November 12, 2015

Can Voluntary Nutrition Labeling Lead to a Healthier Food Market?

Xiaoou Liu
School of Agricultural and Rural Development
Renmin University of China
Beijing, China

Rigoberto A. Lopez
Department of Agricultural and Resource Economics
University of Connecticut,
Storrs, USA

Chen Zhu †
College of Economics and Management
China Agricultural University
Beijing, China

Invited paper prepared for the session "Frontiers in the Economics of Food Labeling," Allied Social Science Association Annual (ASSA) Conference, San Francisco, CA, January 4, 2016.

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† The corresponding author is Chen Zhu, Email: zhuchen@cau.edu.cn. Xiaoou Liu is an associate professor in the School of Agricultural Economics and Rural Development, Renmin University of China in Beijing, China. Rigoberto A. Lopez is head and a professor in the Department of Agricultural and Resource Economics, University of Connecticut in Storrs, CT, USA. Chen Zhu is an assistant professor in the College of Economics and Management, China Agricultural University in Beijing, China. The research is funded by the National Science Foundation of China (71373268), the National Social Science Fund of China (14CJY018), the Chinese Universities Scientific Fund (2015QC010), the Zwick Center for Food and Resource Policy at the University of Connecticut, and the Center for Food and Health Economic Research (C'FHER) at China Agricultural University.

Abstract

This article reviews approaches to voluntary nutrition labeling (VNL), such as front-of-package (FOP) labels, that emerged in the 2001-2014 period to provide simplified nutrition information, thus lowering the search cost for nutritional information. We present a market model to assess consumer and producer responses to changes in information search cost brought about by VNL. We specifically focus on the introduction of VNL in the ready-to-eat cereal (RTEC) market and illustrate trends in labeling and the overall healthfulness of RTEC products. Both the conceptual and empirical evidence suggest that VNL has been instrumental in attaining a healthier RTEC market. Finally, we suggest a research agenda to further theory development and empirical (experimental and big data) research to better comprehend the role of VNL in relation to market healthfulness.

Keywords: nutrition labels; food market; front-of-package labeling; voluntary nutrition labeling.

JEL codes: D12, L66, I19, M30

In the last decade, the food industry voluntarily started to experiment with different front-of-package (FOP) and retail-shelf nutrition labeling schemes. In contrast to its counterpart, the mandatory Nutrition Facts Panel (NFP),[1] voluntary nutrition labels (VNL) have been shown to effectively alter consumers' behavior and choices.[2] Even though many studies are emerging in this area, a fundamental question remains: Can VNL lead to a healthier food market? As the market also includes firms' responses to consumer behavior, insight into firms' behavior in providing VNL is also needed.

A better understanding of the role that voluntary nutrition labeling plays in connecting consumers' food choices, industry strategies, and the overall healthfulness of food markets is important for several reasons. First, nutritional labels are signals of food quality; they have been used to transform credence attributes of food products into search attributes and to solve the ensuing incomplete information problem (Nelson, 1974; Caswell and Mojduszka, 1996). Second, as diet-related chronic diseases become more prevalent, how to effectively use nutritional labels to affect consumers' food choices to trigger socially preferable health outcomes is a major concern of public policy makers. While the mandatory NFP labeling system has been found ineffective

[1] Since 1994, the U.S. government has required manufacturers to print a NFP on the back or side of food packages. The Food and Drug Administration's revision of the NFP emphasizes calories and added sugar content (Cha and Thompson, 2014).

[2] Consumers prefer simpler labels with a summarized key nutrition facts printed conveniently on the front of a package (Williams 2005; Wansink, Sonka, and Hasler 2004; Grunert and Wills 2007), and they are more likely to use information in simplified formats, particularly for calories (Bollinger, Leslie, and Sorensen 2011). Kiesel and Villas-Boas (2013) find that some summarized and simple nutrition labels have a positive impact on sales of microwave popcorn but that the impact diminishes when labels become complicated. Zhu, Lopez and Liu (2016) find FOP labels increase the probability that heterogeneous consumers will choose healthier food products. Zhen and Zheng (2015) show that posting the NuVal score increases sales for products with higher scores.

in terms of consumer behavior or healthfulness of the market, VNL is a product of market forces driven by changes in consumers' attitude towards health as well as firms' responses, potentially leading to a desirable market outcome.[3] Thus, VNL could provide a private market solution to a public health problem.

This article has three goals to address the issues outlined above: (1) it reviews and documents VNL by food manufacturers and retailers in the last decade; (2) it proposes a conceptual analysis to frame questions about the provision of VNLs and their effectiveness; and (3) it provides preliminary empirical evidence on trends in overall healthfulness in the food market using data from the ready-to-eat cereal (RTEC) market. The conceptual analysis and the empirical evidence presented are suggestive but supportive of the fact that VNL can lead to a healthier food market. Our paper also points out gaps in the labeling literature that future research could address.

