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The Effect of Calorie Labels on Caloric Intake and Restaurant Revenue: Evidence from Two Full-Service Restaurants

Brenna Ellison, Jayson L. Lusk, and David Davis

Field experiment data were used to study the effect of numeric calorie labels in two full-service restaurants. Ultimately, both field experiments, despite using different experimental designs, reached the same conclusion: the numeric calorie label had no significant effect on total caloric intake. However, results revealed the addition of a traffic light symbol to the numeric label led to a 67.8-kcal reduction in average calories ordered. Furthermore, results showed restaurant revenue is unlikely to be affected by the addition of calorie labels on menus. The results have implications for restaurant labeling laws that are being considered around the world.

Key Words: caloric intake, numeric vs. symbolic labeling, restaurant revenue, sequential vs. simultaneous design

JEL Classifications: I18, Q18

The United States has experienced a well-documented rise in the rate of obesity. In 1995, all 50 states had obesity prevalence rates of less than 20% among adults. In 2010, however, every state had an obesity prevalence rate of at least 20% with 12 states having a prevalence rate of 30% or higher (Centers for Disease Control and Prevention [CDCP], 2012). Moreover, obesity rates in U.S. children and adolescents have increased over the past 30 years; for children (ages six to 11 years), obesity rates increased from 7% in 1980 to 18% in 2010. Similarly, for adolescents (ages 12–19 years), obesity rates grew from 5% to 18% in the same 30-year period (CDCP, 2013). These changes have sparked concern among medical professionals, insurance providers, and policymakers over the cost of increased weight. Behan et al. (2010) estimated the medical costs of obesity alone were $127 billion in 2009, whereas the entire economic cost of obesity (including employee absenteeism, Workers' Compensation claims, reduced employee productivity, etc.) was estimated at $270 billion per year in the United States.

Given the costs of obesity, policymakers have sought ways to encourage healthier eating. One of the most recent efforts is reflected in the new mandatory calorie labeling policy for chain restaurants included in the 2010 health care bill (Rosenbloom, 2010). This policy was most likely formulated in reaction to the positive link between the increasing proportion of food dollars spent away from home and U.S. obesity rates (Cai et al., 2008). The final labeling guidelines have not been released by the Food and Drug Administration (FDA),

Brenna Ellison is an assistant professor in the Department of Agricultural and Consumer Economics at the University of Illinois at Urbana–Champaign, Urbana, Illinois. Jayson L. Lusk is Regents professor and Willard Sparks Endowed Chair in the Department of Agricultural Economics at Oklahoma State University, Stillwater, Oklahoma. David Davis is a clinical instructor and Ph.D. candidate in the School of Hotel and Restaurant Administration at Oklahoma State University, Stillwater, Oklahoma.

primarily as a result of the challenge of deciding who should be subject to and exempt from the new regulations (Jalonick, 2013). However, under the 2011 proposed rule, restaurants with 20 or more outlets must provide calorie information for all items on all menus and food tags (for food items at a buffet, for example), have full nutrition profiles for all menu items available on site, and provide a statement of the recommended daily caloric intake, 2000 calories/day (FDA, 2011).[1]

The recent growth in menu labeling laws has motivated a stream of research studying the effectiveness of calorie labels on restaurant menus. The topic has been approached in both laboratory and field settings. Laboratory experiments (Harnack et al., 2008; Pang and Hammond, 2013; Roberto et al., 2010) seem to yield some of the larger calorie label effects; however, these studies do not reach the same conclusion on the influence of calorie labels. Harnack et al. (2008) found calorie labels were associated with a 46-calorie increase in calories ordered, whereas Pang and Hammond (2013) and Roberto et al. (2010) found the addition of calorie labels on menus decreased calories ordered by 31 calories and more than 300 calories, respectively; the latter is a magnitude largely incongruent with the calorie labeling literature. Conversely, in the field setting, calorie labels have been examined in worksite cafeterias (Mayer et al., 1987; Milich, Anderson, and Mills, 1976), fast food restaurants (Bollinger, Leslie, and Sorensen, 2011; Downs et al., 2013; Elbel et al., 2009; Finkelstein et al., 2011; Krieger et al., 2013; Wisdom, Downs, and Loewenstein, 2010), and full-service restaurants (Holmes et al., 2013; Pulos and Leng, 2010). Much of the field research has used an event study approach, studying caloric intake before and after a one-time labeling intervention. Despite the commonalities in experimental design and labeling format, results across field studies have also been quite mixed. Some studies conclude the calorie labels fulfill their intended purpose by reducing caloric intake (see Bollinger, Leslie, and Sorensen, 2011; Milich, Anderson, and Mills, 1976; Pulos and Leng, 2010; Wisdom, Downs, and Loewenstein, 2010), whereas others find the label has little to no effect on eating behavior (see Downs et al., 2013; Elbel et al., 2009; Finkelstein et al., 2011;Mayer et al., 1987). Krieger et al. (2013) found mixed results within their own study because calorie labels were effective in coffee and taco chains but ineffective in burger and sandwich chains. The vast majority of studies share one thing in common, however: the magnitude of the calorie effect (in either direction) is relatively small, typically less than 50 calories.

Although most studies have focused on the net effect on calories ordered/consumed, some studies have begun to examine food substitution in the presence of nutrition labels. For instance, Holmes et al. (2013) conclude that although the net effect of calorie labels on calories ordered is insignificant, the labels did lead to significant shifts in preferences between healthy and unhealthy menu items. Bollinger, Leslie, and Sorensen (2011) considered these types of substitution issues in Starbucks and found most calorie reductions occurred in terms of food calories (as opposed to beverage calories). This study is also designed in such a way that total calories can be decomposed into entrée calories, side calories, dessert calories, etc., to more deeply examine the effects of calorie labels on food choice.

This study contributes to the current body of labeling literature by examining 1) alternative experimental designs; 2) alternative labeling formats; and 3) the effects of menu labels on consumers and restaurants. First, consider the traditional one-time labeling intervention. Although this design is likely the most intuitive and easiest to implement, it cannot always account for changes in preferences over time. To address this, one could use an experimental design in which the control and intervention conditions are examined simultaneously. This design is also subject to criticism, because repeat diners may receive a different menu treatment on subsequent visits. This study implements both types of labeling interventions to obtain a more complete picture of the effectiveness of calorie labels in full-service restaurants.

[1] For the proposed rule in full, please refer to: www.gpo.gov/fdsys/pkg/FR-2011-04-06/html/2011-7940.htm.

