

Fat Taxes and Thin Subsidies: Distributional Impacts and Welfare Effects*

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Abstract

The extant literature on fat taxes and thin subsidies tends to focus on the overall effectiveness of such fiscal instruments in altering diets and improving health. However, little is known about the welfare impacts of fiscal food policies on society. This paper fills a gap in the literature by assessing the distributional impacts and welfare effects resulting from a tax-subsidy combination on different food groups. Using the methods derived from marginal tax reform theory, a formal welfare economics framework is developed allowing the calculation of the distributional characteristics of various food groups and approximate welfare measures of prices changes caused by a tax-subsidy combination. The distributional characteristics reveal that many of the food groups target by a fat tax are consumed in greater concentration by low-income households than higher-income households. The overall welfare effect of a fat tax and thin subsidy combination is found to be negative, meaning that the thin subsidy is not enough to compensate for the negative impacts of the fat tax.

JEL Codes: D30, D60, H20, I10, I30.

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1 Introduction

One of the most pressing public health challenges today is the prevalence of diet related chronic disease resulting from poor dietary choices, specifically overweight and obesity. According to the 2004 Health Survey for England, which records body mass index (BMI), nearly 65% of the adult population were overweight (BMI greater than 25) while almost 25% were obese (BMI greater than 30). A great deal of interest and attention is focused on the use of fiscal interventions to combat spiralling obesity rates, both in the United Kingdom and in the United States. Much of the work to date on fat taxes and thin subsidies focuses on their overall effectiveness to reduce unhealthy food consumption and reduce obesity rates. While many of the studies conducted by economists tend to show only a slight decrease in fat consumption resulting from a fat tax (Chouinard et. al 2007; Powell and Chaloupka 2009), studies by health professionals show that fat taxes have meaningful impacts through reduced rates of cardiovascular disease (Marshall 2000; Mytton et. al 2007). For example, Mytton et. al (2007) show that up to 3200 deaths from cardiovascular disease could be avoided in the UK through a fat tax on a wide range of foods, and Marshall (2000) demonstrates that a tax on dietary saturated fat could avert up to 1000 deaths a year in the UK.

Despite the attention on the use of fat taxes and thin subsidies as a method of regulating diets and improving health, very little is known about the expected impacts such policies will have on the welfare of the population as a whole. How much redistribution will be achieved by implementing a combination of taxes and subsidies on various food groups? Will the proposed fiscal interventions harm consumers in terms of social welfare? How much of the welfare change may be attributed to fat taxes, and how much of this damage can be compensated by the use of subsidies? These questions are addressed using the tax reform methodology developed by Feldstein (1972) and Stern (1987) to examine the distributional consequences and welfare implications of fat taxes and thin subsidies on food consumption.¹ Addressing the welfare implications of a fat tax is not as clear as it might initially seem however. Drenowski (2004) finds that obesity and type 2 diabetes follow a socioeconomic gradient in the U.S. in which the highest rates of disease are found among groups with the highest poverty rates and the least education. An obvious explanation is found in Dowler's (2003) concept of "food poverty" where in developed countries a pattern exists with households living on low wages have lower nutrient intakes and worse dietary patterns than households in a better economic position.

¹For summaries see Atkinson and Stiglitz (1980), Stern and Newbery (1987), and Santoro (2007). For applications see Ahmad and Stern (1984), Newbery (1995), Ray (1999), Liberati (2001), and Kaplanoglou (2004).

From a classical welfare economics perspective, taxing foods will be highly regressive on low income households, especially when the tax is targeted on energy-dense, nutrient-poor, fatty foods which are disproportionately consumed in low income households. However, from a public health perspective, taxing unhealthy foods will reduce diet related chronic diseases, increase nutrient intakes, and improve dietary patterns, particularly in the low income households. The extent to which a thin subsidy mitigates these effects is uncertain and largely depends on demand behaviour. Consequently, a fat tax will have a negative welfare effect in terms of regressive *wealth* redistribution, however such a policy will also have a positive welfare effect in terms of progressive *health* redistribution. In short, there is a health-wealth trade-off to a fiscal food policy. Depending on the responsiveness of consumers to price changes in different food groups, a thin subsidy may alleviate (and possibly outweigh) the negative welfare impact of a fat tax. Moreover, the thin subsidy may reinforce the health improvements of a fat tax by increasing consumption of healthier foods. The overall welfare impact and the distributional consequences of a combined fiscal policy of a fat tax and thin subsidy is the focus of this paper. The distributional consequences are assessed using the distributional characteristic derived by Feldstein (1972) while the welfare impacts are measured using the method presented in Stern (1987) and Newbery (1995).

This paper is organised as follows. A brief review of the literature is in section 2, with an emphasis on the welfare effects of fiscal food policies. Section 3 describes the theoretical and empirical methodology. The data are described in section 4, as well as the empirical results. The final section concludes.

2 Fiscal food policies and social welfare

There is a growing literature investigating the effects of fat taxes and more recently thin subsidies. Much of the research emphasises health outcomes and focuses on the effectiveness of fiscal food interventions in reducing diet related chronic disease, such as obesity. However, no known study examines the welfare effects of fat taxes (and none in regards to thin subsidies) in a rigorous economic framework. The few studies that in fact address distributional concerns do not do so within a true social welfare context. When considering tax reform and the welfare effect of changes in relative prices, like the proposed changes in food prices from a combination of taxes and subsidies, analysis that follows from a formal social welfare theory framework provides theoretical advantages and also provides limits on the necessary assumptions about the data (Ahmad and Stern 1984).

