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Fat taxes and thin subsidies: Prices, diet, and health outcomes

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Abstract

"Fat taxes" have been proposed as a way of addressing food-related health concerns. In this paper, we investigate the possible effects of "thin subsidies", consumption subsidies for healthier foods. Empirical simulations, based on data from the Continuing Study of Food Intake by Individuals, are used to calculate the potential health benefits of subsidies on certain classes of fruits and vegetables in the United States. Estimates of the cost per statistical life saved through such subsidies compare favorably with existing U.S. government programs.

Keywords: *Nutrition, fruits and vegetables, disease, food subsidies.*

Introduction

In the past few years, the popular media has given considerable attention to increasing obesity rates in many parts of the developed world. A growing number of researchers have suggested that this is, in large part, an economic issue (e.g., Drewnowski, 2004). This discussion has given rise to a debate on what, if anything, governments should do to decrease both the social and private costs associated with what is increasingly perceived as an epidemic of poor dietary choices. One approach is to apply so-called "fat taxes" to discourage the purchase of those foods that are least nutritious or most harmful. For example, the British Medical Association recently called on lawmakers there to add a 17.5% tax on high-fat foods (Blake, 2003).[1] The opposition to such approaches includes those who argue that such taxes are an undue intrusion on private lives, or that they may have regressive distributional consequences.

As described below, governments have been considering a number of approaches to address food-related health concerns. One policy that has not been seriously proposed, however, is to institute subsidies on the consumption of the healthiest foods. This study investigates the possible health effects of a "thin subsidy" on broad categories of fruits and vegetables in the United States. Using data on individual consumption patterns, we estimate the change in consumption that could be induced through modest subsidies in retail prices. We relate these changes to recent medical studies on the benefits of fruit and vegetable consumption in reducing incidence of ischemic stroke and coronary heart disease. This allows us to calculate both estimates of the number of diseases avoided and the cost per statistical life saved. The analysis suggests that "thin subsidies" on fruits and vegetables would compare favorably with the costs per life saved for many existing US regulatory programs.

Regulating diets

A perceived epidemic of obesity in most of the developed world has ushered in a new era of concern for dietary health. This increased awareness of obesity has been reflected by recent actions in North American legislatures. Since July 2002, when an overweight New York man filed suit against four fast-food restaurant chains, there has been a plethora of both media and government attention paid to obesity issues and the ways in which they can be regulated, legislated and litigated. Some of the proposed legislation directly relates to so-called "obesity lawsuits", such as a March 2004 vote in the United States House of Representatives in favor of a bill that would prohibit such lawsuits. Twenty US states have passed or are considering similar legislation (Holland, 2004).

US state legislatures have also shown a willingness to get involved in setting explicit policies to address

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the problems and causes of obesity. One of the results of this rush to action may be a staggering patchwork of different laws regarding policy areas that had until recently received little regulatory attention. In just the first eight months of 2003, bills to study obesity problems were introduced in at least eight states; bills to require restaurant chains to provide nutritional information were introduced in at least five states; bills to develop diabetes-screening programs for children were passed in two states; bills to impose or broaden sales taxes on soft drinks or syrups were introduced in at least nine states; bills to adjust taxes on food items were introduced in at least seven states; bills to examine or adjust the nutritional content of school meals were introduced in at least 14 states; and bills to ban or limit junk food in vending machines or school cafeterias were introduced at least 15 states (Uhlman, 2003). Canadian legislators have also been considering obesity-related bills, such as the February 2004 proposal by a Winnipeg New Democrat MP that would effectively remove trans-fats from processed foods sold in Canada (Picard, 2004). Similar legislation has already been enacted in Denmark (Food Ingredient News, 2003).

Tax policy is also being used to discourage obesity. One avenue is the so-called "fat tax" approach, which seeks to discourage consumption of unhealthy foods by increasing the effective price to consumers. In many ways, this approach is being modeled on the successful use of taxes to discourage cigarette use (Cash et al., 2004). For example, in April 2004, the Ontario government proposed to begin charging provincial sales tax for restaurant meals under $4.00 (Mackie, 2004). The move was motivated in large part by a desire to increase the effective rate of taxation on fast food meals. In the face of public and industry opposition, some of which was due to the broad array of food items which could be affected, Ontario was forced to back down on the proposal.