In terms of menu labeling format, the current literature has narrowly used a numeric calorie label in which the number of calories is listed by each menu item. The predominant use of this label is not surprising given the specifications set by early menu labeling laws (see Center for Science in the Public Interest, 2009, for local/state labeling laws passed and under consideration before the federal legislation). However, it leaves one to question whether this is the best labeling format to influence consumer behavior. Multiple studies in the United Kingdom, Europe, and Australia have compared alternative labeling formats (percent guideline daily amounts, traffic light schemes, healthy choice checkmark, Swedish keyhole, and so on) on grocery store items and found less knowledgeable consumers often have a more difficult time understanding labels that solely display numeric information (Fuenkes et al., 2008; Gorton et al., 2009). However, these studies have revealed using a color-coded system (such as traffic lights) in addition to text is much easier for consumers to comprehend and aids consumers in quickly and accurately identifying healthier products (see Hersey et al. [2013] and Storcksdieck genannt Bonsmann and Wills [2012] for reviews of front-of-package labeling studies). In the U.S. context, Berning, Chouinard, and McCluskey (2008) found some groups of grocery store shoppers may prefer the simplicity of a summary label format (a star rating system) as opposed to a detailed label format revealing information about specific nutrients. Furthermore, Sutherland, Kaley, and Fischer (2010) found the Guiding Stars system increased the sales of those items receiving stars (versus items receiving zero stars).

Interestingly, however, alternative labeling formats have scarcely been examined within the restaurant context.[2] One study by Thorndike et al. (2012) implemented a traffic light labeling system in a hospital cafeteria and found that sales of red light items significantly decreased and sales of green light items significantly increased, particularly in the beverage category. However, this study spent a great deal of effort educating consumers on their food choices, including the use of nutritional pamphlets, an on-site dietician, and semipersuasive signage (i.e., on signage, a red light meant "there is a better option in green or yellow"). Although there is nothing wrong with educating consumers or encouraging healthy choices, it is unlikely restaurants would go to such lengths. Furthermore, having a dietician present may have pressured some consumers to select healthier items than they would have normally if they felt their behavior was being monitored (Harrison and List, 2004; Levitt and List, 2007). Here, we aim to more naturally compare[3] the effectiveness of two labels at reducing caloric intake in full-service restaurants: 1) the traditional numeric calorie label; and 2) a symbolic calorie label that provides a "traffic light" symbol (used to indicate calorie ranges for each menu item) in addition to the number of calories for each item.

Finally, this study adds to the literature because it explores how menu labels affect both consumers and restaurants. If calorie labels work as intended by reducing calories ordered, one might also suspect revenues to decrease; however, the effect on revenue depends on how the composition of the meal purchased changes (Bollinger, Leslie, and Sorensen, 2011) and Holmes et al. (2013) consider how calorie labels influenced meal composition as well. For instance, a diner could reduce calories by no longer ordering a dessert, or calories could be reduced by switching to a lower calorie entrée and keeping the dessert. The former alternative would most definitely reduce restaurant

[2] Some studies have examined the influence of different symbols such as a heart healthy symbol on restaurant menus (see Holmes et al., 2013; Stutts et al., 2011); however, these labeling schemes only denote specific menu items; in other words, the labeling system is not comprehensive across the entire menu selection, which could complicate item comparisons (especially among nonlabeled items) for consumers.

[3] Here, we mean that consumers are simply presented with the nutritional information as is likely to be the case once the labeling legislation is implemented in the United States. Waitstaff did not draw attention to the nutrition labels; however, they were prepared to answer any questions regarding the labels if they arose. Our main purpose was to observe, not influence, food choices when labels were present.

revenue for this particular diner, but the effect of the latter alternative depends on the price of the new lower calorie entrée. If the new entrée is more expensive, the restaurant could actually benefit from the introduction of calorie labels. To date, only Bollinger, Leslie, and Sorensen (2011) have considered how restaurants may be affected financially by menu labels. After calorie labels were instituted, the authors found revenue per transaction decreased (as a result of the reduction in food calories purchased) but transactions per day increased, leaving store revenue per day unchanged. In this study, we examine the effect of calorie labels on revenues in a more traditional restaurant setting. By decomposing the types of calories (for example, entrée calories, dessert calories, drink calories, and so on) ordered by patrons, we can better understand any changes in restaurant revenues.

The overall purpose of this research is to take a broader approach at studying the impacts of menu labels in full-service restaurants. Using data from two field experiments in two different restaurants (each using different experimental designs and labeling formats), we determine the effectiveness of numeric and symbolic calorie labels at reducing caloric intake and examine how restaurants' sales revenues are influenced by the implementation of menu labels.

Field Experiment 1: Effect of One-Time Numeric Calorie Intervention

Our first experiment used an event study approach to investigate the effect of introducing numeric calorie labels in a full-service restaurant on 1) the number of calories ordered per person; and 2) restaurant revenue per person.

Methods

Daily lunch receipts were collected from September through November, 2010, at Restaurant One, a full-service, sit-down restaurant located on the Oklahoma State University campus at Stillwater, Oklahoma. Receipts were collected on weekdays only (with the exception of Monday when the restaurant was closed). Restaurant One serves faculty, staff, students, and off-campus patrons. The restaurant had never previously been used for research purposes, making it unlikely diners would have any expectation of being part of a research study.

Throughout the data collection period, the restaurant offered 32 menu options. The average menu item price was $9.19 with the least and most expensive items priced at $4.00 and $14.00, respectively. The average number of calories per menu item was 387 calories with the lowest and highest calorie options containing 120 and 660 calories, respectively. Caloric contents were obtained using The Food Processor nutrition analysis software.[4] The head chef entered recipes for each menu option to generate the most accurate calorie counts.

In Restaurant One, we used the traditional approach used in prior studies on this issue, a one-time labeling intervention. The original menu contained each item's name with a brief description and item price below the name. For the first six weeks (preintervention period), we collected receipts and examined food choices under the original menu format. Then, in the seventh week, we changed the existing menu by including the calorie counts of each menu item next to the item's name (to see this menu treatment, refer to Figure 1). Calorie labels were in place for the remainder of the experiment (Weeks seven through 14). All item names, descriptions, and prices were held constant over the experiment so the effect of the calorie labels could be isolated. To be clear, we accounted for all calories ordered per person, including calories from additional side items, appetizers, desserts, and/or drinks.

Data were analyzed using linear regressions, where total calories ordered per diner[5] and total restaurant revenue per diner served as dependent variables. The first model specification

[4] More information on this software is available at www.esha.com/foodprosql.

