Consumer incentives to comply with nutritional recommendations – an economic approach

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2010

Selected Paper
prepared for presentation at the 1st Joint EAAE/AAEA Seminar

"The Economics of Food, Food Choice and Health"
Freising, Germany, September 15 – 17, 2010

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Abstract

Inappropriate diets have been found to cause long-term health problems in most industrial and post-industrial countries worldwide. Despite the existence of dietary guidelines in many countries – and widespread familiarity with these guidelines – large shares of the populations do not comply with these guidelines. The objective of the paper is to investigate economic explanations for non-compliance quantitatively, focusing on consumers' perceived value of reduced freedom of choice, if they should comply with the dietary recommendations. The paper establishes and econometric simulation model for Danish food consumers, which is used for calculating these economic welfare losses, as well as the contribution to these losses from individual recommendations. Results show that if all the official dietary guidelines should be followed, consumers will experience an average perceived welfare loss, which in monetary terms correspond to 10-20 per cent of the food budget. There is some variation across the population, and substantial share of the consumers face a welfare loss below 10 per cent of the food budget. Recommendations on the intake of fruits, vegetables and seafood are found to be most binding.

Keywords: Nutritional guidelines, compensating variation, econometric model

JEL codes: D12, I12, Q18

1. Introduction

Inappropriate diets have been found to cause long-term health problems in most industrial and post-industrial countries worldwide. Such health problems include the increasing prevalence of overweight and obesity (Drewnowski, 2007) – which is a risk factor for several non-communicable diseases, of which some of the more serious ones include diabetes (type II), cardiovascular diseases and some forms of cancer (WHO, 2000, 2003, Kouris-Blazos & Wahlqvist, 2007). But also when unhealthy diets are not manifested in overweight, they pose several health risks and reduced levels of mental well-being (Stunkard & Sobal, 1995).

Several studies have demonstrated potentially large gains for society to be obtained from dietary improvements in these parts of the world, mainly in terms of reduced health care costs and productivity gains (WHO, 2000, 2007, Allender & Rayner, 2007).

Nutrition research has lead to many good and well-founded nutritional recommendations related to e.g. prevention of overweight and lifestyle-related diseases. Dietary guidelines are in general communicated broadly and effectively to the populations in most developed countries. Despite these efforts, an increasing prevalence of overweight and obesity are observed in many countries, and data from dietary surveys also show that a considerable share of the populations exhibit relatively low compliance with these recommendations. It has been estimated that less than one per cent of the Danish population complies with all the Danish official dietary guidelines simultaneously (Fagt, 2010, unpublished results).

This raises a number of issues, which are interesting from a health promotion and nutritional point of view, but also from an economic perspective:

- Apparently, people's compliance with dietary recommendations is hampered by a number of barriers. To what extent do economic factors contribute to such barriers?
- Individuals' adoption of dietary recommendations involve some (financial or non-financial) adjustment costs. What is the magnitude of these adjustment costs?
- What can be done to reduce the adjustment costs to consumers, and hence to lower some of the barriers for compliance with the nutritional recommendations.

Various types of explanations for non-compliance with dietary recommendations have been offered and investigated, including environmental factors such as physical availability or time constraints, social and cultural factors and norms, limited capacity for some consumer groups to process nutritional information, stress factors, etc. (Groth et al., 2009)

Adaption of the diet to nutritional recommendations may involve some extra costs to the consumers, if the price of recommended goods (per calorie) is higher than that of non-recommended goods (price effect). This is an argument that has been widely recognized in the literature (e.g. Jetter & Cassady, 2006, Ni Murchu & Ogra, 2007, Frykberg J., 2005). Although this may be true for some dietary elements, it is certainly not true for others. For example, this argument cannot explain the occurrence of excessive energy intake.

Another aspect is the fact that imposing changes on people's dietary behaviour will imply a welfare loss to these people in terms of reduced freedom of choice and hence lower perceived utility – compared with a situation, where their dietary choices are unrestricted (Cawley, 2004). Although improved health attributes should be expected to be beneficial to the consumers, a recommended diet may also involve reduced access to e.g. hedonistic or convenience attributes in foods, which are also valued by the consumers. When assessing costs and benefits of e.g. policy initiatives aiming at dietary improvements, such welfare losses should also be taken into account.

