Zwick Center for Food and Resource Policy

Working Paper Series

No. 27

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May 16, 2014

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Abstract

We use a market-level natural experiment to evaluate how the voluntary Facts Up Front style Front-of-Package (FOP) nutritional labeling system would affect consumer choices, and whether it can promote the consumption of healthier food products. The new FOP system provides a quick summary of the calories, sugar, saturated fat, and selected positive nutrients, and is listed on the front of food packages. Using data of household-level Ready-to-Eat cereal (RTEC) purchases and difference-in-differences (DD) approaches, we find that the new FOP labels induce consumers to buy less RTEC, consume fewer calories, and less sodium, but only in households purchasing two RTEC packages per month or fewer. For RTEC products containing new FOP labels, consumers are observed to substitute more vigorously from products with poor nutritional quality to healthier RTEC products. We also find that household heads with education levels of a high school degree or less show the greatest improvement in their food choices, suggesting that the FOP labels change consumer behavior primarily through reduced information costs.

Keywords: Front-of -Package (FOP) Nutrition labels, label restriction, self-regulation, distributional effects

Nutrition labeling has become of increasing public interest to policy makers, consumers, and the food and beverage industry. In 1994, the Nutrition Facts Panel (NFP) was added to the back or side of food packages under the Nutritional Labeling and Education Act (NLEA) to provide nutritional information of foods on a standardized label and to promote healthier food choices. However, studies indicate that the NFP may not efficiently provide nutritional information to consumers due to its high information search costs (e.g., hard to read on supermarket shelves, lengthy back or side description) (Drichoutis, Lazaridis and Nayga 2005; Kiesel, McCluskey and Villas-Boas 2011). In October 2007, the food and beverage industry announced the voluntary "Nutrition Key" front-of-package (FOP) system (later renamed "Facts Up Front"), which displays a summary of nutrient-specific information for calories, "negative" nutrients (e.g., sugar, sodium, and saturated fat), and selected "positive" nutrients (e.g., fiber, calcium, protein, vitamins). Figure 1 shows examples of front packages and FOP symbols before and after the voluntary adoption of new FOP labels.

The new FOP labels have created a debate between nutritionists and the food and beverage industry. Although the industry states that it is best to provide consumers with easy-to-read nutrition profiles of both "bad" and "good" nutrients of food products, opponents believe that adding "good" components can be misleading or confusing, and make the overall FOP labels inefficient in helping consumers choose healthier alternatives (Nestle and Ludwig 2010). This article uses a market-level natural experiment and provides empirical evidence on how the new FOP labels affect consumer purchasing behaviors and dietary choices.

Previous studies on nutrition labels have focused on investigating consumers' valuation and usage of various labeling schemes using data from surveys (Ippolito and Mathios 1990; Kim, Nayga and Capps 2000; Drichoutis et al. 2008; Todd and Variyam 2008; Kiesel, McCluskey and

Villas-Boas 2011), controlled laboratory and field experiments (e.g., restaurants, supermarkets; Keller et al. 1997; Kozup, Creyer and Burton 2003; Berning et al. 2010; Barreiro-Hurlé, Gracia and De-Magistris 2010; Kiesel and Villas-Boas 2010). However, only a limited number of studies evaluate consumers' consequent changes in purchasing behaviors and dietary choices. Teisl, Bockstael, and Levy (2001) analyze a nutritional labeling field experiment and find that consumer behavior is significantly altered, but the changes do not necessarily lead to a higher consumption of healthy products. On the other hand, Mathios (2000) uses the pre- and post-NLEA scanner data and finds that the mandatory nutrition labeling has a significant negative impact on sales of higher fat salad dressings.

[Insert Figure 1 about here]

In this study, we investigate consumer responses to the launch of new Facts Up Front style FOP labels of two leading Ready-to-Eat cereal (RTEC) manufacturers by using household-level purchasing data before and after the implementation of new FOP labels. The natural experiment and rich data sets provide a unique opportunity to address features that are new to the literature. First, the availability of detailed pre- and post-treatment purchasing data enables us to identify the average effect of the new FOP labels on households' consumption of RTEC products through a difference-in-differences (DD) approach. Second, by combining with nutritional quality data, we can analyze whether the new FOP labels encourage consumers to purchase more healthy products -- one of the key aims of the new FOP labels (Wartella, Lichtenstein, and Boon 2010). Third, to address potential distributional effects, we employ quantile DD approaches and estimate the heterogeneous treatment effects across distributions of cereal volume consumed, intake of calories, sugar, and sodium obtained from RTEC products, respectively. Fourth, taking advantage of the rich data set that containing detailed product characteristics, nutrition/labeling information, media exposure, and households' sociodemographic characteristics, we can control for a number of potentially confounding factors and explore further on how individual characteristics may lead to different responses to new FOP labels.

We find substantial evidence that the new FOP labels lead to consumers making healthier food choices with a reduced intake of calories, sugar, and sodium, principally through substitution from poor to good nutritional quality products (measured by Nutrient Profile Index scores). Quantile DD results further demonstrate that the effect of new FOP labels is mainly on the lower quantiles of the distribution, or in households that purchase fewer than or equal to two package of RTEC products per month. It is worth noting that the new FOP labels repeat the NFP nutritional information in a new format; hence if consumers have already incorporated NFP information in their food choices, little impact would be observed because no additional nutritional information is provided (Teisl, Bockstael and Levy 2001; Kiesel, McCluskey and Villas-Boas 2011). Therefore, we argue that consumers' changes in purchasing behaviors in this study can be primarily attributed to the reduced information costs offered by the new FOP labels. We also find that household heads with education levels of a high school degree or less show the greatest improvement in their food choices, which supports the role of new FOP labels in reducing information search costs.

The remainder of this article is organized as follows: we first introduce the model and empirical strategies, followed by the data description. The empirical results of mean impacts and distribution treatment effects are presented with robustness verified. We then discuss what types of consumers are likely to be most affected by the labeling change, followed by conclusion.