Evolution of Voluntary Nutrition Labeling

To illustrate, we adopt the RTEC market to show the trends in VNL. The RTEC market provides an excellent case study to illustrate the evolution of VNL for several reasons. First, RTEC is the largest category of breakfast foods in the U.S., with approximately

[3] Many consumers do not understand NFP labels (Rothman et al. 2006; Visschers, Hess and Siegrist 2010). Only 53% of consumers report ever using NFP information, and the usage has been declining (Blitstein and Evans 2006; Todd and Variyam, 2008). In fact, the NFP causes no change in consumers' search behaviors (Balasubramanian and Cole, 2002). Recent evidence even reveals that introduction of the NFP has been counterproductive in terms of promoting healthfulness of food choices—an unintended consequence of the regulation (Moorman, Ferraro, and Huber 2012; Wang, Rojas, and Bauner 2015). An explanation for the ineffectiveness of the NFP is that there is a high information cost when consumers have to process complicated nutrition information (Kiesel, McCluskey, and Villas-Boas 2011; Levy and Fein 1998; Berning, Chouinard, and McCluskey 2008).

$10 billion in sales in 2014 (Strom, 2014). Second, brand entry and exit occur frequently in the RTEC market, affording the reconfiguration of nutritional product characteristics by the firm. Third, none of the national brands has a truly dominant hold on the market, which imposes a considerable informational burden on consumers. Fourth, the industry has been a leader in experimenting with VNL formats in the past decade.

Compared with the mandatory NFP labeling system, the word "voluntary" here means that the nutrition information provided through labeling is determined by the manufacturers and/or retailers in the food industry, not by a regulator.[4] From 2001-2014, the evolution of voluntary labeling systems can be divided into three broad types, discussed below: criteria-based systems, fact-based systems, and evaluative systems (Pereira, 2010; Norton, Rucker and Lamberton, 2015). Figure 1 summarizes the timeline of major labeling events discussed below.

FIGURE 1 AROUND HERE

Criteria-based Labels

The criteria-based nutrition labeling systems categorize food products based on manufacturers' own criteria or guidelines, and qualified products can print certain symbols on the front of the package (FOP). This FOP label usually provides qualitative information only.

[4] Note that VNL systems were introduced in addition to the mandatory NFP; they do not provide new nutritional information not included in the NFP.

The RTEC market began to experiment with criteria-based VNL in 2004, when PepsiCo printed its Smart Spot front-of-package (FOP) label on its packages. General Mills followed by launching the Goodness Corner FOP labeling system, but consumers found it overly complicated. Kraft Foods started to print the Sensible Solution FOP label on food products meeting certain standards in 2005. In August 2009, Smart Choices labels replaced several existing FOP schemes. However, it was soon abandoned, in late 2009, due to its questionable nutritional criteria.

In 2012, Walmart launched the Great For You labeling system for both packaged and fresh food products. The foods that are eligible for this green icon must meet nutrition criteria informed by the latest nutrition science and authoritative guidance of the 2010 Dietary Guidelines for Americans (U.S. Department of Human and Health Services and U.S. Department of Agriculture, 2010). Walmart also invited other leading food manufacturers to adopt these nutrition criteria and its logo.

Fact-based Labels

The fact-based nutrition labeling systems usually restate some of the facts listed on the Nutrition Facts Panel in a more concise manner, which can help consumers quickly find the key nutritional information they need. The nutrients presented often include calories, sugar, sodium, fat and their percent daily value (PVD), but may also include fiber or other micronutrients.

One of the first fact-based FOP label systems was Kellogg's Nutrition at a Glance, introduced in October 2007. Based on the European Guideline Daily Amounts (GDA)

system, Nutrition at a Glance displays the total amount per serving of calories, total fat, sodium, and sugar along with a percentage of the recommended daily amount. The system also highlights additional nutrients, such as fiber, calcium, magnesium, potassium, or vitamins. In the meantime, General Mills adopted the Nutrition Highlights FOP system, which has a similar format. These labeling systems provide at-a-glance information about key nutrients in a standardized format without placing an additional information burden on consumers.

In 2011, the Grocery Manufacturers Association (GMA) and the Food Marketing Institute (FMI) developed the Facts Up Front (formerly known as Nutrition Keys) FOP labeling system. The basic label shows calories per serving and information on three major nutrients to limit in the diet: sugar, saturated fat, and sodium. So far, Facts Up Front is one of the most prevalent voluntary labeling programs, with more than 50 leading manufacturers, retailers and wholesalers participating.

