When do Fat Taxes Increase Consumer Welfare?

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Abstract: Previous analyses of fat taxes have generally worked within an empirical framework in which it is difficult to determine whether consumer welfare increases from the policy. This note outlines a simple means to determine whether consumers benefit from a fat tax by comparing the ratio of expenditures on the taxed good to the weight effect of the tax against the individual's willingness-to-pay to for a one-pound weight reduction. Our empirical calculations suggest that consumers would be have to be willing to pay $6,000 to $7,500 to reduce weight by one pound for a soda tax to be welfare enhancing. The results either suggest that a soda tax is very unlikely to increase consumer welfare or that the policy must be justified on some other grounds that abandon standard rationality assumptions.

Introduction

Given the rapid rise in obesity, academics and policy makers have proposed a variety of options to improve public health. One of the most studied mechanisms is the fat tax, which uses the state's taxing power to alter relative prices in an attempt to encourage healthier eating. Economists have been at the forefront of determining the effects of fat taxes, in large part because of the need to estimate demand elasticities to project consumption and weight changes. Examples of studies that have used demand estimates to simulate weight or health effects of fat taxes include Allais, Bertail, and Nichèle (2009), Cutler, Glaeser, and Shapiro (2003), Cash, Sunding, and Zilberman (2005), Kuchler, Tegene, and Harris, (2005), and Chouinard et al. (2007), among others (see Cash and Lacanilao, 2007 or Etilé, 2011 for reviews).

Although such studies have provided important insights into the potential effects of fat taxes, there is a fundamental inconsistency inherent in the studies. In particular, these studies typically estimate price elasticities, in which estimated demand curves are assumed to arise from constrained utility maximization given prices and budget constraints. The conceptual inconsistency arises from the fact that higher prices (from fat taxes) can only lower welfare within the analyzed framework; the estimated demand curves arise from a system in which utility and thus demand is unaffected by health or weight. Presumably, however, fat taxes are studied because of some underlying belief that it is at least theoretically possible to improve consumer welfare by raising the prices of certain foods. Although many of the aforementioned studies allude to the potential existence of externalities associated with public health care costs, such potential benefits are *outside* the modeling framework used to estimate food demand. In short, previous economic work on fat faxes has lacked transparency in formally identifying *when* fat

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taxes increase consumer welfare, despite the fact that such motivations obviously underlie the policy question addressed.

The purpose of this note is to provide a simple framework to determine whether a fat tax improves consumer welfare. We adopt the framework introduced by Philipson and Posner (1999) and further developed by Schroeter, Lusk and Tyner (2008), who include weight as an argument of the utility function. We show the conditions under which a fat tax can increase consumer welfare within this framework, and provide some empirical calculations on whether a soda tax increases welfare.[1]

Model

Following Schroeter, Lusk, and Tyner (2008), we use a simple two-good model, in which consumers derive utility from consuming a high-calorie food, F^H, and a low-calorie food, F^L, in addition to their weight, W, which is a function of the quantity of foods consumed and exercise, E: $W = W(F^H, F^L, E)$. Weight is increasing in food intake, $\partial W/\partial F > 0$ and decreasing in exercise, $\partial W/\partial E < 0$. The consumers' utility function is $U(W(F^H, F^L, E), F^H, F^L, E)$, which is increasing at a decreasing rate in F^H and F^L. Utility is assumed to be increasing in W at levels below an individual's subjective, ideal weight, W^I, and is decreasing thereafter. Given that the majority of people in the US are overweight, it is likely that $\partial U/\partial W < 0$ for most individuals.

Consumers choose levels of food intake and exercise to maximize utility. Given prices of high- and low-calorie food, and exercise, P^H, P^L, and P^E, and income, I, maximization leads to Marshallian demands for food and exercise, $F^{H*}(P^H, P^L, P^E, I)$, $F^{L*}(P^H, P^L, P^E, I)$, $E^*(P^H, P^L, P^E,$

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[1] Of course, there are other frameworks which could be used to describe how consumers might benefit from a fat tax, such as using behavioral economics or developing a model with externalities. While we are agnostic about the role for the federal government in regulating weight, our objective here is to provide a simple framework that is at least internally consistent in so far as being able to analyze the effects of a fat tax where consumers can be shown to potentially benefit from the policy. We touch on some of these other modeling alternatives in the conclusions.