Such proposals have proven to be controversial. Since consumers are responsive to price, fat taxes may be effective means of lowering the consumption of undesirable food items (Jacobson & Brownell, 2000; Marshall, 2000), although the resulting health gains may be minimal (Chouinard et al., 2005). Moreover, taxes involve an actual redistribution of income that makes all consumers worse off. One can also label fat taxes as regressive because these effects will be felt the hardest by low-income families. Empirical evidence has suggested that this has also been the case for cigarette excise taxes (Farrelly et al., 2001). Potato chips and fast food meals are also substantively different from cigarettes in that the latter are addictive. In moderation, many snack foods can still be consumed in the diet of a healthy person without leading to negative consequences – a fat tax penalizes the person making that choice. Although one could imagine policies designed to tax only excessive levels of poor food choices, such programs would difficult, if not prohibitively expensive, to implement.

In contrast to the "fat tax" approach, tax policy can also be used to encourage healthy behavior. Australia has long allowed consumers to take tax deductions for membership fees in weight-loss programs. In 2002, the United States Internal Revenue Service designated obesity as a disease and started allowing similar deductions. The US write-offs also extend to treatments such as stomach stapling surgery, certain weight-loss drugs, and nutritional counselling (KOMO News Services, 2004).

Similar programs could also be established to subsidize the consumption of healthier foods. Such a program would likely be progressive, in that the largest benefits would go to those with lower incomes. On the other hand, any thin subsidy would necessarily involve new government outlays that would have to be funded by taxpayers. It is therefore useful to investigate whether or not such policies would be cost-effective ways to achieve health improvements.

Benefits of fruit and vegetable consumption

An obvious choice of a target for such subsidies would be fruit and vegetable prices. Numerous health benefits have been associated with consuming a diet rich in a wide variety of fruits and vegetables (Van Duyn & Pivonka, 2000). Scientific evidence is accumulating for a protective effect for fruits and vegetables in the prevention of cancer (Steinmetz & Potter, 1996; World Cancer Research Fund, 1997), coronary heart disease (Ness & Powles, 1997; Liu et al., 2000; Joshipura et al., 2001), ischemic stroke (Joshipura et al., 1999; Feldman, 2001), hypertension (Appel et al., 1997), diabetes mellitus (Ford & Mokdad, 2001), chronic obstructive pulmonary disease (Miedema et al., 1993), and diverticulosis (Aldoori et al., 1994, 1998). The level of protection suggested by these studies is often quite dramatic. One review of several studies found that "the quarter of the population with the lowest dietary intake of fruits and vegetables compared to the quarter with the highest intake has roughly twice the cancer rate for most types of cancer" (Ames et al., 1995).

High consumption of fruits and vegetables (Neumark-Sztainer et al., 1996; Kahn et al., 1997; Müller et al., 1999; Epstein et al., 2001) or consumption of a wide variety of vegetables (McCrory et al., 2000) has also been related to a lower prevalence of obesity or reduced weight gain. Research further suggests that increasing intake of healthy foods, such as fruits and vegetables, may be more effective at reducing weight than focusing on decreased intake of unhealthy foods, such as high fat and high sugar items (Epstein et al., 2001). Taken together, the evidence on consumption patterns and health benefits supports interventions that increase the consumption of a wide variety of fruits and vegetables.

Compared to studies of general fruit and vegetable consumption, the results of studies of the benefits of specific nutrients to reduction of cancer and other health risks have been less uniform and conclusive. In their review of the literature of risk factors for cancer, Ames et al. (1995) explain that although "antioxidants in fruits and vegetables may account for a good part of their beneficial effect ... [it is] difficult to disentagle by epidemiological studies [these benefits from those of] other important vitamins and ingredients in fruits and vegetables". Fruit and vegetable fiber intake have also proven to be important factors for reducing the incidence of certain diseases (Rimm et al., 1996). Such considerations suggest that individuals' aggregate intake of fruits and vegetables is an appropriate level of analysis for investigating health outcomes. We now turn our attention to developing a framework for such an analysis.