Evaluative Labels

The evaluative nutrition labeling systems provide consumers with an overall evaluation of a product's healthfulness and help consumers quickly choose healthier alternatives based on scores within a specific rating system. In the United States evaluative nutrition labels have been provided by grocery retailers at the point of sale. For example, in 2006 Hannaford Brothers, an east coast supermarket chain, launched the first store-wide nutrition rating system, Guiding Stars. Food products were awarded one (good), two

(better) or three (best) stars based on a proprietary algorithm. The system has expanded to more than 1,400 stores representing several supermarket chains.

Another example is the NuVal nutrition scoring system, launched in 2008, which rates the nutritional content of foods with a numeric score from 1 to 100. In stores of participating retailers, NuVal labels are usually displayed on the shelf tags next to prices rather than on the food package. Since 2010 NuVal has also started to appear in cafeterias and vending machines of participating schools, aiming to help students and their parents make healthier dietary decisions.

Conceptual framework

Although no integrated theory with respect to VNL exists, we suggest a conceptual framework stemming from consumer's search for nutritional information to analyze the health outcome of VNL. In the conceptual framework, consumers respond to VNL by increasing their demand for healthier products, and firms respond by changing their portfolios of healthy products to match consumer desires.

Following Salop and Stiglitz (1977), we consider a market with two kinds of products: one category is healthy brands with nutrition indicator $\bar{h}$ and the other contains not-healthy brands with nutrition indicator $\underline{h}$. Consumers are aware of the existence of the two categories but do not know a priori in which category a product belongs. When health-aware consumers search for products, they incur a cost c for obtaining nutrition information to help them to choose healthier brands. Consumers may have different information costs c because of differing ability to understand and

process information. Consumers who do not search for healthy products but just make purchases randomly incur no information cost. Let $G(c)$ be the cumulative distribution of consumers' information cost.

Consumers who search incur health consequences $\bar{h}$, and for consumers who do not search, health consequences will be $x\bar{h}+(1-x)\underline{h}$. For any consumer, the search is worthwhile if $\bar{h}-c \geq x\bar{h}+(1-x)\underline{h}$. Let $k=(1-x)(\bar{h}-\underline{h})$. If $c \leq k$, the consumer searches; if $c>k$, the consumer does not search. The fraction of consumers who search is

(1) $$y = Prob(c \leq k) = G(k) = G((1-x)(\bar{h}-\underline{h}))$$

We assume that firms are risk-neutral and that there is free-entry into the industry. Firms produce differentiated products with different technologies. We use an average cost function to represent technology. The technology producing $\bar{h}$ and $\underline{h}$ products are U-shaped average cost functions $A_{\bar{h}}(q)$ and $A_{\underline{h}}(q)$. For simplicity, we assume firms are monopolistic competitors, following Silberberg and Suen (2000). Let $\bar{q}$ and $\underline{q}$ be the output levels that minimize $A_{\bar{h}}(q)$ and $A_{\underline{h}}(q)$. The firms producing $\bar{h}$ will sell to consumers who search or who randomly purchase the brand. The firms producing $\underline{h}$ sell to consumers who do not search or who randomly purchase the brand.

In market equilibrium, a fraction y of the consumers are perfectly informed. They make their purchases only of healthy brands. The remaining fraction $1-y$ of consumers who are uninformed purchase randomly selected brands. Let x denote the fraction of healthy brands offered by firms. Because a fraction x of the brands are healthy brands, the uninformed consumers will buy healthy brand with probability x

and unhealthy brand with probability $1-x$. The ratio of purchases made of healthy brands to purchases made of unhealthy brands is

(2) $$\frac{(1-x)(1-y)}{y+x(1-y)}.$$

The ratio of total output served by healthy brands to total output served by unhealthy brand is:

(3) $$\frac{x\bar{q}}{(1-x)\underline{q}}.$$

In equilibrium, the two ratios must be equal:

(4) $$x=\frac{\frac{y}{1-y}}{\frac{\bar{q}}{\underline{q}}-1}.$$

Equations (1) and (4) can be used to solve for equilibrium values of x^* and y^*. This type of equilibrium is shown in Figure 2. The x-axis is the fraction of healthy food; y-axis is the fraction of consumers who search and are informed about the healthfulness attributes of a product in the market. The downward sloping curve SS' is the demand for healthy food. When consumers purchase in a healthier market, fewer consumers choose to search because the gains from searching become smaller. The upward sloping curve RR' represents the supply curve for healthier food. When more consumers decide to search, firms increase the fraction of healthier food they supply in the market. The demand and supply meet at the equilibrium point A.