I), which can be substituted into the weight equation to determine economically optimal weight, $W^*(P^H, P^L, P^E, I)$. The economically optimal weight W^* may not necessarily coincide with the ideal weight W^I or even weight that is optimal for the health of the individual. Substituting each of these functions back into objective function yields the indirect utility function:

(1) $V\big(P^H, P^L, P^E, I, W^*(P^H, P^L, P^E, I)\big).$

Now, imagine a policy that implements an ad valorem tax of *t* to the high-calorie food, increasing the price from P^H to $P^H(1+t)$. The welfare effects of the tax can be calculated by determining the consumer's equivalent variation, *EV*, or the amount of money that must be added to income to make the consumer indifferent to the tax hike. The welfare value is determined by the following equality:

(2) $V\big(P^H(1+t), P^L, P^E, I + EV, W^*(P^H(1+t), P^L, P^E, I + EV)\big) =$

$V\big(P^H, P^L, P^E, I, W^*(P^H, P^L, P^E, I)\big)$

The left-hand side of the equality in (2) describes the consumer's utility in the case where the fat-tax is imposed and where *EV* has been added to income in order to off-set the disutility of the tax and the right-hand side represents the consumer's utility in the status-quo before implementing the fat tax.

The welfare effects of the policy can be determined by taking a linear approximation around the inequality in (2) and re-arranging terms:

(3) $EV = \left(\dfrac{-P^H t}{\frac{\partial V}{\partial I} + \frac{\partial V}{\partial W^*}\frac{\partial W^*}{\partial I}} \right) \left(\dfrac{\partial V}{\partial P^H} + \dfrac{\partial V}{\partial W^*}\dfrac{\partial W^*}{\partial P^H} \right).$

Equation (3) shows that the welfare effects of a fat tax involve a trade-off between the disutility consumers receive from higher prices given by $\frac{\partial V}{\partial P^H}$ and the added utility individuals receive from

decreasing body weight as a result of the tax implementation, which is given by $\frac{\partial V}{\partial W^*}\frac{\partial W^*}{\partial P^H}$. It is

useful to consider the special case in which $\frac{\partial W^*}{\partial I} = 0$, which is likely to hold for small marginal

changes in income. In this case, equation (3) can be re-written as:

(4) $EV = P^H t \left(\frac{-\frac{\partial V}{\partial P^H}}{\frac{\partial V}{\partial I}} - \frac{\frac{\partial V}{\partial W^*}}{\frac{\partial V}{\partial I}}\frac{\partial W^*}{\partial P^H} \right).$

Equation (4) can be further simplified by noting that the first term in parentheses, $\frac{-\frac{\partial V}{\partial P^H}}{\frac{\partial V}{\partial I}}$, is equal

to F^{H^*} due to Roy's identity, where the * superscript indicates utility maximizing levels. The

second term in parentheses, $\frac{\frac{\partial V}{\partial W^*}}{\frac{\partial V}{\partial I}}$, is the marginal utility of weight gain divided by the marginal

utility of income, which is equal to the individual's willingness-to-pay to reduce weight by one

pound, WTP^{W^*}, multiplied by negative one. Thus, equation (4) can be re-written as:

(5) $EV = P^H t \left(F^{H^*} + WTP^{W^*} \left(\frac{\partial W^*}{\partial P^H} \right) \right).$

Equation (5) shows that the welfare effects of a fat tax, as indicated by the level of

compensation that must be given to an individual to offset the increased price, EV, is increasing

in the size of the tax, t, and the consumption level of the taxed good, F^{H^*}. However, EV is falling

in WTP^{W^*} because $\frac{\partial W^*}{\partial P^H} < 0$. This means that with this simple framework, in which weight is

included as an argument in the utility function, it is possible to see how consumers could be

made better off from the tax: a condition which occurs if $EV < 0$ or if $F^{H^*} < -WTP^{W^*} \left(\frac{\partial W^*}{\partial P^H} \right).$

The higher the value an individual places on losing weight, the more likely is the condition to

hold.

In a traditional economic model, weight is excluded as an argument of the utility

function, which means equation (5) reduces to $P^H F^{H^*} t$, which is simply the change in

expenditure on the high-calorie good resulting from the tax: a value which can only be positive. That is, in the traditional economic framework *EV* can only be positive, meaning consumers are worse off from the tax (they must compensated a positive amount to offset the disutility of the tax). Equation (5) generalizes this result to allow the benefits of weight loss to be balanced against the costs of the tax.

Empirical Considerations

The question arises as to how one could empirically determine whether the welfare effects of a fat tax are beneficial to consumers. As indicated, this condition occurs if

$F^{H*} < -WTP^{W*}\left(\frac{\partial W^*}{\partial P^H}\right)$. The first term, F^{H*}, is easily observed as it is an individual's level of consumption of the high-calorie good. The weight reductions occurring from the price change, $\frac{\partial W^*}{\partial P^H}$, might initially appear difficult to determine; however, Schroeter, Lusk, and Tyner (2008) show that the value can straightforwardly calculated using own- and cross-price elasticities of demand along with weight-consumption elasticities, which can be determined using energy accounting. In particular, their results imply that $\frac{\partial W^*}{\partial P^H} = (\varepsilon^{HH}\eta^H + \varepsilon^{LH}\eta^L + \varepsilon^{EH}\eta^E)\left(\frac{W^*}{P^H}\right)$, where ε^{HH} is the own-price elasticity of demand for the high-calorie food, ε^{LH} and ε^{EH} are cross-price elasticities of demand for low calorie food and exercise with respect to the price of high-calorie food, and where η^k is the percentage change in weight resulting from a 1% increase in consumption of good $k = H$, L, and E, high-calorie food, low-calorie food, and exercise, respectively.