[5] Although it could be argued that total calories ordered is not as precise a measurement as total calories consumed, the two are likely highly correlated. Additionally, total calories ordered is commonly used as a variable of interest in similar labeling studies (Bollinger, Leslie, and Sorensen, 2011; Downs et al., 2013; Downs, Loewenstein, and Wisdom, 2009; Elbel et al., 2009; Finkelstein et al., 2011; Krieger et al., 2013; Pulos and Leng, 2010; Wisdom, Downs, and Loewenstein, 2010).

...the "new kid on the block" from our stone hearth oven...

Pizza "Rita" (350 calories)
fresh mozzarella, basil pesto, fire-roasted tomatoes, and black olives 11

Pizza "Biancoverde" (360 calories)
parmigiano, pecorino and herbed ricotta cheeses
roasted garlic and arugula 11

Pizza "Proscuitto e Funghi" (375 calories)
Dry-cured ham, exotic mushrooms, smoked mozzarella,
grilled onion, roasted garlic and fresh rosemary 12

...hot plates for knife and fork...

President Hargis' Vegetable Stir-Fry (410 calories)
stir-fried garden vegetables seasoned with ginger-plum sauce
cilantro and roasted peanuts served with jasmine rice 10
add stir-fried chicken (180 calories) 13

Orecchiette and Butternut Squash (410 calories)
"little ears" pasta with apple-wood smoked bacon, butternut squash,
sage, red chili flakes, cream and fresh pecorino cheese 11

Rigatoni & Meat Ragù (470 calories)
rigatoni pasta with a "carnivores' delight" of beef, pork and veal in a
fire-roasted tomato sauce seasoned with garlic, onions, pancetta,
red wine, fresh herbs and parmigiano-reggiano cheese 12

Pappardelle and Duck (490 calories)
"broad noodle" pasta with duck breast confit, mushrooms, garlic, onions,
marsala wine, fresh rosemary, cream and parmigiano-reggiano cheese 13

Taylor's Bistro Chicken (440 calories)
grilled marinated chicken breast topped with ginger-apricot chutney
served on a bed of roasted root vegetables and potatoes 12

Gaucho Ribeye Steak (665 calories)
grilled gaucho style and drizzled with chimichurri, served with
roasted Yukon gold potatoes, peppers and Spanish onions 14

...proper, messy finger food with fresh cut potato chips and slaw...

Turkey Meatloaf "Burger" (540 calories)
grilled and served on a homemade scallion roll with avocado
red onion, mixed greens and chipotle mayo 9

Grilled Bistro Panino (580 calories)
sliced house smoked pork loin, artisan salami, provolone, tomato,
arugula and balsamic onion jam on homemade artisan bread 9

...PLEASE COME HELP US CELEBRATE AUTUMN AGAIN SOON...

*Caloric values are estimates—actual values may vary due to individual meal preparation.

Figure 1. Sample Menu Page from Restaurant 1 (with calorie labels)

only considered the effect of the calorie label on total calories ordered and total restaurant revenue, whereas the second model specification also controlled for variables such as day of the week, a daily time trend, and the interaction between the calorie label and daily time trend.

Results

Restaurant One had a total of 2151 patrons during the field experiment: 824 patrons visited the restaurant during the precalorie label phase, whereas the remaining 1327 patrons were exposed to the new menus containing calorie information for each menu item. Table 1 provides descriptive statistics comparing the pre- and postcalorie label groups for the main variables of interest. From the table, it can be seen that the label did not largely change the number of calories ordered per person. The precalorie label group ordered 622.44 calories per diner per meal, on average, whereas the postcalorie label group ordered 627.44 calories/diner/meal, on average. This result reveals the calorie label is associated with an increase, rather than a decrease, in mean calories ordered per person, a result incongruent with the intended purpose of the labeling legislation proposed by the FDA (although the difference is not statistically significant).

Similarly, total restaurant revenue per person also increased after the calorie label was instituted. Under the regular restaurant menu, diners spent $14.12 per person per meal, on average; however, diners exposed to the calorie label increased their expenditures by $0.25 per meal (on average), pushing total restaurant revenue to $14.37 per person per meal. The results from Table 1 are reproduced in the regressions reported in Table 2, where the effect of the calorie label on total calories ordered per person and total restaurant revenue per person are isolated (see model one specifications). Table 2 confirms the marginal changes in total calories and total revenue associated with the introduction of the calorie label were rather trivial, resulting in only a five-calorie and $0.25 increase per person, respectively. Elbel et al. (2009), Finkelstein et al. (2011), Harnack et al. (2008), and Mayer et al. (1987) draw similar conclusions about the (lack of) effectiveness of calorie labels on caloric intake.

Building on model one, the second specifications included indicator variables for day of the week, a daily time trend, and the interaction between the calorie label and daily trend. Under this specification, the calorie label still did not significantly affect calories ordered per diner; however, the daily time trend variable was negatively related to total calories ordered ($p < 0.05$). This means that for each additional day into the field experiment, average total calories ordered per person decreased, on average, 2.52 calories. Although one might expect this decrease to be explained by repeated exposure to the calorie label over time, the interaction between the calorie label and daily trend was insignificant; so too was the linear effect of the label. In short, there is no evidence that the label intervention had any effect on the number of calories ordered per person. One alternative explanation for this effect is that when it becomes colder, warmer items such as soup are more likely to be ordered. Figure 2 offers daily temperature data over the course of the experiment (Mesonet, 2013).

Table 1. Consumption and Revenue Statistics, Restaurant One

Variable	Labeling Intervention	No.	Mean	Standard Deviation	Minimum	25%	50%	75%	Maximum
Total calories	Precalorie label	824	622.44	194.43	120.00	470.00	590.00	750.00	1400.00
per person	Postcalorie label	1327	627.44	206.95	120.00	450.00	595.00	770.00	1470.00
	Pooled	2151	625.52	202.22	120.00	450.00	590.00	760.00	1470.00
Total restaurant	Precalorie label	824	$14.12	$3.45	$5.00	$12.00	$14.00	$16.00	$25.50
revenue	Postcalorie label	1327	$14.37	$3.95	$5.00	$11.50	$14.00	$17.00	$33.00
per person	Pooled	2151	$14.28	$3.77	$5.00	$12.00	$14.00	$16.50	$33.00

Table 2. Linear Regression Estimates for Two Model Specifications, Restaurant One

	Dependent Variable: Total Calories Ordered per Person		Dependent Variable: Total Restaurant Revenue per Person	
Parameter	Model 1	Model 2	Model 1	Model 2
Intercept	622.44**	649.37**	$14.12**	$14.56**
	(6.77)[a]	(16.09)	($0.12)	($0.28)
Menu label[b]	5.01	16.40	$0.25	$1.67**
	(8.84)	(34.43)	($0.16)	($0.64)
Tuesday[c]		–12.45		–$0.26
		(13.17)		($0.24)
Wednesday[c]		3.63		–$0.24
		(14.15)		($0.26)
Thursday[c]		13.32		$0.11
		(12.82)		($0.24)
Daily trend		–2.52*		–$0.03
		(1.09)		($0.02)
Menu label*daily trend		1.42		–$0.02
		(1.40)		($0.03)
Number of observations	2151	2151	2151	2151
F-Statistic	0.31	2.38*	2.29	3.53**

*Denotes 5% significance; ** denotes 1% significance.
[a] Numbers in parentheses are White's heteroscedasticity-consistent standard errors.
[b] Effect of calorie labels present on menus relative to no calorie labels.
[c] Effect of day of the week relative to Friday.