Now consider the introduction of VNL. Compared with NFP, VNL is characterized by simpler and more accessible labels for consumers and hereby leads to a significant reduction in consumers' search cost c (Zhu, Lopez and Liu, 2016). As $G(c)$ is the

fraction of consumers with search costs less than c, a general decrease of search costs will increase the demand for healthy food (SS') for any given *c*. The new equilibrium occurs at point B in figure 2. Thus, a decrease in search costs increases the fraction of informed consumers as well as the fraction of healthy brands purchased from the supply side. The point is that voluntary nutritional labeling, by conveying nutritional information with a lower search cost, increases both healthiness of consumer product choices and the share of healthy products in the marketplace.

FIGURE 2 AROUND HERE

Preliminary Empirical Evidence

To correlate observed food market healthiness data with the expansion of VNL schemes in the last decade, we present preliminary results that suggest that VNL can lead to a healthier RTEC market. Our preliminary evidence is more suggestive than conclusive, but it does support our claim that VNL has increased the healthfulness of the RTEC market.

We use a unique panel of nutrition information from the Mintel Global New Products Database (GNPD) to show the trend of overall healthfulness in the U.S. RTEC market from 2001-2014.[5] By including all newly launched and available brands, our sample covers 2,149 national and private label cereal brands in this period. Compared with existing studies (Ippolito and Mathios 1990; Wang, Rojas, and Bauner 2015), our

[5] The GNPD database records product reformulations, new product introductions, new product packaging, and new product varieties.

sample shows a more comprehensive trend of the overall nutritional quality of the RTEC market.

TABLE 1 AROUND HERE

Table 1 presents content changes of main nutrients from 2001 to 2014. Although the number of new products doubled during this period, two negative nutrients, sugar and sodium, follow a notably decreasing trend. The median sodium content dropped by 60.2%, from 150.61 to 59.89 milligrams per ounce, and the median sugar content declined by 21.2%, from 8.5 to 6.7 grams per ounce. Meanwhile, the median content of fiber, which is considered a positive nutrient, increased by 18.4%, from 1.74 to 20.6 grams per ounce. Table 1 also reports the Nutrient-Rich Foods Index (NRF), developed by Fulgoni, Keast, and Dewnowski (2009) to evaluate the overall healthfulness of food products.[6]

Figure 3 displays the distribution of NRF (shaded area) and the median NRF scores (big black dots in box plots) of all the newly launched RTEC products each year from 2001-2014. The linear fitted values of median NRF scores are connected by the dashed line. The NRF distribution becomes more concentrated around the median. The dashed line shows an increasing trend of the median NRF score and thereby the improved overall healthfulness of the RTEC market.

FIGURE 3 AROUND HERE

[6] NRF is calculated as the sum of the percent daily values (DV) for dietary fiber minus the DV for sugar, sodium, and saturated fat per 100 kcal RTEC.

Future Research Agenda

While our theoretical framework and empirical evidence are more suggestive than definite, a full framework, theoretical or empirical, is beyond the scope of this paper. Our suggestions to motivate future research are motivated by the need to bridge the gaps between theory and empirics with respect to VNL and emerging research in related fields that may be applicable to food labeling in general. Given the body of literature to date, more research is needed to determine the effects of VNL labeling on consumers' actual shopping behavior (Hersey et al. 2003) as well as on firms' behavior with respect to VNL and product reformulation.

Our theoretical framework and empirical evidence suggest that VNL can result in a healthier food market. The question as to why firms adopt VNL remains elusive. To this end, the literature of firms' voluntarily participation in self-regulated programs provide several plausible models of firms undertaking such behavior, including generating firm-specific public goodwill (Smart 1992; Arora and Gangopadhyay 1995; Esty 1997; Khanna and Damon 1999), adopting stricter self-regulation to avoid potentially more costly government policies (Jochem and Eichhammer, 1999; Nyborg 2000; Roe and Sheldon 2007), or raising the costs of their rivals (Salop and Scheffman, 1983). In the context of search cost theory, an interesting model that generates several untested hypotheses with respect to firm's optimal pricing and profits is the one provided by Branco, Sun, and Villas-Boas (2012).

