The price of one sweet calorie

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Abstract

Objectives. We introduce a new method to calculate the price of different food categories that adjusts for changes in calories consumed over time.

Methods. Combining data on household expenditures share as well as calories consumed, we calculate *per calorie food prices* as household expenditures on food divided by calories consumed.

Results. We show from basic economic theory of supply and demand that changes in per calorie food prices explain the increased popularity of dining out, while changes in food prices cannot. In addition, we analyze the impact of changes in per calorie price of high- versus low-nutrient-dense food on the average body-mass-index. We find that changes in per calorie food prices account for a greater fraction of changes in body-mass index compared with standard food prices.

Conclusions. We recommend that researchers and policy-makers use per calorie food prices to assess the effectiveness of tax policies aimed at reversing the trends in obesity.

Key words: Calories, food prices, obesity, body weight, body mass index

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1 Introduction

In the last thirty years, Americans changed their eating habits in three dramatic ways. First, they consume on average five hundred more calories every day. Second, they dine out more frequently, while portions at restaurants increased (Young and Nestle, 2002 and Ledikwe et al., 2005). Finally, people altered the type of food they eat. Total daily calorie intake coming from food with low-nutrient density increased by thirty-seven percent, while consumption of food with high-nutrient density stayed roughly constant (Putnam et al., 2002 and Patterson et al., 1990). These changes in eating habits, coupled with a decline in physical activity, had dramatic effects on people's weight and the fraction of obese adults in the United States (Lakdawalla et al., 2005 and Cutler et al., 2003); Americans gained on average twenty-two pounds and the obesity prevalence more than doubled, from fifteen percent in 1977 to more than thirty-five percent in 2005.

The growing obesity epidemic has negative consequences at the individual and societal level. First, a growing consensus has emerged in the medical field that being obese or overweight increases the risk of many diseases and health conditions, including coronary heart disease, stroke, type-II diabetes, hypertension, high levels of triglycerides, etc. These diseases and conditions can significantly decrease the quality of life and lead to premature death. Second, economists have pointed out the presence of economic externalities and market failures associated with the obesity problem (Schroeter et al., 2008). Examples of externalities and market failures include the increased cost of medical programs such as Medicare or Medicaid and possible asymmetry of information about the true food calorie content. In addition, some researchers have argued that consumers make suboptimal decisions when it comes to food because their preferences are time-inconsistent (O'Donoghue and Rabin, 1999).

The presence of market failures warrants government policy intervention, such as taxes and subsidies on different types of food, aimed at improving people's food decisions. The effectiveness of tax policies for mitigating the obesity problem, however, critically depends on food-price elasticity, which measures the percentage change in food consumption in response to a one percent increase in food prices.

In this paper, we introduce a new method to measure food prices that adjusts for changes in calories consumed over time. Using household expenditures share data for different food categories, we calculate the *price per calorie* as household expenditures on food divided by calories consumed. Our research is related to Drewnowski et al. (2005) who study the energy cost of adults' diets in France in 1989. There are important differences between our work and theirs, however. First, we measure food prices in terms of dollars per calories consumed, while Drewnowski et al. use euros per joules. Second, we look at changes in per calorie food prices over time from 1977 to 1996, while their measure is only for one year. Finally, we consider changes in per calorie food prices for broadly defined food categories, while their basket includes prices for fifty-seven food items.

We illustrate the impact of changes in per calorie food prices on people's eating decisions and food-price elasticity with two examples. First, we look at the increased popularity of dining out. We find that changes in the relative price of food away from home critically depend on whether one adjusts for changes in calories or not. Food away from home has become cheaper compared with food at home on a per calorie basis, but more expensive when one does not adjust for changes in calorie. Using basic economic theory of supply and demand, we conclude that changes in per calorie food prices can potentially explain the recent increase in calories consumed away from home, while simple food prices cannot.

Second, we analyze the impact of changes in per calorie price of high- versus low-nutrient-dense food on the average body-mass index (BMI). Estimates from existing empirical papers suggest that the quantitative impact of food prices on people's eating habits and weight is small (Chou et al., 2004 and Gelbach et al., 2007). We find that changes in per calorie food prices account for a much greater fraction of changes on BMI compared with changes in simple food prices.