Methodology and data

In order to develop an empirical approach by which we may evaluate the health effects of consumer price subsidies, it is helpful to introduce the concept of a health risk production function. First, note that the level of consumption X is determined by the intersection of supply and demand, and can be written as a function of price, p, and income, y. We can then express consumer i's relative risk of a disease, such as ischemic stroke (s), as being determined by $R_i^s = g(X_i(p,y), Z_i(y))$ where Z_i is a vector of other factors influencing stroke risk that are not directly affected by food prices (although they may be affected by income).

Assuming that income is not affected by the policy intervention, the decrease in this individual's stroke risk resulting from a policy change Q is:

$$\frac{dR_i^s}{dQ} = \frac{\partial g}{\partial X_i}\frac{\partial X_i}{\partial p}\frac{\partial p}{\partial Q}. \qquad (1)$$

This statement is useful because it illustrates that the effect of risk-reducing policies can be decomposed into three stages: A policy price response $(\frac{\partial p}{\partial Q})$, a consumption response $(\frac{\partial X_i}{\partial p})$, and a health response $(\frac{\partial g}{\partial X})$. The decreased incidence of ischemic stroke in the population is given by $\Sigma_{i=1}^{N} \frac{dR_i^s}{dQ}$. Summing over all diseases of interest gives us the total mortality and morbidity reduction for the policy change.

The results shown below were obtained from a series of policy simulations designed to quantify some of the risk reductions that may result from thin subsidies. The initial element in each simulation is a hypothetical government consumption subsidy that results in a broad-based decrease in the market price of fruits and vegetables. The change in the intake levels of a sample population of consumers is then calculated. Finally, the dietary changes in the sample are related to a dose-response function to yield the decreased health risk and corresponding reduced incidence in the population of coronary heart disease and ischemic stroke.

Coronary heart disease and ischemic stroke were chosen for inclusion in this analysis for two reasons. First, they are two of the major causes of death in the United States. They were also the subject of two extensive studies (Joshipura et al., 1999; Joshipura et al., 2001) conducted by Harvard researchers and recently published in major medical journals. These studies were based upon large panel surveys of over 110,000 medical professionals, with 8 years of follow-up for men and 14 years of follow-up for women. These studies divide the sample populations into quintiles of fruit and vegetable consumption and then calculate the relative risk of the disease of interest for members of each quintile, controlling for factors such as age, smoking status, alcohol intake, family history, weight, supplement use, and exercise level. These studies provide strong evidence that relative risk decreases as fruit and vegetable consumption increases. For example, men in the highest quintile had 20% less risk of coronary heart disease and 39% less risk of ischemic stroke than men in the lowest quintile. The findings for differences in consumption of all fruits and vegetables are further summarized in Table I below.

As noted above, aggregate intake of fruit and vegetables is an appropriate level of analysis for considering health outcomes. These studies allow for the calculation of dose-response functions that describe the increase in specific health risks resulting from reduced consumption of broad categories of fruits and vegetables, including all fruits and vegetables, all fruits, all vegetables, total citrus fruits, citrus fruit juices, cruciferous vegetables, green leafy vegetables, etc. In contrast, the literature relating intake of specific nutrients to the incidence of diseases is neither complete nor uniform enough to apply it to overall dietary patterns.

Table I. Relative risk of ischemic stroke and coronary heart disease, by quintile of fruit and vegetable intake and per serving per day.

	1st Quintile	3rd Quintile	5th Quintile	One serving/day
	Ischemic stroke			
Women	1.0	0.75	0.74	0.93
Men	1.0	0.70	0.61	0.96
Pooled	1.0	0.73	0.69	0.94
	Coronary heart disease			
Women	1.0	0.88	0.80	0.97
Men	1.0	0.95	0.80	0.96
Pooled	1.0	0.92	0.80	0.96

Risks by quintile of intake are relative to the risk for the lowest quintile of intake, and are adjusted for age, smoking status, alcohol intake, family history of myocardial infarction, body mass index, vitamin supplement use, vitamin E use, physical activity, aspirin use, hypertension, hypercholesterolemia, total energy intake, and postmenopausal hormone use (among women). One serving per day is risk reduction per one-serving increment, using median values for the quintile of intake (Joshipura et al., 1999; Joshipura et al., 2001).