The term that is most uncertain in equation (5), in the sense that there are not well-established values in the literature, is an individual's willingness-to-pay for a one pound weight

reduction, WTP^{W^*}. As such, it might be useful to use existing values of F^{H^*} and calculated

values of $\frac{\partial W^*}{\partial P^H}$ to infer the value of WTP^{W^*} that would be required for an individual to benefit

from the fat tax. Such a procedure, while not providing a precise answer, can at least provide an

intuitive feel for the likelihood of a fat tax being welfare-enhancing.

Re-writing the welfare-enhancing condition in terms of weight willingness to pay yields:

$$(6) \qquad EV < 0 \text{ if } WTP^{W^*} > F^{H^*}\Big/\left(-\frac{\partial W^*}{\partial P^H}\right),$$

and substituting the equation for $\frac{\partial W^*}{\partial P^H}$ given above and rearranging yields:

$$(7) \qquad EV < 0 \text{ if } WTP^{W^*} > F^{H^*}P^H\Big/\left(W^*(\varepsilon^{HH}\eta^H + \varepsilon^{LH}\eta^L + \varepsilon^{EH}\eta^E)\right).$$

The numerator, $F^{H^*}P^H$ is simply the expenditure on the high-calorie food, and the denominator,

$W^*(\varepsilon^{HH}\eta^H + \varepsilon^{LH}\eta^L + \varepsilon^{EH}\eta^E)$, is the change in weight (in lbs) that results from a 1% increase in

the price of the high-calorie food, P^H.

Equation (7) provides a convenient means of calculating whether a fat tax is welfare-

enhancing by employing the type of data that is normally used to simulate the weight effects of a

fat tax. For example, consider the results in Schroeter, Lusk, and Tyner (2008) related to a tax

on sugary soft drinks – a target of many fat tax advocates. Their results suggest that a 1%

increase in the price leads to a 0.019 lbs weight loss for men and a 0.02 lbs weight loss for

women. They also report that men and women consume about 14.125 oz and 12.156 oz of

caloric soft drinks per day, and the data in Dhar et al. (2003) indicate that caloric soft drinks cost

about $0.027/oz. This means that men spend about $140.97 on caloric soft drinks each year and

women spend about $121.32/year. Plugging this data into equation (7), we can see that men

would have to be willing-to-pay at least 140.97/0.019 = $7,419.47 per lb of weight lost and

women would have to be willing-to-pay at least 121.32/0.02 = $6,066 per lb of weight lost in

order for a fat tax to improve their welfare. It is difficult to imagine that most people would be willing to pay such a large sum of money for a relatively small weight loss. Stated differently, within the framework analyzed here, it is rather unlikely that a fat tax would be welfare-enhancing.

Summary and Conclusions

This note provided a convenient means to determine whether a fat tax is welfare-enhancing. By including weight as an argument to the utility function, we show that a fat tax can be welfare enhancing if the amount people are willing to pay for a one-pound weight reduction is greater than the ratio of the expenditure on the taxed good to the weight loss produced by the tax. Our empirical calculations show that men (women) would have to be willing pay $7,419 ($6,066) per pound of body weight lost for a tax on caloric soft drinks to be welfare enhancing. The fact that consumers are very unlikely to pay such high amount suggest: 1) the soda tax will not improve welfare within the context of the model used here, or 2) a soda tax policy would have be justified on some other grounds.

There are other conceptual models which might be used to motivate a fat tax. For example, many argue that obesity causes an externality. Finkelstein, Fiebelkorn, and Wand (2004), for example, calculate that each obese individual increases the cost of Medicare by $1,486, the cost of Medicaid by an extra $864, and private insurance by an additional $423 annually. A model arguing that the existence of externalities justifies a fat tax would need to link the externality costs imposed on individuals to the offsetting benefits from others' weight reductions. An alternative modeling approach might rely on behavioral economics to motivate a fat tax. For example, O'Donoghue and Rabin (1999 and 2000) argue that people have self-

control problems when dealing with intertemporal decisions that involve choices between immediate benefits (e.g., tasty food) and future costs (e.g., obesity). In such a model, a fat tax could serve to improve social welfare by moving some of the future costs to the present.

While it is clearly *possible* to justify a fat tax by pointing to externalities of behavioral economics, the problem is that it few authors have worked out the steps to actually empirically determine whether a fat tax is welfare enhancing within these frameworks. As fat taxes move closer to being actually implemented, it would seem imperative for authors to actually calculate the welfare consequences of a fat tax rather than making vague reference to a justification based on externalities or behavioral economics. This note provided one simple framework in which such a calculation is possible.

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