2 Methods and Results

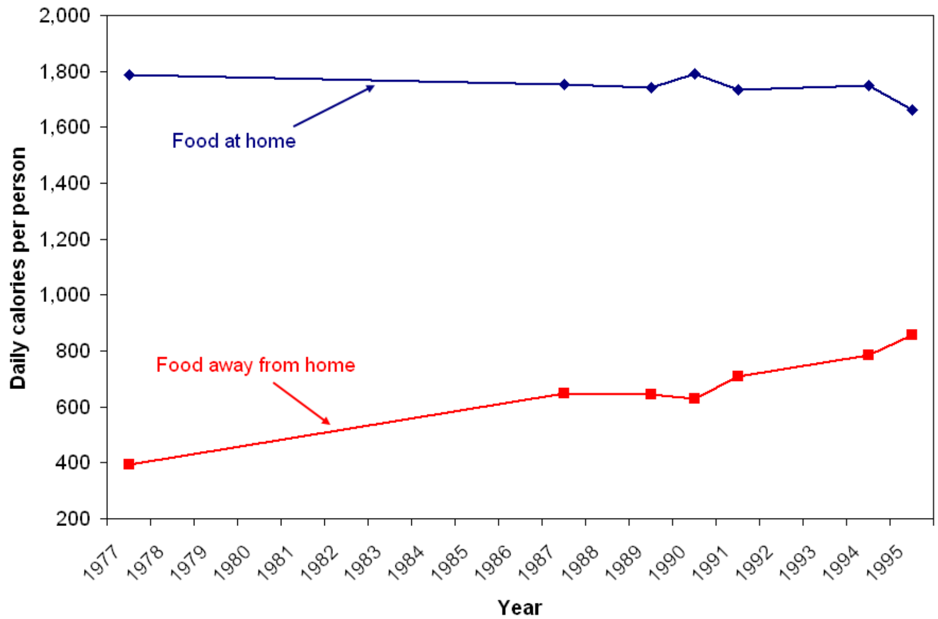
2.1 Adjusting for Portion Size

The increase in calories consumed away from home and larger portions at restaurants are often blamed for the weight gain of Americans. Between 1977 and 1995, calories from food away from home increased from eighteen to thirty-three percent of total daily calories consumed (Guthrie, et al., 2002). Moreover, food portions are larger today than they were in the past. According to Young and Nestle (2002), "in the mid-1950s, McDonald's offered only one size of french fries; that size is now considered small and is one third the weight of the largest size available in 2001" (p.248).

In Figure 1, we present changes in daily calories consumed away and at home between 1977 and 1955. Food away from home includes full and limited service meals and snacks, food at employee sites and schools, food from vending machines and mobile vendors, and other food away from home. Food at home includes all the food prepared at home. We use calorie shares from Lin et al. (1999) as well as data on total daily calories from the US Department of Agriculture to calculate changes over time in total calories consumed at and away from home. Calories away from (at) home are equal to total daily calories times the fraction of calories consumed away from (at) home. Between 1977 and 1995, calories away from home increased by hundred and eighteen percent, while calories consumed at home slightly decreased by seven percent.

In Figure 2, we present changes in the relative price of food at home and away from home between 1977 and 1995. We consider two measures for changes in the relative price. The first one uses data from the Bureau of Labor Statistics (BLS) and does not adjust for changes in calories consumed over time. The second one uses data on household expenditure shares published in the BLS yearly bulletins. For each year between 1977 and 1995, the per calorie price of food away from home, $p_{A,t}$, and food at home, $p_{H,t}$, are