Empirical Strategy

Kellogg's, General Mills, Quaker Oats, and Post are four biggest RTEC manufacturers in the U.S. market; they accounted for more than 75% of sales between 2006 and 2008. In October 2007, Kellogg's started to display a monochrome FOP labeling system called "Nutrition at a Glance," based on the European Guideline Daily Amounts (GDA) system, which was placed on the top-right corner of its cereal packages. About the same time, General Mills started to use a similar Nutrition Highlights FOP regime. Both of these new FOP labels present the total amount per serving of four key nutrients: calories, saturated fat, sodium, and sugar, along with a percentage of the recommended daily intake values. In addition, firms can opt to display up to two "nutrients to encourage," such as protein, vitamins, and fiber. For both companies, the new FOP nutrition labels replaced their original FOP symbols and claims that were often vague and qualitative (e.g., "good source of fiber", "low fat") without information on the actual amount or percentage of the recommended daily intake. On the other hand, Quaker Oats and Post, who have smaller shares of the U.S. market, did not change their FOP formats during the data period. In January 2011, the industry proposed that all food and beverage companies use a Facts Up Front FOP regime that is almost identical to the ones adopted by Kellogg's and General Mills.

The natural experiment allows us to use a DD setup to explore whether the new FOP labels help consumers to make healthier choices of RTEC products. To further investigate the heterogeneous effects on households with different sociodemographic characteristics, we implement the quantile DD approach, which allows the treatment effects to vary across the population.

Specifically, we define the treatment group as products belonging to Kellogg's and General Mills. The control group is a set of products that belong to Quaker Oats and Post, none of which had the new FOP labels during the data period. Because both Kellogg's and General Mills' Facts Up Front style labels were launched in October 2007, we expected that households would have a different cereal consumption pattern in the post-treatment period if the new FOP labels effectively altered consumer purchase behaviors.

Our data document shopping trips taken by households during the period. The purchases of a same household generally correlated over time. To control for the potential serial correlation of shocks that might underestimate the standard errors of treatment effects in a DD setup, we compress multiple data points into single data points before and after the new FOP labels' introduction for each of the product group and for each household (Bertrand, Duflo and Mullainathan 2000; Huang and Yang 2012). Specifically, for each household, we calculate four points: (1) the average pre-treatment monthly cereal purchases of Kellogg's/General Mills products, and (2) of Post/Quaker Oats products; (3) the average post-treatment monthly cereal purchases of Kellogg's/General Mills products, and (4) of Post/Quaker Oats products.

The standard DD specification is based on the following model:

(1) $$y_{itg} = \alpha_0 + a_1 d_T + \alpha_2 d_G + \gamma(d_T \times d_G) + \tau X_{itg} + \epsilon_{itg},$$

where y_{itg} denotes the average monthly purchases of RTEC group g that household i buys in period t [1]. d_T is a dummy variable that equals 1 for the post-treatment period in the data. d_G denotes RTEC product groups, and it equals 1 when household i purchases products from the treatment group (Kellogg's and General Mills). γ is the parameter of interest and the DD estimator. X_{itg} is a vector of control variables, including both marketing mix variables and household sociodemographic variables. ϵ_{itg} is the disturbance term with mean 0 and constant variance.

In covariates X_{itg}, we have prices, advertising exposure, and promotion as marketing mix variables. The price variable is the average price that households paid in a particular DMA. Similarly, the advertising variable represents the average advertising exposure in a DMA. The product promotion variable is defined as the percentage under promotion over all observed choice occasions. In terms of demographic variables, we use the average age of household heads, a high household income indicator (equals to 1 if a household's income is greater than or equal to $60,000 per year), male and female household heads' educational attainments, household size, and the presence of children among different age groups (under the age of 6, between ages 7 and 12, and between ages 13 and 17).

To allow for the effects of the treatment and covariates to flexibly vary across the distribution of the dependent variable y_{itg}, we follow Koenker (2005) and estimate the model in equation (1) at each chosen quantile. The p^{th} conditional quantile of y_{itg} given d_T, d_G, and X_{itg} is:

$$q_p\left(y_{itg} \middle| d_T, d_G, X_{itg}\right) = \alpha_0(p) + a_1(p)d_T + \alpha_2(p)d_G + \gamma(p)(d_T \times d_G) + \tau(p)X_{itg} + \epsilon_{itg}(p). \quad (2)$$

Notice that no additional distribution assumptions are made about the error term ϵ_{itg}. The quantile DD estimates can be obtained by minimizing the sum of the absolute residuals in equation (2).

Data

In this section, we describe data sets used for the empirical estimation, compare summary statistics between the treatment and control groups, and test for the key identification assumption of DD approaches.

Data Description

For this analysis, we employ three proprietary data sets: household purchases, brand-level weekly advertising exposure, and package information for the RTEC category from January 2006 to December 2008. The Nielsen Homescan data tracks household purchases of RTEC products across 16 designated market areas (DMAs)[2]. These data include purchases made at big box retailers, grocery stores, convenience stores, automatic vending machines, and on-line retailers for at-home consumption. For each purchase, we know the time and location of the purchase, price and quantity, and other product characteristics such as brand and package size. The Nielsen Media Research data provide brand-level TV advertising exposure on a weekly basis for the same DMAs during the same weeks. Advertising exposure is measured in gross rating points (GRPs). We also obtain detailed product package and nutritional information from the Mintel Global New Products Database (GNPD), which has provided detailed product listings since 1996 in 245 categories of food, drink, and other grocery store items. Product listings are collected by Mintel based on product reformulations, new product introductions, new product packaging, and new product varieties. The resulting dataset contains 3,977 households in 16 DMAs. Table 1 lists product characteristics of 20 major RTEC brands from the four leading firms.

[Insert Table 1 about here]

Descriptive Statistics

Table 2 compares major household and product characteristics for the treatment and control groups. Eighty-three percent of households in our sample purchased both treatment and control products during the data period. Overall, demographic variables of the households who purchased the products are substantively similar across the treatment and control groups. So are the marketing mix variables, except that brands in the treatment group had twice as much advertising exposure as those in the control group. This is not surprising considering that the treatment group include cereal products of Kellogg's and General Mills, the nation's two biggest RTEC manufacturers and advertisers.

In equation (1), γ is the DD estimate of the average effect of new FOP labels on consumers' RTEC purchases. The key identification assumption is that any difference in the change in means between treatment and control groups is the result of the change of new FOP labels. While we cannot directly test this assumption, we can test whether the time trends in the control and treatment groups are the same in the pre-treatment period. If the trends of RTEC purchases are the same before the launch of new FOP labels, then it is likely that the treatment and control groups would have been the same in the post-treatment period if they remain with their old FOP labeling schemes.