Although the figure reveals there was some variation in the temperature from day to day, the trend line confirms that, in general, temperatures were declining as the experiment progressed. Our sales data further support this explanation because the number of soups ordered steadily increased over the course of the experiment. In this particular restaurant, all soups were relatively low-calorie (the average soup contained 190 calories, whereas the average menu item contained 387 calories), so the switch to this item could help to explain the negative time trend variable. A second possibility could be that student diners have a tighter income constraint (i.e., their meal plan balance dwindles over time) at the end of the semester than at the beginning, which causes them to order less food (and thus fewer calories).

Turning to total restaurant revenue per person, after the introduction of control variables, the presence of a calorie label was associated with an increase in total average revenue by $1.67 per person per meal ($p < 0.01$). Coupling this finding with the fact that the number of calories ordered was unaffected by the label suggests the label caused diners to shift purchases to similar-calorie yet higher-priced menu items.

To examine exactly how ordering behavior changed after the labeling intervention, we decomposed calories ordered into appetizer calories, entrée calories, side item calories, dessert calories, and drink calories for each diner. Table 3 reveals that once the calorie labels were implemented, the most significant changes occurred in the "extras" items: the additional side item, appetizer, and dessert calories ordered per person. Although appetizer calories decreased, this was more than offset by the 34% and 38% increases in side item and dessert calories ordered, respectively. This net increase also helps to explain the net increase in meal expenditures, because the majority of extra calories was derived from items outside of the main entrée and, thus, additional sources of restaurant revenue.

Although the findings may seem somewhat counterintuitive (i.e., calorie labels increased the calories from "extra" items), it is worth

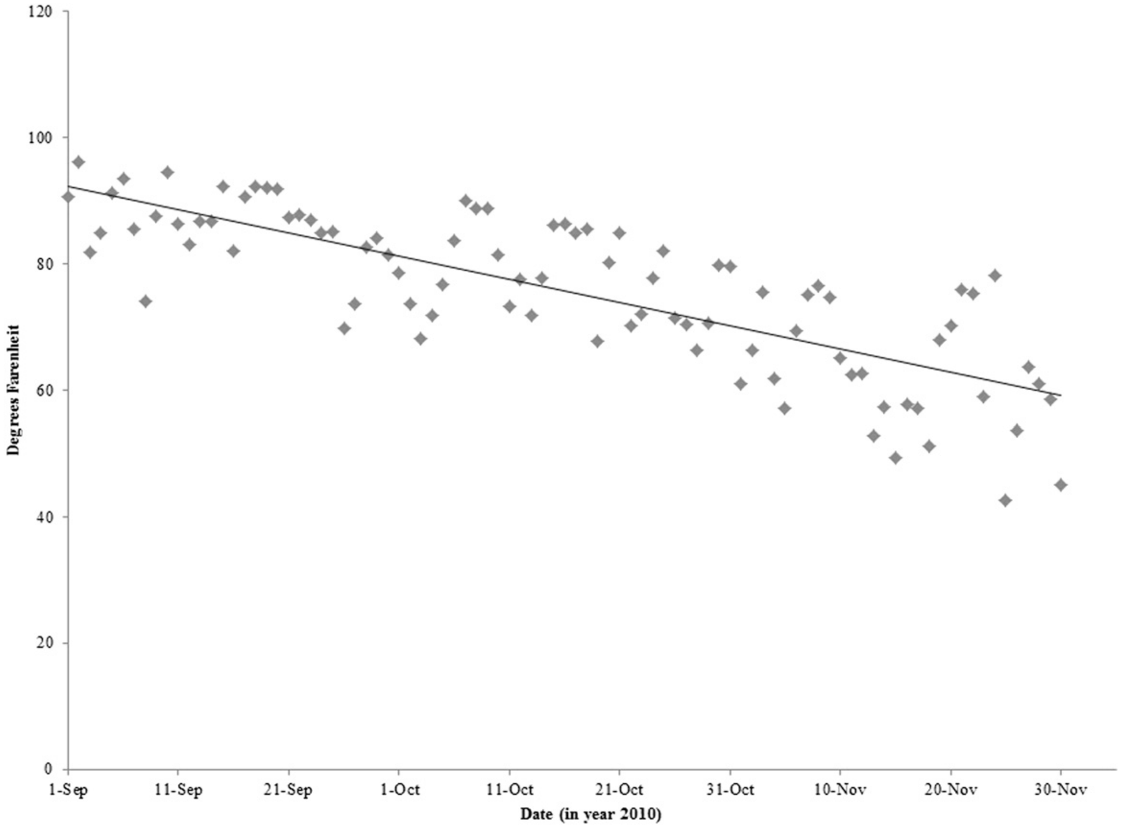

Figure 2. Daily High Temperature in Stillwater, Oklahoma, from September 1 to November 30, 2010

noting Restaurant One promotes relatively healthy eating. According to the restaurant's web site, its goal is to "create well balanced healthy options for guests without losing flavor and nutrients" (Oklahoma State University, 2011). In this case, the information provided may have surprised restaurant patrons in a positive manner (i.e., "I'm eating better than I thought") and led them to reward themselves with an additional side item or dessert (Vermeer et al., 2011; Wilcox et al., 2009).

Field Experiment 2: Effect of Simultaneous Numeric and Symbolic Calorie Label Intervention

In the previous field experiment, a one-time labeling intervention approach was used (standard practice in the labeling literature). However, this experimental approach may have difficulty separately identifying changes in consumer preferences over time. In Restaurant One, the labeling intervention occurred in October, so

Table 3. Calorie Decomposition[a] Relative to the Control Menu, Restaurant One

Menu	Appetizer Calories	Entrée Calories	Side Item Calories	Dessert Calories	Drink Calories	Total Calories
Control	47.92	461.61	30.19	49.88	32.84	622.44
Calorie-only	–12.79**	–7.16	10.25**	18.85**	–4.14	5.00

** Denotes 1% significance.

[a] All caloric values are calculated on a per-person basis.

patrons in the precalorie label treatment may order differently than patrons in the postcalorie label treatment simply resulting from the change in seasons. Regression results support the notion that total calories ordered is affected by more than just menu type, because the daily trend variable was significant at the 5% level. Restaurant Two adjusted for this potential weakness by evaluating all labeling treatments simultaneously.