Figure 1: Daily Calorie Intake for Food at Home and Food Away from Home



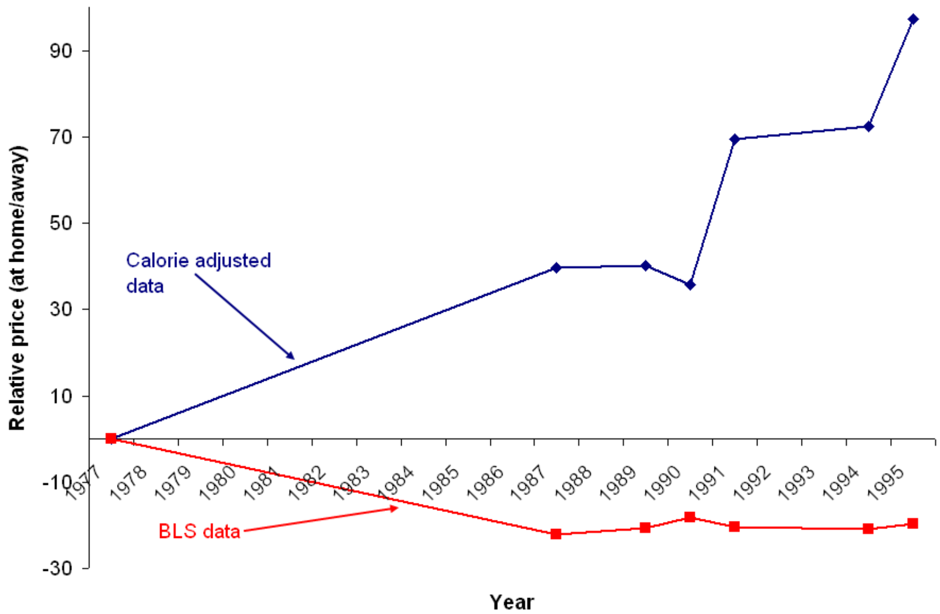
equal to:

$$p_{A,t} = \frac{\alpha_{A,t} I_t}{\text{Calories}_{A,t}}, \quad p_{H,t} = \frac{\alpha_{H,t} I_t}{\text{Calories}_{H,t}} \tag{1}$$

where $\alpha_{A,t}$ and $\alpha_{H,t}$ denote the expenditure share on food away and at home, respectively, and I_t represents real income in period t. The relative price of food at home versus food away from home is defined as $\frac{p_{H,t}}{p_{A,t}}$.

Looking at changes in food prices that are not adjusted for changes in calories consumed, we find that food away from home has become more expensive relative to food at home (see Figure 2). Using basic economic theory of supply and demand alone, we cannot reconcile changes in people's habits (calories consumed away from home doubled) and changes in relative food prices (food away from home became twenty percent more expensive). On the other hand, looking at changes in food prices that are adjusted for changes in calories consumed, the per calorie price of food away from home has become ninety percent cheaper compared to food at home (see Figure 2). We conclude that changes in per calorie food prices can potentially explain the recent increase in calories consumed away from home, while simple food prices cannot. The main reason why food

Figure 2: Percentage Change in Relative Price Over Time



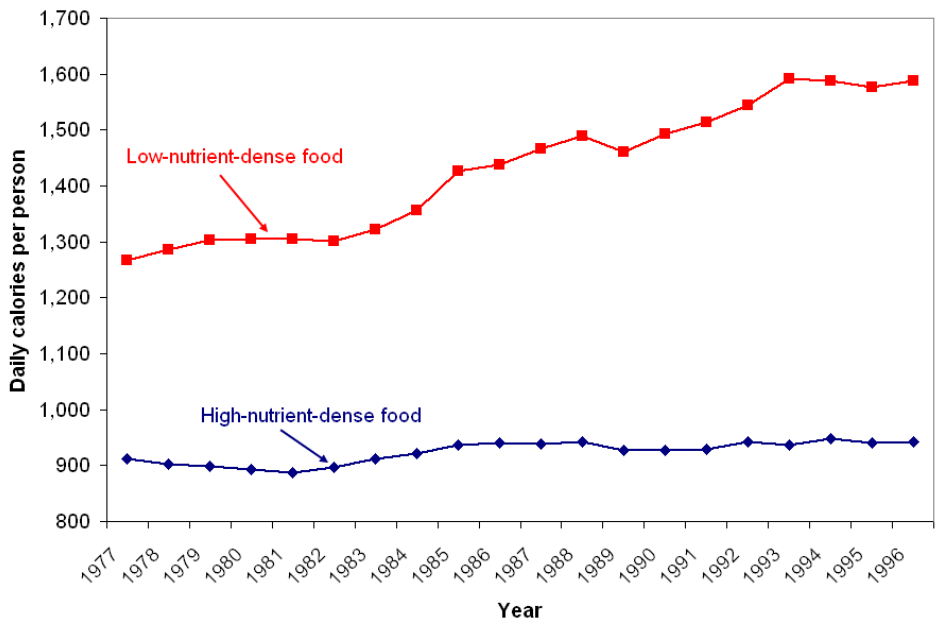
prices that are not adjusted for changes in calories fail to portray an accurate picture is due to the "quality change" bias. It is true that the prices of restaurant meals have been increasing. The food prices that are not adjusted for changes in calories captures this effect. However, during the same period, the portion size at restaurants have also been increasing. Hence, if we control for the increase in the portion size (calories) we see that the restaurant meals today are relatively cheaper.

