*Advances in Management & Applied Economics, vol. 7, no. 2, 2017, 23-44*
*ISSN: 1792-7544 (print version), 1792-7552(online)*
*Scienpress Ltd, 2017*

# Friend or PHO? On the Marginal Valuation of Reducing the Content of Trans Fat in Processed Foods

**Steven S. Vickner**[1]

**Abstract**

Ahead of the January 1, 2006 deadline for mandatory labeling of trans fat, Nabisco, a leading brand in the market for crackers – a $1 billion processed food category and ranked amongst the top sources of trans fat – reformulated a subset of their existing products and voluntarily labeled them as trans fat-free. New products were also introduced in the market and labeled as trans fat-free as well. The purpose of this study was to determine the implicit price of products voluntarily labeled as trans fat-free. Using a national level weekly scanner data set and controlling for the other observable product attributes, such as non-PHO fat labels, whole grain labels, sodium labels, variety, and package size, in addition to market conditions, the implicit price of the voluntary trans fat-free label was estimated to be $0.53 per pound, or a premium over the base case of 17.64 percent.

**JEL classification numbers:** D12, M38, Q18
**Keywords:** Food Labeling Policy, Hedonic Pricing, Retail Scanner Data, Trans Fat.

## 1 Introduction

---

[1] Associate Professor of Business and Director of MBA Program, Ohio Dominican University. USA

Article Info: *Received*: November 3, 2016. *Revised:* December 6, 2016
*Published online*: March 1, 2017

On December 12, 1912, the President of the Royal Swedish Academy of Sciences presented the Nobel Prize in chemistry two Frenchmen, Victor Grignard and Paul Sabatier [24]. Though working independently of each other in separate fields of organic chemistry each shared one-half of the coveted award. Professor Sabatier of Toulouse University, however, earned his share of the Nobel Prize for his seminal research in the Nineteenth century on the hydrogenation of organic compounds. This technology was later embraced by food scientists circa 1900 to make partially hydrogenated oil (PHO) or artificial trans fat.[2] In 1911, Proctor & Gamble launched Crisco, possibly the first PHO product targeted to consumers in the food-at-home distribution channel [2]. Over the years, thousands of other consumer food products using trans fat appeared on shelves throughout a typical grocery store.[3]

Approximately a century later, on January 1, 2006, the U.S. Food and Drug Administration (FDA) required manufacturers of both food and dietary supplements to declare the quantity of trans fat per serving in the Nutrition Facts panel (NFP) on the line just below saturated fat (Federal Register).[4] Incidentally, the NFP was a major tactical component of the underlying public health strategy of the Nutrition Labeling and Education Act (NLEA) of 1990 to help inform consumers of the nutritional consequences of their food choices. Including trans fat on the NFP was the biggest change to date in its structure since the implementation of the NLEA in 1994. Understandably pressure grew to change public policy as more research emerged measuring trans fat consumption and then linking trans fat consumption to coronary heart disease (CHD).

Across ten published studies surveyed in Kris-Etherton et al. [14] the average intake of trans fat as a percent of total dietary fat ranged from 4.2 percent to 11.8 percent, and the average intake of trans fat ranged from 2.6 grams per day (g/day) to 12.8 g/day. Similarly, Allison et al. [1], using the 1989-1991 Continuing Survey of Food Intakes by Individuals, found trans fat as a percent of energy and total dietary fat, respectively, to be 2.6 percent and 7.4 percent. The FDA now reports that average intake of trans fat decreased to approximately 1.0 g/day in 2012 from 4.6 g/day in 2003 [31]. The 2005 Dietary Guidelines for Americans clearly states that individuals should "consume less than 10 percent of calories from saturated fatty acids and less than 300 mg/day of cholesterol, and keep trans fatty acid consumption as low as possible" [29]. Increased consumption of saturated fat, dietary cholesterol, and trans fat increase the level of low-density lipoprotein (LDL), or bad cholesterol, in the blood and hence increases the risk of CHD. Moreover, increased consumption of trans fat also decreases the level of high-density lipoprotein (HDL), or good cholesterol, in the blood and so again increases the risk of CHD [30].

---

[2] Trans fat can occur naturally in some dairy and meat products. The use of the term hereafter will be understood to represent artificial trans fats or PHOs, not those naturally occurring.

[3] Trans fat can be used to lengthen the shelf life of a product as well as help preserve its flavoring.

[4] Since 1994, the FDA required the reporting of dietary cholesterol and saturated fat on the NFP.

It is estimated more than one million individuals suffer from a heart attack annually in the U.S., over 12.5 million individuals have some form of CHD, and approximately 500,000 die annually from CHD. Moreover, heart disease is ranked first in the U.S. in the cause of death in both men and women [30]. More recently, on November 7, 2013, the FDA initiated the process to effectively define PHOs as a food additive after deeming them unsafe to be included as an ingredient in food [31]. Hence, if the proposed trans fat ban is approved, PHOs "could not be used in food unless authorized by regulation" [31]. According to the FDA's most recent statistics, further reductions in trans fat could reduce the number of heart attacks by 20,000 and the number of deaths by 7,000 annually [31].

In this paper, a historical analysis of the pre-2006 era is undertaken as it was a period in which existing products were being reformulated to remove trans fat content and new products were being introduced with low trans fat content. According to the FDA's November 7, 2013 press release, if they did in fact implement a ban on trans fat in processed foods "the agency would provide adequate time for producers to reformulate products in order to minimize market disruption" [31]. Given the dearth of published research that addresses the market impact of product reformulations due to imminent required reductions in trans fat content in processed foods, this research effort attempts to help fill that gap in the literature. Moreover, this research effort not only models the market impact of product reformulations but also new product introductions apparently not even yet considered by policy makers at the FDA. A hedonic pricing model for cracker products was estimated to measure the marginal values or implicit prices of their observable attributes both before and after voluntary trans fat-free labeled products became available to consumers in the market; 10 reformulated products and 11 newly introduced products in the $1 billion U.S. cracker product category were analyzed. The cracker product category was also chosen among other reasons, as is discussed in more detail later, as it ranks as one of the highest sources of trans fat compared to all other processed foods. The other product characteristics controlled for in the hedonic analysis include labels for non-PHO fats, whole grain, and sodium as well as variety, package size, and brand. The hedonic model, built using a historical weekly scanner data set for the U.S. grocery store distribution channel from the Saturday ending September 21, 2002 through February 26, 2005, also controlled for potentially influential market conditions such as holidays and seasonality. This study is also an important contribution to the literature in that findings from this study may assist lawmakers trying to anticipate the market impact of a wide variety of other voluntary food labeling policy issues. A brief overview of labeling concepts and trends is provided next, followed by sections for the voluntary food labeling natural experiment, literature review, methodology, empirical results, and summary and conclusions.