Figure 2 plots RTEC monthly volume sales of the treatment (Kellogg's and General Mills) and control (Post and Quaker Oats) groups between November 2006 and September 2008. As Figure 2 shows, the treatment and comparison groups are following similar trends before the launch of the new FOP systems in October 2007 (vertical dotted line). We formally test that the pre-treatment RTEC purchasing trends for the treatment and control groups are not different, by estimating a model with separate interactions of month dummies and the treatment/control groups (Galiani, Gertler, and Schargrodsky 2005). From test results, we cannot reject the hypothesis that month dummies are the same for both the treatment and control groups before the launch of new FOP labels[3]. It validates the DD identification strategy.

[Insert Figure 2 about here]

Figure 3 displays a histogram of households' average monthly cereal volume purchased in the sample. The distribution shows a heavy right tail and strong skewness. Although a majority of households consume about 10–50 ounces of cereal products per month, the long right tail indicates that some households have a very high level of cereal demand. This pattern indicates that the standard DD approach of the conditional mean regression, though appropriate to model the average treatment effect, may be incomplete for describing the full distributional relationship between consumers' heterogeneous RTEC consumption and the effect of new FOP labels. Therefore we used the quantile DD approach to capture a more comprehensive picture of how the new FOP labeling system affects different households across the whole distribution, which is robust in handling "outliers" and reduces the importance of functional-form assumptions (Meyer, Viscusi and Durbin 1995; Athey and Imbens 2006).

[Insert Figure 3 about here]

Figure 4 depicts the spread of households' monthly RTEC volume purchased estimated at quantiles between the 10^{th} and 90^{th}, from November 2006 to September 2008. From the figure, households in the sample exhibit great heterogeneity in RTEC volume purchases throughout months.

[Insert Figure 4 about here]

Estimation Results

We begin by discussing the estimation results from the standard DD regression specification. We then compare the results with estimates from the quantile DD specification where the treatment effect is allowed to vary over the entire distribution of various dependent variables measuring households' purchase volume and intake nutrients from RTEC products.

Mean Impacts from the Standard DD Estimation

Table 3 presents standard DD estimation results controlled for major demographic characteristics, marketing mix variables, and DMA fixed effects. The dependent variables from Column 1–4 are households' average monthly (1) RTEC products volume purchased, (2) intake of calories, (3) intake of sugar, and (4) intake of sodium from purchased RTEC, respectively.

[Insert Table 3 about here]

The DD estimators ($d_T \times d_G$) are all negative and statistically significant. Thus, Table 3 indicates that, on average, the new FOP labels reduce consumers' volume purchased of Kellogg's/General Mills' products relative to the rivals' brands (column 1). At the same time, consumers' purchases contain fewer calories, and less sugar and sodium (columns 2-4).

The coefficients of price and advertising exposure (GRP) are all significant and have the expected signs for all dependent variables, indicating that consumers respond positively to advertising and negatively to price. We do not find significant impacts from the percentage of promotion on consumer purchase behavior.

Of the sociodemographic variables, household size, households with an annual income of $60,000 and above, and households with children between 7 and 12 years and 13 and 17 years display generally positive effects on various dependent variables that are also statistically significant. Household head's age is positively related to cereal volume purchased, and calorie and sodium consumed from cereals, but not sugar consumed from cereals, suggesting that households with younger household heads have higher incentives to purchase cereals with more sugar. It is interesting that male household heads' with more education (i.e., college degrees and above) tend to buy more RTEC products, and consume more calories and sodium from cereals. A more detailed examination of the impacts on households with different educational attainments is discussed in the following section.

To test the robustness of estimated mean impacts of the new FOP labeling, we include clustered standard errors at the household level and individual fixed effects to benchmark regressions. Clustering by households allows nonzero correlation between the errors for different observations of the same household, i.e., controls for common household-level shocks. By further estimating with individual (household) fixed effects, which is equivalent to difference all variables from their means, all unobserved households' differences between the treatment and control groups are removed. Results show that DD estimates are robust in both circumstances (available upon request).

From Table 3 we see that the availability of new FOP labels on Kellogg's/General Mills' products result in reductions in volume purchased, as well as calories, sugar, and sodium from the purchased products, relative to control brands. Whether the reductions represent dietary improvements depends on whether and how consumers substitute. For instance, consumers might simply eat less of the RTEC category because of the salience of the FOP nutrition information. They might switch from Kellogg's/General Mills' brands that show FOP labels to the rival brands that do not have such labels, either assuming that the brands without FOP labels are healthier or determining that the rivals' brands are healthier after reading the NFPs on these brands. Or they might switch from less healthy brands to the healthier brands produced by Kellogg's and General Mills based on information in the FOP labels. For some consumers, they might also switch from healthier products to less healthy ones if the new FOP labels elicit negative taste perceptions.

To further understand consumers' switching and substitution behaviors induced by the new FOP labels, we divide RTEC products into "good" and "poor" nutritional quality groups based on their Nutrient Profile Index (NPI) scores. The NPI score reflects the food quality assessments and is calculated based on a model developed for the Food Standards Agency (FSA) of UK (Castetbon, Harris, and Schwartz 2011). Different with relying on a single measurement of nutrient (e.g. sugar), NPI scores take into account both positive (e.g. protein, fiber, vitamins) and negative (e.g. sugar, sodium, saturated fat) nutrients in the entire nutrient composition; hence it provides a more comprehensive evaluation of the nutritional quality of food products. Based on NPI scores (Table 1), two categories of nutrient quality are created: (1) NPI-Poor (less than 40 points); and (2) NPI-Good (larger than or equal to 40 points).

[Insert Figure 5 about here]

Four RTEC groups are further categorized based on the nutritional quality and the status of treatment: (1) NPI-Good products in the treatment group; (2) NPI-Poor products in the treatment group; (3) NPI-Good product in the control group; and (4) NPI-Poor products in the control group. Figure 5 gives average proportions of consumers' volume purchases and intakes of calories/sugar/sodium from four RTEC groups before and after the launch of new FOP labels. From all figures, in the post-treatment period, a substitution from NPI-Poor (decreasing proportions) to NPI-Good (increasing proportions) products occurs in both the treatment and control groups, while the switch is more sharply in the treatment group.

Distributional Effects from the Quantile DD Estimation

The standard DD approach describes the mean treatment effect. However, in case the dependent variable has an asymmetric heavy- or long-tailed distribution, quantile regression is more appropriate than the mean regression (Yu, Lu and Stander 2003). From a policy maker's perspective, it is essential to examine whether there are different effects on different sections of the distribution. Given the right-skewed nature of the dependent variable, the standard DD estimation-based conclusion and policy suggestions may overlook specific population sections.