Restaurant Two also moved beyond the simple numeric calorie label. Although the numeric calorie labels were used in Restaurant One in an effort to mimic previous labeling research and the FDA's proposed menu labeling legislation, it is possible other presentation formats might be more effective, especially considering the finding that numeric labels had little to no effect. Thus, in Restaurant Two, the numeric calorie information was supplemented with a traffic light symbol for each menu item to indicate a specific calorie range. The traffic light symbols should allow diners to process the nutrition information more quickly and easily.

Methods

From August to October 2010, daily lunch receipts (Tuesday through Friday) were collected from Restaurant Two, another full-service, sit-down restaurant in Stillwater, Oklahoma. Restaurant Two is upscale relative to Restaurant One, and it focuses on creating a quality dining atmosphere, which includes offering rich comfort foods and steaks (as opposed to "healthy options"). Similar to Restaurant One, Restaurant Two is located on the Oklahoma State University campus but is frequented by residents without affiliation with the University. Furthermore, Restaurant Two had never previously been used for research purposes.

Restaurant Two offered a total of 51 menu options over the 12-week experiment with a wide range of item prices and caloric contents. The average menu item contained approximately 580 calories with the lowest and highest calorie options containing 50 and 1540 calories, respectively. In terms of pricing, the average item cost $15.88 with the least and most expensive items listing at $3 (cup of soup) and $58 (prime steak), respectively.

Rather than using a one-time labeling intervention, Restaurant Two was divided into three sections, and guests were randomly assigned to one of these sections by the restaurant host. Seating options did differ across the sections, leading a few patrons to request a specific section (for instance, some diners requested to have booth seating, whereas others requested to avoid it); however, we assume a diner's preference for seating is independent of one's reaction to a specific menu treatment (calorie label).

Each of the three restaurant sections was assigned a specific menu treatment.[6] Menu treatments varied by the type and amount of caloric information provided to restaurant patrons. The control menu treatment contained no caloric information, just each item's name, description, and price. The numeric, or calorie-only, menu treatment retained all the control menu information and added the number of calories for each menu item (listed in parentheses before each item's price). The calorie-only menu essentially replicated the postlabeling intervention menu in Restaurant One. In the symbolic, or calorie + traffic light, menu treatment, diners continued to receive information regarding each item's name, description, price, and caloric content. In addition, a green, yellow, or red traffic light symbol was added for each menu item.[7] For examples of the calorie-only and calorie + traffic light treatments, refer to Figures 3 and 4, respectively.

Determining what constituted a green, yellow, or red traffic light was challenging. In the

[6] Although it would have been ideal to rotate the menu treatments across sections, the restaurant hosts and servers changed frequently. Thus, we felt it was better to maintain consistency throughout the experiment insofar as accurately determining which table was in which treatment.

[7] Again, customers were not directed to the calorie labels (numeric or symbolic) by waitstaff. However, waitstaff were trained on how to answer questions should they arise. Additionally, a key was given at the bottom of the calorie + traffic light menu to explain the calorie ranges for each traffic light color (see Figure 3).

United Kingdom, foods are given four traffic lights, each based on a specific nutrient content (fat, saturated fat, sugar, salt) per 100 grams (Food Standards Agency, 2007). In the United States, however, policymakers have been more narrow in terms of menu labeling in restaurants; their primary unit of interest is calories. Second, nutrition information is given on a per-serving basis in the United States, and servings are not always constant across foods. Finally, the purpose of this study was to compare the effectiveness of symbolic and numeric calorie information; if information on specific nutrients was included in the traffic light color definitions, people in the calorie + traffic light menu treatment would be receiving more information than those in the calorie-only treatment (so the effect of the symbol could not be isolated). Thus, traffic lights in this study served as indicators for different calorie ranges; green light items contained 400 calories or less, yellow light items had between 401 and 800 calories, and red light items contained more than 800 calories. Calorie ranges were designed so that 1) each traffic light color would be well represented on the menu; and 2) the ranges would still fit with the daily recommended caloric intake (2000 calories/day). For instance, many red light items on the menu contained far more than 800 calories (some over 1500 calories); thus, when items start to compose 40–75% of the daily recommended intake, these are items diners should probably think twice about. Likewise, people who eat yellow light items are consuming approximately 20–40% of their daily calories. If diners eat in this range across three meals, they will be hovering around the daily recommended intake.

The simultaneous experimental design presented a few challenges. First, it was imperative diners at each table received the same menu and that the entire table received the correct menu treatment. Second, it is possible that repeat customers could use information received from a prior dining experience to make a meal selection on a subsequent dining occasion, even if the information was not present during the subsequent visit. If this occurred, the impact of the labels would wear off over time. This is an issue we controlled for in the data analysis through a daily time trend variable and interactions between each menu treatment and the daily time trend.

Data analysis for Restaurant Two was conducted in virtually the same manner as Restaurant One. Linear regressions were estimated with total calories ordered per diner and total restaurant revenue per diner as dependent variables. Again, two model specifications were used for each dependent variable with the first isolating the effects of the two types of calorie labels on total calories ordered per person and total restaurant revenue per person and the second controlling for variables such as day of the week, a daily time trend, and the interaction between each labeling treatment and the daily time trend.

Results

Over the 12-week field experiment, 946 patrons visited Restaurant Two with 302, 301, and 343 patrons assigned to the no calorie, calorie-only, and calorie + traffic light labeling treatments, respectively. Table 4 shows that diners in the no-calorie label treatment ordered 740.82 calories per person per meal, on average. Conversely, diners assigned to the calorie-only labeling treatment ordered 708.36 calories, on average, which is approximately 32.5 calories less than the control treatment; however, a t test revealed this difference was not significant.

When the traffic light symbol was added to the numeric calorie information, the average diner ordered 673.07 calories, resulting in a statistically significant 67.8-calorie reduction per capita relative to the control. Hence, adding the traffic light symbol to the existing calorie information doubled the effectiveness of the standard numeric label as currently proposed.