## 2 Labeling Concepts and Trends

The labeling of nutritional content in food and beverages has been continually reshaped by the ongoing interaction of numerous stakeholders in the market including, but not limited to, manufacturers, retailers, regulators, consumers, and media [6, 23]. To better illustrate the voluntary trans fat labeling issue, consider Figure 1 for the example of a reformulation of a Triscuit product sold by Nabisco. Consistent with Lancaster [15], in this representation of the attribute utility model the horizontal and vertical axes represent characteristics of the underling products. For example, let the horizontal axis represent grams of trans fat per serving and let the vertical axis represent sodium measured in milligrams per serving. Typically, in such a diagram, several different products are depicted with rays or vectors emanating from the graph's origin. In this diagram, the same product, a Nabisco Triscuit, is depicted for two time periods, pre-label and post-label. Vector A represents a serving of Triscuits prior to the voluntary trans fat-free label. For example, let Vector A contain 2.4 g of trans fat and 160 mg of sodium.[5] Next, Kraft reduced the number of crackers per serving and removed some, but not all, of the trans fat per cracker. This product reformulation is represented by Vector B. The vector is shorter since the serving size decreased, but the slope of the vector became steeper as the ratio of sodium to trans fat increased due to the reformulation of the product. Given that the level of trans fat per serving is less than 0.5 g threshold, it can be labeled as trans fat-free [10]. This is represented by Vector C. Hence, what is observed by the consumer is a product represented by a vector that is vertical (i.e., labeled as trans fat-free), or Vector C, not Vector B. Incidentally, both Vectors B and C must contain the same level of sodium, as indicated by the horizontal hatched line at the level 137 mg.

[5] The values listed are provided for pedagogical purposes only and do not necessarily represent the actual levels of trans fat and sodium.

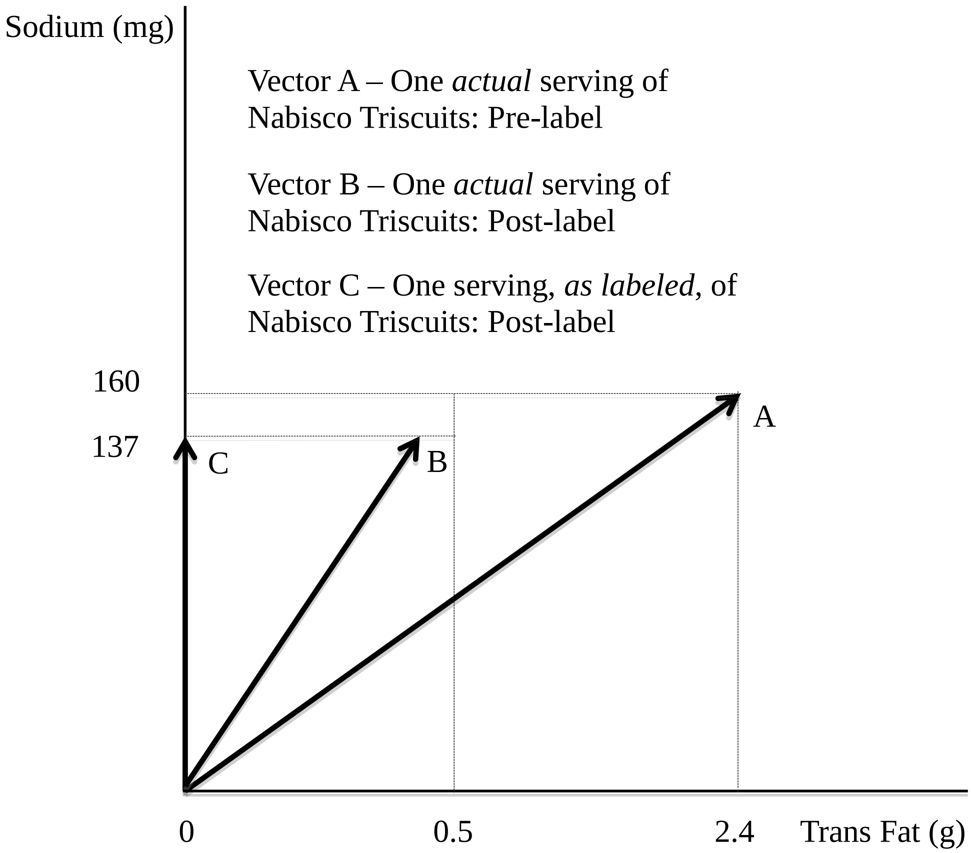


Figure 1: Pre-label and Post-label Depiction of Product Attribute Space

As previously mentioned, this study is concerned not only with the implicit price of the trans fat-free label, but also for labels of other non-PHO fats, whole grain, and sodium. Consider the half-decade trends in aggregate processed food sales by label type[6] chronicled in Figure 2 for the U.S. combined grocery, mass merchandiser, and drug store distribution channels [28]. From the 4-week period ending January 29, 2000 through the 4-week period ending January 22, 2005, expenditures for products with a reduced fat or fat-free label averaged $788 million monthly; seasonal increases in sales were quite predictable during the first month of each calendar year most likely correlated with New Year's resolutions for improved health and fitness. Private label brands with low/no fat labels accounted for 23.38 percent of these sales. Expenditures for products with labels denoting whole grain ingredients, while at a lower sales level than the other two series, slightly increased over the 5-year period and averaged $499 million monthly. Private label brands accounted for 6.97 percent of these expenditures. Sales of products with a reduced sodium or sodium-free label were stable and

[6] Low/no fat labels in Figure 2 exclude trans fat-free products.

averaged $874 million per month. Of these expenditures, private label brands comprised 8.30 percent of total.

