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Fat Taxes: Big Money for Small Change

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ABSTRACT

In an attempt to improve the nation's health, many U.S. policy makers have or are considering imposing taxes on the fat in food. Dairy products constitute a large portion of at home fat consumption of particularly harmful types of fat, and nearly all US households consume these products. We estimate a demand system for dairy products, which we use to simulate substitution effects among dairy products and the welfare impacts of fat taxes on various consumer groups. We find that even a 10 percent ad valorem tax on the percentage of fat would reduce fat consumption by less than a percentage point. Given that the demand for most dairy products is inelastic, a fat tax is an effective means to raise revenue. However, these fat taxes are unattractive because they are extremely regressive, and the elderly and poor suffer much greater welfare losses from the taxes than do younger and richer consumers.

JEL: H2, I18

Key words: equivalent variation, fat tax, regressive

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I. INTRODUCTION

People like cheese, ice cream, butter, and other foods with high fat content, but that fat may kill them by greatly increasing their cholesterol and obesity levels and raising their risk of heart disease. Consequently, many jurisdictions throughout the world have passed or are contemplating imposing taxes on fatty foods to save people from themselves.[1] Half of the states in the US have already imposed taxes or restrictions on foods with high levels of sugars or fats in place. Because more than half of all fat consumed comes from dairy products, and dairy products contain especially unhealthy types of fat we estimate a dairy demand system. We examine whether a fat tax on dairy products will result in a decrease in fat consumption for various demographic groups, whether such taxes are effective in raising revenues, whether they are regressive, and how they affect consumer welfare.

To predict the effects of a fat tax, we use estimates of the demand elasticities. If the point of the tax is to influence behavior, then a very low elasticity of derived demand for fat is disappointing because the tax will have little effect on reducing fat consumption. However, if the point of the tax is to raise tax revenue, then a low elasticity is desirable, as such a tax could raise billions of dollars.[2] However, such taxes may be regressive and reduce consumer welfare by a comparable amount.

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[1] These calls from nutritionists, politicians, and others are reported in the popular press in many countries. See for example, *Newsweek* June 25, 2000; *Roll Call* June 1, 2000; *Reuters News Service* June 3, 2000, *Associated Press* June 10, 2000, *Seattle Post-Intelligencer* April 30, 2002; *Australian IT* August 16, 2002, and **www.eas.asu.edu/~nfapp/html/july98.htm** in Australia.

[2] Jacobson and Brownell (2000) argued that a "steep" tax would probably reduce the consumption of the taxed foods and could be used to generate funding to subsidize healthful

In this study we obtain estimates of the own- and cross-price elasticities of demand for the major categories of dairy products using a demand system and grocery store scanner data. We use these estimates to simulate the effects of a fat tax on consumption patterns of dairy products for different demographic groups. The results allow us to examine the extent by which a fat tax reduces the intake of fat from dairy products and by how much it reduces the welfare of consumers.

We begin with a discussion of the health effects of fat, and the potential effectiveness of a fat tax on dairy products. We then describe our theoretical model and our approach to estimating dairy-product demand functions. A brief description of the data follows. Finally, we report the demand system estimates and discuss the effects of a fat tax.

II. DAIRY PRODUCTS, FAT, AND DISEASE

Most American households purchase dairy products. Nearly 97 percent purchase milk (Cornick, Cox and Gould 1994) and over 80 percent buy cheese (Yen and Jones 1997). Between 1980 and 2004 the annual per capita cheese consumption doubled to over 31 pounds. Per capita butter consumption increased 10 percent from 1995 to 2004 (Miller and Blayney 2006). Since nearly all households consume dairy products, and the fat in these products may raise particular health concerns we focus on the consumption of dairy products.

Studies of the link between fat intake and heart disease (Ascherio et al. 1999, Hu et al. 1997, and Willett 2001) or obesity (Bray and Popkin 1998, Bray et al. 2002, Labib 2003) conclude that

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foods; however they also noted that a small tax may be more politically feasible because it would not be noticed by the public but would raise substantial revenues, which could be used to subsidize healthy foods and raise awareness. He estimated that a 1¢ national tax per unit would raise tax revenues of $1.5 billion annually on soft drinks (per 12-ounce), while a 1¢ per pound tax would raise $70 million on candy, $54 million chips, and $190 million on other snack foods or fats and oils. They cite a poll suggesting that 45 percent of U.S. adults would support such a tax.

not all types of fat have identical effects on health. Recent research demonstrates that monounsaturated and polyunsaturated fats increase the levels of HDL (good) cholesterol and reduce the levels of LDL (bad) cholesterol. Saturated fat raises levels of LDL cholesterol more than it raises HDL cholesterol. Trans-fats reduce HDL and raise LDL.[3] These findings suggest that compared to unsaturated fats, saturated and trans-fats are more likely to lead to heart disease, while trans-fats are also more likely to result in obesity than other types of fat.[4]

The main sources of saturated fats in American diets include whole milk, butter, cheese, ice cream, red meat, and coconut products. Trans-fats come from many types of margarine, vegetable shortening, and partially hydrogenated vegetable oils (Willett 2001). Dairy products contain particularly unhealthy fat, which may disproportionately contribute to obesity and heart related problems, and consequently, are of particular concern when examining the intake of fat and the impacts of a fat tax.

It is estimated that one billion adults worldwide are overweight and at least 300 million are clinically obese (WHO 2004). Among OECD countries, it is estimated that the United States has the highest proportion of overweight people (65 percent), followed by Mexico (62 percent) and the United Kingdom (61 percent) (Loureiro and Nayga 2005). The percentage of overweight and obese Americans rose from 45 percent to 65 percent from 1960 to 2002.[5] The data suggest weight problems vary by demographic group. In 1999-2000, 60 percent of U.S. black males, 68

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[3] Trans fat is created by vegetable shortening, cracker, cookie, snack food, other food manufacturers when they add hydrogen to vegetable oil—the hydrogenation process—to increase the shelf life and flavor stability of foods.

[4] More generally, about three-quarters of heart disease deaths are attributed to ischemic heart disease (IHD). Roughly a third of the cases of IHD among persons 65 and younger in the United States are due to dietary and lifestyle factors (Strnad 2004).