In this section, we conduct quantile DD regressions with respect to a variety of dependent variables, including households' average monthly RTEC volume purchased and intakes of calories/sugar/sodium from purchased RTEC, to explore potential distribution effects of the new FOP labels' implementation. Quantile DD estimates from 20 regressions are reported in Tables 4.

[Insert Table 4 about here]

In particular, Table 4 shows the quantile DD estimation results at the 5^{th}, 25^{th}, 50^{th}, 75^{th}, and 95^{th} percentiles of the distribution of each dependent variable. To judge from the results, households with different levels of cereal demand do respond differently to the new FOP labels. The new FOP labels are still negatively and significantly associated with lower cereal volume purchases (row i), intake of calories (row ii) and sodium (row iv), but only at the quantiles between 0.05 and 0.5 of the distribution. The 0.05-0.5 quantile corresponds to households' consumption of about 3–16 ounces of RTEC products per month, which is roughly equivalent to purchasing up to two cereal packages in a month. In row i column 3 of Table 4, we can see that the treatment effect is the largest at the 0.5 quantile, in which households buy about two packages of cereal products per month. The implementation of new FOP labels, however, have little impact on households that purchase cereal products at a high level or excessively (column 4 and 5 of row i, representing the long right tail shown in Figure 3). Regarding consumers' intake of sugar (row iii), new FOP labels exhibit significant and increasing adverse impacts across the quantiles, indicating a general effectiveness of new FOP labels in helping consumers avoid sugar consumption from RTEC products.

Figure 6 graphically demonstrates the quantile DD effects (solid line) on consumers' RTEC volume purchases with 95% confidence intervals (dotted lines). For comparison purposes, the mean DD effect is plotted as a horizontal dashed line.

[Insert Figure 6 about here]

How Does Education Affect Consumer Response?

Kiesel and Villas-Boas (2010) find that NFP labels prevent consumers from incorporating nutritional information due to high information costs. The new FOP labels may affect consumers through two aspects regarding to reduced information costs: (1) by making nutritional information more accessible, especially to consumers with higher opportunity cost of time (e.g., busy parents with young children); and (2) by making nutritional information easier to understand for consumers with different levels of knowledge and cognitive ability. In terms of the latter, education may play an important role in determining the treatment effect of new FOP labels. In this section, we discuss how individual educational attainments may influence consumers' RTEC preferences and FOP labeling impacts by examining the detailed demographic data in the sample.

Previous studies have found positive relationships between education and nutrition label usage from survey data (Kim, Nayga and Capps 2001; Drichoutis, Lazaridis and Nayga 2005).

This does not necessarily mean that the implementation of new FOP nutritional labels would affect better-educated consumers more and lead to bigger buying behavior changes in real-world settings. To further explore how consumers with different educational attainments respond to the Facts Up Front style FOP label changes, we evaluate treatment effects of different categories: (1) both household heads with high school degrees or below; (2) one of the household heads with a college degree or above; and (3) both household heads with college degrees or above.

Table 5 presents DD estimates for each of the education categories. The specification is similar to the standard DD model described in equation (1). The rows correspond to three education subsamples, and the columns correspond to different dependent variables, including RTEC volume purchased, calories, sugar, and sodium obtained from purchased cereals. Individual fixed effects are included in the estimation, and only DD estimates from regressions of each *Subsample* × *Dependent Variable* combination (15 regressions in total) are displayed. Households in which both heads have high school degrees or below had the strongest response to the new FOP labels compared with other education subsamples; and cereal volume purchased, calories, sugar, sodium, and fiber intake obtained from RTEC products are all affected negatively (see row 1). In contrast, households in which both heads have college or graduate school degrees are not associated with any significant change from new FOP labels (see row 3).

One explanation for the minor effect of FOP labels on households in which both heads have higher educational attainment is that household heads with college degrees or above may have already read and understand the nutritional information contained in NFPs, which have been available on the side or back of food products since 1994[4]. Thus, the new FOP labels do not add any new information for these consumers. In a previous study, Blitstein and Evans (2006) show that only 53% of consumers claim to use NFPs when purchasing food products, whereas more educated individuals are more likely to use NFPs (Kiesel, McCluskey and Villas-Boas 2011). In contrast, new FOP labels could be more informative for shoppers with less education. Our results highlight the fact that the new FOP labeling scheme effectively helps consumers with high school degrees or less understand and process the nutritional information better, and leads to a significant decrease in the intake of calories, sugar, and sodium from RTEC products. The implied reduction in consumer's cost of processing nutritional information may be due to the format used in the new FOP labels, which are considerably easier to access and understand than traditional NFPs.

[Insert Table 5 about here]

Conclusion

In this article, we analyze whether the implementation of Facts Up Front style FOP labels affect consumers' purchase decisions of RTEC products, and whether it leads to choices of more healthy food products. By using a panel of household RTEC purchase data spanning before and after the introduction of the new FOP labels, we are able to estimate the average labeling impacts on consumers' actual purchasing behavior, as well as distributional effects across the population. Using both DD and quantile DD approaches, the new FOP labels show strong negative effects on consumers' RTEC volume purchased, and intake of calories, sugar, and sodium obtained from RTEC products. However, the suppressing impacts mainly work on households that purchase fewer than or equal to two cereal packages per month. Consumers with greater cereal demand are less likely to be influenced by the new labeling scheme. Because the nutrition information has been available on NFPs since 1994, consumers' changes in food choices can be principally attributed to the reduced information costs provided by the new FOP labels. For products containing new FOP labels, consumers are observed to switch more vigorously from products with poor nutritional quality to healthier RTEC products.

We further investigate how individual characteristics may determine FOP impacts and consumers' food choices by taking advantage of the detailed demographic characteristics combined with household scanner data. In general, household size, household head age, and income are positively associated with the consumption of RTEC products. Regarding the labeling effects of different education subsamples, the largest treatment effect is found among households in which both household heads have high school degrees or below. As a result, the new FOP labels are the most successful in helping less-educated consumers interpret nutritional information, make healthier dietary choices, and consume fewer calories and less sugar and sodium from RTEC products.