Assuming rational consumers and substitutability between goods, it is possible to estimate a monetized representation of such utility losses from forced compliance in terms of a monetary compensation that would ensure maintenance of the utility level. Hence, an economic/financial measure of the utility loss due to compliance with dietary recommendations – equivalent variation or compensating variation - can be calculated as the amount of monetary compensation necessary to restore the current utility level under the recommended diet (Varian, 1984).

As mentioned above, such compliance cost estimates should be included in cost-benefit assessments of dietary policy initiatives. In a regulation context, such economic measures can also be useful for cross-individual comparisons of the incentives to comply with recommendations, which in turn can be utilized in the design and targeting of new interventions to promote healthier diets.

Provided the recognition that consumers face adjustment costs in order to comply with nutritional recommendations, a natural next step is to try to understand the nature of these costs, the distribution of the costs and ways to reduce these costs.

Against this backdrop, the objective of the present paper is to contribute to the understanding of such explanations for non-compliance by means of quantitative economic analysis. In particular, it is the objective to assess the orders of magnitude of these different economic arguments as explanations for non-compliance for different groups of consumers.

The paper is organized as follows. After these introductory remarks, section 2 outlines the theoretical and empirical methodology of the study. Section 3 presents some results from the analysis, and section 4 discusses these findings and their robustness. Finally, section 5 draws some conclusions and perspectives.

2. Methodology

Several approaches have been applied in the literature to measure utility loss from interference with consumer behaviour. Many of these approaches have a qualitative nature, e.g. in terms of ranking different alternatives, assessment of perceived consequences on Likert scales, etc. or even more open-ended qualitative approaches, such as statements about individuals' perception of different situations or outcomes.

In this paper, we will attempt to measure consumers' welfare loss from compliance with nutritional recommendations in monetary terms. Various methods to undertake such monetary valuation of utility-related matters have been developed in the literature, including contingent valuation, choice experiment or experimental auction methods, which can be used for estimating individuals' willingness to pay for specific attributes in marketed or non-marketed goods, based on Lancaster's (1966) theory of consumption (see Mørkbak et al., 2008, for an overview of studies using such methods in relation to food attributes).

None of the mentioned monetary approaches are however very suitable for estimating the consumer welfare loss related to restrictions on the diet as a whole in monetary terms. This paper offers an approach, where we estimate the compensating variation as a representation of the value of the utility loss on the diet as a whole, induced by a set of nutritional requirements – under the assumption that individuals are obliged to comply fully with these requirements.

Theoretical approach

The study is based on a traditional neoclassical micro-economic framework, where rational consumers are assumed to exhibit utility maximization behaviour subject to a budget constraint. One implication of this assumption is that the consumers' current choice provides them with the highest available utility level, given their current budgetary situation. Hence, for a given utility function, and for the given budget and price configuration, any attempt to change their consumption (e.g. to comply with nutritional recommendations) from the current (possibly non-complying) pattern will provide consumers with a loss of utility. And according to the utility maximization assumption, consumers will have an incentive to avoid such utility losses and hence not to comply. The larger the potential utility loss due to compliance (compared with the present consumption), the stronger are the consumers' incentives not to comply.

One approach to measuring this potential utility loss quantitatively is to estimate the minimum level of compensation that the consumer would be willing to accept in order to follow the recommendation voluntarily (the compensating variation, CV). This measure depends on the substitutability between non-recommended and recommended foods or beverages. The easier it is to substitute, the lower the utility loss. Substitutability may be represented by elasticities of substitution, cf. section 2.3 below.

The theoretical point of departure for estimating the costs of utility loss is the dual representation of standard microeconomic consumption theory, according to which the consumer is assumed to aim at the utility level $U\left(x_1,...,x_n\right)=\overline{U}$ at the lowest possible consumption expenditure $E=\sum_{i=1}^{n} p_i \cdot x_i$, where x_i is the consumed quantity of commodity i and p_i is the corresponding price, and where the utility U represents the consumer's level of satisfaction derived from a particular market basket $\{x_1,...,x_n\}$.