The reported results from these studies suggest that the relative risk curves generally exhibit a log-linear shape. Using these reported results, we estimated parameterized curves for use in the simulations. When calibrated to an appropriate set of baseline risks for the control group (here, the observed incidence for the quintile with the lowest consumption of fruits and vegetables), the relative risk curves yield dose-response functions for the protective benefits of fruit and vegetable consumption. Because these curves were estimated from a limited number of reported data points, we assume a 50% standard deviation in the calculations below to simulate deviations in individual health responses.

In order to quantify the health outcomes from a broad-based subsidy program, it is necessary to have information on the consumption habits of a representative sample of the population. The sample population used in this study is the 18,081 individuals over the age of two included in the US Department of Agriculture's Continuing Study of Food Intakes by Individuals (CSFII) for 1994–1996 and 1998 (United States Department of Agriculture, 2000a). The CSFII also provides a set of sampling weights that allows for extrapolation of this analysis to the entire US population, i.e., 253.9 million people over two years of age. In addition to detailed information on individual food and nutrient intake, CSFII data include measures of dietary knowledge, attitude, and behavior, and household demographics.

The CSFII reports food consumption over a two-day period. In order to relate the diets in the sample to the parameterized dose-response curves, it was necessary to translate specific meal choices (e.g., chicken parmesan, caesar salad) to numbers of servings by food type. A set of "cookbooks" available from USDA was used to convert the CSFII consumption data to food pyramid servings (United States Department of Agriculture, 2000b). These serving data were then used as the baseline level of fruit and vegetable intake from which the consumption changes were measured.

The consumption response of the individuals in the sample to the simulated changes in the price of fruits and vegetables can be described by demand elasticities, which give the percentage change in quantity demanded for a one-percent change in price. Here we used recent elasticities for fruit and vegetable consumption calculated by researchers at the US Department of Agriculture, shown in Table II below (Huang & Lin, 2000). These elasticities are particularly appropriate for this study as they are segmented by income level, and were calculated from a earlier survey similar in format to the CSFII.

In calculating health outcomes, we are constrained by the methodology and scope of the medical literature. As a result, these simulations are limited to changes in the price of broad categories of produce. For example, we can not use this methodology to estimate the health outcomes that might result from a 3% price subsidy on broccoli. It is not likely, however, that any subsidies would be so narrowly targeted in practice. A single-crop subsidy would be politically difficult because of the lobbying efforts of other fruit and vegetable producers, and would not be likely to effect any meaningful changes in dietary behavior. Consumer preferences for variety are such that even a significant reduction in the price of a product would be unlikely to induce many people to eat broccoli three times per day!

Price and disease incidence

We simulated the impacts of small changes in the price of broad categories of fruits and vegetables.

Table II. Own-price demand elasticities by income group.

Commodity	All incomes	Low income	Medium income	High income
Fruit	−0.7196 (0.0282)	−0.6472 (0.0693)	−0.6614 (0.0469)	−0.7523 (0.0409)
Vegetables	−0.7238 (0.0179)	−0.6965 (0.0391)	−0.7436 (0.0301)	−0.7087 (0.0272)
Juice	−1.0109 (0.0364)	−1.0498 (0.0837)	−0.8997 (0.0591)	−1.0387 (0.0563)

Low income refers to families below 130% of the poverty income guidelines, and high income households are above 300% of this level. Numbers in parentheses are standard errors (Huang & Lin, 2000).

These results are shown in Table III below. The table describes the health outcomes of a policy that causes a lasting 1% average decrease in the price of all fruits, all vegetables, or all fruits and vegetables. By "lasting" we mean a change in price that persists at least as long as the study period of the medical research used in the simulations. The number of induced diseases reported is the mean from an extensive series of Monte Carlo trials. Standard errors reflect the likely variations in individuals' economic and health responses. In each trial, every individual in the sample was assigned a different elasticity drawn from the distribution implied by Huang & Lin's findings. The assumed 50% variation in individual dose-response functions is also reflected here. Negative health outcomes are shown for the entire population, as well as by income group. Note that the results by income group shown below are not weighted by group size. For example, no distributional implications should be read into the fact that approximately half of the induced cases of stroke and heart disease occur in the high income category, as the definition of "high income" used here applies to a majority of the US population.