In the case of VNL, an alternative explanation is that when consumers become more aware of diet-related risks, firms respond by supplying VNL and reformulating

products to meet the changing demand.[7] To test this premise, we explore the role that increases in consumers' concerns towards food and health may have on the healthfulness of the market, using the RTEC industry as an illustration. More specifically, we use the number of media incidences of health-related keywords since January 2001 from LexisNexis News data as a proxy of consumers' concern.[8] The trend in Figure 4 shows a significant increase in the number of publications in the media regarding food and health in last 15 years, thus indicating that consumer concerns about food healthfulness have increased in this time period, during which food manufacturers and retailers introduced and expanded VNL. In addition, we determined that consumer

[7] As more scientific evidence over the past decades reveals solid links between diet and health, the mass communication of this knowledge to consumers has increased their awareness of this issue. Consumers' attitudes toward health are usually captured by consumers' risk aversion over health capital in the utility function (Grossman, 1972). The pioneering work of LaValle (1968) has shown consumers' risk aversion is a driving force of consumers' demand value of information. A recent application connecting the demand for information and consumer preferences for nutrition attributes is the work of Berning, Chouinard, and McCluskey (2008), who conclude that consumers who have stronger preferences for nutrition attributes tend to demand more information.

[8] The difficulty in outlining consumers' concerns about health is to find a valid proxy variable. Mocan and Altindag (2014) use the proportion of correctly answered questions about health risks of certain behaviors via surveys as a proxy. The limitation of this proxy is that it cannot be used to study a long-run and continuous evolution in consumers' health concerns. We adopt the approach by Cawley and Ruhm (2011), using the trend of numbers of media publications. As discussed by Cawley and Ruhm (2011), although many factors may drive the increasing trend in media publications concerning health, the trend of popularity on public platforms can be used as a proxy for the increasing concern of the public and government with health. The media data in this paper is from LexisNexis News data, which is drawn from national and international newspapers, news transcripts from TV and radio, popular and general-interest magazines, economics and trade journals, company financial reports, and the "Public Opinion Online" database produced by the Roper Center for Public Opinion Research at the University of Connecticut. We searched the database using the criteria "calories OR sugar OR healthy food OR nutritional health OR diet health OR food label OR nutritional information."

concerns about food healthiness Granger-cause an increase in healthiness in the RTEC market.[9]

FIGURE 4 AROUND HERE

TABLE 2 AROUND HERE

More recent theory on consumer search for information focuses on consumers' ability to process information to explain why they may ignore complex or over-abundant information. More specifically, this work points to consumers being "bounded rational" (exhibiting limited attention) or "rationally inattentive" (optimally allocating attention) (Manzini and Mariotti 2014; Matjka and McKay 2015), which would suggest that simplified labeling, such as VNL, increases the likelihood of healthy food choices.

In the empirical area, researchers could synthetically use experimental methods, observed (big) data, or surveys to test hypotheses regarding the impact of VNL format on the healthfulness of consumers' choices. In this section, we focus on the first two. Recently there has been a significant increase in the use of experimental economics to investigate consumers' reaction to nutrition labeling formats, which has implications for VNL. Recent work in this area is being conducted at several centers of experimental economics research that have focused on nutrition, including RTI International in North Carolina, Cornell's Lab for Experimental Economics and Decision Research as well as

[9] We use a Granger causality test to illustrate the second fact. The results are in table 2. The F-statistics are significant at the 5% level for lags of 1-4 and confirm that the variable of consumers' health concerns Granger-cause the variable of RETC market healthfulness. In contrast, market healthfulness does not Granger-cause consumers' health concerns given the insignificant F-statistics for all lags of 1-4.

its Center for Behavioral Economics and Child Nutrition Programs, whose aims are not focused exclusively on VNL but that are contributing to the understanding of consumer behavior with respect to food attributes, presentation and labeling contexts.[10] The work in experimental psychology and computational modeling can also contribute to the evaluation and improvement of VNL (e.g., Helfer and Shultz (2014), who show that quantitative, single attribute labeling schemes have greater usability than multi-attribute and binary ones). Comprised of psychologists and public health faculty, the newly created Duke/University of North Carolina/USDA Center for Behavioral Economics and Healthy Food Choice Research aims to conduct field experiments in conjunction with big data analysis to investigate both consumer and industry behavior and impacts of nutrition policies, including VNL.[11]

Another emerging area of interest applicable to empirical work with implications for the effective design of VNL is eye-tracking (documenting consumers' visual attention via cameras or similar equipment), particularly on the effectiveness of capturing consumer attention and comprehension. Further research in this growing field can guide label modification to improve consumers' ability to use nutrition labels and to select healthy foods via evaluation of alternative labeling designs on packages and on retail shelves. A comprehensive review of this research is provided by Graham,

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[10] For example, the work of Liaukonyte, Streletkaya, and Kaiser (2015).

[11] Nutrition labeling, and VNL research in particular, can also benefit from new knowledge being acquired through research in environmental labeling. In this regard, it is also worth mentioning that centers and labs at other universities are conducting important, related work on consumer behavior towards environmental labeling and consumer responses to perceived risks, such as the USDA Center for Behavioral and Experimental Agri-Environmental Policy Research at the University of Delaware.