The introduction of (binding) nutritional recommendations poses restrictions on the composition of the consumption vector. For example, recommended intakes of healthful foods x_h^* (e.g. fruits, vegetables, seafood) imply inequality restrictions on the consumers' optimization problem, corresponding to $\{x_h\} \geq \{\overline{x}_h\}$.

The change in consumer expenditure (compensating variation) after implementing the recommendations can be calculated as

$$\begin{aligned} CV = \Delta E &= \sum_h p_h \cdot \left(\overline{x}_h - x_h^0\right) + \sum_g p_g \cdot \left(x'_g - x_g^0\right) \\ &= \sum_h p_h \cdot \left(\overline{x}_h - x_h^0\right) + \sum_g p_g \cdot \left(\tilde{x}_g - x_g^0\right) + \sum_g p_g \cdot \left(x'_g - \tilde{x}_g\right) \end{aligned} \qquad (1)$$

x_h^0, x_g^0 represent the current consumption of healthful and less healthful products, respectively, $\overline{x}_h$ represents the recommended intake of healthful foods, $\tilde{x}_g$ represents the consumption of other goods given $\overline{x}_h$, if the original energy intake should be maintained (where the parameter ν_i represents the energy content per unit of commodity i, i.e.

$$\sum_h \nu_h \cdot \left(\overline{x}_h - x_h^0\right) + \sum_g \nu_g \cdot \left(\tilde{x}_g - x_g^0\right) = 0 \qquad (2)$$

Correspondingly, x'_g represents the consumption of these goods, if the original level of consumer utility is to be maintained, i.e.

$$\sum_h \frac{\partial U}{\partial x_h} \cdot \left(\bar{x}_h - x_h^0\right) + \sum_g \frac{\partial U}{\partial x_g} \cdot \left(x'_g - x_g^0\right) = 0 \qquad (3)$$

Hence, the sum of the first two terms in expression (1) represents a pure price effect, i.e. a changed average price per calorie, whereas the last term represents a quantity effect, in that a larger amount of less preferred goods is necessary to compensate for a reduction in the consumption of more preferred products.

Whereas the quantities $\bar{x}_h$ are assumed to be determined exogenously by the recommendations, the quantities of x_g are assumed to be affected by these recommendations according to standard economic theory of the consumer. This theory states that marginal rates of substitution between any pair of goods i and j equals the ratio between these two goods' prices, including „shadow prices" representing binding restrictions relevant for the respective goods. An implication of this condition, along with the definition of the elasticity of substitution $\sigma_{ij} = \left(\dot{x}_i / \dot{x}_j\right) \Big/ \left(\dot{\frac{\partial U}{\partial x_j}} \Big/ \dot{\frac{\partial U}{\partial x_i}} \right)$, is that

$$\left(\dot{x}_j - \dot{x}_i\right) = \sigma_{ij} \cdot \left(\lambda_{r(i)} / p_i - \lambda_{r(j)} / p_j\right) \qquad (4)$$

where λ's are shadow prices of restriction r (e.g. nutritional recommendations) pertaining to the respective goods, and $\dot{z}$ denotes relative change in variable z. There is one non-zero (positive) shadow price associated with each binding restriction, whereas for non-binding restrictions/recommendations, the shadow price equals zero. The shadow prices have a number of economic interpretations. One interpretation is that they represent the economic value to the consumer (in terms of reduction in compensation requirement) if the respective restrictions/recommendations are relaxed at the margin. For example, the shadow price of the fruits and vegetable recommendation is the reduction in compensation requirement, if the recommendation was changed from 600 g/day to 599 g/day.

Alternatively, the shadow prices can be interpreted as indications of the recommendations, for which the implementation is most severely hampered by various barriers, and in turn where efforts to reduce such barriers (e.g. by altering consumers' preferences through education, promotion, etc.) should be directed. For recommendations related to specific product types (e.g. fruits, vegetables, seafoods), the shadow prices may also provide indication of the magnitude of relative price changes (e.g. via tax differentiation) that might support a development in the recommended direction.