With a 1% decrease in the average price of all fruits and vegetables, the simulations indicate a mean decrease of 6,733 cases of coronary heart disease and 2,946 ischemic strokes, for a total of 9,680 prevented cases of disease. The outcomes for subsidizing only fruits or only vegetables are less substantial, as the epidemiological evidence indicates the greatest risk reduction benefits stem from consuming higher levels of both fruits and vegetables.

Many US risk-reduction programs evaluate risks in terms of a *lifetime* of exposure to a hazard. Here our baseline is the number of incidences of ischemic stroke and coronary heart disease observed during the duration of the Joshipura studies. It is certain that a substantial number of the participants in these studies experienced or will experience ischemic stroke or coronary heart disease after the study period's end. Since the baseline risk here is not calculated on a lifetime basis, the quantities calculated in these simulations are likely to be underestimates.

Table III. Cases of coronary heart disease and ischemic stroke avoided in the US population by a 1% price decrease in all fruits, all vegetables, or all fruit and vegetables.

Disease	All incomes	Low income	Medium income	High income
	All fruit			
Coronary heart disease	1,402 (61.14)	221 (28.34)	410 (31.41)	771 (44.05)
Ischemic stroke	723 (33.55)	127 (16.03)	219 (18.41)	377 (22.96)
Total	2,125 (80.80)	348 (37.89)	629 (42.54)	1,148 (57.13)
	All vegetables			
Coronary heart disease	2,891 (66.89)	516 (28.33)	988 (37.03)	1,387 (47.99)
Ischemic stroke	1,452 (36.69)	278 (15.48)	497 (20.66)	677 (26.13)
Total	4,343 (93.28)	794 (39.49)	1,485 (51.94)	2,063 (66.65)
	All fruit and vegetables			
Coronary heart disease	6,733 (143.18)	1,118 (63.09)	2,204 (77.07)	3,411 (102.99)
Ischemic stroke	2,946 (67.23)	551 (29.93)	973 (37.40)	1,423 (47.23)
Total	9,680 (180.80)	1,668 (80.19)	3,177 (98.41)	4,834 (128.96)

Results reported are the simulation means and standard errors (in parentheses) from a series of Monte Carlo trials ($N = 100,000$). Low income refers to families below 130% of the poverty income guidelines, and high income households are above 300% of this level. The US poverty level in 1998 was $16,680 for a family of four (United States Census Bureau, 2002). Number of cases across income groups and disease category may not sum perfectly because of rounding.

These numbers also do not reflect a complete accounting of all health outcomes; rather, they include only those from two major causes of death. Taken together, these numbers are likely to be very conservative estimates of the health benefits of fruit and vegetable subsidies.

Cost per life saved

The only additional information needed to calculate the cost per statistical life saved by a fruit and vegetable subsidy is the average cost per serving of fruits and vegetables for relevant categories of consumers. Huang and Lin (2000) report the average cost per pound of fruits and vegetables across income categories observed in the 1987–88 Nationwide Food Consumption Survey. Consumer price indices for fruits and vegetables maintained by the United States Department of Labor, Bureau of Labor Statistics (2003) were used to convert these prices to 2002 dollars. Finally, USDA summaries of the CSFII data showing numbers of grams per serving were used to calculate average price per serving for both fruits and vegetables by sex and income (United States Department of Agriculture, 1999).

The policies simulated here involve a small subsidy in the market price of all fruits, all vegetables, or all fruits and vegetables sold to consumers in the United States. This small subsidy would translate into slight increases in fruit and vegetable consumption across the population, and if these increases were sustained over time the result would be a decrease in a variety of diseases. Again, here we only model the benefits of decreasing cases of ischemic stroke and heart disease in the current US population over the age of two. For the purposes of calculating the present value of the cost of this intervention, it was presupposed that, for the present population, it would be necessary to sustain the subsidies for an average of 40 years.