First, informal welfare measures of social welfare, such as money-metric measures like equivalent and compensating variation, are far from ideal. Money metric utility measures assume by definition that the social marginal utility of income is equal to one in every household (Banks, Blundell, and Lewbel 1996). As is discussed in the next section, this is a limiting assumption worth relaxing since it does not allow distributional judgements. Moreover, Blackorby and Donaldson (1988) show that money metric measures violate concavity of social orderings over optimal commodity allocations unless household preferences are homothetic.² Thus, while data requirements tend to be modest for money-metric measures, they only represent valid measures of welfare under very strict assumptions which are not normally descriptive of actual behaviour (Blackorby and Donaldson 1988). Second, considerations of distributional equity can only be assessed under a rigorous social welfare model, which allows the social marginal utility of income to differ between households and permits social judgements on equality. By specifying a social welfare function with heterogeneous marginal utilities, not only can welfare impacts due to price changes be assessed, but distributional implications can be analysed using the distributional characteristic. The distributional characteristic gives a measure of the concentration of consumption in low income households for a set of commodities and allows the analyst to see which price changes resulting from a tax will have a greater impact on poor or rich households (Feldstein 1972). Hence, the distributional characteristic allows a policy-maker to appropriately target commodity groups for taxes and subsidies and is a powerful tool in applied welfare economics. However, unlike money-metric measures, the distributional characteristic requires a formal social welfare framework with a well-defined social welfare function and so accounts for social preferences.

Leicester and Windmeijer (2004) simulate a fat tax in the UK and assess the distributional effects. In their simulation, food was taxed based on four nutrients found to have adverse health consequences when consumed in large quantities (saturated fat, mono-unsaturated fat, sodium, and cholesterol). The tax was assessed at the rate of one pence per a kilogram of the nutrient. Based on the simulated tax rate and using data from the 2000 National Food Survey, the fat tax is found to be highly regressive. The poorest 2% of the 8000 household sample spend 0.7% of their income on the tax, while the richest pay only 0.1% (the median income group pay about 0.25%). However, the welfare analysis in Leicester and Windmeijer (2004) is very limiting. First, the calculations do not account for the potentially offsetting impact of subsidies. Second, the calculations do not allow for consumers to shift consumption in the

²Assuming homothetic preferences implies that an individual income consumption curve is linear over the whole consumption set, which represents a critical flaw for applied welfare analysis. See Blackorby and Donaldson (1988) for a theoretical proof.

event of a price change. Third, the analysis is not based on a formal social welfare framework.

Chouinard et. al (2007) examine the welfare effects of a fat tax on various dairy products using a unique micro-data set on weekly average household purchases for a sample of 23 US cities. They simulate the effects of a fat tax based on the fat percentage of different dairy products. Based on a 10% tax rate, they calculate the equivalent variation as a measure of the welfare loss resulting from the tax. Their results find the fat tax to be highly regressive, with the burden falling mostly on the low-income households: the burden is 0.24% for households with an annual income of \$20,000 USD, but only 0.024% for households with an annual income of \$100,000 USD. While the analysis in Chouinard et. al (2007) uses demand elasticities and represents an improvement over the analysis in Leicester and Windmeijer (2004), there remain key limitations. First, the framework in Chouinard et. al (2007) is limited to dairy products and the elasticities computed in their paper do not account for the full range of substitutability across different groups of goods. Furthermore, as already discussed, the use of equivalent variation is open to a range of problems and is widely accepted to be a poor welfare measure (Slesnick 1998).

Allais et. al (2010) conduct an analysis similar to Chouinard et. al (2007) except they estimate the demand elasticities for a full range of food groups for a sample of French households using the TNS Worldpanel survey. Simulating a 10% tax on foods in the cheese and butter category they find the tax regressive as well: the burden is 0.22% for modest income households but only 0.068% for well-off households. However, their analysis suffers from similar flaws mentioned above since the welfare calculations are based on equivalent variation and do not examine the impact of subsidies. Although elementary in their welfare analysis, the papers by Leicester and Windmeijer (2004), Chouinard et. al (2007), and Allais et. al (2010) represent the only attempt in the literature to investigate the welfare effects of fat taxes. To be fair, the focus of each of these papers is not on social welfare but rather on the effectiveness of fat taxes in changing diets and improving health, which is generally the focus of all research regarding fat taxes and thin subsidies.

While the impact on health from fiscal food policies is an important area of study, little to nothing is known about the impact on social welfare resulting from a combination of fat taxes and thin subsidies. This paper examines the impact of fat taxes and thin subsidies within a formal and rigorous welfare economics framework. The analysis provides two distinct economic measures of welfare. First, the distributional characteristic is computed providing information on the degree of concentration of different food items in low income households and makes clear the extent to which taxes and subsidies will

impact the poor. Second, first-order and second-order welfare measure approximations are calculated to assess the overall impact of fat taxes and thin subsidies on social welfare. The next section derives each of these measures and provides an intuitive interpretation of both the distributional characteristic and welfare approximations in the context of fiscal food policies.

3 The welfare impact of price changes

The method employed in this paper is based on the theory of marginal tax reform and normative optimal taxation theory. The theory originates with Feldstein (1972) and Ahmad and Stern (1984) and is based on the optimal commodity taxation rules derived by Ramsey (1927) and Samuelson (1986). Good summaries are found in Atkinson and Stiglitz (1980), Newbery and Stern (1987), and Santoro (2007). In this method, a set of indirect tax policies are judged based on their distributional impact within a utilitarian social welfare framework. Two aspects of a change in price are being assessed. First, the redistributive effect of the price change is gauged through the calculation of the distributional characteristic for a set of disaggregate goods. Second, the overall impact of the price change on social welfare is assessed using an approximate measure of welfare.

