FAT TAX: A POLITICAL MEASURE TO REDUCE OVERWEIGHT? THE CASE OF GERMANY

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Abstract

Using an Almost Ideal Demand System food price elasticities for German households are calculated. These elasticities serve as a basis to simulate the effect of the substitutions of different food types due to a tax on saturated fat. The change of food structure causes effects on the energy and nutrient supply of individuals as well as, on consumer welfare. These effects are analyzed for different German household groups. It is found that decreases in energy and fat intake are small but potentially effective especially for low-income households. However, due to the collateral decrease of nutrients which Germans have deficient supply of, the total health effects of a fat tax remain unclear. Furthermore the results show that low-income groups would bear higher welfare losses than high-income groups. Due to these results and the fact that a fat tax is not an efficient measure to reduce the negative welfare effects of overweight, other measures to reduce overweight should be taken into account.

JEL classification: D12; Q18; P46; I12

Keywords: Fat tax, foods, nutrients, welfare effects, Almost Ideal Demand System

1 Introduction

Increasing obesity rates have become a greater problem worldwide. The World Health Organization (WHO) estimates that globally there are more than one billion overweight adults and at least 300 million of them are obese. For Germany, the recent National Nutrition Survey of 2006 finds that the percentage of overweight individuals is 51% for women and 67% for men and the obesity rate is 20%. Thus, pressure on politicians to create effective counteractive measures clearly exists.

Current German efforts to reduce obesity rates involve information and schooling programs. The participation of individuals in these programs is predominantly voluntary. As obesity rates have increased continuously over time, these measures are obviously not sufficient. Hence, economic incentives to reduce obesity rates are discussed occasionally. These include, among others, the subsidization of healthy food such as fruits and vegetables and/or taxation of unhealthy food such as fat and sugar. Such price strategies seem to be promising as decreasing food prices are considered a main determinant of the growing overweight problem. In particular, the taxation of food is discussed widely in some countries (e.g., the United Kingdom and Denmark).

Review of previous studies raises several issues and questions about the fat tax: in fact nutritional studies verify a connection between fat consumption and being overweight (Bray et al 2002). Furthermore, some economic studies demonstrate that a fat tax leads to a reduction of fat consumption (Smed et al. 2007; Chouinard et al. 2007). However, economists believe that a fat tax involves a strong violation of consumer sovereignty; that is, the freedom of individuals to choose for themselves which of their needs are to be satisfied. Economists also question whether market failure with respect to overconsumption of fat really exists, and if so, if a fat tax is an appropriate correction measure (Becker 2006). In addition, it is unclear by how much consumers would reduce fat consumption if a fat tax was implemented and to which products they would switch. If they switched to sugared and salted products a fat tax might be counterproductive. It can be expected that the changed consumption structure has implications for the supply of nutrients and the reduction of calories. Thus, the health effects of a fat tax are of great interest. Furthermore, some authors criticize the regressive nature of a fat tax by which poorer individuals are more affected than richer individuals as food accounts for a greater share of their expenditure.

The aim of this presentation is to examine these issues related to the fat tax. Hence, the presentation starts with a short discussion about overconsumption, market failure and the fat tax. Thereafter, the effects of the fat tax are analyzed empirically. The methodology is based on the estimation of price elasticities using the Almost Ideal Demand System (AIDS). Using these elasticities, the effects of a fat tax can be simulated and the change in the food demand structure of individuals can be predicted. Furthermore, it is possible to forecast the change in fat, calorie and nutrient supply to determine impact on the health of individuals. Welfare effects can also be calculated. As a fat tax leads to an increase in food prices, welfare losses for households can be expected. My focus is the estimation of the magnitude of these losses for different population groups. Finally, taking all discussion points into account, conclusions will be drawn.