Orqui and Visschers (2012), and a good example of a recent application to RTEC products is provided by Pennings, Striano, and Oliveiro (2014).

In the non-experimental area, the use of big data (e.g., scanner data) and natural experiments for identification of strategies promises to shed additional light on the effectiveness of VNL and other labeling schemes, particularly their impact on consumers' choices of healthy food. The literature in this area has focused on the consumer side, given the policy interest in influencing consumer choices, but research is also needed to explore incentive schemes and the motivations in the food industry. Europe has a rich history of evaluating and experimenting with VNL and other labeling schemes, albeit focused on consumer response, that could provide some guidance for future research in other countries (e.g., Grunert and Wills 2007; Boztug et al. 2015, on consumers' response to an FOP label in the U.K. using scanner data). It is also worth mentioning Mintel database pictures of labels of most U.S. products at the UPC level, which can be instrumental in both collecting detailed nutrition information (which can be converted into healthfulness metrics), product entry and exit, as well as the incidence of various types of VNL. A recent example is the paper by Zhu, Lopez and Liu (2016), which utilizes 2.8 million observations matched to Mintel data to assess the impact of labels on consumers' healthy food choices.[12]

[12] A barrier to entry into research with customized big data is their cost of scanner data (IRI or Nielsen) or other datasets like Mintel or Nielsen's advertising datasets. Researchers interested in these databases could also consider non-customized datasets such as those available from the Kilts Center for Marketing at the University of Chicago or the IRI Academic Dataset that can be used in conjunction with labeling data, such as Mintel. For a review of the conditions of using non-customized IRI marketing dataset see the paper by Bronnenberg, Kruger, and Mela (2008). For applications of Nielsen databases see Mrrick and Lambert (2013).

In sum, while there has been significant progress on the economics of labeling literature, methods, and data relevant to analyzing the effects of VNL on market healthfulness, the field is wide open for significant contributions on how the private provision of nutritional information can improve consumer choices, market healfulness and what role can government policy play in such an evolving labeling landscape.

Concluding Remarks

This article reviewed the introduction of voluntary nutrition labeling formats in the last decade and examined whether or not these can result in a larger market share for healthier food, using the RTEC industry as a case study. The answer to our main question is that VNL can lead to a healthier food market, at least when driven by consumers' desire for healthier foods coupled with the lower search costs that simplified labeling affords. This private solution to a public health problem has significant implications for the role of government as perhaps further mandatory labeling may not result in the outcome desired. There is a clear goal in the government's devoting to sensitizing consumers about food health concerns (e.g., through nutrition education, public information), and companies appear to take this into account in their profit-maximizing behavior, as well as in their monitoring the thruthfulness of some of the VNL claims to ensure that the informaton being transmitted is accurate.[13]

[13] In this regard, the Food and Drug Administration established a Font-of-Package Labeling Initiative in 2009, issuing warning letters to selected manufacturers whose claims were not consistent with provisions of the Federal Food, Drug and Cosmetic Act that require s labels to be truthful and not misleading.

The ground is fertile for further research to advance the frontier of knowledge in this important area of public health, either using experimental data (including eye-tracking and lab experiments) or big data (including scanner data and labeling-specific data such as Mintel GNDP). Additional work using any of the avenues suggested in this paper would provide further insights into the relationship of voluntary nutrition labeling and market healthfulness while also addressing important public health questions that await further theoretical and empirical analysis

Table 1. Median contents of key nutrients in top RTEC brands, 2001-2014

Year	Observations	NRF (per 100 kcal)	Sugar (g/ounce)	Sodium (mg/ounce)	Fiber (g/ounce)	Calories (per ounce)
2001	101	-0.15	8.50	150.61	1.74	108
2002	82	-0.15	8.57	137.70	1.20	110
2003	112	-0.11	7.80	146.32	1.77	109
2004	153	-0.11	7.32	129.60	1.89	108
2005	143	-0.15	8.55	132.30	1.77	110
2006	183	-0.13	7.94	132.30	1.89	107
2007	152	-0.10	7.09	118.12	2.13	106
2008	136	-0.11	7.09	116.31	1.98	107
2009	128	-0.09	6.64	113.40	2.06	108
2010	166	-0.08	6.45	77.87	2.14	106
2011	159	-0.09	6.47	97.93	2.02	108
2012	164	-0.08	6.27	97.93	2.33	108
2013	224	-0.08	6.25	72.59	2.27	109
2014	246	-0.09	6.70	59.89	2.06	111