The starting point is the social welfare function, which aggregates individual welfare levels. Define the social welfare function over $h = 1, \dots, H$ households³

$$W = W(U^1, \dots, U^H) = W(V^1(e^1, p), \dots, V^H(e^H, p)), \quad (1)$$

where for household h , U^h is the direct utility function and is equivalent to the indirect utility function $V^h(e^h, p)$, which is a function of household expenditures, e^h and a vector of prices, p .⁴ Note that the household consumes a number of goods, where $i = 1, \dots, G$ and each household is assumed to face the same set of prices. The social welfare function in equation 1 is of the Bergson-Samuelson class, in which society's welfare is a function only of the individual utilities of its members (Bergson 1938, Samuelson 1956).

Consider a marginal change in the consumer price of good i from p_i to p_i^* , where $p_i^* = p_i + \Delta p_i$ and Δp_i is the marginal price change. The impact on social welfare, W , from a marginal change in

³Given that household expenditure data is used in the welfare analysis, the relevant unit of measure in this paper is the household rather than the individual agent. See Slesnick (1998, p. 2123 - 2125) for a discussion on the justifications and limitations of modelling the household as the decision-making unit.

⁴Indirect utility is a function of expenditure rather than income in the welfare analysis. Slesnick (1998, p. 2146) states that "in a static context the appropriate welfare indicator should be a function of total expenditure rather than income," therefore expenditure can be taken as a proxy for income.

consumer price is

$$\frac{\Delta W}{\Delta p_i} = \frac{W^* (V^1 (e^1, p^*), \dots, V^H (e^H, p^*)) - W (V^1 (e^1, p), \dots, V^H (e^H, p))}{\Delta p_i}, \quad (2)$$

where W^* is social welfare at the changed price and W is social welfare at the original price. The first step in examining the welfare impact of a price change, such as one resulting from a fat tax or thin subsidy, is to approximate the effect in equation 2. To gauge the distributional consequences of a price change on food expenditure, the distributional characteristic is computed. Attention now turns to the derivation of the distributional characteristic, followed by the derivation of the approximate welfare measure.

3.1 The distributional characteristic

Feldstein (1972) introduces the concept of the distributional characteristic of a good as a way of explicitly considering the distributional equity of optimal prices and taxes. By considering not just efficiency but also equity, the distributional characteristic represents a value judgement. The distributional characteristic is commonly used to examine distributional consequences from indirect taxes and price changes (See, for example, Newbery (1995), Ray (1999), and Liberati (2001)).⁵ In the context of a fiscal food policy, changes in food prices can have implications for the distribution of income, especially since the poor tend to spend a disproportionately large share of income on food-related items. The distributional characteristic measures the extent consumption of a good (such as chips or fresh fruit) is distributed across the distribution of income (or expenditure). The key advantage of computing the distributional characteristic is that it provides information on the distributional impacts of indirect price changes, like those caused by fat taxes and thin subsidies, by showing what price changes in goods will impact the less well-off the most. With the distributional characteristic, the policy-maker is equipped with a tool to aid in targeting decisions of indirect taxes and subsidies.

The approach is based on that pioneered by Bergson (1937) and Samuelson (1947). Before deriving the distributional characteristic, first consider the impact on social welfare from a change in household expenditure

⁵Previous studies tend to use the distributional characteristic in an ex post fashion in which the welfare impact of price changes that have already occurred is being analysed. The use of the distributional characteristic in this paper is ex ante, that is, the welfare impact of price changes that *may* occur is being analysed. This is similar in spirit to the problem investigated in Banks, Blundell, and Lewbel (1996) who suppose a hypothetical price change on clothing to assess first-order and second-order welfare approximations.

$$\beta^h \equiv \frac{\partial W(V^1(e^1, p), \dots, V^H(e^H, p))}{\partial V^h(e^h, p)} \cdot \frac{\partial V^h(e^h, p)}{\partial e^h} = \frac{\partial W}{\partial V^h} \cdot \alpha^h, \quad (3)$$

where α^h is the private marginal utility of expenditure (or income). The value of β^h is the social weight or the social marginal utility of household h receiving an additional unit of expenditure (Newbery 1995) and it therefore combines the weighting of the policy maker or social planner $\frac{\partial W}{\partial V^h}$ with that of the private individual, α^h .⁶ More simply, β^h represents society's valuation of one additional unit of expenditure given to household h . The distributional value judgements of the policy maker determine the form of the social welfare function in equation (Mas-Colell, Whinston, and Green 1995). In practise the form chosen is typically the additive utilitarian form where $W = \sum_h V^h$, which implies that the social weights β^h for each household equal the private marginal utility of income, α^h . The form chosen for the indirect utility function is usually the isoelastic form whose marginal utilities have constant elasticity. This is discussed in more detail in section 3.3.

The distributional characteristic is used to measure the extent to which consumption of a particular good is concentrated in those households which are deemed to be socially deserving where "socially deserving" is recognised by those households with higher values of β^h . This is achieved by constructing a measure in which the consumption of the i^{th} good by the h^{th} household (q_i^h) with its marginal social utility and aggregating across households. Thus, following Newbery (1995), the distributional characteristic, d_i , for the i^{th} good is

$$d_i \equiv \frac{\sum_h^H \beta^h q_i^h}{\bar{\beta} Q_i}, \quad (4)$$

where $\bar{\beta} \equiv \frac{1}{H} \sum_h^H \beta^h$ is the average of the social utility weights over all households and $Q_i \equiv \sum_h^H q_i^h$ is aggregate consumption of the i^{th} good.⁷ The measure is unit free, given the normalisation of the individual household social weight (β^h) by the overall average social weight ($\bar{\beta}$), and is bounded between zero and one. In terms of price changes, the distributional characteristic is interpreted as a measure of the relative harm/benefit of placing a tax/subsidy on the i^{th} good relative to the harm/benefit of placing a tax/subsidy on all households directly (Kaplanoglou 2004).