This empirical large-scale panel study adds market-based evidence to the existing literature on how FOP nutrition labels can reduce information costs, affect purchasing behavior, and promote healthier food choices in real-world settings. It also highlights the possibility that standard conditional mean regressions may overlook effects on certain parts of the distribution, and that a quantile regression can be more appropriate for examining different distribution labeling impacts. Future research on different food categories may be beneficial to explore potentially different consumer responses to FOP nutrition labels, such as food products that contain a larger taste–nutrition trade-off.

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Footnotes:

1. y_{itg} is measured by a number of different variables, e.g., volume purchased, intake of calories, sugar, and sodium from cereal products.

2. Sixteen DMAs are: New York, Philadelphia, Detroit, Boston, Washington DC, Baltimore, Atlanta, Miami, Hartford, Springfield, Chicago, Kansas City, Houston, Los Angeles, San Francisco, and Seattle.

3. The results for “common trends” test are available upon request.

4. NFP lists detailed nutritional information of total calories, calories from fat, total fat, saturated fat, cholesterol, sodium, total carbohydrate, dietary fiber, sugars, protein, etc., in both quantitative amount per serving and percent of the Daily Value (DV) (Kulakow, Baggett and McNeal 1993).

TABLE 1. SUMMARY STATISTICS OF TOP READY-TO-EAT CEREALS

Firm	Brand	Calories (/oz)	Sugar (g/oz)	Saturated Fat (g/oz)	Sodium (mg/oz)	Fiber (g/oz)	Price ($/oz)	Observed Share	Nutrition Profiling Index Score
Kellogg's	Frosted Flakes	103	11	0	129	1	0.144	3.03%	42
Kellogg's	Raisin Bran	90	8	0	162	3	0.128	2.01%	54
Kellogg's	Froot Loops	110	13	1	132	1	0.170	1.29%	39
Kellogg's	Rice Krispies	108	3	0	254	0	0.193	1.17%	41
Kellogg's	Special K Red Berries	103	9	0	199	1	0.204	1.24%	48
Kellogg's	Apple Jacks	109	12	0	124	0	0.173	0.97%	40
Kellogg's	Corn Pops	106	13	0	108	0	0.173	0.84%	33
Kellogg's	Smart Start	102	8	0	154	2	0.176	0.71%	48
General Mills	Cheerios	103	1	0	186	3	0.188	3.48%	58
General Mills	Cinnamon Toast Crunch	121	9	0	196	1	0.162	1.90%	37
General Mills	Lucky Charms	114	11	0	190	1	0.177	1.47%	36
General Mills	Cocoa Puffs	112	13	0	149	1	0.175	0.88%	39
General Mills	Reese's Puffs	121	11	0	187	1	0.178	0.70%	34
Quaker	Cap'n Crunch	113	12	1	209	1	0.148	0.67%	28
Quaker	Life Cinnamon	104	7	0	134	2	0.144	0.72%	53
Quaker	Cap'n Crunch Crunchberries	113	13	1	196	1	0.153	0.64%	28
Quaker	Cap'n Crunch Peanut Butter Crunch	116	9	1	208	1	0.156	0.40%	32
Post	Honey Bunches of Oats	112	6	0	140	2	0.151	3.39%	54
Post	Fruity Pebbles	112	12	1	164	3	0.167	0.70%	26
Post	Cocoa Pebbles	111	12	1	151	3	0.169	0.57%	26

Notes: Based on the Nutrition Profiling Index (NPI) scores, RTEC products of less than 40 points are classified as having poor nutritional quality.

TABLE 2. CHARACTERISTICS OF TREATMENT AND CONTROL GROUPS

	Treatment Group		Control Group	
	Mean	Standard Deviations	Mean	Standard Deviations
Demographic Characteristics				
Average Household Size	3.32	1.22	3.44	1.22
Average Househod Heads' Age	45.22	9.77	44.26	9.31
% of High Income Households ($60,000 and above/year)	55.54	-	55.71	-
% of Hispanic Households	10.13	-	10.67	-
% of Both of Household Heads with College Degrees and Above	42.01	-	42.17	-
% of Presence of Children Under 6	15.89	-	16.93	-
% of Presence of Children 7 to 12	30.13	-	32.98	-
% of Presence of Children 13 to 17	29.15	-	31.80	-
RTEC Product Characteristics				
Average Price Per Ounce ($)	0.17	0.07	0.15	0.06
Averge Monthly Advertising Exposure (GRP)	357.47	136.88	177.30	59.65
% of Products on Promotions	43.31	-	41.84	-

TABLE 3. MEAN OUTCOMES AND IMPACTS

Variable	(1) Volume	(2) Calories	(3) Sugar	(4) Sodium
d_T	0.113	12.393	0.325	5.476
	(0.410)	(45.384)	(3.059)	(63.129)
d_G	8.307***	819.139***	67.283***	1,536.469***
	(0.538)	(54.283)	(4.477)	(81.753)
$d_T \times d_G$	-1.560**	-168.910**	-13.882***	-223.389**
	(0.654)	(69.670)	(5.114)	(98.942)
Price	-27.809***	-2,888.886***	-232.831***	-3,959.738***
	(2.437)	(204.722)	(18.348)	(328.678)
GRP	0.011***	1.208***	0.072***	1.709***
	(0.003)	(0.308)	(0.023)	(0.397)
Promotion	0.622	169.373	50.924	-283.404
	(5.915)	(664.873)	(45.311)	(995.004)
Household Size	0.686***	83.364***	9.725***	115.332***
	(0.148)	(15.483)	(1.269)	(26.454)
Household Head Age	0.041***	3.406**	-0.680***	8.092***
	(0.012)	(1.347)	(0.112)	(2.162)
High Income	0.824***	87.288***	6.739***	139.394***
	(0.315)	(32.446)	(2.474)	(45.666)
Kids Under 6	-0.286	-39.411	-8.740**	-79.737
	(0.418)	(49.629)	(4.044)	(68.803)
Kids 7 to 12	0.788**	98.002**	11.980***	117.123*
	(0.375)	(39.809)	(3.506)	(67.290)
Kids 13 to 17	1.537***	180.969***	25.217***	232.846***
	(0.321)	(42.243)	(3.481)	(63.161)
Male College	0.674**	65.170**	-5.732**	137.785**
	(0.319)	(33.062)	(2.336)	(55.390)
Female College	0.386	41.800	1.534	75.442
	(0.305)	(32.383)	(2.702)	(47.671)
Constant	8.831***	940.945***	88.628***	1,428.818***
	(2.911)	(345.499)	(24.276)	(505.201)
DMA Fixed Effects	Yes	Yes	Yes	Yes
Observations	11,813	11,813	11,813	11,813