In order to increase the realism, we generalize the model slightly. Specifically, we include two types of nutritional recommendations:

- Recommendations regarding minimum intake of specific food categories (fruit, vegetables, seafood, grain products), i.e.

$$x_h \geq \bar{x}_h \tag{5}$$

- Recommendations regarding the maximum intake of specific nutrients (e.g. fats or sugar) that may be present in several food categories

$$\sum_h \beta_h \cdot x_h + \sum_g \beta_g \cdot x'_g \leq \bar{\alpha} \cdot \left(\sum_h \nu_h \cdot x_h + \sum_g \nu_g \cdot x'_g \right) \tag{6}$$

where β_h and β_g represent coefficients for the content of e.g. fat or sugar per kg of the respective foods and $\bar{\alpha}$ represents the maximum recommended E% of the specific macro-nutrient in the diet.

The x_g 's in the iso-energy setting ($\tilde{x}_g$) can be determined by solving the system of equations (1), (3-6), along with an assumption of a numeraire good (milk) for which the relative change in marginal utility is determined exogenously (e.g. $\Delta \partial U / \partial x_{numeraire} = 0$) to yield $\bar{x}_h$, $\tilde{x}_g$, λ_r and ΔE . Correspondingly, the iso-utility consumption of x_g can be determined by solving expressions (1-2),(4-6) simultaneously with respect to $\bar{x}_h$, x'_g , λ'_r and ΔE . Within this model framework, the current situation represents the solution to the expressions (1-2,4) and/or (1,3-4) with respect to x_h , x_g and ΔE .

Elasticities of substitution between different goods (i.e. parameters representing, how "easy" it is to substitute one good for another – the larger elasticity, the larger substitutability) provides the necessary information about the utility function. Provided empirical estimates of the elasticities of substitution, combined with data for prices and for current and recommended consumption, it is possible to determine the utility loss associated with fulfilment of the dietary requirements, and to decompose this loss into a price effect and a quantity effect.

Some static-comparative properties can be derived from the above theoretical model. First, the more the current food consumption patterns deviate from the nutritional recommendations, the larger is the compensation requirement, if consumers are to maintain their current utility level, ceteris paribus – because larger adjustments will then be necessary. Secondly, the larger the elasticities of substitution (between recommended and non-recommended goods), the lower is the compensation requirement, because consumers are more prone to give up non-recommended goods upon increased consumption of recommended goods, than if elastictities of substitution are low. Thirdly, the higher the prices on recommended goods (relative to non-recommended goods), the larger is the compensation requirement.

Data sources

Individual dietary survey data from the Danish National Dietary Survey 2001-2004 (Lyhne et al., 2005, Fagt et al., 2007) have been used to describe the initial dietary patterns. The survey is based on a representative sample of 3151 Danish adult individuals in the age span 18-75 years, and contains their recordings of food and beverage intake (16 categories) over a 7-day period. Some descriptive statistics from the survey are given in table 1.

Table 1. Daily intake of foods among adults (18-75 years, n=3151), 2000-2002

	Mean	Std. Dev.	Median	10% fractile	90% fractile
Milk (g/day)	307	260	248	42	635
Cheese (g/day)	29	19	26	8	53
Cereals, bread etc. (g/day)	218	84	209	122	324
Vegetables – incl. potatoes (g/day)	285	132	265	140	453
Fruit (g/day)	260	204	218	44	518
Meat (g/day)	113	62	102	46	194
Poultry (g/day)	27	29	20	0	64
Seafood (g/day)	19	19	14	0	43
Eggs (g/day)	16	15	13	3	34
Fats (g/day)	36	21	33	14	65
Sugar (g/day)	31	28	25	4	63
Beverages (g/day)	2235	932	2117	1163	3461
Added sugar (E%)	9	5.5	8	3	16
Fat (E%)	33	5.6	33	25	40

Source: Lyhne et al. (2005), Fagt et al., (2007)

In the analysis, we assume that individuals are to comply with official Danish dietary guidelines (table 2).