2 Overconsumption, market failure and fat tax

There seems little doubt that overweight creates substantial external costs for society. Because health insurance premiums in Germany, as in many other developed countries, are determined solely by the income of individuals and not by their health risk and behavior, individuals have no financial incentives to maintain a healthy weight. If they become overweight, the costs they incur are carried by society. Hence, an internalizing of these external costs is warranted from an economic point of view. However, it open to discussion whether the fat tax is the appropriate internalization method. As fat consumption is not the only reason for being overweight - sugar intake and lack of physical activity are also important - and normal weighted people must also pay higher prices for food, a fat tax seems inappropriate. Instead, among others, Garry Becker (2006) suggests changing the incentives in the health insurance system.

Furthermore, market failure occurs when information gaps exist. Consumers may have insufficient information to make informed choices consequently the foods they consume may not actually match their preferences. However previous studies show that consumers are already well informed about the health value of most foods (Variyam, Blaylock 1998, Kuchler Golan 2004) but less informed about the health value of food away from home (Jessup 2001). Obviously, they also lack information in terms of the self-assessment of their overweight status (Kuchler, Variyam 2002). Of course, these information gaps need to be closed, but a fat tax can not contribute to this.

Finally, it is questionable whether fat is a demerit good whose consumption is considered unhealthy because of the negative effects on the consumers themselves. Examples of demerit goods are tobacco and drugs. The difference with fat is that tobacco and drugs are unhealthy in principle while fat is desirable to a certain limit. It should be consumed up to a share of 30% of the daily energy intake and delivers important liposoluble vitamins (German Nutrition Society 2000). Therefore, fat can not be fully characterized as a demerit good. In summary, in terms of overconsumption, market failure can be detected in respect to information gaps and negative externalities, but it is doubtful whether a fat tax is an appropriate measure to counter such market failure. Nevertheless, a fat tax is often discussed to fight against overweight.

3 Method and data

To forecast the effects of a fat tax on German consumers, this analysis makes use of the Almost Ideal Demand System introduced by Deaton and Muellbauer (1980). The AIDS is derived from economic consumption theory, assuming that consumers maximize their utility subject to a budget constraint. The AIDS is specified as follows:

(1) $$w_i = \alpha_i + \sum_j^n \gamma_{ij} \log p_j + \beta_i \log(y/P) \qquad i = 1,\ldots,n$$

where w_i is the expenditure share of the respective food category i, α, γ and β are the parameters to be estimated, p_i can be considered the price of food type i, Y is the total food consumption budget and P is a price index that is a weighted average price of all included food category prices. P is defined as:

(2) $$\log P = \alpha_0 + \sum_j^n \alpha_j \log p_j + \frac{1}{2}\sum_i^n \sum_j^n \gamma_{ij} \log p_i \log p_j$$

To avoid nonlinearity of parameters this price index can be replaced by the Stone Price Index (P^S) suggested by Deaton and Muellbauer (1980), where $\overline{w_i}$ represents the average budget share:

(3) $$\log P^S = \sum_i^n \overline{w_i} \log p_i$$

When price index (3) is used instead of price index (2) the AIDS is the linear approximated AIDS (LA/AIDS).

The underlying data set to estimate the LA/AIDS is the German Income and Consumption Survey. These cross-sectional data are collected every five years in Germany. In this analysis, the 2003 survey with approximately 12000 households is used. The data record the expenditure behavior of households as well as several socio-demographic characteristics such as income and age, and size and composition of the household. Hence, it is representative for 98% of German households. To calculate nutrient content information for each household, the households' purchased quantities of foods are combined with the German table of nutrient content, the Bundeslebensmittelschlüssel (BLS). The BLS has information on 30 macro and micronutrients as well as the caloric content for each food product. The estimation of the AIDS on the basis of the cross-sectional data of the German Income and Consumption Survey needs consideration of two additional methodical aspects.

The first aspect to be considered is that prices (p_i) are not directly available. Expenditures and quantities of foods are listed in the data set. The division of expenditures by quantity yields unit values as a proxy variable for the price. The problem with using the unit values is that variations of the unit values not only express price but also quality effects. Therefore, the unit values must be adjusted by the quality effects. For this reason, the approach of Cox and Wohlgenannt (1986) is used. The basis of this method is a hedonic price equation where unit values (UV_i) are estimated in dependence of different quality characteristics (C_{ij}, $j=1, ..., n$).