[5] Culter et al. (2003); www.cdc.gov/nchs/products/pubs/pubd/hestats/obese/obse99.htm.

percent of white males, and 74 percent of Mexican-American males were overweight or obese.[6] The corresponding fractions for women were 78 percent for blacks, 58 percent for whites, and 72 percent of Mexican-Americans.

According to the American Heart Association in 2003 over 13 million Americans suffered from coronary heart disease. Coronary heart disease includes heart attack, angina pectoris, and other heart problems. Coronary heart disease resulted in over 2 million inpatient hospital visits and 500,000 deaths in 2001. Approximately 6.9 percent of white, 7.1 percent of black, and 7.2 percent of Mexican-American males have coronary heart disease. Nearly 5.5 percent of white, 9.0 of black, and 6.8 percent of Mexican-American women suffer from the disease.

In the United States, health care for overweight and obese individuals costs an average of 37 percent more than it does for normal weight people. In particular, the average annual medical bill for an overweight person is estimated to be $732 higher than for a person of normal weight (Loureiro and Nayga 2005). The direct costs of health care plus the indirect costs of lost productivity associated with coronary heart disease exceeds $133 billion (Willet 2001). Obesity related medical expenditures are $75 billion or 9 percent of all U.S. health expenditures (Finkelstein et al. 2004).

Obesity and heart disease are clearly increasing in the U.S. population, and the personal and societal costs are large. Many public health interventions at an individual level have been implemented in the hopes of changing behavior. School-based education programs, mass media education, work-site programs, home correspondence, and other community programs have been specifically targeted in attempts to reduce obesity rates. To date, these efforts have had little impact on obesity rates (Brownell and Fairburn 1995.)

[6] www.obesity.org/subs/fastfacts/Obesity_Minority_Pop.shtml.

A shift in the public health focus now places more emphasis on modifying the environment, such as prices, instead of individual behavior. Jeffery, French, Raether, and Baxter (1994) were among the first to examine price as a public health tool to influence food choices. They found, not surprisingly, that fruit and salad purchases greatly increased in a cafeteria when the prices of these items fell 50 percent. Other work (Jeffery et al. 1994, French et al. 1997, French et al. 2001) suggests that low-fat vending snacks are more often purchased when the price of these items is reduced.

The growing emphasis on changing the food environment as a means to reduce fat intake has lead to a debate on fat taxes. State and local taxes on soft drinks and snack foods date back to at least 1925 (Jacobson and Brownell 2000).[7] Table 1 shows that many U.S. jurisdictions have or are considering laws regulating sugar, snack foods, and fats. Half the states and a couple of U.S. cities have such laws. In addition, Australia, Canada, the United Kingdom and many other countries have or are considering imposing such laws.

In recent years, some public health experts and politicians around the world have proposed fat taxes—"Twinkie Taxes" or "McTaxes"—as a public health tool to fight obesity (Brownell 1997, Marshall 2000, Nestle 2002). Others view such a tax as an unnecessary government intervention (The Economist) that might have unintended consequences that would reduce its effectiveness (Kuchler et. al. 2005). In addition, the fast-food industry has been hit in the last few years with a series of lawsuits associated with causing obesity.

By studying a system of demands for dairy products, we can determine how changes in retail prices that would result from a fat tax affect the short-run consumption of various dairy products

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[7] Maine, the District of Columbia, California, and Maryland have recently repealed snack food taxes. In the application of these taxes, no distinction is made between the levels of fat found in each product. The taxes are simply an equal percent increase in snack food prices.

by consumers and the associated welfare impacts. We estimate the effects of fat taxes on the dairy product purchase decisions and the welfare impacts by estimating a demand system for dairy products that incorporates demographic variables. We calculate the own- and cross-price elasticities of demand for dairy products and the equivalent variation from imposing fat taxes for different consumer groups. We also calculate the regulation burden on households with different income levels.

III. DEMAND MODEL AND WELFARE MEASURES

We assume that city-level weekly aggregate purchases of dairy products can be modeled with a representative consumer. We use a generalized Almost Ideal Demand System that is linear and quadratic in prices and linear in income (LQ-IDS), is flexible with respect to price and income effects, and meets the necessary and sufficient conditions for a rational, representative consumer (LaFrance 2004). The demand equations for the LQ-IDS can be written in matrix form as

$$\boldsymbol{q} = \boldsymbol{\alpha} + \boldsymbol{A}\boldsymbol{s} + \boldsymbol{B}\boldsymbol{p} + \boldsymbol{\gamma}\left(m - \boldsymbol{\alpha}'\boldsymbol{p} - \boldsymbol{p}'\boldsymbol{A}\boldsymbol{s} - \tfrac{1}{2}\boldsymbol{p}'\boldsymbol{B}\boldsymbol{p}\right), \tag{1}$$

where q is the vector of quantities demanded, α and γ are vectors of parameters, A is a matrix of parameters, $\boldsymbol{B} = \boldsymbol{B}'$ is a symmetric matrix of parameters, p is the vector of normalized final consumer prices for dairy products, m is normalized income, and s is a vector of demographic variables. All prices and income are normalized by a known, linear homogeneous function of the prices of other goods.

To determine the impact of a change in the prices of dairy products on consumer welfare, we need to compare the utility level at the initial prices, to the utility level at the final prices. If consumer prices for dairy products change from $\boldsymbol{p}_0$ to $\boldsymbol{p}_1$, the equivalent variation, ev, is the change in income at the original price vector, $\boldsymbol{p}_0$, that is just necessary to bring the consumer to the new utility level at the final price vector, $\boldsymbol{p}_1$. Writing the equivalent variation then gives

$$ev = \left(m - \boldsymbol{\alpha}'\boldsymbol{p}_1 - \boldsymbol{p}_1'\boldsymbol{As} - \tfrac{1}{2}\boldsymbol{p}_1'\boldsymbol{Bp}_1\right)e^{\boldsymbol{\gamma}'(\boldsymbol{p}_0 - \boldsymbol{p}_1)} - \left(m - \boldsymbol{\alpha}'\boldsymbol{p}_0 - \boldsymbol{p}_0'\boldsymbol{As} - \tfrac{1}{2}\boldsymbol{p}_0'\boldsymbol{Bp}_0\right). \tag{2}$$

The compensating variation measure of welfare is proportional to the equivalent variation measure for this model, $cv = ev \times e^{\boldsymbol{\gamma}'(\boldsymbol{p}_1 - \boldsymbol{p}_0)}$, so we focus only on the equivalent variation.