2.2 Food Price Aggregation

Nutritionists and dieticians have long been aware that Americans eat too much of low-nutrient-dense food (e.g., added fats and sugars, refined pasta and grain) and not enough of high-nutrient-dense food (e.g., vegetables, fruits, dairy products).

In Figure 3, we present changes in calorie consumption of high- and low-nutrient-dense food between 1977 and 1996. The high-nutrient food group consists of calorie intake from fruits and vegetables, dairy, meat, eggs, and nuts. The low-nutrient food group consists of calories intake from added sugars, added fats, and flour and cereal products. Daily calorie

Figure 3: Daily Calorie Intake over Time for High-Nutrient and Low-Nutrient Food



intake from the high-nutrient-dense food category remained roughly constant (it increased slightly by thirty calories per day or by three percent), while daily calorie consumption of low-nutrient-dense food increased by twenty-five percent from 1268 calories in 1977 to 1589 calories in 1996.

For each year between 1977 and 1996, we calculate the price of high-nutrient-dense food per calorie, $p_{H,t}$, and low-nutrient-dense food per calorie, $p_{L,t}$, as follows:

$$p_{H,t} = \frac{\alpha_{H,t} I_t}{\text{Calories}_{H,t}}, \quad p_{L,t} = \frac{\alpha_{L,t} I_t}{\text{Calories}_{L,t}} \tag{2}$$

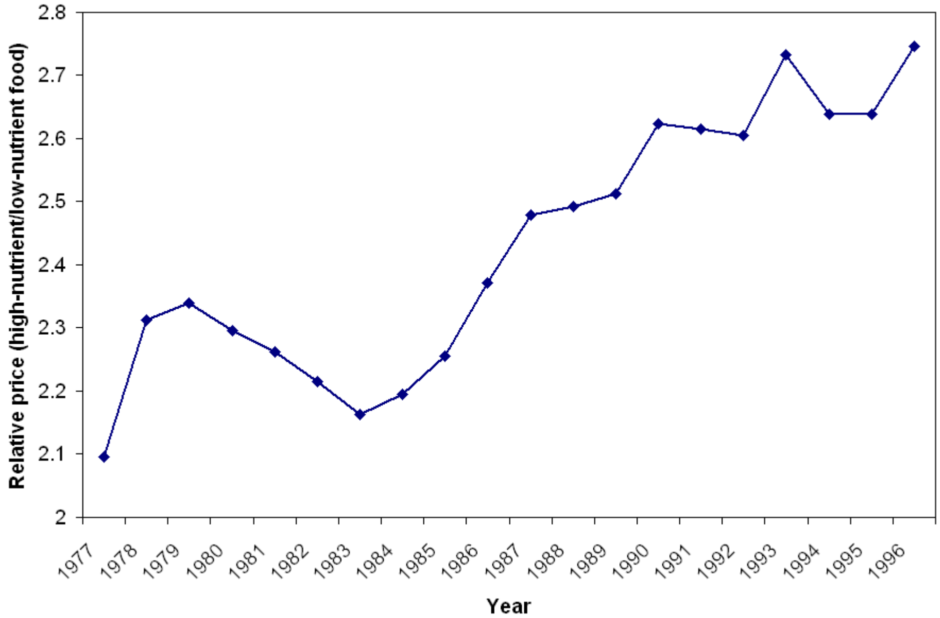
where $\alpha_{H,t}$ and $\alpha_{L,t}$ denote the expenditure share on high- and low-nutrient-dense food, respectively, and I_t represents real income in period t.