(4) $$UV_i = \alpha_i + \sum_j \gamma_{ij} C_{ij} + e_i$$

The sum of the constant (α_i) and residuals (e_i) controlling for the quality characteristics yields quality adjusted prices (p_i^*).

(5) $$p_i^* = \alpha_i + e_i$$

When quality characteristics (C_{ij}) of foods are not available in the data, socioeconomic household characteristics can be used as proxy variables for the non observable quality characteristics (Cox, Wohlgenannt 1986). In this paper, quality adjusted prices are estimated by the use of the following household characteristics (1) income, (2) number of household members, (3) number of children, (4) age of children, (5) age, (6) education and (7) occupation of the head of the household. To exclude regional and seasonal price variations, additional variables for region and quarter of the year are introduced into the regression analysis (Park et al. 1996).

The second aspect to be considered by the use of the cross-sectional data is the presence of zero expenditures. This may occur because the survey period is short (here it is one month) and it is obvious that households don not buy certain food products, such as meat, every month. Secondly, households may have no preference for specific foods types. Thirdly, income restrictions could constrain households to buy certain food products. The inclusion of zero expenditures in the estimation leads to biased results, while the exclusion causes a selectivity bias. To correct for the selectivity bias, the approach of Shonkwiler and Yen (1999) is used. Thereby, two correction factors that are estimated by a probit analysis are included in the AIDS. These factors express the likelihood of buying a specific food category.

(6) $$w_i = \Phi(z_i'\rho_i)\left[\alpha_i + \sum_{j=1}^{n} \gamma_{ij} \log p_j + \beta_i \log(y/P^S)\right] + \sigma\phi_i(z_i'\rho_i)$$

where ϕ and Φ are the density and cumulated density functions of the standard normal distribution, ρ_i is the coefficient vector estimated by the probit analysis, z_i is the vector of variables that determine the purchase decision and σ is the parameter to be estimated. In this analysis, equation (6) is estimated using 10 different food categories: (1) meat and fish, (2) milk and milk products, (3) cheese and cream, (4) fruits, (5) vegetables and salad, (6) potatoes, noodles and rice, (7) bread, cereals and flour, (8) beverages, (9) sweets and (10) fat and eggs.

Based on the estimated coefficients of equation (6) and average budget shares, the own- (ε_{ii}) and cross-price elasticities (ε_{ij}) are calculated according to Green and Alston (1990) as follows:

(7) $$\varepsilon_{ii} = \Phi(z_i^{'}\rho_i)*\left(\frac{\gamma_{ii}}{w_i} - \beta_i\right) - 1$$

(8) $$\varepsilon_{ij} = \Phi(z_i^{'}\rho_i)*\left(\frac{\gamma_{ij} - \beta_i w_j}{w_i}\right)$$

The price elasticities measure the responsiveness of the demand for a good (in percent) to a change in the price of this good (own-price elasticity) or another good (cross-price elasticity) by one percent.

As a change in the price of a food item (e.g., meat) causes not only a redistribution of consumption within the food group but also changes the price and consumption of the food group as a whole, unconditional price elasticities are calculated according to Edgerton (1997)[1] as follows:

(9) $$\varepsilon_{ij,u} = \varepsilon_{ij} + \eta_i * w_i\left(1 + \varepsilon_{ii}^F\right)$$

where ε_{ij} and η_i represent the (conditional) price and expenditure elasticity, w_i the expenditure share of the respective food category i and ε_{ii}^F is the price elasticity of the food group as a whole.

The unconditional price elasticities are used to simulate the substitution effects among different food categories. The percentage change in the quantities consumed of different food types ($\%\Delta x_i$) because of a fat tax can be calculated as follows (see Park et al., 1996; Sheng, 2002):

(10) $$\%\Delta x_i = \varepsilon_{ii,u} * \%\Delta p_i + \varepsilon_{ij,u} * \%\Delta p_j$$

[1] The approach of Edgerton (1997) is based on the assumption that the utility maximization decision of consumers can be decomposed into separate stages. In the first stage total expenditure is allocated over broad groups of goods, while in subsequent stages group expenditures are allocated over subgroups and specific commodities.