The marginal effect of a change in the k^{th} demographic variable on the equivalent variation for the change in dairy product prices from $\boldsymbol{p}_0$ to $\boldsymbol{p}_1$ is

$$\frac{\partial ev}{\partial s_k} = \sum_{j=1}^{n} a_{jk}\left[p_{j0} - p_{j1}e^{\boldsymbol{\gamma}'(\boldsymbol{p}_0 - \boldsymbol{p}_1)}\right]. \tag{3}$$

This depends on the coefficients on s_k in the demands for dairy products, the relative prices changes, and the vector of income coefficients. Therefore, we would expect that the welfare effects of a fat tax on dairy products vary systematically across consumer characteristics. This is what we find in our empirical work.

IV. DATA AND VARIABLES

The quantity data are city-level weekly average household purchases of fourteen dairy products calculated from weekly Information Resources Incorporated's (IRI) Infoscan™ scanner data for the three-year period January 1, 1997 through December 30, 1999 for 23 U.S. cities.[8] The city populations range from 50,000 to 10 million. Each region of the country is represented with several cities. IRI records both purchase price and quantity information at the Universal Product Code (UPC) level for a panel of customers for a number of grocery stores in each city. We group the UPC code data into 14 products: non-fat milk, 1% milk, 2% milk, whole milk, dairy cream including half and half, coffee creamers, butter and margarine, ice cream including frozen yogurt

[8] Atlanta, Boston, Cedar Rapids (IA), Chicago, Denver, Detroit, Eau Claire (WI), Grand Junction (CO), Houston, Kansas City, Los Angeles, Memphis, Midland (TX), Minneapolis/St. Paul, New York, Philadelphia, Pittsburgh, Pittsfield (MA), San Francisco/Oakland, Seattle/Tacoma, St. Louis, Tampa/St. Petersburg, and Visalia (CA).

and ice milk, cooking yogurt (plain and vanilla yogurt), flavored yogurt (all other yogurt that is not categorized as cooking yogurt), cream cheese, shredded and grated cheese, American and other processed cheese, and natural cheese. The dependent variable in the demand system is the average quantity purchased per household in each city in each week for each of the fourteen dairy products.

The consumer prices of dairy products are city-level weekly average prices. Given a generic city, the j^{th} product category, and the t^{th} week, define the city's average price for product *j* in week *t* by

$$p_{jt} = \sum_{i_j=1}^{n_j} \left(p_{i_j t}\bar{q}_{i_j} \Big/ \Sigma_{k_j=1}^{n_j} \bar{q}_{k_j} \right), \; j = 1,\dots,14 , \tag{4}$$

where n_j is the number of unique UPC codes for that dairy product, $\bar{q}_{i_j}$, $i_j = 1,\dots,n_j$, is the average quantity purchased per household per week in the given city of the dairy product with UPC code i_j,[9] and $p_{i_j t}$ is the retail price of that good in week *t*. We adjusted these city-level average prices for the effects of sales taxes and inflation in two ways. We first multiplied each price by one plus the state-level retail sales tax on food items to adjust for the effects of sales taxes on the final retail prices paid by consumers. We then deflated by the regional consumer price index for all items excluding food for all urban consumers, not seasonally adjusted (nonfood CPI), which in turn was multiplied by one plus the general retail sales tax rate in the state where the city is located.[10]

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[9] The average quantity weights are calculated over all 156 weeks in the sample period.

[10] If the general ad valorem retail sales tax rate in the state is τ, then the after-tax nonfood CPI is $(1 + \tau)$CPI. Retail sales tax rates are taken from the Council of State Governments (1997-1999) and the regional nonfood CPI's are from the Bureau of Labor Statistics (1997-1999), with 1982 as the base year. We linearly interpolated monthly nonfood CPI data to obtain weekly series. We matched each IRI city to one of four CPI regions: Northeast, South, Midwest, and West.

The data includes each household's annual income bracket. There are eight income brackets with midpoints ranging from \$7,500 to \$200,000.[11] We constructed a weekly estimate of the city-level average household income by taking the sum of the products of the proportion of households in each income bracket times the midpoint of that income bracket. The population proportions used to calculate the city-level income distribution were calculated as the fractions of households who purchased at least one dairy product in that city during that week. We deflated the city-level average household income with that city's after-tax nonfood CPI. Finally, we divided these measures of deflated average annual household income associated with each week by 52 to construct estimates of the deflated average weekly income per household for each city and week in our sample.

We also constructed weekly city-level aggregate measures of several demographic variables in a manner similar to the calculations for weekly average household income. These variables include household ethnic group, home ownership, employment status, occupation, whether the household has children under 18, has young children (ages 0-5.9), has medium aged children (ages 6-11.9), or has older children (ages 12-17.9), the number of young, medium, and older children in the household, number of individuals in each household, years of education of male and female heads of household, household weekly income, and ages of the heads of household. Table 1 presents summary statistics for weekly household income and other demographic

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[11] The last category is top coded as income at or above \$100,000 per year. We arbitrarily set \$200,000 as the conditional mean of the top income category. This amount is roughly the mean income level of all U.S. households that earned at least \$100,000 per year in the years 1997-1999. We calculated this national average conditional mean income using the full household income samples in the March supplement of the Continuing Population Survey for each of these three years.

variables included in the model. Not shown in the table, but included in the empirical model, are city-level fixed effects.

V. DEMAND SYSTEM ESTIMATES

We estimate the demand system, Equation (1), by nonlinear three stage least squares (NL3SLS) to account for the joint determination of city-level average quantities and prices. The instruments that we use in the first-stage price equations include city-level fixed effects, the demographic and income variables in the demand equations, the current and lagged deflated wholesale price of milk by city, the Herfindahl-Hirschman market power index (HHI) for the city, the squares of average household income, the wholesale milk price, and the HHI, and interactions between the race, home ownership, and income variables with the wholesale milk price and the HHI. This set of instruments produced coefficients of multiple determination in our sample ranging from 0.691 to 0.956.[12]

In equation (1), each structural parameter enters each demand equation through the income term, $m - \alpha'\boldsymbol{p} - \boldsymbol{p}'\boldsymbol{As} - ½\boldsymbol{p}'\boldsymbol{Bp}$. In this expression, market prices interact with each parameter. Amemyia (1985) showed that best NL3SLS estimators are obtained if (and only if) the set of instrumental variables can be expressed as a linear combination of the expected values of the partial derivatives of the structural equations with respect to the structural parameters, conditional on the instrument set. To meet this requirement, we need a set of instrumental variables for each demand equation that includes a constant, city-level fixed effects dummies, demographic variables including average weekly household income, predicted prices, own- and cross-product second-order interactions between predicted prices, and interactions between

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[12] We also tried additional instruments, such as the market shares of each of the eight largest firms in each city and the squared market share variables, with similar results.

predicted prices and the city dummies and the demographic variables. Thus we need 856 instruments for the 819 structural parameters with a total of 3,583 cross-section/time-series observations per demand equation and 14 demand equations, for a total of 50,162 observations.