We compute the distributional characteristic for different food groups (milk, cheese, pork, fresh fruits and vegetables, tinned fruit and vegetables, etc). This will reveal if consumption of certain food groups are distributed to the socially deserving or not. The higher the value of d_i , the more

⁶Feldstein (1972) defines the marginal social utility of income as the derivative of the social welfare function with respect to household income.

⁷The numerator of the distributional characteristic is actually the absolute impact of a price change on social welfare, which is derived in the next section.

concentrated the consumption of the food group on the more socially deserving households. A typical welfare framework would imply that food groups with a low d_i should be taxed while food groups with a high d_i should be subsidised. In a social welfare context, any tax on the food group with a relatively high distributional characteristic will be highly regressive if evaluated against income or total expenditure. However, from a public health perspective the implications are different. Given the extant literature, high distributional characteristics are likely to be found for energy-dense, nutrient-poor, fatty foods (e.g., pre-packaged ready made meals), which tend to be less expensive than healthier, low calorie, nutrient-rich foods (e.g., fresh fruits and vegetables) per calorie (Dowler 2003; Drenowski 2004; Frazao et. al 2007). Consumption of fatty and sugary foods contributes to a range of public health problems, such as diabetes and heart disease, and so the use of fiscal instruments has been debated as a means of shifting consumption towards healthier choices.

In this paper, the distributional characteristics reveal the extent to which consumption of unhealthy foods (e.g., fats and cheeses) is concentrated in the “socially deserving” (i.e., low-income households) and the extent to which consumption of healthy foods (e.g., fresh fruits and vegetables) is concentrated in the “socially undeserving” (i.e., high-income households). If this is the case, then from a public health perspective unhealthy foods should be taxed while healthy foods should be subsidised to improve the distribution of health among low-income households. However, from a social welfare perspective the opposite could be true: unhealthy foods should be subsidised while healthy foods should be taxed. If the distributional characteristics reveal that consumption of unhealthy foods are not concentrated in low-income households, then a fat tax appears more attractive both from an economic welfare perspective and a public health perspective. While obviously still regressive on low-income households, the negative welfare effect of the fat tax may be compensated for by a thin subsidy on healthier food options. The direction of the welfare effect, in terms of income changes, is approximated by the welfare measures derived in the next section.

3.2 Welfare approximation

While computation of the distributional characteristics discussed in the previous section is important for summarising the distributional impact of fat taxes and thin subsidies, it does not address the aggregate change change in social welfare. Measures that approximate the effect in equation 2, that is the impact on welfare from a change in price, are used to gauge aggregate welfare effects. First-order welfare approximations are discussed, which have the notable advantage of not requiring information

on consumer demand behaviour. While second-order welfare approximations extend the first-order approximation to account for possible shifts in consumption resulting from price changes, the calculation requires estimation of demand elasticities. As such, the current paper confines attention to the first-order approximations (with the second-order approximations to be considered in future work).

As a starting point, suppose the the price of good i increases through a marginal change in the tax rate. In money terms, household h is worse by the quantity consumed, q_i^h , or in utility terms is worse off by $\alpha^h \cdot q_i^h$ (Ahmad and Stern 1984). Using Roy's identity the change in household utility from a price change is given by

$$\frac{\partial V^h}{\partial p_i} = -\alpha^h q_i^h. \quad (5)$$

The change in social utility for a small change in price (e.g., a tax or subsidy on quantities) in equation 2 can be approximated to provide a numerical measure of the change in social welfare. The first-order welfare approximation of the effect of a small change in price (of good i) is given by

$$\frac{\Delta W}{\Delta p_i} \approx \frac{\partial W}{\partial p_i} = \sum_h^H \frac{\partial W (V^1 (e^1, p), \dots, V^H (e^H, p))}{\partial V^h (e^h, p)} \cdot \frac{\partial V^h}{\partial p_i}. \quad (6)$$

Using equation 5 and social welfare function in equation 1, the level form of the first-order approximation is obtained

$$\frac{\Delta W}{\Delta p_i} \approx \frac{\partial W}{\partial p_i} = - \sum_h^H \beta^h q_i^h. \quad (7)$$

From the first-order approximation in equation 7, the welfare impact of a price change is seen to depend on two factors: the distribution of consumption, given by the social weights β^h , and the level of consumption among households, given by q_i^h (Newbery 1995). The first-order welfare measure in equation 8 expresses the idea that if the marginal price paid for good i changes through either a tax or a subsidy, then the welfare loss or gain to the household depends upon the current expenditure by the household on the i^{th} good. In the context of fat taxes and thin subsidies, suppose a government policy proposes a tax (subsidy) on food group i totalling £1. An alternative to the fiscal policy proposal would be to apply the tax (subsidy) directly on all households so that each household is taxed (subsidised) in the amount of $\frac{1}{H}$ £1. The tax (subsidy) on the good is preferred over the direct tax (subsidy) only when household expenditure on good i is below (above) the average household (Alan et. al 2002).

The approximate welfare change resulting from a marginal change in price of the i^{th} good is found

by summing the social marginal utilities of income, β^h , weighted by consumption of good i over all households.⁸ Alternatively, the first-order approximation can be written in terms of the distributional characteristic

$$\Delta W = -\bar{\beta}d_iQ_i\Delta p_i, \quad (8)$$

since the numerator of the distributional characteristic defined in equation 4 is equal to the welfare approximation in equation 7 (Newbery 1995). The relevance of the distributional characteristic to the welfare effects of price changes is made more clear in the approximation given by equation 8. When a price increase occurs for a good whose consumption is concentrated in households with high marginal utilities of expenditure (i.e., low-income or socially deserving households), the price increase will have a more negative impact than if the price increase occurred on a good whose consumption is concentrated in households with low marginal utilities of expenditure (i.e., high-income households). Given that price changes may occur over the spectrum of goods consumed, the effect on social welfare from multiple price changes is

$$\Delta W = -\sum_i^G \bar{\beta}d_iQ_i\Delta p_i, \quad (9)$$

An expression for the proportional change in social welfare resulting from changes in prices is obtained by normalising equation 9 by the initial level of welfare

$$\frac{\Delta W}{W} = -\frac{\sum_i d_iQ_i\Delta p_i}{\sum_i d_iQ_i p_i}. \quad (10)$$

Equation 10 measures the proportional impact of price changes on aggregate social welfare and has the useful interpretation of the percent change in welfare caused by a change in price.