Turning to total restaurant revenue per person, Table 4 reveals, on average, Restaurant Two diners spent $12.98 per meal when no nutritional information was present. Adding calorie labels did not significantly affect restaurant revenue per person; however, the labeling treatments produced opposite effects. When the calorie-only label was added to the menu, average total revenue fell by $0.51 per person per meal; however, diners in the calorie + traffic

Comfort

Soup and Salad

STOCK POT seasonal preparation cup (50 calories) 3 bowl (80 calories) 5

Ranchers house with SEASONAL GREENS and preparation half (70 calories) 5 full (90 calories) 6

CAESAR with romaine, grana padano, creamy Caesar, olive oil croutons half (330 calories) 5 full (550 calories) 7

WEDGE with crisp iceberg, bacon, shaved red onion, Roquefort , butter milk ranch half (420 calories) 5.5 full (620 calories) 7.5

Add chicken (250 calories) 4, shrimp (60 calories) 6, 6 oz sirloin (290 calories) 8

Burgers and Sandwiches

SIGNATURE CHEESE BURGER with cheddar, lettuce, shaved red onion (820 calories) 8.5

BACON CHEESE BURGER with apple smoked bacon, shaved red onion, cheddar cheese (920 calories) 8.5

MUSHROOM SWISS BURGER with gruyere cheese, crimini mushrooms (820 calories) 8.5

BLEU CHEESE BACON BURGER with apple smoked bacon, shaved red onions, lettuce (920 calories) 8.5

WEST COAST CHEESE BURGER with colby jack, avocado, apple smoked bacon, lettuce, chipotle mayo (970 calories) 8.5

WEST COAST RANCHER with chicken, colby jack, avocado, apple smoked bacon, lettuce chipotle mayo (590 calories) 9.5

RANCHERS CLUB with sliced Berkshire ham, prime rib, avocado, apple smoked bacon, lettuce and chipotle mayo (760 calories) 9

PRESSED CUBAN with sliced Berkshire ham, chipotle mayo, pickles, bacon, gruyere, cowboy toast (660 calories) 9

PRIME RIB sandwich with caramelized onion, white cheddar, roasted garlic mayo, butter toasted roll (890 calories) 14

CRAB CAKE sandwich with fresh Maine crab, lemon aioli, lettuce, butter toasted roll (350 calories) 10

Combo Meals

PONY EXPRESS with 1/2 sandwich (chicken salad or ham n cheese), soup or salad, drink (370 calories) 7

COWBOY COMBO with petit house salad, sandwich or burger, dessert, drink (sandwich + 370 calories) 13

Prime rib is an additional 5

Homemade Pasta and Rice

Shaved garlic, extra virgin olive oil, SPAGHETTI cherry tomatoes half (340 calories) 6 full (550 calories) 10

Fennel sausage, RIGATONI, greens half (260 calories) 8 full (490 calories) 12

Black pepper, LINGUINI FINI, grana padano, pecorino half (370 calories) 7 full (660 calories) 11

Curried LENTILS with jasmine rice (210 calories) 8

PINCHITOS of farmers market vegetables, mozzarella, and cous cous (280 calories) 8

We proudly serve locally grown produce, meats, and cheeses.

**Caloric values are estimates - actual values may vary due to individual meal preparation.*

Figure 3. Sample Menu Page from Restaurant 2 (calorie-only menu treatment)

Comfort

Soup and Salad

STOCK POT seasonal preparation cup (50 calories) 3 bowl (80 calories) 5

Ranchers house with SEASONAL GREENS and preparation half (70 calories) 5 full (90 calories) 6

CAESAR with romaine, grana padano, creamy Caesar, olive oil croutons half (330 calories) 5 full (550 calories) 7

WEDGE with crisp iceberg, bacon, shaved red onion, Roquefort , butter milk ranch half (420 calories) 5.5 full (620 calories) 7.5

Add chicken (250 calories) 4, shrimp (60 calories) 6, 6 oz sirloin (290 calories) 8

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BLEU CHEESE BACON BURGER with apple smoked bacon, shaved red onions, lettuce (920 calories) 8.5

WEST COAST CHEESE BURGER with colby jack, avocado, apple smoked bacon, lettuce, chipotle mayo (970 calories) 8.5

WEST COAST RANCHER with chicken, colby jack, avocado, apple smoked bacon, lettuce chipotle mayo (590 calories) 9.5

RANCHERS CLUB with sliced Berkshire ham, prime rib, avocado, apple smoked bacon, lettuce and chipotle mayo (760 calories) 9

PRESSED CUBAN with sliced Berkshire ham, chipotle mayo, pickles, bacon, gruyere, cowboy toast (660 calories) 9

PRIME RIB sandwich with caramelized onion, white cheddar, roasted garlic mayo, butter toasted roll (890 calories) 14

CRAB CAKE sandwich with fresh Maine crab, lemon aioli, lettuce, butter toasted roll (350 calories) 10

Combo Meals

PONY EXPRESS with 1/2 sandwich (chicken salad or ham n cheese), soup or salad, drink (370 calories) 7

COWBOY COMBO with petit house salad, sandwich or burger, dessert, drink (sandwich + 370 calories) 13

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Fennel sausage, RIGATONI, greens half (260 calories) 8 full (490 calories) 12

Black pepper, LINGUINI FINI, grana padano, pecorino half (370 calories) 7 full (660 calories) 11

Curried LENTILS with jasmine rice (210 calories) 8

PINCHITOS of farmers market vegetables, mozzarella, and cous cous (280 calories) 8

We proudly serve locally grown produce, meats, and cheeses.

**Caloric values are estimates - actual values may vary due to individual meal preparation.*

Items with 400 calories or less *items with 401-800 calories* *items with over 800 calories*

Figure 4. Sample Menu Page from Restaurant 2 (calorie + traffic light menu treatment)

Table 4. Consumption and Revenue Statistics, Restaurant Two

Variable	Labeling Treatment	No.	Mean	Standard Deviation	Minimum	25%	50%	75%	Maximum
Total calories per person	Calorie + traffic light label	343	673.07	321.82	50.00	370.00	620.00	890.00	1680.00
	Calorie-only label	301	708.36	337.03	103.24	410.00	640.00	920.00	1680.00
	No calorie label	302	740.82	342.26	70.00	450.00	717.50	970.00	1813.00
	Pooled	946	705.93	334.12	50.00	408.24	660.00	920.00	1813.00
Total restaurant revenue per person	Calorie + traffic light label	343	$13.69	$8.27	$3.00	$9.38	$11.75	$15.00	$63.00
	Calorie-only label	301	$12.47	$4.83	$6.25	$9.50	$11.60	$14.00	$49.00
	No calorie label	302	$12.98	$7.06	$5.00	$8.54	$11.50	$14.00	$61.90
	Pooled	946	$13.07	$6.95	$3.00	$9.00	$11.54	$14.00	$63.00

light treatment spent $0.71 more, on average, compared with diners in the control group.