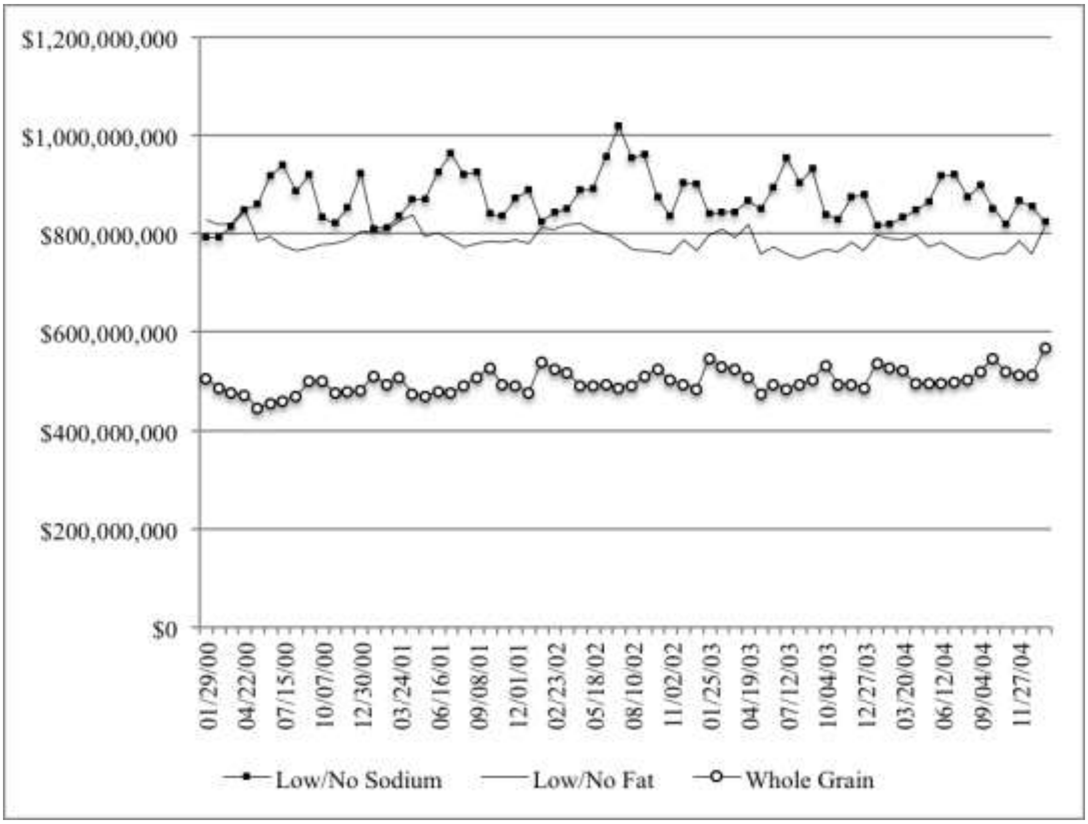


Figure 2: U.S. Processed Food Sales by Label Type

## 3 A Voluntary Food Labeling Natural Experiment

The cracker product category represents an ideal case study for the voluntary labeling event for several reasons. As previously mentioned, this product category captured both reformulated and newly introduced products with reduced trans fat content. According to the 2005 Dietary Guidelines for Americans [29], processed foods accounted for 80 percent of trans fat consumed and crackers specifically were part of the food group ranked as the highest dietary source of trans fat consumed, or 40 percent. Moreover, for the 52 weeks ending January 22, 2005, the cracker product category ranked 7$^{th}$ out of all product categories based on expenditures of low-fat (i.e., non-PHO fats) labeled products. Similarly, crackers ranked 4$^{th}$ based on sales derived from products labeled as having whole grain ingredients and ranked 3$^{rd}$ based on sales derived from products labeled as low sodium [28].

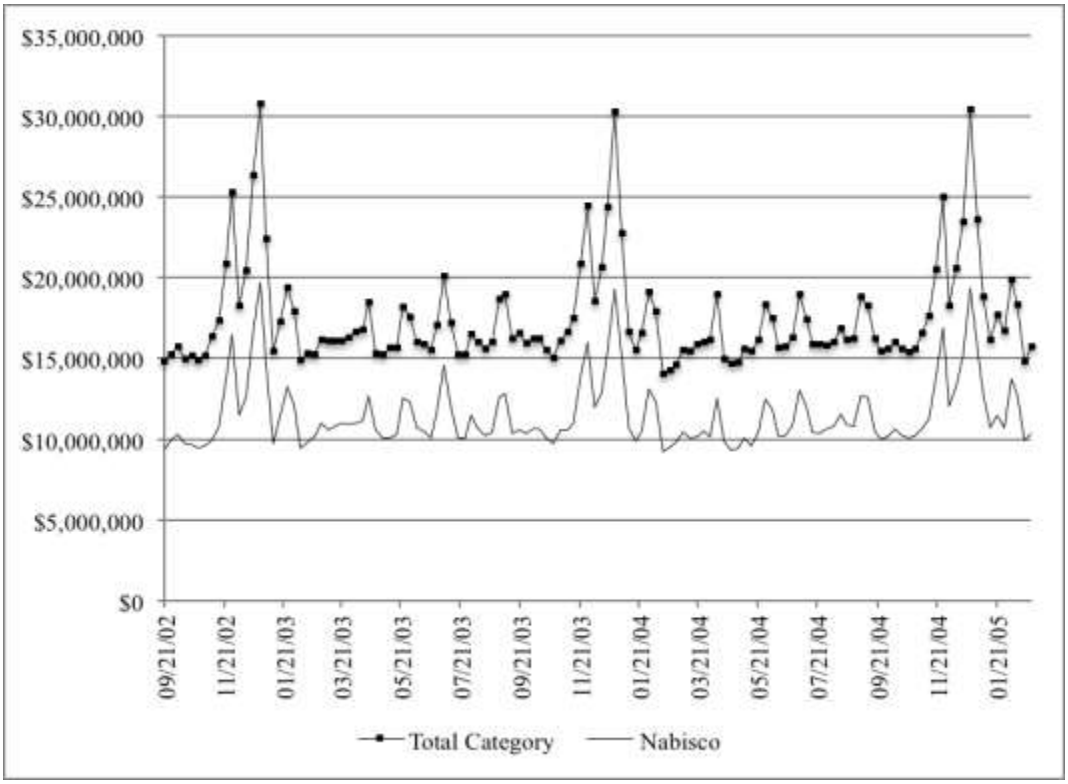


Figure 3: U.S. Cracker Sales

From a statistical perspective, given the mean-reverting or stationary expenditure series in Figure 3, the cracker category is clearly in the mature stage of the product life cycle and so is quite stable over the 128-week analysis period.[7] Weekly total category expenditures averaged approximately $17.5 million and weekly Nabisco expenditures averaged $11.5 million, or roughly two-thirds of total expenditures. Seasonal spikes in sales, both in total and for the dominant brand Nabisco, correspond to the usual calendar holidays. The analysis period is evenly split with 64 weeks of data prior to the labeling event and 64 weeks after the labeling event. Nabisco's ten reformulated Triscuit products possessing a voluntary trans fat-free label occurred at the beginning of the second 64-week period; week 65 corresponds to the week ending December 13, 2003. Due to demand-induced seasonality, each of weeks 65 through 68 is well above the weekly average expenditure with week 67 demarking peak sales of the year (i.e., the week ending December 27, 2003). In week 67, total category expenditures equaled an astounding $30.3 million and Nabisco expenditures equaled $19.3