Furthermore, it was assumed that the incidence of disease (mortalities and morbidities) observed over the duration of the medical studies is a good proxy for the number of premature deaths these diseases that will cause over the lifetime of the current population. This assumption is certainly an underestimate. Over 31% of all deaths in the United States are caused by coronary heart disease. An additional 7% of deaths are due to strokes, the majority of which are ischemic (National Center for Health Statistics, 2002). These rates are a full order of magnitude larger than those observed in the studies used to calculate the dose-response functions here. Although this may seem to be a gross understatement of the appropriate rates, this discrepancy needs to be balanced against the fact that many deaths due to stroke and heart disease could not be considered to be "premature". Such counterarguments notwithstanding, the net result of this assumption is that the costs calculated here should be interpreted as upper bounds of the true costs.

Table IV shows the calculated cost per statistical life saved for a 1% retail price subsidy on all fruits and vegetables, as well as for just fruits or just vegetables. On average, the present value of the cost per statistical life saved for a fruit and vegetable subsidy is $1.29 million. This cost goes up to $2.12 million if the subsidy is provided just for fruit, or $1.80 million if the focus is just on vegetables. These price differences simply reflect the medical findings that the protective benefits of increasing both fruit and vegetable consumption are greater than those realized from increasing just one or the other, and that stronger protective benefits have been observed for vegetables than for fruit. As a result, the most cost effective policy will be one that covers both fruit and vegetables.

Sensitivity analyses indicate that for higher subsidy levels, the number of diseases prevented goes up dramatically, but the cost per statistical life rises only slightly. For example, the cost per life saved for a 10% subsidy for all fruit and vegetables goes up to $1.33 million. This modest increase in cost as the program scale increases reflects the diminishing marginal health benefits of fruit and vegetable consumption.

Conclusions

The calculations here assume that the entire cost of a price reduction would be covered by government

Table IV. Present value of cost per life saved by avoiding heart disease and stroke through dietary subsidies.

Commodity	All incomes	Low income	Medium income	High income
Fruit and vegetables	1.29	1.02	1.19	1.45
Fruit	2.19	1.82	2.17	2.31
Vegetables	1.80	1.33	1.62	2.12

Low income refers to families below 130% of the poverty income guidelines, and high income households are above 300% of this level. All numbers are in millions of 2002 US dollars.

spending. This assumption does not take into account any pre-existing market distortions. For example, it may be the case that trade restrictions or agricultural support programs may already be raising fruit and vegetable prices. If so, some of the reductions in price may be achieved without direct government outlays by reducing the level of the existing distortions. In this case, the actual cost to the government could actually be much lower, although some costs would be borne by other parties currently benefiting from any such distortions.

These estimates compare favorably to the cost per statistical life saved for many government programs. For example, Van Houtven and Cropper (1996) find the implicit value per cancer case avoided under federal toxics and pesticides programs to be over $65 million.[2] These costs are also far below most US labor market estimates of the value of a statistical life, which typically range between $4 and $9 million (Viscusi & Aldy, 2003). This suggests that retail price subsidies on fruit and vegetables pass a benefit-cost test by a large margin.

The distributional impacts of such a policy are also worth noting. The CSFII surveys indicate that on average, lower income consumers eat fewer fruit and vegetables. They are therefore more responsive to slight changes in their diets than individuals who consume more fruit and vegetables, again because of the diminishing marginal health benefits of produce consumption. As a result, the cost of saving the life of a low income consumer is almost 30% less than that of a high income consumer. This is both because the intervention is more effective for low income individuals and because they are purchasing less expensive fruits and vegetables. In contrast to the possible regressive effects of a price-increasing regulation, a subsidy would provide the greatest benefits to the most disadvantaged consumers.

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Notes

1. The ability of individual EU member states to unilaterally impose taxes above the prevailing rate of VAT is currently restricted by European Union rules on food taxation.
2. In 2002 dollars; the figure reported by Van Houtven and Cropper was $45 million in 1989 dollars.

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