Table 2. Danish official dietary recommendations

600 g fruits and vegetables per day (excluding potatoes)
2-300 g fish/seafood per week
250 g potatoes/rice/pasta per day
250 g grains/bread per day
Max 10 E% added sugar
Max 35 E% fats

Source: Danish Veterinary and Food Administration

Comparing the figures in tables 1 and 2 shows that Danes' dietary habits deviate somewhat from the official recommendations. For example, the average intake of fish and seafood is about half of the recommended intake, between 10 and 20 per cent have an intake at or above the recommended level, and more than 10 per cent did not consume any seafood during the week of the survey.

According to table 1, the average reported intake of fruits and vegetables appears to be slightly below the recommended level of 600 g/day. However, a considerable share of the survey participants reported a consumption that was way below this recommendation. It should also be noted that the figures in table 1 include potatoes, whereas the recommendation does not – so the deviation from the recommendation is larger than what appears at first glance.

As regards the energy share of fats and added sugar, a similar picture emerges – that the average individual may be relatively close to the recommended maximum, but there is considerable variation across individuals.

The nature of the dietary survey, i.e. recording during a 7-day period, should be kept in mind when interpreting these figures. In particular, it is expected that the variation across individuals is larger for such a short time period than would be the case if intakes were reported over a longer period.

Elasticities of substitution

As knowledge about elasticities of substitution is crucial for the estimation of utility losses associated with compliance with nutritional recommendations, cf. expression (4), we conduct econometric analysis to obtain estimates of such elasticitites. Specifically, based on household-level panel data from the Danish GfK Consumer Tracking Panel (GfK, 2010) spanning the period 2001-2004 on a weekly basis (however aggregated to monthly observations to reduce problems of missing values and short-term fluctuations due to special offers etc.), we estimate a linearized Almost Ideal Demand (AID) System (Deaton & Muelbauer, 1980), where demand for individual goods is represented by budget share equations (assuming weak separability between foods/drinks and other consumption goods), defining the goods as closely as possible to the definitions of the dietary survey. For household f (belonging to socio-demographic group s), the budget share of good i in period t is given by

$$w_{it}^{f} = \gamma_{i}^{s} + \sum_{j} \gamma_{ij}^{s} \cdot \ln p_{jt}^{f} + \theta_{i}^{s} \cdot \left(\ln M_{t}^{f} - \ln P_{t}^{f}\right) + \varepsilon_{it}^{f} \quad (7)$$

$\ln P_{t}^{f} \approx \sum_{j} w_{jt}^{f} \cdot \ln p_{jt}^{f}$ (Stone index), $M_{t}^{f} = \sum_{j} p_{jt}^{f} \cdot x_{jt}^{f}$ (budget) and $w_{it}^{f} = p_{it}^{f} \cdot x_{it}^{f} / M_{t}^{f}$ (budget share). We allow parameters of the model to vary according to socio-demographic household characteristics (gender, age and education of main shopper in the household, presence children).

"Raw" household-level price data contained a lot of missing values (because not all commodity types are bought every month by every household), which is a problem for the estimation, as the price information is also important in "no-purchase" months. For this reason, we replaced raw prices with "synthetic" household-level commodity prices defined as $\hat{p}_{jt}^{f} = \phi_{j}^{f} + \phi_{jp} \cdot p_{jt}$, where p_{jt} is an average of the price variable across households in month t ($= \sum_{h} p_{jt}^{f} \cdot x_{jt}^{f} / \sum_{h} x_{jt}^{f}$), and ϕ_{j}^{f} and ϕ_{jp} are parameter estimates from a fixed-effect linear regression of observed household-level prices on the constructed average price variable. Having estimated the AID-system, partial elasticities of substitution estimates between good i and j can be calculated as

$$\hat{\sigma}_{ij}^{s} = 1 + \frac{\gamma_{ij}^{s}}{\overline{w}_{i}^{s} \cdot \overline{w}_{j}^{s}} \quad (8)$$