We include White's robust heteroskedasticity consistent covariance matrix estimator in the NL3SLS system estimates to calculate robust, asymptotically consistent standard errors. Table 3 presents summary statistics for each of the fourteen dependent variables and the models error variances and goodness of fit measures. As can be seen from this table, the demand model appears to fit the available data reasonably well.

We estimated the LQ-IDS demand model for the fourteen dairy products using a large number of demographic variables, and it is impractical to report all of the coefficient estimates in a table, or series of tables.[13] Many coefficients on the demographic variables are statistically different from zero at a 5% significance level in some, but generally not all, equations. However, the demographic variables are collectively strongly statistically significant. Rather than try to describe the effects of all of the demographic variables on quantities demanded variable by variable, we turn to their effects on the price elasticities of demand and the distribution of the welfare effects due to fat taxes.

As the prices of dairy products change, households that consume dairy products alter the mix of dairy products that they demand. Table 3 shows the own- and cross-price elasticities for dairy products calculated at the mean of all of the variables (from table 1). In each row, each cell shows the price elasticity for the product due to a change in the price listed at the top of the corresponding column.

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[13] However, a complete list of empirical results is available from the authors on request.

All of the own-price elasticities are negative, statistically significant, and inelastic with the exception of 1% milk. The magnitudes of the point estimates for the own-price elasticities are comparable to those reported in the previous literature.[14] The own-price elasticities of demand for the four types of fresh milk (1%, 2%, no-fat, and whole) range from –0.628 for nonfat milk to -2.05 for 1% milk. The demands for other dairy products are less elastic, and the demand for butter is the least elastic, with an estimated own-price elasticity of demand of -0.295. There are roughly equal numbers of positive and negative cross-price elasticities of demand. All of these are close to zero – generally below 0.15 in absolute value and none are larger than 0.3 in absolute value. Most cross-price elasticities of demand are not statistically different from zero at a 5% significance level.

Table 4 reports the income elasticities, also evaluated at the sample means of the data. All of the income elasticities are negative, and eight are statistically different from zero at the 5% significance level. The estimated income elasticity fall generally in the range of other estimated income elasticities for dairy products.[15]

VI. WELFARE EFFECTS OF A FAT TAX

Many possible fat taxes have been applied or proposed (Table 1). However, if the intent is to discourage fat consumption, we presumably want a tax that varies with the fat content of foods such as an ad valorem tax on the percentage of fat—analogous to the carbon tax used to control pollution. If the tax rate on fat is τ, then the tax rate for a given product is τ times the fraction of

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[14] Park, Holcomb, Raper and Capps (1996) and Huang and Lin (2002) estimate own-price elasticity of demand for milk and cheese, and total dairy products respectively, from –0.1 to –0.8. Also see Bergtold, Akobundu and Peterson (2004), Heien and Wessells (1988), and Gould, Cox, and Perali (1990).

[15] See Heien and Wessells (1990), Park, Holcomb, Raper and Capp (1996), Huang and Lin (2000), Gould, Cox and Perali (1990) and Bergtold, Akobudu and Petersen (2004).

that good that is fat. Table 6 shows the proportion of fat in each dairy category, which ranges from 0 for no-fat milk to over 77 percent for butter.

If a product is competitively supplied with a horizontal supply curve and product "quality" is constant, the tax will have a proportional effect on the final retail price.[16] Given these assumptions, and the price elasticities in Table 4, we calculate the quantity effects of a 10 percent and of a 50 percent fat tax on the consumption of dairy products (Table 7). Because the elasticities do not vary substantially across demographic groups, we report only average effects. The effect of the tax is proportional: The 50 percent tax effects are almost exactly 5 times the effects for the 10 percent tax. Thus, we only discuss the 10 percent tax henceforth.[17] For some relatively low-fat items, the tax increases demand; whereas for most high-fat goods, the tax lowers demand.

Because the price elasticities are relatively inelastic, the tax on any one good has relatively small effects on total quantity.[18] Although it is nonetheless possible that the tax could have a more substantial effect on fat consumption due to substitution between goods, it does not.

The second column of Table 7 shows the estimated percentage change in the quantity of the good demanded for each category for the 10 percent tax, while the third column shows the

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[16] Barzel (1976) argues that an ad valorem tax imposed on a subset of characteristics of a product has the effect of reducing the product's quality. We assume product quality remains constant, consequently the fat consumption effect we estimate below, while small, may be overstated. Barzel's analysis suggests that while product price may rise when an ad valorem tax is imposed, it will not rise as much as it would if quality were restricted to remain constant. We doubt that this effect is important in dairy products.

[17] We assume a 100% pass through, which gives an estimate of the upper bound welfare effect on consumers from an ad valorem fat tax. Equivalently, if the consumers' share of the tax burden borne is, say, 50%, then a 10% consumer tax burden is equivalent to a 20% overall tax rate. The impact of any other pass through rate can be calculated similarly to identify the implied total ad valorem tax rate that is equivalent to a final consumer tax burden of 10%.

[18] A similar point is made in Kuchler et al. with respect to an ad valorem tax on snack foods.

change in fat grams per household per week. We divide by the average family size, 2.82 members, to get the per person effect. Without a fat tax, individuals in our sample daily consume 77.61 grams of fat from dairy product.[19] Imposing a 10 percent fat tax on dairy products reduces the daily fat intake to 76.94 grams, a drop of only two-thirds of a gram, or less than one percentage point (0.86 percent) of total dairy fat.

These effects are negligible. For example, the estimated reduction in fat would have no noticeable effect on a person's weight. Because a gram of fat contains about 9 calories, the tax would reduce a person's average daily consumption by only 6 calories. (Even a 50% tax would cut daily consumption by only 30 calories.) It takes a reduction of about 100 calories a day for the average person to lose one pound of body weight in a month.