Notes: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 4. QUANTILE TREATMENT EFFECTS

Dependent Variable	(1) 5%	(2) 25%	(3) 50%	(4) 75%	(5) 95%
(i) Volume	-0.720***	-0.775**	-1.776***	-1.015	-3.869
	(0.219)	(0.363)	(0.529)	(0.959)	(2.447)
(ii) Calories	-81.692***	-89.422**	-172.428***	-134.997	-429.728
	(18.063)	(40.775)	(60.519)	(108.126)	(352.633)
(iii) Sugar	-2.609*	-4.952*	-13.078**	-16.205*	-45.294*
	(1.435)	(2.829)	(5.307)	(8.417)	(24.267)
(iv) Sodium	-63.327*	-165.363**	-243.643**	-211.427	-403.169
	(37.751)	(66.598)	(97.103)	(143.978)	(368.116)

Notes: Results from quantile DD regressions controlled for major demographic characteristics, marketing mix variables, and DMA fixed effects. Only quantile DD estimates ($d_T \times d_G$) are shown above. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 5. TREATMENT EFFECTS OF HOUSEHOLD HEADS AT DIFFERENT EDUCATIONAL ATTAINMENTS

Subsamples	(1) Volume	(2) Calories	(3) Sugar	(4) Sodium	Observations
(i) Both Household Heads: High School and Below	-5.547***	-608.397***	-46.813***	-855.862***	2,797
	(1.297)	(148.298)	(12.213)	(214.090)	
(ii) One of Household Heads: College and Above	-2.322*	-252.994**	-25.059***	-412.206**	4,028
	(1.228)	(117.294)	(9.078)	(173.702)	
(iii) Both Household Heads: College and Above	-0.223	-56.776	-11.160	-40.996	4,988
	(0.886)	(98.778)	(8.251)	(157.184)	

Notes: Results from DD regressions with individual fixed effects to eliminate any other observed and unobserved household heterogeneity. Only results of the mean DD estimates ($d_T \times d_G$) are shown above. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

FIGURE 1. EXAMPLES OF FRONT-OF-PACKAGE LABELS

Notes: Front packages of Kellogg's Rice Krispies in February 2007 (left) and March 2008 (right).