In this presentation, it is assumed that the fat tax applies to saturated fat. Furthermore, it is presumed that prices increase by 0.5 cents per gram of saturated fat. This fat tax scenario implies, e.g., for full cream milk with 21.62 grams of saturated fat per liter, a price increase of approximately 11 cents and for partially skimmed milk with 9.71 grams of saturated fat per liter, an increase of approximately five cents. Beyond that, it is assumed that consumers bear 100% of the taxes.

In addition, the AIDS is used to calculate changes in consumer welfare resulting from a fat tax. Consumer welfare effects are measured by the concept of compensating variation (*CV*), which is defined by the difference in costs (*C*) between two price conditions (p^1 and p^2) and a constant utility level (u^0).

$$(10) \qquad CV = C(u^0, p_i^1) - C(u^0, p_i^0)$$

CV reflects the additional amount of money a household would need to reach its initial utility after a price change. The cost function of the AIDS is:

$$(11) \qquad \log C = \log P + u * \beta(p)$$

where *logP* and *β(p)* are the price index (3) and

$$(12) \qquad \beta(p) = \prod_{i=1}^{n} p_i^{\beta_i}$$

Utility and cost changes are calculated on the basis of these formulas (see Heien 1988; Sheng 2002).

Price elasticities and welfare effects are calculated for the average of all households as well as for the low- and high-income groups. A household belongs to the low-income group when its net equivalence income is less than 60% of the median household. A household is assigned to the high-income group when its net equivalence income is more than 200% of the median household. The equivalence income is the quotient of income and an equivalence weighting factor, and considers that households of different sizes and composition need a different income to realize an equal standard of living.[2]

[2] The following equivalence weighting factors are used: first person in the household = 1, each additional person aged ≥ 14 = 0.5, each additional child ≤ 14 = 0.3 (see OECD, 1994).

4 Results

Table 1 shows own- and cross-price elasticities calculated for the average of all households.[3]

Table 1: Own and cross price elasticities, German Income and Consumption Survey 2003, all households

Price \ Quantity	meat fish	milk/ -prod.	cheese cream	Fruits	vegetab. salad	potatoes noodles rice	bread cereals flour	bever-ages	sweets	fat eggs
meat, fish	**-0.76**	0.12	0.25	0.22	0.07	-0.05	0.15	0.19	0.14	0.06
milk/-products	0.05	**-0.93**	0.05	0.10	0.02	0.00	-0.04	0.10	0.04	0.02
cheese, cream	0.15	-0.03	**-0.77**	-0.07	0.05	0.12	0.06	0.06	-0.03	-0.01
fruits	0.06	-0.02	0.03	**-0.69**	0.02	0.11	-0.06	0.13	0.09	0.03
vegetables, salad	0.01	0.00	0.05	-0.03	**-0.47**	0.03	-0.02	0.03	-0.01	0.02
potat., noodles, rice	0.01	0.05	0.04	0.00	-0.06	**-0.83**	0.02	0.05	0.04	0.02
bread, cereals, flour	0.00	0.07	0.00	0.07	0.00	0.04	**-0.48**	0.08	-0.13	-0.03
beverages	0.08	0.14	0.12	0.12	0.10	0.10	0.11	**-0.90**	0.19	0.10
sweets	0.05	0.00	0.06	0.02	-0.02	-0.08	-0.04	0.03	**-0.50**	-0.07
fat, eggs	-0.12	-0.03	0.08	0.14	0.27	0.09	0.02	-0.03	-0.01	**-0.48**

As expected, all own-price elasticities shown on the diagonal are negative. The highest values are for meat and fish, milk and milk products, cheese and cream and beverages. In the case of a price increase of one percent, the quantities would be reduced by 0.76, 0.93, 0.77 and 0.90%, respectively. In contrast, vegetables and salad, bread, cereals and flour and fat and eggs have the lowest own-price elasticities. A one percent price increase in these product groups leads to a reduction of quantities by less than 0.5%. The elasticity values for low- and high-income households are slightly different. In general higher elasticities can be found for poor households and lower elasticities can be found for rich households. Hence, it can be expected that in the case of a fat tax, low-income households would reduce their food consumption to a higher level than high-income households. The cross price elasticities show complementary as well as substitutive relationships between the food groups. When the price for the food group meat and fish rises, households reduce their consumption of potatoes, noodles and rice, which are complements. In contrast, they increase their demand of other food groups like cheese and cream.