[7] The results of the Fisher-type panel data unit root tests for expenditure, quantity, and price are all available upon request from the author. Across a very broad array of assumptions regarding lag length, trends, and intercepts in the panel data version of the augmented Dickey-Fuller and Phillips-Perron unit root tests, the null hypothesis of a unit root was routinely rejected at all reasonable levels of significance for expenditure, quantity, and, most importantly for the hedonic analysis, price (i.e., indicating an integrated series of order 0 or I[0] stationary series).

million. Thus, it stands to reason that the seasonal spikes in expenditures served to help deplete the older inventory from the system and hence expedite the replenishment of stocks with the newly formulated products. The eleven new product introductions labeled as trans fat-free occurred later in the second 64-week period.

## 4 Literature Review

The literature on the economics of nutritional labeling is quite vast hence only a few of the representative articles are briefly reviewed here. Depending on the empirical objectives, there are a wide variety of methodologies used in food industry research such as stated preferences, experimental auctions, and other revealed preferences [17]. Brown and Schrader [4] developed an index of health information regarding the impact of cholesterol on heart disease. They used the health information index to help explain the decline in U.S. shell egg consumption observed in aggregate quarterly disappearance data. Yen and Chern [34] used Brown and Schrader's [4] cholesterol information index to test structural change in the demand for oils and fats from 1950 to 1986. Nayga and Capps [22], using cross-sectional self-reported data sourced from the USDA National Food Consumption Survey from 1987 to 1988, considered not only the intake of cholesterol but also saturated fat in both the food-at-home and food-away-from-home distribution channels; the authors also controlled for demographic factors in the analysis. Chern, Loehman, and Yen [8] used a Bayesian information model to test if demand shifted from butter and lard to vegetable oils over the 1950 to 1988 analysis period. To help explain structural change in the meat industry, Kinnucan et al. [13] combined both health information and generic commodity advertising measures in a demand system for meat based on quarterly data. Mathios [19] investigated the salad dressing market both pre-NLEA and post-NLEA using grocery store scanner data. Using a random sample of 200 grocery store shoppers, Nayga [21] tested whether knowledge of nutrition affected the use of food labels. Teisl, Bockstael, and Levy [27] conducted store-level labeling experiments for six food product categories to estimate a theoretically consistent demand system in which nutrition labeling information and demographic factors were used as shift variables.

Post-NLEA implementation just after the turn of the 21st century, the incidence of overweight and obese Americans did not decline, hence the literature began to question the effectiveness of the NFP and other labeling considerations such as good and bad fats as well as trans fat. Caswell et al. [7] investigated both nutrient claims and less-common health claims in 1992, 1995, and 1999 for all the products contained in 19 separate categories. Malla, Hobbs, and Perger [18], by linking consumption of trans fats to cholesterol and cholesterol to CHD, were able to provide welfare estimates for substituting non-PHOs for trans fats in Canada. Loureiro and Nayga [16] used the 2003 Behavioral Risk Factor Surveillance

System survey data to analyze the influence of a physician's recommendation on food consumption behavior. Howlett, Burton, and Kozup [11] used a sample of 153 diabetics to assess whether the interaction of the knowledge of trans fats and the amount of trans fat contained in a product affected the perceived risk of CHD. Cook, Burton, and Howlett [9] analyzed the use of information in the NFP by at-risk individuals having both high cholesterol and high blood pressure. Kiesel and Villas-Boas [12] conducted store-level experiments to assess the impact of nutritional labels on weekly consumer purchases of microwave popcorn products.

Although Mills [20] considered the influence of product attributes on price, Waugh [32], using data from the market for asparagus, is perhaps the first study to provide empirical estimates of implicit prices of product attributes. Lancaster [15] theorized consumers received utility from the attributes of products rather than the quantity of products consumed. Rosen [26] developed a two-stage methodology to formalize the process of obtaining marginal values or implicit prices of product characteristics, though most empirical studies estimate only the first-stage as is done here.

## 5 Methodology

Consistent with the first-stage estimation of the hedonic price function proposed by Rosen [26], where price ($P_{it}$) is modeled as some function of the observed product attributes and market conditions, the stylized model for the U.S. cracker market is given by

$$P_{it} = f(\text{labels, variety, size, brand, holidays, seasonality}) + e_{it} \quad (1)$$

for i = 1,…,685 cracker products in the pre-label period, i = 1,…,720 in the post-label period, and t = 1,…,$T_i$ weeks where $T_i$ is less than or equal to 64 in both the pre-label and post-label periods. Although the data have a panel structure, the model estimated is a pooled regression model with a common intercept [3]. It is noted the one-way fixed effects and the one-way random effects models were not used. In the case of the former, the time-invariant fixed effects would not permit estimation of parameters on any categorical variables in the hedonic price function. In the case of the latter methodology, the distributional assumptions of the error components were not consistent with the underlying data generation process in the sample.

The Stata/SE 14.2 software was used to estimate the hedonic price function with White's (1980) heteroskedasticity-consistent standard errors [5]. The error term $e_{it}$ maintains all the usual properties for regression analysis [3]. The semilog functional form was selected over competing functional forms. Percentage differences, either premiums or discounts relative to the base case, and implicit prices are calculated and presented as well.

Cracker product attributes, observable to both the consumer and the econometrician, include the trans fat-free label (i.e., observable in the post-label period only), a fat-free label, a reduced fat label, a whole grain label, a reduced sodium label, variety, package size, and brand. Market conditions include holidays and seasonality. For each of the label variables (i.e., trans fat-free, fat-free, reduced fat, whole grain, reduced sodium, and variety) there are two categories for the respective indicator variable; the dummy variable takes on the value of 1 if the label condition is present and 0 otherwise. Hence, the coefficient on an indicator variable represents the implicit value of the information embodied in that respective label. It is noted the fat-free label and reduced fat label dealt with fat content claims unrelated to trans fats. There are six categories of the package size attribute; 0.000 to 0.250 pounds, 0.251 to 0.375 pounds, 0.376 to 0.500 pounds, 0.501 to 0.625 pounds, 0.626 to 0.750 pounds, and the base category of 0.751 pounds and above. Thus, there are five reported parameter estimates which will be evaluated individually with *t*-statistics and then collectively with a *F*-statistic. There are sixteen categories to the brand attribute; Nabisco, Keebler, private label, Bremner, Carrs, Crostini, Dare, Deli-catessen, Goya, Manischewitz, Old Stone Mill, Pepperidge Farm, Ralston, Red Oval Farms, Sunshine, and the base category of all other brands. Thus, there are fifteen reported parameter estimates.