3.3 Implementation

To make the welfare approach operational, knowledge of two components is required: household expenditure on a set of goods and the ability to determine socially deserving households. Expenditure

⁸ Implicitly producer prices are assumed fixed so the change in price on good i is equivalent to the tax on that good. While the assumption simplifies distributional issues and serves as an appropriate benchmark, tax over-shifting is a possibility (Liberati 2001).

data is easily obtained from household budget surveys. The social weights, β^h , provide the ability of identifying households more deserving of marginal increases in income. To calculate the social weights, the social welfare function must first be given a functional form.

An additive social welfare function of isoelastic utility functions, originally proposed by Atkinson (1970), is the most frequently used social welfare function in the marginal indirect taxation literature (see, for example, Ahmad and Stern (1984), Madden (1995a), Madden (1995b), Newbery (1995), and Banks, Blundell, and Lewbel (1996)) and is formally represented by

$$W = \sum_h V^h. \quad (11)$$

Indirect utility is defined over real expenditure (consumption) per equivalent adult, E^h , and is parametrised as

$$\begin{aligned} V^h &= (1 - \rho)^{-1} (E^h)^{1-\rho} & \rho \neq 1 \\ V^h &= \ln E^h & \rho = 1 \end{aligned}, \quad (12)$$

where $\rho \geq 0$ is the coefficient of inequality aversion. The social welfare function is more egalitarian with greater values of ρ . Thus, under additive social preferences, social welfare is approximated by the weighted sum of expenditures per equivalent adult.⁹ The indirect utility function, V^h , is in the family of isoelastic utility functions where the marginal utilities have constant elasticity.

Given the functional form in equation 12, the social weights (i.e., marginal social utility) are

$$\beta^h \equiv \frac{\partial W}{\partial V^h} \cdot \frac{\partial V^h}{\partial E^h} = (E^h)^{-\rho}. \quad (13)$$

The social value of a marginal unit of income to the poorest household is worth 2^ρ times as much to a household with twice the income. Thus, values of ρ that are successively greater than zero lead to greater weight being applied to poorer households. By increasing the value of the coefficient of inequality aversion, ρ , the relative weight given to consumption of low-income households in the distributional characteristic (i.e., β^h) is also increased. In other words, different values of ρ lead to different judgements regarding income transfers. For example, suppose Household *A* has half the income of Household *B*. If $\rho = 1$, a marginal unit of income has twice as much social value when transferred to Household *A* rather than Household *B*. If $\rho = 2$, a marginal unit of income has quadruple

⁹Total expenditure on all goods in each household is divided by the number of equivalent adults in each household to obtain expenditure per equivalent adult. The actual number of equivalent adults are obtained using the OECD equivalence scales, which counts the first adult in the household as one ‘‘full’’ person. Additional adults count as 0.7 and children under the age of 14 count as 0.5.

the social value when transferred to Household *A*. The precise definition of the social welfare weights in equation 13 depends upon the specification of the social welfare function and the indirect utility function.

The additive social welfare function in equation 11 based on the isoelastic indirect utility function in equation 12 is one example of a generalised utilitarian social welfare function (i.e., $W = \sum_h \mathcal{F}(V^h)$, where $\mathcal{F}(\bullet)$ is an increasing, concave function) in which the welfare weights only depend on the expenditure level and are independent of prices.¹⁰ In this framework, the social planner makes an intentional decision or social judgement to weight household utility. The isoelastic form is convenient since the coefficient of inequality aversion has an intuitive meaning: a one percent decrease in income (or expenditure) implies a ρ percent increase in marginal social utility (Feldstein 1972). The isoelastic utility function is also convenient in the context of indirect tax reform because assumptions about inequality can be adjusted by means of a single parameter (Mas-Colell, Whinston, and Green 1995).¹¹ On one extreme end when $\rho = 0$ then $W = \sum V^h$ is the Benthamian pure utilitarian case of no inequality aversion and β^h collapses to unity meaning all households are applied the same social weight so distributional issues are of no concern. In the pure utilitarian case, increases and decreases in individual household utility imply a one-for-one change in social utility, and is often referred to as the linear-in-utility welfare function since the indifference curves are linear (Varian 1992). On the other extreme end when $\rho \rightarrow \infty$ then $W = \min \{V^1, \dots, V^H\}$ is the Rawlsian maximin case in which only the utility of the poorest household matters (i.e., the utility of the household with the lowest consumption or expenditure). In the maximin case all the social weight is applied to worst-off household and the indifference curves are lexicographic or L-shaped (Mas-Colell, Whinston, and Green 1995). A range of values for ρ are used in the empirical analysis to see if conclusions are robust to different distributional judgements.

4 Data and empirical results

4.1 Food data and fiscal policy

Data on food expenditures and quantities are from the UK government's Expenditure and Food Survey (EFS) for 2003-2004, which records data on a wide range of food eaten. The EFS (starting in

¹⁰Banks, Blundell, and Lewbel (1996) discuss the drawbacks associate with assuming price-independent social weights.

¹¹While most welfare studies on indirect taxes and price changes utilise the isoelastic form, other function forms can be used. Cragg (1991), for example, uses the Kolm-Pollak utility function.