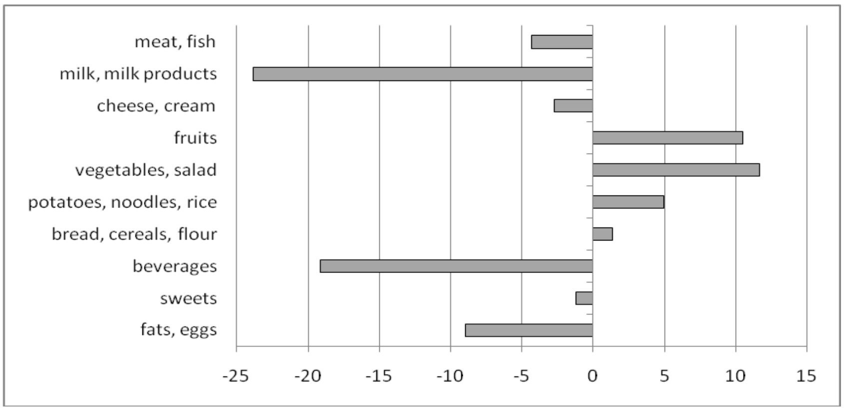
The response of the households to price increases because of the fat tax is shown in Figure 1a) (average of all households) and 1b) (comparison of low- and high-income group). Figure 1a)

[3] The LA/ AIDS estimation results and the price elasticity results for the low- and high-income group are available from the author upon request.

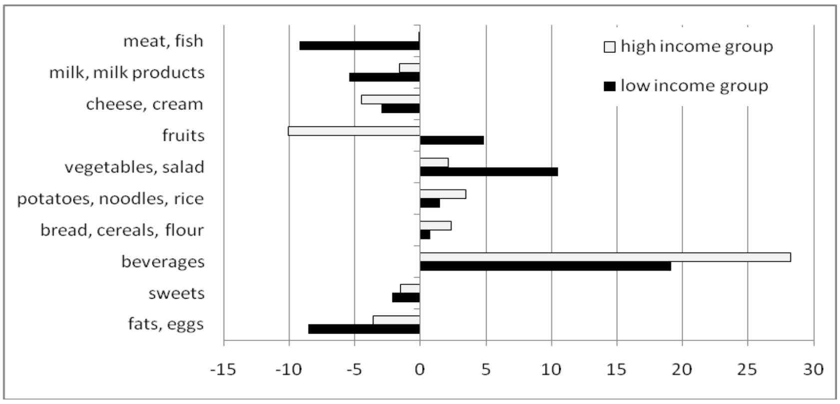
indicates that households would reduce their consumption of meat and fish, milk and milk products, cheese and cream, beverages, sweets and fat and eggs. On the other hand, they would consume more fruits, vegetables and salad, potatoes, noodles and rice and bread, cereals and flour. Hence, a fat tax would induce a change in food structure recommended by nutritionists. All households on average would hold their total food consumption close to constant, with only a slight daily reduction of four grams per person. Figure 1b) indicates that low- and high-income households have similar changes in their food composition. In general, they consume less animal and more plant foods. It is also shown that both groups would increase slightly their total food consumption: high-income groups by 15 grams and low-income groups by 8 grams per day per person.