FIGURE 2. MONTHLY RTEC VOLUME SALES TRENDS OF TREATMENT AND CONTROL GROUPS

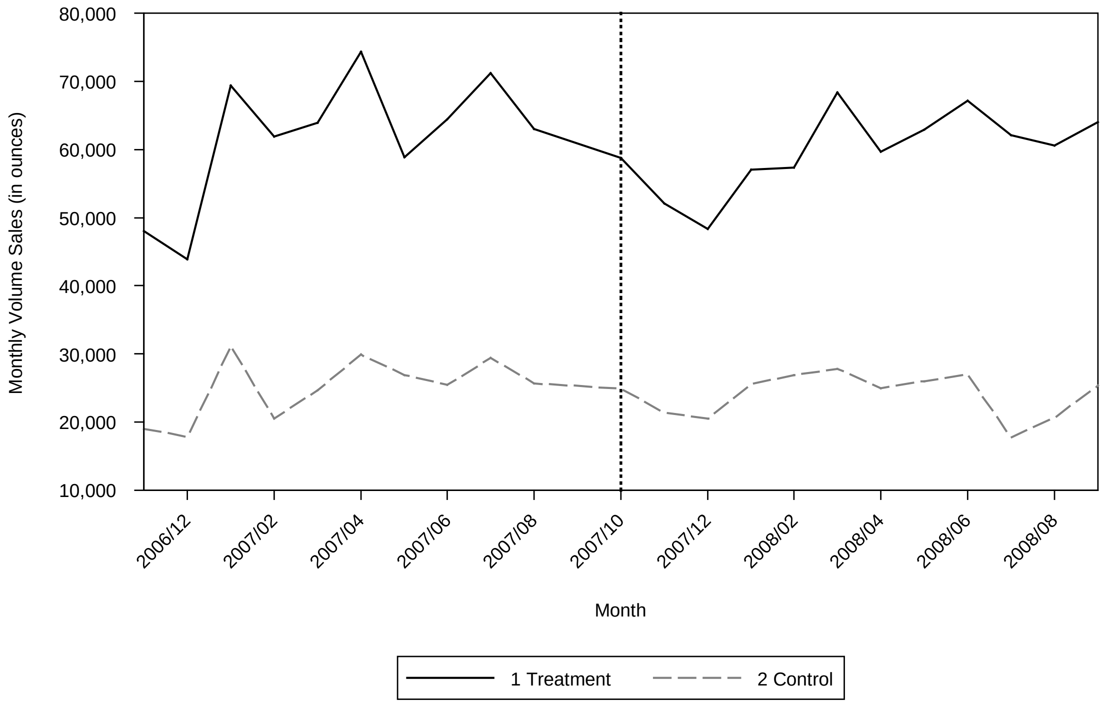


FIGURE 3. HISTOGRAM OF HOUSEHOLDS' AVERAGE MONTHLY RTEC VOLUME PURCHASES

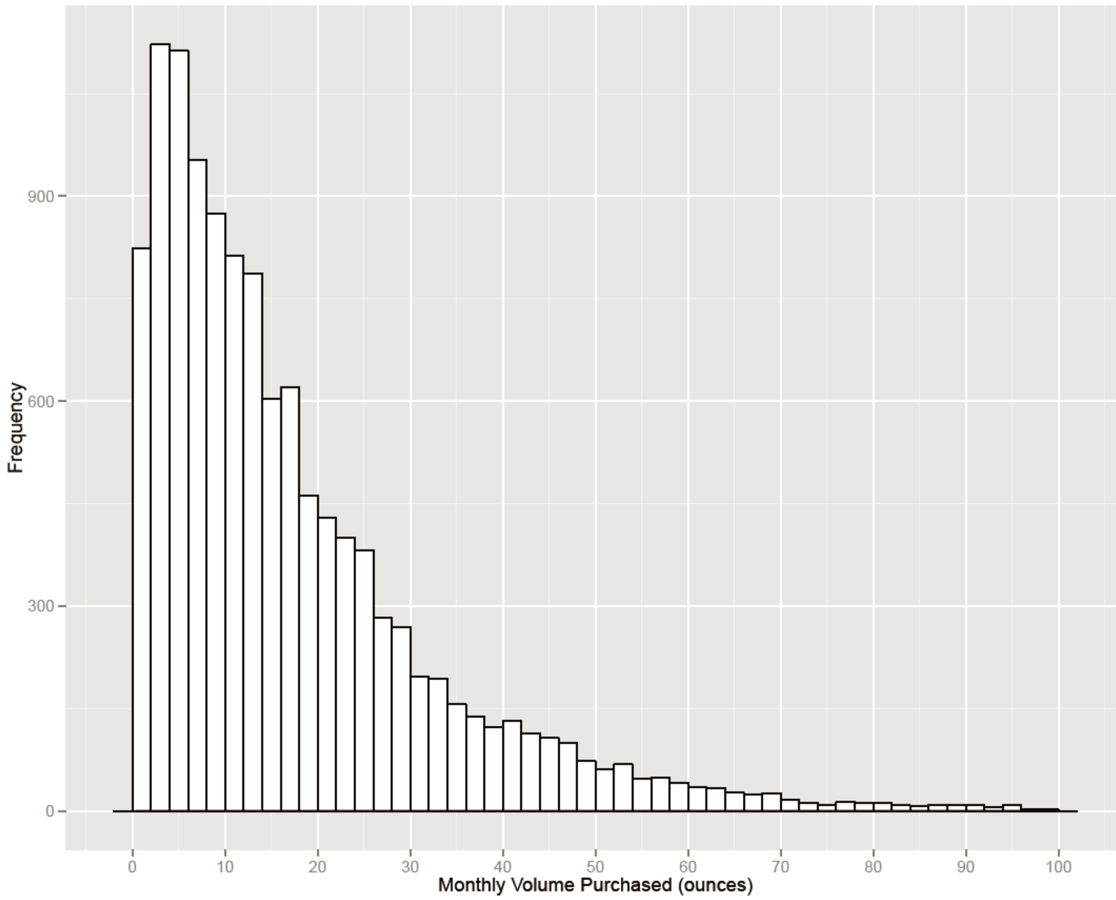


FIGURE 4. QUANTILES OF HOUSEHOLDS' MONTHLY RTEC VOLUME PURCHASES

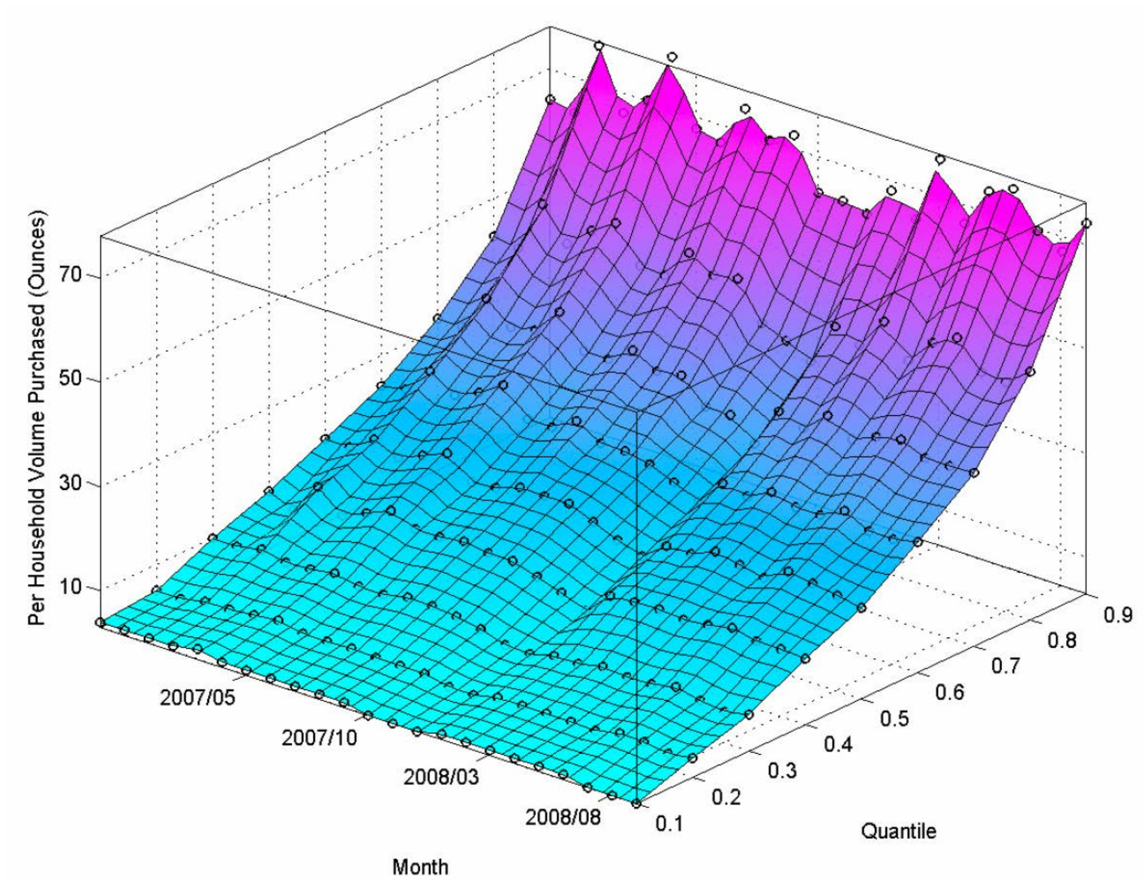


FIGURE 5. AVERAGE PROPORTIONS OF RTEC PURCHASES