The hedonic pricing model also includes regressors which control for holiday effects and seasonality effects. There are seven calendar holidays accounting for the week in which the holiday fell; the holidays include New Year, Easter, Memorial Day, July Fourth, Labor Day, Thanksgiving, and Christmas. Any non-holiday week belongs to the base category. Thus, there are seven reported parameter estimates. Finally, there are eleven monthly seasonality regressors for the months January through November where the base category is December. Hence, there are eleven reported parameter estimates. Including the common model intercept, there are 44 parameters estimated in the pre-label semilog hedonic pricing model and 45 in the post-label model.

## 6 Empirical Results

The Nielsen Company compiled the grocery store scanner data for this study. The data covered the 128-week time period from the Saturday ending September 21, 2002 through February 26, 2005. It includes measures for prices and product characteristics of 685 products in the pre-label period (i.e., weeks 1 to 64), and 720 products in the post-label period (i.e., weeks 65 to 128). Respectively, in the pre-label and post-label periods of the data, there were 32,300 observations and 31,625 observations. Of the 21 products labeled as trans fat-free in the post-label period, 10 were reformulated Triscuit products sold by Nabisco and 11 were new product introductions to the market. Of the 11 new products, two products were introduced by Nabisco and the remaining 9 products were introduced by four other brands.

Descriptive statistics are given in Table 1 for selected variables in hedonic analysis. The average price of crackers was $4.67 per pound in the pre-label period and $4.87 per pound in the post-label period. In the post-label period 3 percent of the observations was labeled trans fat-free. Other label variables are interpreted similarly. It is noted at the time the data were collected Nabisco was a flagship brand of the dominant Big Food player Kraft Foods Global, Incorporated.[8]

Given the product reformulation issue as described in Figure 1, two separate hedonic price functions were estimated. Parameter estimates and robust standard errors, both pre-label and post-label, may be found in Table 2 for the semilog functional form of the hedonic pricing model. While two sets of parameter estimates are presented, it is done so for completeness. It is not possible to determine if the two sets of parameter estimates are statistically different than each other by inspection. Still, the results are remarkably stable across both periods for the reasons previously mentioned in this paper. Due to space considerations only the parameter estimates in the post-label period are discussed.

The penultimate hypothesis test of this study relates to the parameter estimate on the voluntary trans fat-free label. The parameter estimate of 0.1625 was statistically different than zero ($p<0.01$) and, as expected a priori, positive. Given the semilog functional form, the parameter estimate has to be converted to both a percentage difference and implicit price. These results are provided in Table 3. Compared to the base category of a product without a voluntary trans fat-free label, those products with the label sell at a premium of 17.64 percent. Similarly, the implicit price or marginal value of the voluntary trans fat-free label was estimated to be $0.53 per pound. The author is unaware of any other estimates of an implicit price of a voluntary trans fat-free label. Hence this is an original and important contribution to the literature.

The other two categories of fat labels relate to fats other than PHOs. The first is given by a fat-free label while the second is given by a reduced fat label. Respectively, these parameter estimates of 0.0355 and 0.1289 were statistically different than zero ($p<0.01$) and, as expected a priori, both positive. As observed in Table 3, products with a fat-free label sold at a 3.62 percent premium over the base case while products with a reduced fat label sold at a premium of 13.75 percent relative to the base case. Implicit prices corroborated this pattern. The marginal value of products with a fat-free label was $0.11 per pound, which was about one-fifth of the implicit price of the voluntary trans fat-free label. The implicit price of the reduced fat label was $0.41 per pound; the marginal value was approximately fourfold higher than the implicit price for fat-free labeled products and 80 percent of the implicit price of the voluntary trans fat-free label.

---

[8] In 2011 Kraft divested its snack business. The Nabisco brand is now owned by the legal entity created in the divestiture, Mondelez International LLC.

The parameter estimate for whole grain labeled products of 0.0447 was statistically different than zero ($p<0.01$) and, as expected a priori, positive. As documented in Table 3, the percent premium over the base case and the implicit price, respectively, were estimated to be 4.58 percent and $0.14 per pound. These levels were very similar to those estimated for products labeled as fat-free. Moreover, the parameter estimate for reduced sodium labeled products of 0.0653 was statistically different than zero ($p<0.01$) and, as expected a priori, positive. Products labeled as reduced sodium sold at a 6.74 percent premium over the base case and had a marginal value of $0.20 per pound.

Product variety has been argued to be an important consideration in the food industry [25]. The parameter estimate for products containing a variety of flavors or styles was 0.5180; this parameter was statistically different than zero ($p<0.01$) and, as expected a priori, positive. As seen in Table 3, the premium over the base case for products with a variety label was 67.87 percent, and the implicit price was $2.05 per pound. Each of the five categories of the package size attribute was found to be positive, as expected a priori, and statistically significant ($p<0.01$). Also, the smaller the package size, the higher was the parameter estimate as expected a priori. For example, the parameter estimate for the most common package size category of 0.376 to 0.500 pounds was equal to 0.5320. This corresponded to a price premium of 70.23 percent and an implicit price of $2.12 per pound. Taken collectively, the *F*-test for the null hypothesis that all five parameter estimates for package size simultaneously equaled zero was, not surprisingly, rejected ($p<0.01$); the *F*-statistic was 3803.09.

Fifteen brand effects were modeled relative to the base case. Each was found to be statistically significant ($p<0.01$) and most conformed to a priori expectations. For example, it was expected that major brands like Nabisco and Keebler would have positive parameter estimates (i.e., 0.1077 and 0.2081 respectively), yet private label was expected to have a negative parameter estimate (i.e., -0.2572). Several smaller national brands, such as Deli-catessen, Goya, and Ralston, unexpectedly had negative parameter estimates. As documented in Table 3, the premiums over the base case for Nabisco and Keebler, respectively, were 11.37 percent and 23.13 percent. The implicit prices for Nabisco and Keebler, respectively, were $0.31 per pound and $0.63 per pound. The discount under the base case for private label was 22.68 percent, and the associated implicit price was negative $0.61 per pound. Taken collectively, the *F*-test for the null hypothesis that all fifteen parameter estimates for brand simultaneously equaled zero was rejected ($p<0.01$) with a *F*-statistic of 1318.45.