Figure 1: Changes of consumption in gram per person per day

a) Average of all households (in total -4g food)

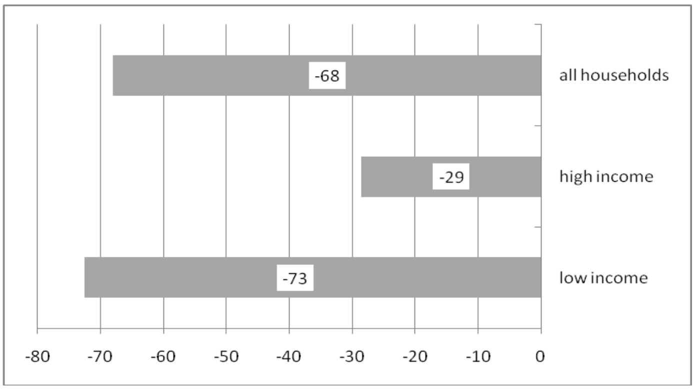


b) Low- and high-income group (in total +8g and +15g food)



The change in the composition of food consumption is connected to a decrease in energy intake. Figure 2 indicates clearly that low-income households have the greatest energy decline of 73 kcal per person per day. High-income households reduce their energy intake per day by only 29 kcal per person.

Figure 2: Reduction of energy in kcal per person per day



It must be remembered that these values are calculated on the basis of purchase data. It can be assumed that first of all households reduce the food waste when prices increase. This means that energy intake will be effectively reduced to a lesser degree than shown in Figure 2. Assuming 70% of the calculated values are allocated to a reduction in food waste, and the remaining 30% to a reduction in energy intake, then the energy decline per person per day amounts to 20.4 kcal on average for all households. However, this small reduction in energy would lead to a decrease in body weight of approximately 1 kg per year.

The change in food quantities is not only associated with a decline in energy intake but also with changes in nutrients. It is of great scientific interest to know whether the change in consumption structure because of a fat tax leads to a decrease of excess and/or deficient intakes of nutrients. Table 2 shows the change in the supply of selected nutrients for excess and deficient intake. The first column shows the change in the respective nutrient because of a fat tax calculated on the basis of the LA/AIDS. It becomes apparent that the fat tax leads to a decrease of all nutrients except for folic acid. As expected, the largest changes can be identified for the three fat components and among them for fat and saturated fat (8.7% and 8.5%, respectively). Furthermore, for vitamin D and iodine, two nutrients subject to deficient intake, relatively high changes are observed. The percentage change in vitamin D is found to be as high as that for cholesterol (7.2%). The second column of Table 2 displays the average recommendation of the nutrient per person per day[4], the third and fourth columns present the supply before (t_0) and after (t_1) the fat tax per person per day in Germany.[5] Columns V and VI, which compare the supply in t_0 and t_1 with the recommendation, indicate clearly that

[4] The Guidelines of the German Nutrition Society (DGE) were used as a reference for nutrient intake (DGE, 2000). The recommendation values refer to an adult aged 25-51 with low physical activity (PAL-value 1.4).
[5] The values are calculated on the basis of the German Nutrition Survey 1998.

Germans on average are oversupplied with all three fat components. If the fat tax was implemented, only the mean total fat consumption would fall under the recommended values (by 2.8 grams per day).[6] Unfavorably, the nutrients subject to deficient intake also fall slightly more below the recommended values than until now (except folic acid). Noteworthy is that the supply of folic acid improves slightly, which can be traced back to the increased consumption of plant foods. In particular, the supply of calcium is discussed with respect to the fat tax. The main sources of calcium are milk products, the group with the highest decrease on average when a fat tax is implemented (see Figure 1a). Therefore, it is of great interest by what amount calcium consumption declines and the associated implications regarding the occurrence of illnesses such as osteoporosis. Table 2 indicates a relatively small decrease in calcium (22.6 mg/day, 1.9%). As the average supply is clearly higher than the recommendation (1000 mg/day), apparently no problem exists. A more detailed view on the empirical data shows that 61% of the German population consumes sufficient quantities of calcium, but 39% do not reach the recommendation levels. Ten percent of the latter are considerably undersupplied, as they consume less than two thirds of the values recommended by the German Nutrition Society (< 666.6 mg/day). For these people in particular, further reductions of calcium are not desirable.