According to most proponents, the main justification for a fat tax would be to increase the health of consumers who eat fatty goods—whether they want it or not. Presumably people would live longer and be healthier, which would have desirable long-term effects on their well-being.

If convinced of the wisdom of this recommendation, people could increase their health and presumably their utility by reducing their fat intake voluntarily. However, if a tax is used to induce them to reduce fat consumption, consumers will view themselves as being worse off at least in the short run, as they have to pay more for food and do not see an immediate health benefit.

How great is this welfare loss? Table 8 shows the equivalent variations for various groups based on our estimates. The first column shows the mean for all variables except for the variable

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[19] This number is virtually the same as reported in the literature that the average U.S. consumption of fat per person was 75 grams daily from 1994-1996 (despite the U.S. Department of Agriculture 2005 Dietary Guidelines Advisory Committee Report that recommends 24 grams of healthy fat per day on a 2,000-calorie diet).

shown on the rows. The first row of the first column shows the mean for all variables. The equivalent variation loss of the typical (mean of the explanatory variables) family, $40.34, is the annual change in income that the family is willing to accept instead of experiencing a 10 percent fat tax. Black families with average income suffer a relatively small loss, $36.34, which may be due to their relatively high level of lactose intolerance. By multiplying the annual average individual household's welfare loss by 111 million households, we obtain an estimate of the national welfare loss of $4.48 billion.

One justification of the fat tax is to raise tax revenues—according to some proponents, to be spent on promoting health. Table 9 shows that the annual tax burden from a 10 percent fat tax on dairy products for a typical household is $40.10, and national tax revenues are $4.45 billion.Thus, the tax revenues are almost as much as the consumers' welfare loss. The government raises $40.10 from the average family compares to a welfare loss of $40.34. The comparable national figures are $4.48 billion versus $4.45 billion.

However, this tax is extremely regressive. Almost the entire burden of the fat tax falls on poor families. We define the tax's regulatory burden as the annual equivalent variation associated with the tax divided by a household's annual income. The regulatory burden for the average family declines rapidly with income as seen in Figure 1. For an otherwise typical household, the burden is 0.24 percent at $20,000. It falls to 0.15 percent at $30,000, 0.10 percent at $40,000, 0.077 percent at $50,000, and 0.024 at $10,000. Thus, the burden at $20,000 is nearly 10 times larger than that at $100,000. The regulatory burden curves associated with different ethnicities do not vary much from the average household. The burdens by income for white, black, and Asian families are slightly below these averages, and those for Hispanic families lie slightly above these averages.

Similarly, the welfare effects are comparably regressive as Table 8 shows. The welfare loss, $24.29, of relatively well-to-do families with an income of $100,000 is only about half the loss of poor families with an average income of only $20,000, $47.38.

VII. CONCLUSIONS

We study the effect of a fat tax on dairy goods because over half of all fat consumed comes from dairy. Using supermarket scanner data, we estimate an incomplete demand system to determine the effects of taxing the fat content of dairy products on various demographic groups. We calculate the price elasticities and the equivalent variations associated with price changes.

Household demand for dairy products is inelastic. Price elasticities of demand also vary little across demographic groups. A 10 percent tax on fat content has relatively little effect on the quantity of dairy products consumed of any group. Such a tax results in less than a 1 percent reduction in average fat consumption. A tax on dairy products would account for over four-fifths of the fat reduction if the tax were extended to all food items. To have a substantial effect, the tax rate would have to be extremely high. Even a 50 percent tax would only lower fat consumption by a little over 3 percent.

Clearly in the short run, a 10 percent fat tax would not raise welfare. People could reduce their consumption of fattier dairy products without government intervention. Forcing them to do so by raising prices lowers their short-run welfare. The welfare effects vary much more than do the elasticities across demographic groups.

Because the demands are relatively inelastic, the fat tax raises tax revenue relatively efficiently in the sense that the welfare loss is only slightly greater than the revenue raised. Nationally, the 10 percent tax would raise $4.45 billion annually, but consumers would suffer a welfare loss of $4.48 billion. However, the tax is extremely regressive, falling almost entirely on poor consumers. Similarly, the welfare loss to a family earning $20,000 is nearly double that of a family earning $100,000. Moreover, families in their sixties suffer roughly double the welfare loss of families in their twenties.

Presumably the main justification of a fat tax is from long-run health increases, which hopefully offset the consumers' welfare losses from higher prices by allowing them to live longer (and possibly, reductions in healthcare expenses). If some people over-consume (by their own reckoning) unhealthy fatty foods, while other people do not over-consume, then O'Donoghue and Rabin (2003, 2005) argue that imposing optimal (possibly very large) "sin taxes" on unhealthy items and returning the proceeds to consumers without control problems can increase social surplus and can cause Pareto improvements. Given the limited current medical knowledge about the link between fat ingestion and length of life and the very small effect on fat consumption, calculating such gains is not feasible at this time. However, because even moderate fat taxes do little to reduce fat intake, long-run health increases are unlikely to materialize. Thus, consumers—particularly the poor and the elderly—will bear the burden of the fat tax as well as bad health.

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Table 1. Laws and Proposed Laws Regulating Foods Containing Sugar and Fats.