Table 2. Results of Granger Tests

No. of lags	F-statistics	p-value	R-squared of the regression
(A) H0: Awareness does not Granger-cause healthfulness improvement			
1	26.96	0.0000	0.1514
2	11.61	0.0000	0.1542
3	5.71	0.0010	0.1495
4	3.28	0.0129	0.1605
5	1.50	0.1936	0.1894
(B) H0: Market healthfulness improvement does not Granger-cause awareness			
1	0.39	0.5338	0.9482
2	0.36	0.7008	0.9590
3	0.67	0.5723	0.9627
4	1.24	0.2959	0.9643
5	0.92	0.4713	0.9642

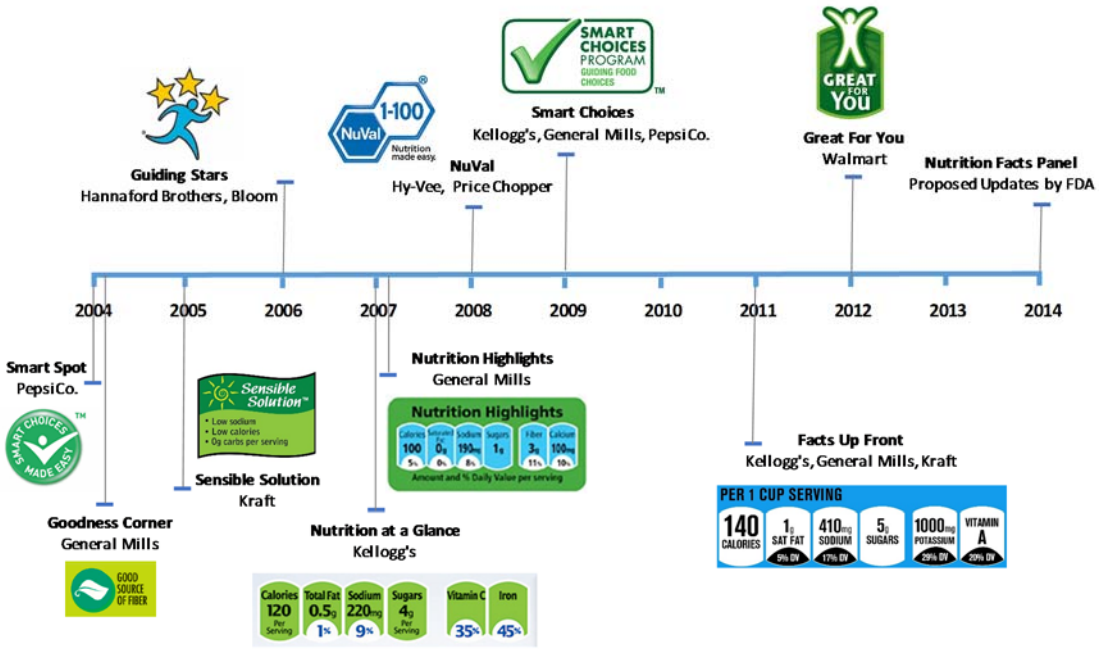

Figure 1. Timeline of major voluntary nutritional labeling systems in RTEC market, 2004-2014