Table 2: Changes of nutrients, recommendation and supply due to fat tax (unit per day)

		I	II	III	IV	V	VI
		Changed amounts due	Recom men-	Supply		Difference supply - recommend.	
Nutrient	Unit	fat tax	dation	t_0	t_1	t_0	t_1
Nutrients of excess supply							
Fat	g/day	-7.4 (-8.7%)	80	85	77	4.6	-2.8
Saturated Fat	g/day	-3.1 (-8.5%)	27	37	33	9.9	6.8
Cholesterol	mg/day	-25.0 (-7.2%)	300	348	323	47.6	22.6
Nutrients of deficient supply							
Vitamin D	µg/day	-0.2 (-7.2%)	5	3.31	3	-1.7	-1.9
Iodine	µg/day	-2.0 (-6.0%)	200	111	109	-89.0	-91.0
Folic acid	µg/day	0.6 (+0,2%)	400	289	290	-111.0	-110.4
iron (female)	mg/day	0.0 (0%)	15	14	14	-1.0	-1.0
Calcium	mg/day	-22.6 (-1.9%)	1000	1195	1172	195.0	172.4

[6] As mentioned before, it can be assumed that a part of the fat reduction must be assigned to a reduction of food waste.

At last, consumer welfare effects associated with the fat tax are now examined. Table 3 indicates that the additional money that an average German household would need to compensate for the price increase because of the fat tax is 17.05€ per month. It is also observable that a low-income household needs less money (13.64€) than a high-income household (16.91€) to reach its initial utility level.

Table 3: Consumer welfare effects per month

	Compensating Variation (€)	Income (€)	Loss as percentage of income (%)
All households	17.05	3499	0.49
Low-income	13.64	1291	1.06
High-income	16.91	7486	0.23

Considering the income of the different household groups, it is obvious that low-income households must bear higher welfare losses than high-income households. The loss as a percentage of income is 1.06% for poorer and 0.23% for richer households. Hence, the thesis that poorer people are more affected by a fat tax than richer people is supported empirically for German households.

5 Summary and conclusion

The results of the empirical analysis of German households support the hypothesis that a taxation of fat would change household's food purchasing structure. Maintaining their total food amounts nearly constant they would alter their food composition in the direction recommended by nutritionists, thus they would buy less animal but more plant based foods. The changed food demand structure is not only connected with a decrease of energy and fat consumption especially in low-income households - those most in need -, but likewise with a decline of deficient intake nutrients such as vitamin D and calcium. Both nutrients are responsible for countering the development of osteoporosis. As in the case of Germany, individuals on average are already undersupplied with vitamin D and many Germans also show inappropriate calcium consumption. Further reductions of these nutrients are not desirable. It can be concluded that a fat tax has positive as well as negative health outcomes. However, the total amount of these health effects is unclear to a large extend. To identify this, comprehensive cost benefit analyses are necessary.

The implementation of a fat tax causes not only health but also welfare effects. The price elasticities indicate that the demand of low-income households responds more to a change in prices than of high-income households. Such reactions cause welfare effects as households have to revise their previous optimal consumption decision. Considering welfare losses as a percentage of income, it is clearly shown that low-income consumers have to suffer higher welfare losses than high-income consumers. Thus the regressive effect of the fat tax can be affirmed empirically for German households.

Although a fat tax would improve the composition of consumed food types, as well as reduce energy intake and in the long run the overweight condition of individuals, it is questionable if a fat tax is an appropriate measure to reduce the negative welfare effects of overweight. As not only overweight but also normal weight people must bear the costs of a fat tax and because fat is not the only reason for being overweight the fat tax doesn't seem to be target oriented. Higher health insurance premiums for overweight people seem a straighter way to tackle the overweight problem. Above all, fat is not unhealthy in principle and delivers important liposoluble vitamins. This analysis has shown that the percentage reduction of vitamin D is as high as of cholesterol. Until now it is unclear which health effects can be expected from this. Comprehensive nutritional as well as economic analyses are necessary to evaluate all outcomes of a fat tax.

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