Market conditions were controlled for in the modeling effort as well. However, none of the holiday effects was found to be statistically significant individually or jointly ($p>0.10$). Holiday spikes in Figure 3 in the expenditure series were also observed in the quantity series as well leaving price statistically unchanged during the holiday weeks. Finally, three of the eleven monthly seasonality effects were statistically significant (i.e., $p<0.05$ for January and $p<0.01$ for February and October). Taken collectively, the *F*-test for the null hypothesis that all eleven parameter estimates for seasonality simultaneously equal zero was rejected ($p<0.10$).

The overall intercept of the model was statistically significant ($p<0.01$) with a value of 0.9372. The $R^2$ measure in the post-label period was 0.5720; the level of goodness-of-fit was on the higher end of the spectrum compared to other studies in the hedonic pricing literature. The $F$-statistic of 2410.84 in the post-label period rejected the null hypothesis ($p<0.01$) that all slope parameters in the model were jointly equal to zero with 44 numerator and 31,580 denominator degrees of freedom.

## 7 Summary and Conclusions

While Professor Sabatier's pioneering work in the underlying methods of hydrogenation of organic compounds was deemed worthy of one of the world's most esteemed awards in science a century ago, its application to PHOs, or trans fat, has come under sharp criticism by the allied medical and public health professions. Decades worth of mounting evidence of adverse health impacts due to the consumption of trans fat has finally led to a complete transformation of food labeling policy through the NFP – in fact the biggest change to the NFP since its implementation pursuant to the NLEA. Mandatory since January 1, 2006, the disclosure of the level of trans fat per serving in the NFP was intended to inform consumers of the nutritional consequences of their food choices. Moreover, dietary guidelines established and promoted by the federal government recommend minimizing the consumption of trans fat. Even more recently, the FDA announced on November 7, 2013 that it is considering a ruling to ban all trans fats in processed foods. This reversal of fortune, from once-perceived friend to now-proven foe, is quite astonishing.

Ahead of the January 1, 2006 deadline for mandatory labeling of trans fat, Nabisco, a leading brand in the market for crackers – a $1 billion processed food category and ranked amongst the top sources of trans fat – reformulated a subset of their products and voluntarily labeled them as trans fat-free. New products were also introduced in the market and labeled as trans fat-free as well. The purpose of this study was to determine the implicit price of products voluntarily labeled as trans fat-free. Using a national level weekly scanner data set and controlling for the other observable product attributes, such as non-PHO fat labels, whole grain labels, sodium labels, variety, and package size, in addition to market conditions, the implicit price of the voluntary trans fat-free label was estimated to be $0.53 per pound, or a premium over the base case of 17.64 percent.

If the November 7, 2013 proposed ban on trans fat is in fact implemented, while a triumph for consumers and the allied medical and public health professions, the opportunity to differentiate processed foods based on trans fat content would cease to exist for food manufacturers. In fact, in Figure 1, Vector C would not only represent one serving *as labeled*, but would also represent one *actual* serving. By collapsing the entire trans fat dimension in the product attribute space through a ban, each product remaining in the category would have a content of 0 g of trans fat. The indicator variable in the hedonic pricing model to distinguish trans fat-free labeled products from the base case would become an entire column of 1s and hence be perfectly collinear with the model's intercept; hence the parameter would no longer be estimable and the respective implicit price of a trans fat-free label would necessarily be driven to zero. If the proposed ban is implemented and a food manufacturer was able to include trans fat as a food additive in its product as authorized by a new regulation, the trans fat dimension would reappear in the product attribute space as shown in Figure 1. However, it would be expected a priori that the parameter estimate, and its corresponding percentage change and implicit price, for a product labeled as containing the trans fat food additive would necessarily be negative.

## References

[1] D.B. Allison, K. Egan, L.M. Barraj, C. Caughman, M. Infante, and J.T. Heimbach, Estimated intakes of trans fatty and other fatty acids in the US population, *Journal of the American Dietetic Association*, **99**, (1999), 166-174.

[2] American Heart Association. A History of Trans Fat. http://www.heart.org/HEARTORG/GettingHealthy/FatsAndOils/Fats-Oils_UCM_001084_SubHomePage.jsp (accessed August 29, 2013).

[3] B.H. Baltagi, Econometric Analysis of Panel Data, 3rd Edition, John Wiley & Sons, Hoboken, NJ, 2005.

[4] D.J. Brown and L.F. Schrader, Cholesterol information and shell egg consumption, American Journal of Agricultural Economics, 72, (1990), 548-555.

[5] A.C. Cameron and P.K. Trivedi, Microeconometrics Using Stata, Stata Press, College Station, TX, 2009.

[6] J.A. Caswell, How labeling of safety and process attributes affects markets for food, Agricultural and Resource Economics Review, 27, (1998), 151-158.

[7] J.A. Caswell, Y. Ning, F. Liu, and E.M. Mojduska, The impact of new labeling regulations on the use of voluntary nutrient-content and health claims by food manufacturers, Journal of Public Policy & Marketing, 22, (2003), 147-158.

[8] W.S. Chern, E.T. Loehman, and S.T. Yen, Information, health risk beliefs, and the demand for fats and oils, Review of Economics and Statistics, 77, (1995), 555-564.

[9] L.A. Cook, S. Burton, and E. Howlett, Health risk factors and their effect on consumers' use of nutrition facts panels, Journal of Consumer Affairs, 45, (2011), 516-527.

[10] Federal Register. https://www.federalregister.gov/articles/2003/07/11/03-17525/food-labeling-trans (accessed August 29, 2013).

[11] E. Howlett, S. Burton, and J. Kozup, How modification of the nutrition facts panel influences consumers at risk for heart disease: the case of trans fat, Journal of Public Policy & Marketing, 27, (2008), 83-97.

[12] K. Kiesel, and S.B. Villas-Boas, Can information costs affect consumer choice? Nutritional labels in a supermarket experiment, International Journal of Industrial Organization, 31, (2013), 153-163.

[13] H.W. Kinnucan, H. Xiao, C.J. Hsia, and J.D. Jackson, Effects of health information and generic advertising on U.S. meat demand. American Journal of Agricultural Economics, 79, (1997), 13-23.

[14] P.M. Kris-Etherton, E.A. Emken, D.B. Allison, J.M. Deitschy, R.J. Nicolosi, and M.A. Denke, Trans fatty acids and coronary heart disease risk, American Journal of Clinical Nutrition, 62, (1995), 655S-707S.

[15] K.J. Lancaster, A new approach to consumer theory, Journal of Political Economy, 74, (1966), 132-157.