Jurisdiction	Law/Proposed Law
Arkansas	$2.00 per gallon of soft drink syrup $.21 per gallon for each gallon of bottled soft drinks $.21 per gallon of liquid soft drink produced from powder (*a*) *"Junk food tax" of 1% on items that contain less that 20% of the RDI of a list of vitamins and minerals, either per serving or per 100 calories – exempts beverages, fruits, vegetables, and foods with 4 or more grams of protein per serving, and foods that contain yogurt. The bill is currently inactive.*(a)
Chicago	Fountain drinks are taxed at 9 percent on sales of soft drink syrups
California	Carbonated soft drinks are excluded from sales tax exemption for food. *A bill proposed and excise tax on soft drinks and soft drink syrup:* *$2.00 per gallon of soft drink syrup* *$.21 per gallon for each gallon of bottled soft drinks* *$.21 per gallon of liquid soft drink produced from powder* (*c*)
Connecticut	Exempts from food sales tax exclusions: Soft drinks, soda, candy, and confectionery unless sold in school cafeterias, college dining halls, sororities and fraternities, hospitals, residential care homes, assisted living facilities, senior centers, day care centers, convalescent homes, nursing homes, or rest homes, or unless sold from a vending machine for less than 50 cents (*b*)
Detroit	*Tax fast-food at 2% in addition to a 6% general tax on restaurant food*
Idaho	*Excise tax on soft drinks: 1¢/12 fluid ounces (or fraction) on each bottled soft drink, $1 and in like ratio on each part gallon thereof on each gallon of soft drink syrup, 1¢ on each ounce by weight of dry mixture or fraction thereof used for making soft drinks.*(*c*)
Illinois	Excludes soda from lower sales tax rate for food (*b*)
Indiana	Excludes candy, confectionery, chewing gum, soft drinks, vending machine sales, and prepared food from sales tax exemption (*c*)
Kentucky	Excludes candy, soft drinks, sales from vending machines, and prepared food from sales tax exemption (*c*)
Maine	Excludes soft drinks, iced tea, soda or beverages such as are ordinarily dispensed at bars or soda fountains or in connection with bars or soda fountains, water, including mineral bottled and carbonated waters and ice, candy and confections, and prepared food from sales tax exemption (*b*) *Tax soda: $2 per gallon of syrup or .2 cents per gallon of soft drink. Exempts products of 10 percent or more fruit juice, as well as sales to the government and state exports. Creates a Health Promotion fund with the proceeds to be distributed as follows: 1) 50% on a per-student basis to schools that adopt "polices that prohibit the advertising and sale of soft drinks and candy on all school property and that make available on a daily basis Maine dairy products and fresh in-season farm products for sale as snack foods and as part of regular school meal programs." 2) 50% to go to a dental health residency program at qualifying hospitals* (*a*)
Maryland	*Sales tax (5%) on potato chips, nuts, and other salty snacks* (*c*)
Minnesota	Excludes prepared food sold by retailer, soft drinks, candy, all food sold through vending machines from sales tax exemption (*b*)
Missouri	Inspection fee of $0. 003 per gallon of soft drinks manufactured or sold in the state, up to a maximum of $0.04 per month per case of 24 bottles or cans of a manufacturer's bottling capacity (*a*,*b*)

Montana	*Tax of 5¢ for each bottle, can or 12 ounces of bulk items of soft drink manufactured or imported by the bottler or importer of soft drinks* (*a*)
Nebraska	*Tax for vending machine items and for bakery goods, candy, snack foods, and soft drinks (a)*
New Jersey	Not exempt from regular sales and use tax: candy and confectionery, and carbonated soft drinks and beverages whether or not sold in liquid form (*b*)
New York	Not exempt from regular sales and use tax: candy confectionery, fruit drinks less than 70% natural fruit juice, soft drinks, and sodas and beverages such are ordinarily dispensed at soda fountains or in connection therewith (other than coffee, tea, and cocoa); all items excluded from the exemption shall be exempt when sold through a vending machine for less than 75¢ (*b*) *Additional 0.25% sales tax on a) food and drink currently taxed, except for bottled water, b) sale and rental of video and computer games, and video game equipment and, sale and rental of video and DVD movies; would require a one percent sales tax on a) food and drink defined as sweets or snacks in the USDA`s National Nutrient Database for Standard Reference and b) admission to movie theaters funds from revenues raised by these provisions to be used in the NYS Childhood Obesity Prevention Program* (*c*)
North Carolina	*Tax (3¢) per container tax on soft drinks to provide funds for education* (*a*)
North Dakota	Excludes from regular sales and use tax exemption: candy or chewing gum, carbonated beverages, beverage commonly referred to as soft drinks containing less that 70% fruit juice, powdered drink mixes, coffee and coffee substitutes, cocoa and cocoa products (*b*)
Oklahoma	*Soft drink tax code would levy a tax of $2 per gallon of syrup used to make soft drinks or 21 cents per gallon for bottled soft drinks—exempting exports to other states, sales to the government and any item that contains over 10 percent fruit juice* (*a*)
Rhode Island	Tax of 4¢ on each case (12 24 oz. cans) of beverage containers (soda, carbonated soft drinks, mineral water) (*a,b*)
Tennessee	1.9% of gross receipts derived from manufacturing, producing and selling, or importing and selling, bottled soft drinks (*a,b*)
Texas	Excluded from sales tax exemption: carbonated and noncarbonated packaged soft drinks, diluted juices, ice and candy; and foods and drinks (which include meals, milk and milk products, fruit and fruit products, sandwiches, salads, processed meats and seafood, vegetable juices, ice cream in cones or small cups) served, prepared, or sold ready for immediate consumption in or by restaurants, lunch counters, cafeterias, vending machines, hotels, or like places of business or sold ready for immediate consumption from push carts, motor vehicles, or any other form of vehicle (*a,b*) *A bill would levy a snack tax of 3 percent in addition to the sales tax on all snacks, which include cookies, candy, chips and soft drinks not consumed in restaurants (c).*
Vermont	*A bill would add soft drinks as a taxable item. The revenues would be used in a new Dairy Farm Income Stabilization Fund.* *Extend the sales tax to snack food (long list) (a)*
Virginia	Excise tax on gross receipts from carbonated soft drink sales as follows: $50 if gross receipts are $100,000 or less $100 if gross receipts are between $100,000 and $250,000 $250 if gross receipts are between $250,000 and $500,000 $750 if gross receipts are between $500,000 and $1 million $1,500 if gross receipts are between $1 million and $3 million $3,000 if gross receipts are between $3 million and $5 million $4,500 if gross receipts are between $5 million and $10 million

	$6,000 if gross receipts exceed $10 million (*a,b*)
Washington	$1 per gallon (proportionate for fractional amounts) on each wholesale sale of syrup (concentrate added to water to produce carbonated soda); excludes carbonated beverages, ice, bottled water from sales tax exemption (a,b) *Eliminate state sales tax exemption for candy* (b)
West Virginia	Excise tax on sales, handling, use, or distribution of bottled soft drinks and soft drink syrup: 1¢ on each bottle of 16 9/10ths fluid ounces or half a liter or fraction of bottled soft drink 80¢ on each gallon of bottled soft drink 84¢ on each four liters of soft drink syrup 1¢ on each ounce or 28. 35 grams of dry mix used to make soft drinks Tax cannot be collected more than once with respect to any bottled soft drink or soft drink syrup made, sold, used, or distributed in the state; revenues to build four-year school of medicine, dentistry, and nursing (a) *Extend soft drink tax to include bottled water, and to change the tax from 1¢ to 5¢s on each 16 9/10ths fluid ounces, from 80¢ to $4.00 per gallon of syrup* (a)

Sources: (a) National Conference of State Legislatures Health Promotion Database;
(b) Lohman, Judith S. "Taxes on Junk Food," OLR Research Report, available at: **www.cga.ct.gov/2002/olrdata/fin/rpt/2002-R-1004.htm**;
(c) media reports and State Legislature websites.