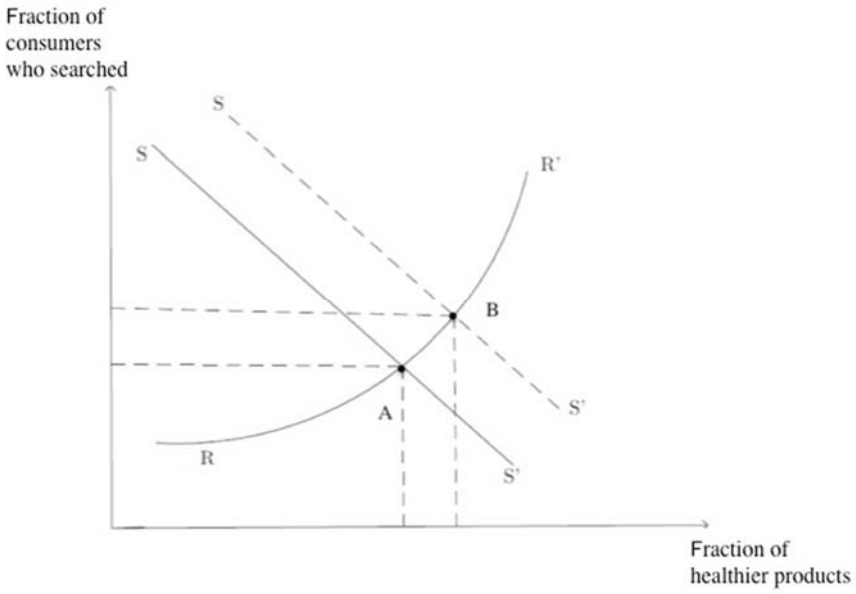

Figure 2. Demand and supply curves for healthy products

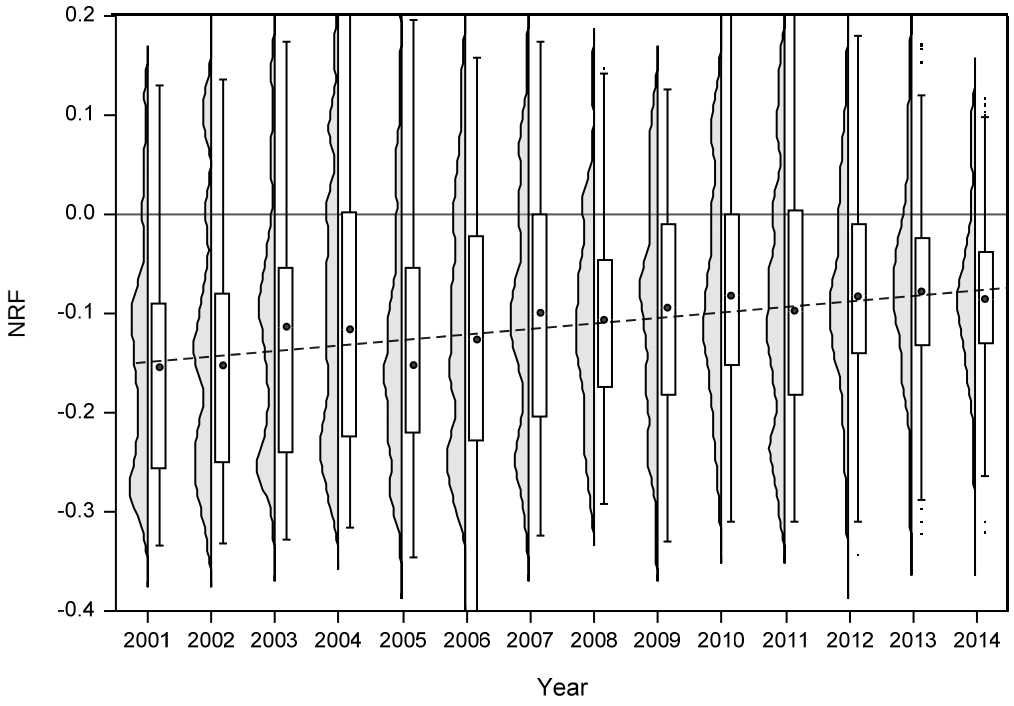

Figure 3. Distribution of Nutrition-Rich Foods (NRF) scores, 2001-2014

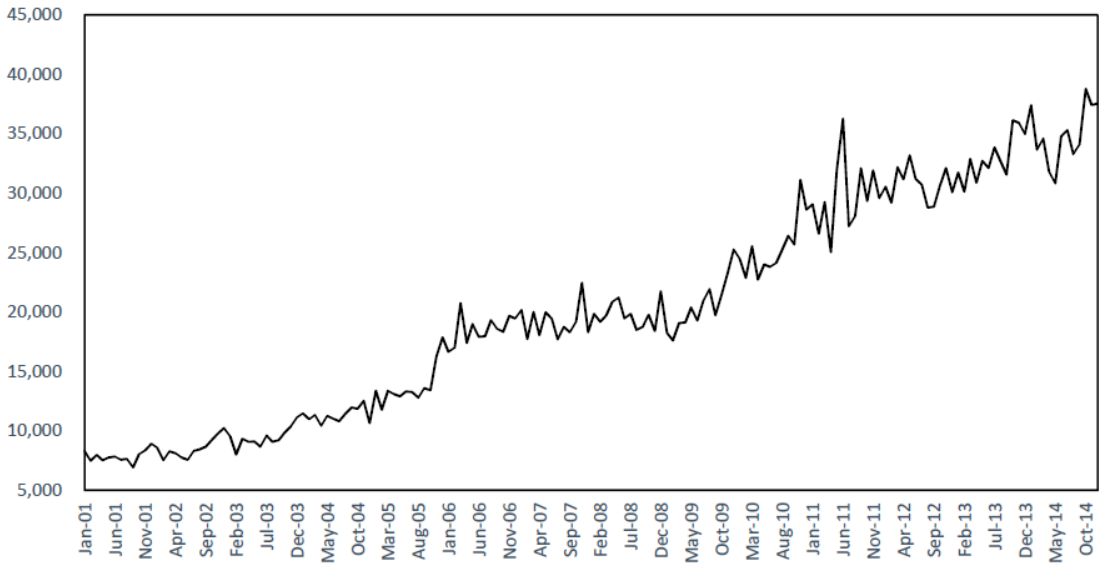

Figure 4. The number of media publications containing health related keywords, 2001-2014

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