[16] M.L. Loureiro and R.M. Nayga, Physician's advice affects adoption of desirable dietary behaviors, Review of Agricultural Economics, 29, (2007), 318-330.

[17] J.L. Lusk, J. Roosen, and J. Shogren, The Oxford Handbook of the Economics of Food Consumption and Policy, Oxford University Press, Oxford, UK, 2011.

[18] S. Malla, J.E. Hobbs, and O. Perger, Valuing the health benefits of a novel functional food, Canadian Journal of Agricultural Economics, 55, (2007), 115-136.

[19] A.D. Mathios, The impact of mandatory disclosure laws on product choices: An analysis of the salad dressing market, Journal of Law and Economics, 43, (2000), 651-678.

[20] F.C. Mills, The Behavior of Prices, National Bureau of Economic Research, New York, NY, 1927.

[21] R.M. Nayga, Nutrition, knowledge, gender, and food label use, Journal of Consumer Affairs, 34, (2000), 97-112.

[22] R.M. Nayga and O. Capps, Analysis of away-from-home and at-home intake of saturated fat and cholesterol, Review of Agricultural Economics, 16, (1994), 387-398.

[23] M. Nestle, 2002, Food Politics: How the Food Industry Influences Nutrition and Health, University of California Press, Berkeley, CA, 2002.

[24] Nobel Prize. http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1912/ (accessed September 18, 2013).

[25] T.J. Richards and P.M. Patterson, Firm-level competition in price and variety, Journal of Agricultural and Applied Economics, 38, (2006), 491-512.
[26] S. Rosen, Hedonic prices and implicit markets: product differentiation in pure competition, Journal of Political Economy, 82, (1974), 34-55.
[27] M.F. Teisl, N.E. Bockstael, and A. Levy, Measuring the welfare effects of nutrition information, American Journal of Agricultural Economics, 83, (2001), 133-149.
[28] The Nielsen Company, AC Nielsen Label Trends: Health and Wellness Characteristics, 2005.
[29] U.S. Department of Health and Human Services. Dietary Guidelines for Americans 2005. http://www.health.gov/dietaryguidelines/dga2005/ (accessed August 28, 2013).
[30] U.S. Department of Health and Human Services. National Institutes of Health. National Heart, Lung, and Blood Institute. http://www.nhlbi.nih.gov/health/public/heart/chol/cholesterol_atglance.pdf (accessed August 28, 2013).
[31] U.S. Food and Drug Administration. News Release: FDA takes step to further reduce trans fat in processed foods. http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm373939.htm (accessed November 7, 2013).
[32] F.V. Waugh, Quality factors influencing vegetable prices, Journal of Farm Economics, 10, (1928), 185-196.
[33] H. White, A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity, Econometrica, 48, (1980), 817-838.
[34] S.T. Yen and W.S. Chern, Flexible demand systems with serially correlated errors: Fat and oil consumption in the United States, American Journal of Agricultural Economics, 74, (1992), 689-697.

Table 1: Descriptive Statistics for Hedonic Pricing Model Variables

| | Pre-Label Period | | Post-Label Period | |
|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation |
| Price | $4.67 | $2.49 | $4.87 | $2.65 |
| Trans Fat-Free Label | --- | --- | 0.03 | 0.16 |
| Fat-Free Label | 0.05 | 0.21 | 0.03 | 0.18 |
| Reduced Fat Label | 0.19 | 0.40 | 0.18 | 0.39 |
| Whole Grain Label | 0.10 | 0.30 | 0.11 | 0.32 |
| Reduced Sodium Label | 0.04 | 0.20 | 0.04 | 0.19 |
| Variety | 0.02 | 0.13 | 0.02 | 0.13 |
| Size (pounds) | | | | |
| 0.000 to 0.250 | 0.07 | 0.25 | 0.08 | 0.27 |
| 0.251 to 0.375 | 0.16 | 0.37 | 0.17 | 0.37 |
| 0.376 to 0.500 | 0.34 | 0.47 | 0.33 | 0.47 |
| 0.501 to 0.625 | 0.23 | 0.42 | 0.23 | 0.42 |
| 0.626 to 0.750 | 0.11 | 0.32 | 0.11 | 0.31 |

Table 1: Continued

| | Pre-Label Period | | Post-Label Period | |
|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation |
| Brand | | | | |
| Nabisco | 0.09 | 0.28 | 0.09 | 0.29 |
| Keebler | 0.04 | 0.20 | 0.04 | 0.20 |
| Private Label | 0.23 | 0.42 | 0.21 | 0.40 |
| Bremner | 0.01 | 0.11 | 0.01 | 0.11 |
| Carrs | 0.03 | 0.16 | 0.02 | 0.15 |
| Crostini | 0.01 | 0.10 | 0.01 | 0.10 |
| Dare | 0.02 | 0.12 | 0.02 | 0.14 |
| Deli-catessen | 0.02 | 0.15 | 0.02 | 0.13 |
| Goya | 0.01 | 0.08 | 0.01 | 0.09 |
| Manischewitz | 0.01 | 0.10 | 0.01 | 0.10 |
| Old Stone Mill | 0.02 | 0.13 | 0.02 | 0.13 |
| Pepperidge Farm | 0.03 | 0.18 | 0.03 | 0.17 |
| Ralston | 0.01 | 0.07 | 0.01 | 0.08 |
| Red Oval Farms | 0.03 | 0.16 | 0.02 | 0.12 |
| Sunshine | 0.004 | 0.06 | 0.01 | 0.11 |

Based on a sample of 32,300 observations in the pre-label period and 31,625 observations in the post-label period. Mean and standard deviation for holidays, seasonality, and base model attributes are omitted to conserve space yet available upon request from the author.