Table 2. Summary Statistics of the Households that Purchase Dairy Products.

Variable	*Mean*	*Standard Error*
Household (HH) Size	2.816	0.176
Weekly Income	854.03	153.289
Own House	0.826	0.074
Race/Ethnicity		
Share White	0.880	0.110
Share Black	0.054	0.075
Share Hispanic	0.045	0.063
Share Asian	0.014	0.032
Male Head of Household		
Age	54.200	2.080
Years of Education	12.900	0.492
Share Unemployed	0.030	0.012
Share Employed Part Time	0.037	0.010
Share Employed Full Time	0.650	0.051
Share Nonprofessional Occupation	0.356	0.113
Technical Education	0.110	0.058
Female Head of Household		
Age	53.551	2.124
Years of Education	13.373	0.398
Share Unemployed	0.226	0.046
Share Employed Part Time	0.170	0.035
Share Employed Full Time	0.366	0.051
Share Nonprofessional Occupation	0.430	0.076
Share Technical Education	0.068	0.039
Children		
Children present in HH	0.350	0.058
Average Number of Young Children Ages 0-5.9	0.133	0.041
Average Number of Middle Children Ages 6-11.9	0.249	0.050
Average Number of Older Children Ages 12-18	0.307	0.064
Share of HH with children with Young Children	0.309	0.059
Share of HH with children with Middle Children	0.524	0.039
Share of HH with children with Older Children	0.562	0.060

Table 3. Equation Summary Statistics.

Dairy Product	*Average Quantity Purchased*		*Regression Equation*	
	Mean (ounces)	*Standard Deviation*	*Error Variance*	R^2
Milk 1%	151.409	77.692	3553.0	.41
Milk 2%	137.592	24.049	107.7	.81
Milk No-Fat	127.630	25.798	101.8	.85
Milk Whole	121.439	27.128	169.4	.77
Fresh Cream	15.298	3.080	3.9	.59
Coffee Additives	30.249	5.194	12.6	.53
Natural Cheese	13.417	2.418	2.2	.63
Processed Cheese	15.780	2.255	2.1	.68
Shredded Cheese	11.834	1.759	1.1	.64
Cream Cheese	11.405	1.641	1.9	.30
Butter	18.302	3.929	11.0	.29
Ice Cream	79.484	12.936	90.1	.46
Yogurt Cooking	22.060	5.937	25.9	.26
Yogurt Flavored	33.882	4.480	9.7	.52

Table 4. Price Elasticities of Demand for Dairy Products Calculated at the Mean of the Explanatory Variables.

Dairy Product	*Milk 1%*	*Milk 2%*	*Milk No-Fat*	*Milk Whole*	*Fresh Cream*	*Coffee Additives*	*Natural Cheese*	*Processed Cheese*	*Shredded Cheese*	*Cream Cheese*	*Butter*	*Ice Cream*	*Yogurt Cooking*	*Yogurt Flavored*
Milk 1%	-2.052*	0.019	0.110*	0.168*	-0.038	-0.046*	0.051	0.016	-0.043	0.011	0.095	0.016	-0.113*	0.011
Milk 2%	0.018	-0.742*	0.079*	0.022	-0.050*	-0.045	0.163*	0.105*	0.025	-0.013	0.032*	-0.098*	0.045	-0.031
Milk No-Fat	0.115*	0.084*	-0.628*	-0.022	0.089*	0.091*	-0.048	-0.098*	0.008	-0.013	-0.062*	-0.023	0.211*	0.000
Milk Whole	0.181*	0.025	-0.022	-0.652*	-0.036	-0.072*	-0.222*	-0.098*	-0.047	0.006	0.001	0.023	-0.069	0.030
Fresh Cream	-0.063	-0.084*	0.139*	-0.056	-0.407*	0.022	0.101	0.274*	0.118*	0.173*	0.004	-0.016	-0.139	0.035
Coffee Additives	-0.071*	-0.070	0.130*	-0.103*	0.020	-0.496*	-0.014	0.007	-0.056	-0.082*	-0.016	0.137*	0.019	0.144*
Natural Cheese	0.042	0.140*	-0.039	-0.176*	0.052	-0.007	-0.641*	0.132*	0.040	-0.015	0.014	0.104	-0.035	0.052
Processed Cheese	0.013	0.094*	-0.083*	-0.082*	0.147*	0.004	0.137*	-0.734*	-0.009	-0.122*	-0.019	0.275	0.057	-0.028
Shredded Cheese	-0.038	0.020	0.006	-0.038	0.060*	-0.031	0.039	-0.008	-0.404*	-0.082*	0.022	0.036	0.068	0.044
Cream Cheese	0.014	-0.019	-0.018	0.006	0.149*	-0.076*	-0.026	-0.194*	-0.138*	-0.515*	0.064*	0.128*	-0.225*	-0.012
Butter	0.093	0.033*	-0.056*	0.001	0.003	-0.009	0.019	-0.019	0.029	0.045*	-0.295*	0.136*	0.047	-0.038*
Ice Cream	0.010	-0.062*	-0.013	0.013	-0.006	0.058*	0.077	0.196*	0.028	0.057*	0.087*	-0.741*	0.187*	0.090*
Yogurt Cooking	-0.196*	0.079	0.348*	-0.111	-0.147	0.023	-0.071	0.113	0.142*	-0.276*	0.084	0.520*	-0.911*	-0.070
Yogurt Flavored	0.011	-0.035	-0.001	0.029	0.023	0.103*	0.066	-0.034	0.057	-0.009	-0.044*	0.154*	-0.044	-0.808*

Notes: The table shows the price elasticity given that the price of the good shown in the column changes. An asterisk shows that we can reject the null hypothesis that the elasticity is zero at the 5% significance level.