Moving to the regression results in Table 5, the findings from Table 4 are replicated in the model one specifications for total calories ordered per diner and total restaurant revenue per diner. The calorie-only and calorie + traffic light labels reduced total calories ordered per person by 32.5 and 67.8 calories, respectively, yet only the effect of the calorie + traffic light label is statistically different from zero ($p <$ 0.01). The magnitude of the calorie + traffic light reduction is consistent with that found by Ellison, Lusk, and Davis (2013) in a smaller study. Neither of the calorie label treatments significantly impacted total restaurant revenue per person.

The second model specifications included indicator variables for day of the week, a daily time trend, and interactions between each menu labeling treatment and the daily time trend. In the case of total calories ordered per diner, neither menu labeling treatment significantly affected calories ordered, although the magnitude of the effect for the calorie + traffic light was more consistent across the two models than the effect of the calorie-only label. Although the calorie-only label appears to have a greater influence on calories ordered in model two, the interaction between the calorie-only label and the daily time trend is positive and much larger in magnitude than the interaction between the calorie + traffic light label and the daily time trend (however, neither interaction was significantly different from zero). This result suggests the effect of the calorie-only label may be less stable over time than that of the calorie + traffic light label. Furthermore, model two reveals diners eating on Tuesdays ordered approximately 61 fewer calories (on average) than diners eating on Fridays. This could be explained in part by Restaurant Two's close proximity to the University hotel. The restaurant may receive more travelers toward the end of the week, especially Fridays. If these diners are on vacation or visiting for a University event (i.e., football game), they may be less concerned with the "healthfulness" of their food choices.

Joint F-tests reveal both model specifications for total calories ordered per person were statistically significant, so the question is which model is "best?" Because model one is a restricted version of model two, an F-test was used to determine whether the additional parameters included in model two were significantly different from zero (if yes, model two would be preferred). Test results revealed, however, the null hypothesis could not be rejected, meaning the results in model one are preferred.

In terms of total restaurant revenue per capita, the results reveal only the interaction between the calorie-only menu and the daily time trend is significant ($p = 0.05$); however, the joint F-test for the overall model was not statistically different from zero.

The calorie labeling treatments in Restaurant Two were more effective at reducing calories ordered per diner than the labeling treatment implemented in Restaurant One. Although we

Table 5. Linear Regression Estimates for Two Model Specifications, Restaurant Two

	Dependent Variable: Total Calories Ordered per Person		Dependent Variable: Total Restaurant Revenue per Person	
Parameter	Model 1	Model 2	Model 1	Model 2
Intercept	740.82**	839.76**	$12.98**	$12.43**
	(19.66)[a]	(49.43)	($0.41)	($0.87)
Calorie + traffic light label[b]	–67.75**	–70.57	$0.71	$2.03
	(26.22)	(59.08)	($0.60)	($1.12)
Calorie-only label[b]	–32.46	–120.95	–$0.51	$1.03
	(27.62)	(63.01)	($0.49)	($0.91)
Tuesday[c]		–61.57*		–$0.26
		(28.83)		($0.75)
Wednesday[c]		–30.63		–$0.72
		(29.88)		($0.65)
Thursday[c]		–13.92		–$0.58
		(30.95)		($0.65)
Daily Trend		–2.82		$0.04
		(1.52)		($0.02)
Calorie + traffic light label*daily trend		–0.01		–$0.05
		(1.99)		($0.04)
Calorie-only label*daily trend		3.29		–$0.06*
		(2.11)		($0.03)
Number of Observations	946	946	946	946
F-Statistic	3.33*	2.24*	2.53	1.11

* Denotes 5% significance; ** denotes 1% significance.
[a] Numbers in parentheses are White's heteroscedasticity-consistent standard errors.
[b] Effect of calorie + traffic light and calorie-only labels relative to no calorie labels.
[c] Effect of day of the week relative to Friday.

know the net effect of both the calorie-only and calorie + traffic light labels on calories ordered per capita is negative, we do not know where those reductions occurred. Thus, similar to Restaurant One, we decomposed total calories ordered into entrée calories, side item calories, dessert calories, and drink calories for each diner in Table 6.

Interestingly, Restaurant Two experienced much different decomposition results than Restaurant One. Table 6 shows that in both the calorie-only and calorie + traffic light menu treatments, all types of calories ordered per diner decreased relative to the control treatment except for drink calories. Under the calorie-only menu, the largest decreases (approximately 18 calories each) occurred in entrée and dessert calories ordered per person. When looking at the types of entrées ordered in this treatment relative to the control, we found diners were ordering more pasta dishes, vegetarian entrées, and low- to medium-calorie burgers and sandwiches. These increases were accompanied by decreases in high-calorie combination meals and choice steaks. The shift away from choice steaks was surprising Because this category was relatively low-calorie (the average choice steak meal contained 530 calories). However, the shift away from choice steaks does help to explain the decline in average revenue per capita in the calorie-only treatment. The items diners were moving toward were lower cost, on average, than the choice steaks ($8.88 for the average pasta/vegetarian item/lower-calorie burger versus $19 for the average choice steak).

In the calorie + traffic treatment, we also observed the largest decreases in entrée and dessert calories ordered per capita (significant reductions in this particular treatment). Looking at entrée choices in this treatment relative to the control, we found diners ordered more

Table 6. Calorie Decomposition[a] Relative to the Control Menu, Restaurant Two

Menu	Entrée Calories	Side Item Calories	Dessert Calories	Drink Calories	Total Calories
Control	598.44	59.60	70.73	12.05	740.82
Calorie-only	–18.34	–0.13	–17.92	3.93	–32.46
Calorie + traffic light	–45.32*	–4.91	–20.90*	3.38	–67.75**

* Denotes 5% significance; **denotes 1% significance.
[a] All caloric values are calculated on a per-person basis.

salads, low-calorie combination meals, pasta dishes, vegetarian items, and prime steaks. Furthermore, we saw diners shift away from burgers and sandwiches (at all calorie levels) and high-calorie combination meals. With the exception of prime steaks, this treatment experienced diners moving away from higher-calorie, red light items to lower-calorie, yellow and green light items. Based on similar menu item prices, we would have expected most of these shifts in preferences to offset one another; however, we suspect the larger proportion of prime steaks ordered in this treatment drove the average revenue per person up, because the average prime steak cost $44.56.