2001-2002) is the result of the merger between the Family Expenditure Survey (FES) and the National Food Survey (NFS), two well established surveys and important sources of information for government and the broad research community on UK spending and food consumption patterns. In this study we use the 2003-2004 data-set, which is the latest (at the time of starting to work with the data) complete dataset available from the Economic and Social Data Service (ESDS). The 2003-2004 sample is based on 7,014 households in 672 postcode sectors stratified by Government Office Region in England and Wales. Participating households voluntarily record food purchases for consumption at home for a two week period using a food diary for each individual over seven years of age. The data collected by the food diaries are supplemented with the use of till receipts.

The EFS identifies four major categories of interest: food (sub-divided in 55 categories), non-alcoholic drink (sub-divided in 7 groups), alcoholic drink (sub-divided in 4 groups) and catering services (split into 3 categories). In addition to data on food expenditure and quantity, other key variables are available, including: ownership of food-related durables (fridges, freezers etc.), housing tenure, key demographics (age, sex, employment status etc.) for each household member, type and composition, social class of head of household, region and categorical degree of activity for head of household (i.e. sedentary, active etc.). While information is collected on eating out expenditure, food eaten out of the home is omitted from the analysis since no data on quantities is provided. The data extracted from the EFS are prepared into a form suitable for welfare calculation.

Individual food items and farm commodities are converted into aggregate food groups that can be identified for a fat tax or thin subsidy. Five main food group aggregations are used in the analysis: dairy, eggs, and fats; meat and fish, cereals and potatoes; fruits and vegetables; and drinks. A sixth category of “other foods” is used to categorise those component food items that do not clearly fit into the other five categories.¹² Each of the main food groups are composed of component food item groups (25 in total), which are detailed in the first two columns of Table 1. While such broad aggregates simplifies the analysis, detailed information is inevitably lost in the aggregation process. For example, the “milk” category includes both full-fat and skimmed milk, and the distributional characteristics may potentially differ between these two sub-category items. Table 1 also presents the expenditure shares as well as the mean and standard deviation of the quantity consumed and the expenditure of the component food group items. In regards to units, mean quantities consumed per household are in grams or millilitre equivalent and expenditure per household is in pence. The food items with the

¹²The exact food group items that compose each of the component food groups is available in an appendix upon request to the author

three highest budget shares are alcohol, fresh fruits and vegetables, and other meats. The food items with the three lowest budget shares are frozen fruits and vegetables, eggs, and fruit and vegetable ready-based meals.

The fat tax applied to selected food groups is based on saturated fatty acids, while the subsidy is applied to fruit & vegetables. The fiscal policy used, based on a combination of taxes and subsidies, is designed to be a revenue-neutral scheme. The choice of saturated fatty acids as the prime target of the fat tax is justified by evidence from the medical literature. Saturated fats are an important risk factor in the occurrence of coronary heart disease (Hu et al. 1997), higher systolic blood pressure (Esrey et al. 1996), and higher plasma concentration of cholesterol (Ascherio et al. 1994). Fruit and vegetables, on the other hand, are positively linked to lower risks of various cancers (Ames et al. 1995; Riboli and Norat 2003), major chronic diseases (Hung et al. 2001), and ischaemic stroke (Joshiyura et al. 2001). Specifically, the fiscal scheme simulation increases the price of each food group by 1% for every percent of saturated fats the group contains. The EFS dataset contains nutrient conversion tables that are used to convert food group items into nutrient content. For example, since milk contains 1.72% of saturated fats, its price increasing by 1.72%. A ceiling of 15% is placed on the simulated price increase. To offset this tax burden, and to encourage the consumption of fruit and vegetables, a subsidy on fruit and vegetables is introduced, so as to exactly cancel the costs of the fat tax paid by consumers. Table 1 presents the tax and subsidy rates applied to the different component food group items and assigns an index number to each group.

4.2 Results

Recall from section 3.1 that the distributional characteristic of a good is a measure of the relationship between a household's consumption of a good and the marginal value of a change in household income. The distributional characteristic is a scale free measure, between zero and one, with values closer to one indicating that consumption of a particular good is concentrated in poor households. Tax receipts will be disproportionately paid by lower-income households the larger the distributional characteristic of a good. A subsidy on a good with a smaller distributional characteristic will be disproportionately paid to higher income households. Subsequently, from an economic welfare viewpoint, goods with larger distributional characteristic ought to be subsidised while goods with a smaller distributional characteristic ought to be taxed. Table 4 presents the distributional characteristics of the component food items in descending order as well as the rank order of the commodities. The distri-

butional characteristics are calculated based on different values of the inequality aversion coefficient reflecting low ($\rho = 0.5$), moderate ($\rho = 1.0, 1.5$), and high ($\rho = 2.0$) inequality aversion.

Generally, the four food groups with the highest ranking (i.e., the highest distributional characteristics), reflecting expenditure being concentrated amongst households with high marginal utilities of expenditure (i.e., low-income households) are milk, bread, eggs, and potatoes. Although when $\rho = 2.0$, the fats food group replaces potatoes in ranking as the fourth highest and potatoes drop in ranking to eighth. The four food groups with the lowest ranking, reflecting expenditure being concentrated in the higher income households are alcohol, lamb, fruit and vegetable ready-based meals, and fish, which is consistent throughout the different degrees of inequality aversion. In between the two extremes the rankings of food items does not remain constant but shifts.

Table 4 also shows that in many instances the distributional characteristics are very close in value for some goods. For example, when $\rho = 1.0$, tea and coffee, fats, rice and pasta, cereal, other foods, and other cereals have distributional characteristics that are very close. Overall, results show minor variation in the value of the distributional characteristics over the food groups considered for the different values of inequality aversion. For example, when $\rho = 1.0$, the distributional characteristics are all greater than 0.5, meaning food consumption is relatively concentrated in the socially deserving households.