Table 2: Hedonic Pricing Models for U.S. Cracker Market

| | Pre-Label Period | | Post-Label Period | |
|---|---|---|---|---|
| | Parameter Estimate | Standard Error | Parameter Estimate | Standard Error |
| Trans Fat-Free Label | --- | --- | 0.1625*** | 0.0098 |
| Fat-Free Label | 0.0458*** | 0.0073 | 0.0355*** | 0.0091 |
| Reduced Fat Label | 0.1583*** | 0.0043 | 0.1289*** | 0.0049 |
| Whole Grain Label | 0.0790*** | 0.0054 | 0.0447*** | 0.0064 |
| Reduced Sodium Label | 0.0108 | 0.0080 | 0.0653*** | 0.0078 |
| Variety | 0.4362*** | 0.0114 | 0.5180*** | 0.0130 |
| Size (pounds) | | | | |
| 0.000 to 0.250 | 0.9611*** | 0.0117 | 1.0376*** | 0.0115 |
| 0.251 to 0.375 | 0.8250*** | 0.0103 | 0.9210*** | 0.0100 |
| 0.376 to 0.500 | 0.4697*** | 0.0074 | 0.5320*** | 0.0077 |
| 0.501 to 0.625 | 0.1501*** | 0.0073 | 0.1705*** | 0.0077 |
| 0.626 to 0.750 | 0.0404*** | 0.0084 | 0.0581*** | 0.0087 |
| 0.751 and Above | Base | Base | Base | Base |
| *F*-statistic | 3108.56*** | | 3803.09*** | |

Table 2: Continued

| | Pre-Label Period | | Post-Label Period | |
|---|---|---|---|---|
| | Parameter Estimate | Standard Error | Parameter Estimate | Standard Error |
| Brand | | | | |
| Nabisco | 0.1586*** | 0.0058 | 0.1077*** | 0.0070 |
| Keebler | 0.1463*** | 0.0073 | 0.2081*** | 0.0062 |
| Private Label | -0.2924*** | 0.0053 | -0.2572*** | 0.0054 |
| Bremner | 0.5537*** | 0.0210 | 0.4442*** | 0.0153 |
| Carrs | 0.1929*** | 0.0071 | 0.2334*** | 0.0074 |
| Crostini | 0.2980*** | 0.0084 | 0.2856*** | 0.0082 |
| Dare | 0.1314*** | 0.0073 | 0.1549*** | 0.0072 |
| Deli-catessen | 0.0904*** | 0.0090 | -0.0673*** | 0.0187 |
| Goya | -0.2542*** | 0.0217 | -0.2742*** | 0.0229 |
| Manischewitz | 0.2467*** | 0.0083 | 0.2308*** | 0.0093 |
| Old Stone Mill | 0.3104*** | 0.0063 | 0.3142*** | 0.0078 |
| Pepperidge Farm | 0.0018 | 0.0098 | 0.0366*** | 0.0105 |
| Ralston | -0.4949*** | 0.0075 | -0.4163*** | 0.0123 |
| Red Oval Farms | 0.3081*** | 0.0060 | 0.3572*** | 0.0084 |
| Sunshine | 0.0809*** | 0.0118 | 0.2163*** | 0.0101 |
| All Other Brands | Base | Base | Base | Base |
| *F*-statistic | 2159.18*** | | 1318.45*** | |

Table 2: Continued

| | Pre-Label Period | | Post-Label Period | |
|---|---|---|---|---|
| | Parameter Estimate | Standard Error | Parameter Estimate | Standard Error |
| Holidays | | | | |
| New Year | -0.0185 | 0.0163 | -0.0121 | 0.0119 |
| Easter | -0.0120 | 0.0166 | 0.0068 | 0.0179 |
| Memorial Day | -0.0141 | 0.0162 | -0.0070 | 0.0176 |
| July Fourth | -0.0065 | 0.0115 | -0.0095 | 0.0141 |
| Labor Day | -0.0172 | 0.0113 | -0.0116 | 0.0126 |
| Thanksgiving | -0.0174* | 0.0103 | -0.0150 | 0.0156 |
| Christmas | -0.0171 | 0.0134 | -0.0093 | 0.0104 |
| All Other Weeks | Base | Base | Base | Base |
| *F*-statistic | 1.38 | | 0.62 | |
| Seasonality | | | | |
| January | -0.0014 | 0.0113 | 0.0194** | 0.0095 |
| February | 0.0244** | 0.0113 | 0.0300*** | 0.0096 |
| March | 0.0210* | 0.0112 | 0.0138 | 0.0104 |
| April | 0.0137 | 0.0120 | 0.0144 | 0.0117 |
| May | 0.0178 | 0.0112 | 0.0082 | 0.0117 |
| June | 0.0268** | 0.0115 | 0.0088 | 0.0117 |
| July | 0.0219** | 0.0110 | 0.0018 | 0.0109 |
| August | 0.0283** | 0.0115 | 0.0122 | 0.0114 |
| September | 0.0202* | 0.0106 | 0.0118 | 0.0107 |
| October | 0.0227** | 0.0097 | 0.0292*** | 0.0110 |
| November | 0.0144 | 0.0112 | 0.0195 | 0.0137 |
| December | Base | Base | Base | Base |
| *F*-statistic | 1.55* | | 1.71* | |
| Intercept | 0.9679*** | 0.0118 | 0.9372*** | |
| $R^2$ | 0.5809 | | 0.5720 | |
| *F*-statistic | 3324.90*** | | 2410.84*** | |

Note: Single, double, and triple asterisks (*) denote statistical significance at the 0.10, 0.05, and 0.01 levels, respectively. The dependent variable is the natural logarithm of price, where price is measured in U.S. dollars per pound. The model is estimated with White's heteroskedasticity-consistent standard errors and based on a sample of 32,300 observations in the pre-label period and 31,625 observations in the post-label period.

Table 3: Selected Estimates of Percentage Differences and Implicit Prices

| | Pre-Label Period | | Post-Label Period | |
|---|---|---|---|---|
| | Percentage Difference | Implicit Price | Percentage Difference | Implicit Price |
| Trans Fat-Free Label[1] | --- | --- | 17.64 | $0.53 |
| Fat-Free Label | 4.69 | $0.15 | 3.62 | $0.11 |
| Reduced Fat Label | 17.15 | $0.56 | 13.75 | $0.41 |
| Whole Grain Label | 8.22 | $0.27 | 4.58 | $0.14 |
| Reduced Sodium Label[2] | --- | --- | 6.74 | $0.20 |
| Variety | 54.68 | $1.78 | 67.87 | $2.05 |
| Size (pounds) | | | | |
| 0.000 to 0.250 | 161.46 | $5.25 | 182.23 | $5.50 |
| 0.251 to 0.375 | 128.19 | $4.17 | 151.17 | $4.56 |
| 0.376 to 0.500 | 59.96 | $1.95 | 70.23 | $2.12 |
| 0.501 to 0.625 | 16.19 | $0.53 | 18.59 | $0.56 |
| 0.626 to 0.750 | 4.12 | $0.13 | 5.98 | $0.18 |
| Brand | | | | |
| Nabisco | 17.19 | $0.48 | 11.37 | $0.31 |
| Keebler | 15.75 | $0.44 | 23.13 | $0.63 |
| Private Label | -25.35 | -$0.70 | -22.68 | -$0.61 |

[1] Trans fat-free label was not present in pre-label period.

[2] Parameter estimate for reduced sodium label was not statistically different than zero in pre-label period.