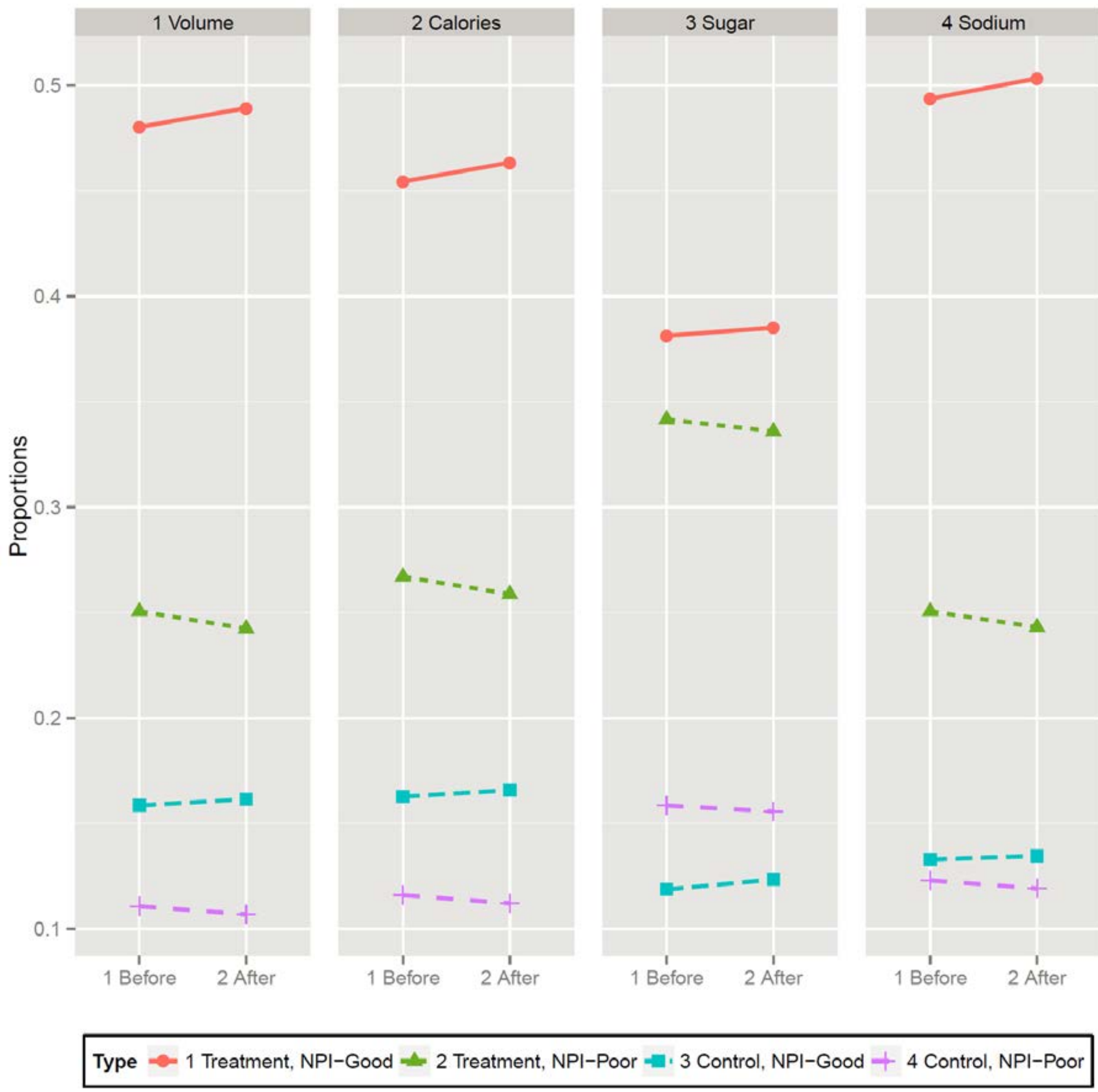
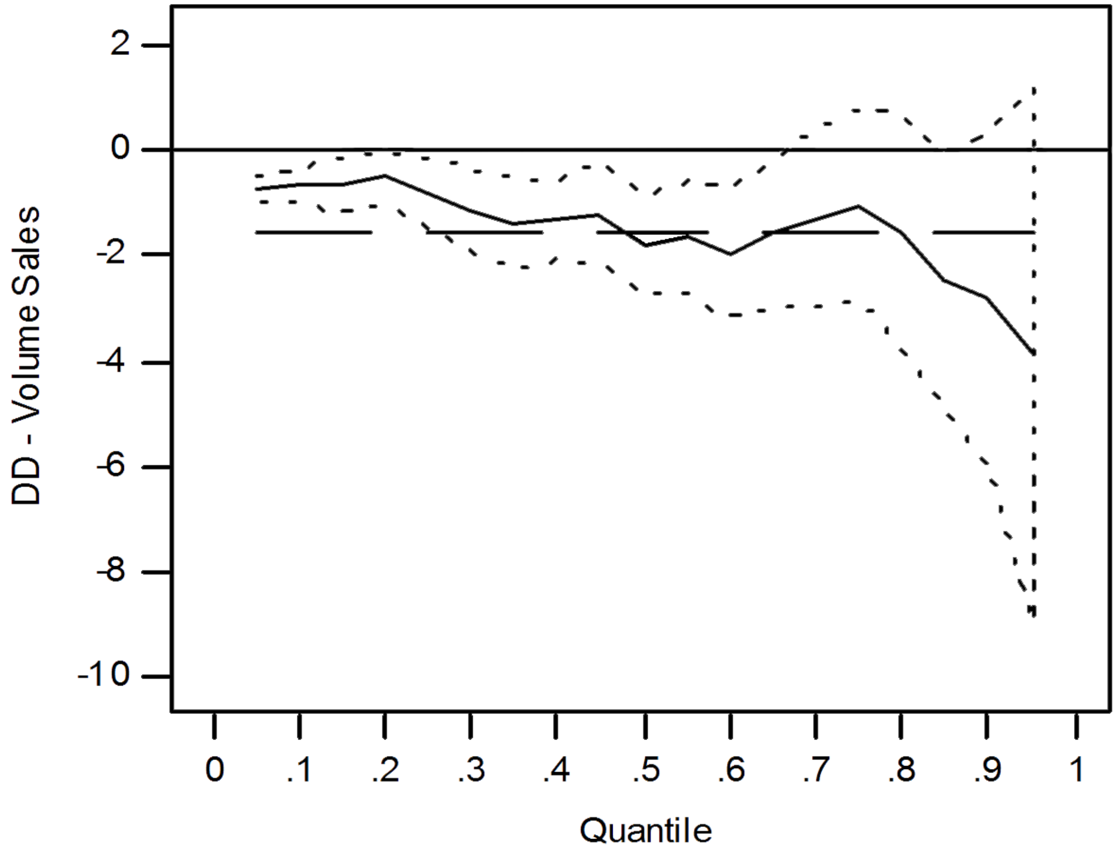


FIGURE 6. QUANTILE DD EFFECTS ON THE DISTRIBUTION OF RTEC VOLUME PURCHASES



Note: solid line is the quantile DD effect on RTEC volume purchased (results reported in Table 4, row i); dotted lines give 95% confidence intervals; dashed line is the mean DD effect (results reported in Table 3, column 1).