Table 5. Income Elasticities for Dairy Products.

Dairy Product	*Income Elasticity*	*Standard Deviation*
Milk 1%	-0.558	0.468
Milk 2%	-0.221*	0.058
Milk No-Fat	-0.239*	0.059
Milk Whole	-0.484*	0.075
Fresh Cream	-0.205*	0.098
Coffee Additives	-0.071	0.087
Natural Cheese	-0.209*	0.077
Processed Cheese	-0.040	0.066
Shredded Cheese	-0.115	0.068
Cream Cheese	-0.109	0.091
Butter	-0.676*	0.127
Ice Cream	-0.406*	0.082
Yogurt Cooking	-0.327	0.182
Yogurt Flavored	-0.151*	0.071

Note: An asterisk shows that we can reject the null hypothesis that the elasticity is zero at the 5% significance level.

Table 6. Serving Size and Fat Content for Dairy Product Categories.

Dairy Product	*Serving Size*	*Fat grams*	*Percentage Fat*
Milk 1%	1 cup	2.5	1.10
Milk 2%	1 cup	5	2.20
Milk No-Fat	1 cup	0	0
Milk Whole	1 cup	8	3.51
Fresh Cream	1 tablespoon	4.5	31.61
Coffee Additives	1 tablespoon	2	14.05
Natural Cheese	1 ounce	9	31.61
Processed Cheese	0.7 ounces	4.5	23.68
Shredded Cheese	1 ounce	9	31.61
Cream Cheese	2 tablespoons	10	35.12
Butter	1 tablespoon	11	77.27
Ice Cream	½ cup	8	7.02
Yogurt Cooking	6 ounces	1.5	0.88
Yogurt Flavored	6 ounces	1.5	0.88

Notes: We recorded the fat content and serving size information from their labels for many products within each category. We then selected as a representative product for each category the one that most closely matched the average fat content/serving size unit for the category.

Table 7. Changes Due to a Fat Tax on Dairy Products.

	10% Fat Tax			50% Fat Tax		
Dairy Product	*Price*[a]	*Quantity*[a]	*Fat*[b]	*Price*[a]	*Quantity*[a]	*Fat*[b]
Milk 1%	0.11	0.46	0.22	0.55	2.30	1.09
Milk 2%	0.22	0.59	0.51	1.10	2.94	2.52
Milk No-Fat	0.00	-0.44	0.00	0.00	-2.21	0.00
Milk Whole	0.35	-1.44	-1.75	1.76	-7.23	-8.78
Fresh Cream	3.16	0.64	0.88	15.81	3.19	4.39
Coffee Additives	1.40	-1.18	-1.43	7.02	-5.91	-7.14
Natural Cheese	3.16	-1.31	-1.58	15.81	-6.54	-7.90
Processed Cheese	2.37	-1.22	-1.24	11.84	-6.11	-6.20
Shredded Cheese	3.16	-1.10	-1.17	15.81	-5.48	-5.84
Cream Cheese	3.51	-1.84	-2.10	17.56	-9.21	-10.51
Butter	7.73	-1.86	-7.50	38.64	-9.32	-37.53
Ice Cream	0.70	1.21	1.92	3.51	6.02	9.57
Yogurt Cooking	0.09	-0.03	0.00	0.44	-0.13	-0.01
Yogurt Flavored	0.09	0.19	0.02	0.44	0.94	0.08
Change in fat grams from all products			-13.22			-66.26

[a] Percentage change.

[b] Change in fat grams per household per week.

Table 8. Equivalent Variation ($/Year) from a 10% Fat Tax for Various Demographic Groups.

			Only Child's Age Bracket		
Demographic Group	*Mean*	*No Children*	0-5.9	6-11.9	12-18
Mean	-40.34	-38.95	-49.79	-34.23	-40.13
White	-40.13	-41.45	-48.98	-33.41	-39.31
Black	-36.34	-37.67	-45.20	-29.63	-35.53
Asian	-48.22	-49.54	-57.07	-41.50	-47.40
Hispanic	-38.75	-40.07	-47.62	-32.04	-37.96
Income=$20,000	-47.38	-46.00	-56.85	-41.27	-47.18
Income=$30,000	-44.50	-43.12	-53.96	-38.39	-44.29
Income=$40,000	-41.61	-40.23	-51.07	-35.50	-41.41
Income=$50,000	-38.72	-37.34	-48.19	-32.61	-38.52
Income=$60,000	-35.84	-34.46	-45.30	-29.73	-35.63
Income=$70,000	-32.95	-31.57	-42.41	-26.84	-32.75
Income=$100,000	-24.29	-22.91	-33.75	-18.18	-24.09
10 Years of Education	-32.69	-33.99	-41.54	-25.97	-31.87
16 Years or Education	-46.35	-47.68	-55.21	-39.64	-45.54
HH Heads 25 Years Old	-24.89	-26.19	-33.74	-18.17	-24.07
HH Heads 35 Years Old	-30.21	-31.53	-39.06	-23.49	-29.39
HH Heads 60 Years Old	-43.55	-44.85	-52.40	-36.82	-42.73
No Children	-38.95				
Young Family[a]	-31.49				
Childless Couple[b]	-41.72				

[a] The young family' household heads are 25 years old, they have a real income of $30,000, the wife is not employed, the husband works in a non-professional occupation, they have two children under 6 years of age, and they rent their dwelling.

[b] The Childless couple's household heads are 40 years old, they have a real income of $60,000, both are working professionals, and they own their dwelling.

Table 9. Annual Tax Revenue Raised from a 10% Fat Tax on Dairy Products.

Dairy Product	*Average Household* ($)	*National* ($ million)
Milk 1%	0.19	20.89
Milk 2%	0.36	39.69
Milk No-Fat	0.00	0.00
Milk Whole	0.51	56.42
Fresh Cream	3.12	345.80
Coffee Additives	1.46	15.33
Natural Cheese	5.84	647.73
Processed Cheese	4.24	471.18
Shredded Cheese	5.99	665.50
Cream Cheese	3.87	429.39
Butter	12.50	1,387.40
Ice Cream	1.82	201.63
Yogurt Cooking	0.09	9.39
Yogurt Flavored	0.13	14.62
All Dairy Products	40.10	4,451.60

Figure 1. Percent Tax Burden for Various Income Levels.