Discussion

Results from Restaurant Two revealed a similar fate for the calorie-only label as proposed by current legislation: it was relatively ineffective. There was some weak evidence that the calorie-only label might reduce total calories ordered in the very early part of the study, but by the end, there was no difference. The addition of a traffic light symbol appeared overall more effective. At mean values, it was twice as effective as the calorie-only label (32.5 average calorie reduction for the calorie-only label versus 67.8 average reduction for the calorie + traffic light label when the effects of the labels were evaluated in isolation). Neither labeling treatment proved to significantly impact restaurant revenue.

Conclusion

With obesity and other diet-related diseases on the rise, U.S. policymakers are focused on designing legislation to help Americans help themselves at making "healthier" (generally interpreted as lower-calorie) food choices. To improve food choices away from home, the FDA has proposed chain restaurants will be required to provide calorie information for all menu items on all menus and menu boards along with a statement of the daily recommended caloric intake. Additional nutrition information (fat, sodium, sugar, etc.) on menu items must also be available on site (FDA, 2011).

The increased attention on menu labeling laws has generated a large stream of research regarding the potential (and actual, in some cases) effectiveness of these labels. Unfortunately, many studies suffer from some common weaknesses in experimental design; furthermore, the majority of current literature has solely focused on the numeric calorie label as proposed by the FDA. In this study, these issues are addressed by conducting two separate field experiments in full-service restaurants using different experimental designs and multiple labeling formats. We chose to study the standard numeric calorie label used in much of the current literature as well as traffic light calorie labeling, which has been far less common. Thorndike et al. (2012 also implemented a traffic light labeling scheme; however, it is less transparent to the end consumer because each product's traffic light is determined by multiple nutritional factors. This study also adds to the literature by examining how the labels affect parties beyond the consumer; namely, how labels influence total restaurant revenue (to date, only Bollinger, Leslie, and Sorensen, [2011] have considered the financial impact of calorie labels on restaurants).

Results revealed, regardless of the experimental design used, the numeric calorie label (as currently proposed by the FDA) was relatively ineffective at reducing calories ordered (averaged a five-calorie increase per person in Restaurant One and a 32.5-calorie decrease per person in Restaurant Two, neither of which was significant). This result is consistent with the findings of Downs et al. (2013), Elbel et al. (2009), Finkelstein et al. (2011), Harnack et al. (2008), and Mayer et al. (1987). If helping Americans curb their daily caloric intake is the goal of policymakers, their efforts may be more successful if some type of symbolic label is used in conjunction with the number of calories (adding a traffic light symbol resulted in a 67.8 average calorie reduction per person in Restaurant Two). Second, this research revealed that calorie labels minimally affect restaurant revenue.

In light of these results, one is left to question: Is a 67.8-calorie reduction large? As a one-time reduction, probably not. If the reduction persists over time, however, it is possible using the labels could translate into losing a few pounds a year. Unfortunately, no studies have examined the effects of these labels in the longer term, so it is difficult to conclude how to view a reduction of this magnitude.

A final interesting result in this study was how meal composition changed in the face of calorie labeling. Prior research has shown calorie labels led consumers to reduce their food, as opposed to beverage, calories (Bollinger, Leslie, and Sorensen, 2011) as well as shift away from combo meals and toward a la carte items instead (Holmes et al., 2013). In this study in Restaurant One, the addition of calorie labels was associated with significant increases in dessert and side item calories per person, changes that would seem to positively influence restaurant revenue but not necessarily consumer health outcomes. Conversely, in Restaurant Two, diners in both calorie label conditions exhibited the largest decreases in entrée and dessert calories ordered per person, a result that may be more ideal from a public health standpoint but less favorable from a restaurant owner's point of view. This difference may be explained by the dissimilarity in the two restaurant menus. Restaurant One positioned itself to be a healthier restaurant; thus, when consumers learned just how healthy (low-calorie) the menu items were, some felt obliged to go ahead and order an additional side item or dessert, an unintended consequence of menu labeling for certain. When consumers received calorie information for Restaurant Two's rich comfort foods, on the other hand, many decided to skip dessert and/or switch to a lower-calorie menu option, a result more compatible with policymakers' intent. The question then becomes: which effect will dominate?

Although this study contributes to the labeling literature in a number of ways, there are some limitations. One issue in this study—an issue in virtually every labeling study—is generalizability. Although these experiments were only conducted in one location, the results can broaden the generalizability of results found in other U.S. studies (that numeric calorie labels have little effect on food choices) because we found the same result but in a nonmetropolitan geographic area. Additionally, our labeling results align with those in non-U.S. settings in that we also found a symbolic nutritional label (particularly, one using a color-coded scheme) is more influential on food choices than numeric nutritional information alone.

Another potential weakness is this study did not account for table size/group ordering effects. Ariely and Levav (2000) and Quester and Steyer (2010) have both found individuals' choices are influenced by their peers, and Wansink (2004) discusses that individuals seated with larger parties are likely to consume more food than those diners eating alone. However, we leave this issue to future research.

A final limitation of the present study is it cannot account for a number of reactions to a mandatory labeling policy. In the case of diners, their food choices are unknown beyond the restaurant; maybe an individual ordering a large lunch adjusts by having a smaller evening meal. Additionally, we cannot foresee individuals' food behaviors long term (i.e., as consumers become more educated on foods, will they make healthier choices?). Restaurants could also react to these policies by reformulating some of their menu items to contain fewer calories (see Unnevehr and Jagmanaite, 2008, for industry response to trans fat policies). Finally, policymakers would likely react to the implementation of calorie labels by promoting large-scale educational campaigns. Although these campaigns could influence food choices, no such attempts were made in the present study. Nevertheless, educational campaigns have been made in some locations (King County, 2010), yet Finkelstein et al. (2011) found food choices did not significantly change before or after label implementation. This suggests, at least in one location, educational campaigns had minimal effect on ordering behavior. Ultimately, these reactionary effects are more "general equilibrium" effects that go beyond the pure labeling effect this study seeks to identify.

One question this study did not address is why traffic light symbols might be more effective than simple numeric statements at reducing caloric intake. It could be the symbols are more easily and quickly interpreted by diners (i.e., the cost of information acquisition might be lower for symbolic labels). A different interpretation, however, is the labels go beyond information provision and send a normative statement about what the consumer should order. A red traffic light, after all, is synonymous with "STOP." Although many people are relatively comfortable with the federal government taking on the role of providing unbiased information to facilitate market transactions, at least some subset of the population is likely to be less enthusiastic about policies that are viewed as paternalistic. Moreover, determination of cutoffs for traffic light labels is likely to be open to political manipulation by interested parties who do not want to find themselves on the wrong side of yellow. We leave to future research some of the challenges associated with traffic light labeling.

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