Suppose the distributional characteristics under each value of inequality aversion are split into a top half and bottom half, say at the 13th ranking, for example. Then what becomes clear is that generally the fruit and vegetable food groups targeted for subsidy are often found in the bottom half (i.e., amongst those food items whose consumption is concentrated in the less socially deserving households). Moreover, the food items that have the heaviest tax applied to them (fats, for example) amongst the food items that are more heavily concentrated in the socially deserving households.

According to the distributional characteristics in Table 4, a welfare enhancing policy prescription would be to tax the food items with the lowest distributional characteristics while subsidising the foods with the highest distributional characteristics. However, according to the fiscal policy scheme implemented, with the intention of inducing healthier diets, the foods with the highest distributional characteristics are all targeted for fat taxes. While policy guided by public health concerns may desire higher prices in food groups such as fats and lower prices in fresh fruits and vegetables, an policy guided by economic welfare considerations would suggest a subsidy on fats and a tax fresh fruits and vegetables.

While the distributional characteristics suggest that a fat tax policy will disproportionately burden low-income households, the welfare approximation in equation 10 is calculated to provide a measure of the overall impact on welfare as a result of the fiscal policy. Given that there is a possibility that the thin subsidy may offset the negative welfare impacts of the fat tax, the welfare measure yields the percent change in welfare caused by the simulated price change. Table 5 reports the results of computing expression 10 for the fiscal policy described in Table 3 for different values of inequality aversion. While the percent changes in welfare are small, the overall impact on social welfare from the fiscal policy is negative. Moreover, the negative changes in welfare are increasing in the level of aversion to inequality, which implies that the fiscal policy has redistributive effect that is particularly adverse to low-income households. The relatively small impact is not surprising, given that food represents just one of many different consumption bundles and the overall basket of goods consumed by households. The important outcome is the negative impact on welfare, despite the revenue-neutral stance of the fiscal policy and its intention to improve public health. On economic welfare grounds, the fat tax and thin subsidy policy used in this paper would harm social welfare overall. This finding is important since it suggests that even a revenue-neutral fiscal food policy can have negative redistributive impacts and casts doubt on the ability of a combined fat tax and thin subsidy to improve health without negatively affecting the poor and the population at large.

5 Conclusions

Obesity is of increasing concern throughout the developed world. Some estimates suggest that by 2015, 60% of men and 50% of women will be obese. Being obese increases the risks of a range of chronic health problems including heart disease, type 2 diabetes and high blood pressure. Additionally it has been shown that increased levels of fruit and vegetable consumption will contribute to a reduction in the incidence of some cancers. As a result, there is an increase in interest in public health policies that are designed to reduce the impacts of diet related disease. One such policy is a fiscal intervention designed to reduce the consumption of calorie and fat dense food and to encourage the consumption of fruit and vegetables.

There is a trade-off between health and wealth from imposing a fat tax on society. In terms of public health, taxing unhealthy, fatty foods is likely to have a positive health effect as consumers shift their distribution of consumption to healthier food choices. However, in terms of social welfare, since

consumption of fatty and calorie dense foods tends to be concentrated in low income households, a fat tax is likely to be extremely regressive. This paper fills a knowledge gap by focusing on the redistribution of income resulting from a tax-subsidy combination on different food groups. Further, unlike previous studies, this paper uses a formal welfare economics framework to assess the welfare implications of a combination of fat taxes and thin subsidies.

This paper examines the distributional consequences and economic welfare impacts of such a policy. The study finds that there is a trade-off between public health and economic welfare from imposing a fat tax on society. Energy-dense/nutrient-poor foods are disproportionately consumed among low-income households, which are the foods most likely to be taxed by a “fat tax” policy. Fiscal interventions will have adverse welfare implications for the very population it is intended to benefit. The research shows that while a fat-tax/thin-subsidy may have a progressive redistribution of health, it will have a regressive redistribution of wealth. Results suggest that a blanket fiscal policy is too blunt an instrument to achieve the intended results. Too many people are consuming diets that are considerable distance from recommended health guidelines. The overall conclusion is that the taxed food groups will hurt the poor in terms of economic welfare and will be highly regressive. Moreover, the subsidies applied to fruits and vegetables is not large enough in magnitude to offset the negative welfare impacts of the fat taxes imposed. Therefore, a blanket fiscal policy is too blunt an instrument and what is needed are specifically targeted policies focusing on people consuming extremely bad diets.

Future work will incorporate several modifications. First, while the first-order welfare approximation used here has the advantage of limited data requirements (since only knowledge of expenditure is required), it may also be a biased estimate. The first-order approximation does not account for changes in consumption in response to price changes, so it may overestimate the welfare impact of a price increase from a tax or underestimate the welfare impact of a price decrease from a subsidy (Banks, Blundell, and Lewbel 1996). A second-order approximation will be computed in future work to assess the extent of this bias. Moreover, different fiscal food policies can be constructed, which may have differential welfare impacts. While the tax in this paper is based on grams of saturated fat content, other options include taxes on selected food categories or on the calorie content of foods. Subsidies are likely to be limited to fruit and vegetables, though this could be generalised to be based on dietary fibre content. Lastly, while this paper uses the 2003-2004 EFS dataset, future work will include additional years.

