convenience lunch line that contained only healthier food options as well as flavored milk
Nudge	**Convenience**
Outcome	Sales of healthier foods
Measure	Purchase data
Results	Sales of healthier foods increased by 18% (significant)
Conclusion	Convenience most likely nudged the students to take the food but food preference may have led them to limit their consumption.
Comprehensiveness	Action can be replicated at low cost to other lunchrooms and cafeterias outside school lunchroom
Recommends	Post intervention data collection
Pre-sliced fruits - middle school lunchroom, Wansink et al. (2013).	
Action	Offer pre-sliced fruits
Nudge	**Convenience, size and shape**
Outcome	Selection and Intake
Measure	daily apple sales, percentage of an apple serving consumed per student, percentage of an apple serving wasted per student
Results	Increased by 71% compared to control Percentage who ate more than half increased by 73% Percentage that wasted half or more decreased by 48%
Conclusion	An example of low cost environment change that promotes healthy eating and decrease waste
Assumption	No seasonal effect Novelty effect
Comprehensiveness	Has a cost component
Attractive names - elementary school lunchroom, Wansink et al. (2012b).	
Action	Study 1:Paired carrots with an attractive name in five elementary schools Study 2:Systematically attractively named or not named vegetables
Nudge	**Attractive names**
Outcome	Study 1: Selection and consumption of carrots Study 2: Vegetable selection
Measure	Study 1: Selection and consumption of carrots Study 2: Food sales of vegetable
Results	Study 1: Elementary students ate twice the percentage of their carrots – named "X-ray Vision Carrots" than when named "Food of the Day" Study 2: Elementary school students were 16% more likely to persistently choose more hot vegetables when given fun and attractive names
Conclusion	Attractive names effectively and persistently increased healthy food consumption. Impact of attractive names lasts.
Comprehensiveness	Little or no cost, one volunteer student could do it!

Table 2. *Continued*

Active choice - Kindergarten through 8th grade lunchroom, Hakim and Meissen (2013).	
Action	Introduced an active forced choice into the school lunchroom
Nudge	**Active choice**
Outcome	Consumption of fruits and vegetables
Measure	daily apple sales, percentage of an apple serving consumed per student, percentage of an apple serving wasted per student
Results	An average daily 15% significant consumption increase of fruits and vegetables during the intervention period. Students were almost three times more likely to consume more that 50% of the vegetable serving than they were when they are not given a choice.
Conclusion	The model works in both "offer" and "serve" NSLP model
Environmental interventions - elementary school lunchroom, Goto et al. (2012).	
Action	School 1: White milk made easily accessible vs. ask for chocolate milk School 2: Three fold greater quantity of white compared to chocolate milk
Nudge	**School 1: Accessibility and School 2: Visual cue**
Outcome	Selection decision
Measure	Selection of white milk
Results	School 1: Significantly increased selection of white milk School 2: No significant alteration in selection pattern
Conclusion	School based practices that apply behavioral economics may offer useful strategies for improving food selection
Comprehensiveness	Suggest the research implication for school policies.
Trigger foods - high school lunchroom, Hanks et al. (2012b) and Hanks et al. (2013a).	
Action	Offer foods that either increase or decrease the selection of fruits, vegetables, or unhealthy sides simply through their presence on the lunch
Nudge	**Libertarian paternalism**
Outcome	Selection and consumption of healthier food options
Measure	Waste data
Results	Demonstrates the impacts of offering a single vegetable or fruit may have significant implications for the whole meal (Hanks et al., 2012). The students were 13.4% more likely to take a fruit and 23% more likely to take a vegetable following the lunch room makeover and the makeover increased actual fruit consumption by 18% and vegetable consumption by 25% (Hanks et al., 2013).
Conclusion	Small change in cafeterias and lunchroom can have a significant influence in guiding students towards healthier behaviors.
Comprehensiveness	Points that the makeover took only 3 hours to implement and cost less than $50 (Hanks et al., 2013).
Pre-ordering, elementary school lunchroom, Hanks et al. (2013b).	
Action	Students use an electronic system to pre-order their lunch entrée.
Nudge	**Libertarian paternalism**
Outcome	Selection and consumption of healthier food options
Measure	Sales record

Table 2. *Continued*
Pre-ordering, elementary school lunchroom, Hanks et al. (2013b).

Results	When students preordered their entrée, 29.4 % selected the healthier entrée compared with 15.3% when preordering was not available. The paper has not reported consumption data but has reported that the consumption data collected by visual estimation techniques supports the robust result.
Conclusion	Pre-ordering can effectively lead students to pick healthier entrée.
Comprehensiveness	The reported research used a computerized preordering system but reports that an alternate paper- based system is easy, inexpensive and an immediately implementable alternate.

INTERNATIONAL FOOD AND AGRIBUSINESS MANAGEMENT REVIEW
The Official Journal of the International Food and Agribusiness Management Association
www.ifama.org