Expenditure shares on high- and low-nutrient-dense food come from yearly bulletins provided by the Bureau of Labor Statistics and are equal to:

$$\begin{aligned} \alpha_{H,t} &= \alpha_{FV,t} + \alpha_{D,t} + \alpha_{ME,t} \\ \alpha_{L,t} &= \alpha_{O,t} + \alpha_{S,t} + \alpha_{C,t} + \alpha_{NB,t} \end{aligned} \tag{3}$$

where $\alpha_{FV,t}$, $\alpha_{D,t}$, and $\alpha_{ME,t}$ denote the expenditure share on fruits and vegetables; dairy;

Figure 4: Changes in Relative Price Over Time



and meats, poultry, and egg, respectively, and $\alpha_{O,t}$, $\alpha_{S,t}$, $\alpha_{C,t}$, and $\alpha_{NB,t}$ denote expenditure share on oil and fats; sugar and sweets; and cereal and bakery products; and nonalcoholic beverages and other prepared foods, respectively. The reason why we include bakery products, nonalcoholic beverages, and other prepared foods in our expenditure share is to capture all added sugars and added fats consumed, that are not captured in the "sugar and sweets" and "oil and fats" category.

In Figure 4, we present changes in the relative price of high- versus low-nutrient-dense food between 1977 and 1996. Note that, per calorie, high-nutrient-dense food is always more expensive than low-nutrient-dense food. Moreover, the ratio between high- and low-nutrient-dense food widens from 2.1 in 1977 to 2.75 in 1996, an increase of thirty-one percent.

Gelbach et al. (2007) use data on average BMI from the National Health Interview Survey (NHIS) to study the impact of changes in relative food prices on people's eating decisions and weight. They find that, as healthful food become more expensive relative to unhealthful foods, individuals exhibit higher BMI, as well as higher likelihoods of being overweight or obese, and these effects are statistically significant. However, the quantitative effect of price food changes is small and accounts for only about one percent of the rise in average BMI. They conclude, that given such a small sensitivity of individuals to relative food prices, a "fat tax" would have very little effect.

Using the same data set as Gelbach et al. (2007), we analyze the impact of changes in the per calorie price of high- and low-nutrient food on the average body-mass index (BMI) using the following regression equation:

$$\log(\text{Average BMI}_t) = a + b\log(\frac{p_{H,t}}{p_{L,t}}) + e_t \tag{4}$$

where the error term, e_t, is i.i.d. over time and the per calorie price for high- and low-nutrient-dense food are calculated as in equation (2).

Table 1: Regression Results for Various Subgroups - Standard Deviation in Parenthesis

		b			b	
By race:	Black	0.287	(0.026)	White	0.229	(0.027)
By Marital Status:	Married	0.219	(0.026)	Not Married	0.303	(0.032)
By Gender:	Men	0.222	(0.024)	Women	0.268	(0.030)
By Education	HS degree	0.310	(0.035)	College degree	0.295	(0.035)

We find that per calorie prices have a positive impact on the average BMI. Our point estimate for the coefficient b is equal to 0.25 and this estimate is statistically significant. Based on simple calculations, changes in the per calorie price of high- versus low-nutrient-dense food accounts for almost all of the increase in the average BMI of Americans, a much larger impact compared to Gelbach et al. (2007). We also report the results of the regression for different subgroups of the population in Table 1. We find that per calorie prices have a positive impact on the average BMI for all subgroups. The quantitative impact of relative prices, however, is the greatest for women, blacks, and single people.

3 Concluding Remarks

In this paper, we proposed a new method to calculate the price of different food categories that adjusts for changes in calories consumed over time. We believe that this new measure for food prices improves our understanding of the causes of obesity in the following two ways. First, we showed that per calorie food prices can explain two important changes in people's eating habits and weight, while changes in simple food prices cannot. Second, per calorie food prices have important policy applications. We argue that the relevant food price elasticity measures the impact of per calorie food prices on calories consumed. In addition, the per calorie food prices should be used by policy-makers to assess the effectiveness of public health policies aimed at reversing the trends in obesity, including "fat taxes" and healthy food subsidies.

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