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Table 1: Food groups

Main Food Groups	Component Foods	Quantity	Expenditure
Dairy, Eggs, & Fats	Milk	84.63	(75.92)
	Cheese & cream	5.76	(6.65)
	Other dairy	22.16	(26.72)
	Eggs	0.07	(0.09)
Meat & Fish	Fats	10.33	(12.15)
	Beef	7.60	(11.32)
	Lamb	2.44	(9.80)
	Pork	8.43	(10.66)
	Poultry	11.81	(16.99)
Cereals & Potatoes	Fish	7.19	(10.92)
	Other meats	20.70	(20.69)
	Potatoes	13.02	(16.27)
	Breads	46.96	(35.73)
	Breakfast cereals	7.22	(9.58)
	Rice & pasta	7.88	(20.66)
	Other cereals	14.47	(14.30)
	Fresh fruit & vegetables	68.68	(60.07)
	Frozen fruit & vegetables	3.60	(8.01)
	Tinned fruit & vegetables	28.61	(34.80)
Fruit & Vegetables	Prepared fruit & vegetables	6.07	(10.07)
	Fruit & vegetable based meals	2.90	(5.16)
	Tea & coffee	2.63	(3.63)
	Soft drinks	105.72	(132.17)
	Alcohol	36.70	(69.53)
	Miscellaneous food items	20.25	(18.95)
	Other		
Beverages	Other	9.81	(10.55)
	Other	3.55	(4.10)
	Other	7.63	(6.45)
	Other	1.97	(2.61)
	Other	1.73	(3.05)
	Other	6.03	(6.74)
	Other	10.71	(10.21)
	Other	0.51	(1.08)
	Other	2.97	(3.69)
	Other	1.40	(2.09)
Other	Other	1.22	(2.42)
	Other	1.94	(2.62)
	Other	4.48	(5.40)
	Other	12.33	(21.99)
Other	7.04	(7.78)	

Table 2: Total expenditure shares

Main Food Groups	Component Foods	Budget Share
Dairy, Eggs, & Fats	Milk	0.043
	Cheese & cream	0.025
	Other dairy	0.038
	Eggs	0.008
	Fats	0.021
Meat & Fish	<i>Total dairy, eggs, & fats share</i>	<i>0.135</i>
	Beef	0.033
	Lamb	0.012
	Pork	0.044
	Poultry	0.043
	Fish	0.041
	Other meats	0.092
	<i>Total meat & fish share</i>	<i>0.265</i>
	Potatoes	0.034
	Breads	0.072
Cereals & Potatoes	Breakfast cereals	0.019
	Rice & pasta	0.016
	Other cereals	0.057
	<i>Total cereals & potatoes share</i>	<i>0.198</i>
	Fresh fruit & vegetables	0.101
	Frozen fruit & vegetables	0.005
	Tinned fruit & vegetables	0.028
	Prepared fruit & vegetables	0.013
	Fruit & vegetable based meals	0.012
	<i>Total fruit and vegetable share</i>	<i>0.159</i>
Beverages	Tea & coffee	0.018
	Soft drinks	0.042
	Alcohol	0.116
Other	<i>Total beverage share</i>	<i>0.176</i>
	Miscellaneous food items	0.066
	<i>TOTAL shares</i>	<i>1.00</i>

Table 3: Fiscal food policy

Index Number	Component Foods	Tax / Subsidy
1	Milk	1.46%
2	Cheese & cream	15.00%
3	Other dairy	2.83%
4	Eggs	3.20%
5	Fats	15.00%
6	Beef	5.98%
7	Lamb	6.38%
8	Pork	4.55%
9	Poultry	1.93%
10	Fish	1.58%
11	Other meats	5.40%
12	Potatoes	1.16%
13	Breads	0.58%
14	Breakfast cereals	0.88%
15	Rice & pasta	1.16%
16	Other cereals	4.75%
17	Fresh fruit & vegetables	-14.78%
18	Frozen fruit & vegetables	-14.78%
19	Tinned fruit & vegetables	-14.78%
20	Prepared fruit & vegetables	-14.78%
21	Fruit & vegetable based meals	2.27%
22	Tea & coffee	0.55%
23	Soft drinks	0.00%
24	Alcohol	0.01%
25	Other (excluded from policy)	0.00%

Table 4: Distributional characteristics of food groups

Social weight based on:								
rank	$\rho = 0.5$		$\rho = 1.0$		$\rho = 1.5$		$\rho = 2.0$	
	d_i	index	d_i	index	d_i	index	d_i	index
1	0.941	1	0.828	1	0.582	1	0.272	1
2	0.924	13	0.793	13	0.528	13	0.191	13
3	0.915	4	0.780	4	0.518	4	0.189	4
4	0.914	12	0.768	12	0.485	12	0.156	5
5	0.905	22	0.755	22	0.478	22	0.156	25
6	0.903	14	0.753	5	0.478	5	0.155	22
7	0.903	5	0.749	15	0.474	15	0.154	15
8	0.901	15	0.749	14	0.470	25	0.154	12
9	0.900	16	0.745	25	0.466	14	0.145	14
10	0.899	25	0.742	16	0.457	23	0.144	23
11	0.896	18	0.737	23	0.456	16	0.142	19
12	0.896	23	0.735	18	0.451	18	0.138	16
13	0.895	11	0.734	11	0.450	11	0.137	11
14	0.888	19	0.726	19	0.449	19	0.136	18
15	0.886	3	0.718	3	0.436	6	0.136	6
16	0.878	6	0.711	6	0.434	3	0.135	17
17	0.878	17	0.709	17	0.434	17	0.131	20
18	0.875	8	0.704	20	0.428	20	0.130	3
19	0.874	20	0.703	2	0.425	2	0.128	2
20	0.874	2	0.700	8	0.423	9	0.127	9
21	0.871	9	0.699	9	0.418	8	0.124	8
22	0.870	10	0.695	10	0.415	10	0.122	10
23	0.866	21	0.687	21	0.408	21	0.120	21
24	0.840	7	0.648	7	0.375	7	0.107	7
25	0.807	24	0.598	24	0.332	24	0.091	24

Table 5: Welfare effect of fiscal policy

Proportional change in welfare			
$\rho = 0.5$	$\rho = 1.0$	$\rho = 1.5$	$\rho = 2.0$
-0.0031	-0.0033	-0.0034	-0.0035