Table 3. Econometrically estimated elasticities of substitution

	Milk	Cheese	Icecream	Cereals	Vegetables	Fruits	Meat	Fish	Poultry	Eggs	Fats	Sugar	Beverages	Spices	Potatoes
Cheese	0.27														
Icecream	0.01	0.01													
Cereals	0.57	0.67	0.38												
Vegetables	0.85	1.08	0.65	0.93											
Fruits	0.92	1.04	0.88	0.93	1.07										
Meat	0.72	1.03	0.36	0.73	1.02	1.13									
Fish	0.01	0.51	0.01	0.29	0.95	0.95	1.17								
Poultry	0.50	0.98	0.32	0.79	0.95	1.09	1.27	1.48							
Eggs	0.31	1.23	0.01	0.03	0.87	1.14	1.42	0.87	0.84						
Fats	0.57	1.24	0.13	0.44	0.94	0.89	0.99	1.16	0.53	0.07					
Sugar	0.49	1.18	0.77	0.53	1.18	0.99	1.25	1.31	1.35	0.39	0.47				
Beverages	0.70	0.93	1.19	0.81	1.14	1.02	1.00	0.60	0.94	0.90	0.82	1.04			
Spices	0.70	1.21	0.80	0.97	1.05	1.12	1.38	0.01	0.92	0.77	1.05	1.76	1.35		
Potatoes	0.01	0.01	0.01	0.01	0.78	1.13	1.06	0.01	0.00	2.11	2.09	1.13	0.01	1.40	
Juice	1.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1.00	0.01	0.01

Mean estimates of the elastictities are given in table 3. Please note that the elasticities of substitution are estimated on the basis of household-level data, but are applied for simulation analysis at the level of the individual. Although household data is considered to be the most suitable data source for feasible estimation of such elasticities, it is recognized that this imprecision in the linkage in principle poses a source of uncertainty to the simulation – especially in households, which are relatively heterogeneous with respect to socio-demographic characteristics.

3. Results

The model outlined in the previous section has been solved (in a linearized approximate version) using the Gauss® software for each of the individuals in the dietary survey data, attaching the most relevant set of estimated elasticities of substitution. The model was solved in the “iso-energy” as well as the “iso-utility” settings, thus allowing for the above-mentioned decomposition of compensation requirement into a “price” and a “quantity” component, cf. expression (1).

Figure 1 shows the distribution of the size of the estimated compensation requirement, in absolute per day terms, as well as relative to the daily budget for foods and drinks. Two compensation measures are provided

- Compensation corresponding to obtaining a food budget maintaining the current aggregate energy intake (iso-energy) with the lowest possible loss of utility, respecting the outlined nutritional recommendations (price effect)
- Compensation corresponding to the minimum food budget necessary to maintain the current utility level (iso-utility), respecting the nutritional recommendations (price + quantity effect).

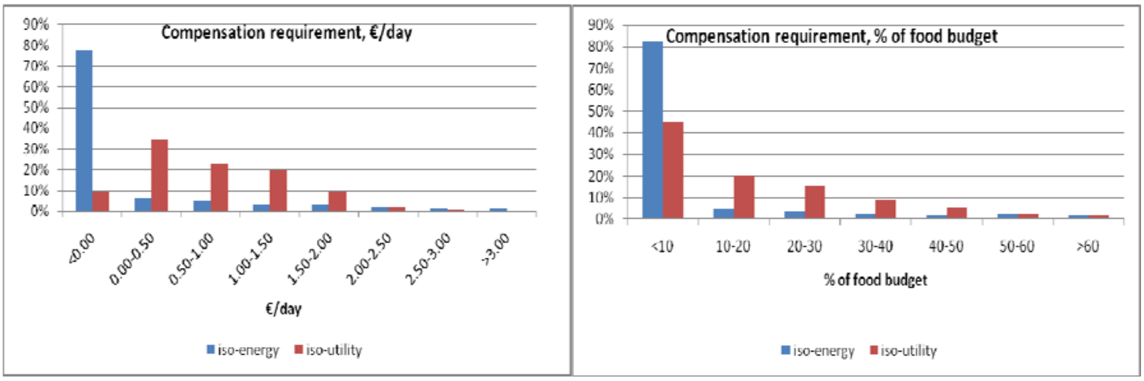

Figure 1. Distribution of compensation requirement across individuals

The results suggest that under the nutritional recommendations in table 2, about 75-80 per cent of the individuals would be able to achieve the current energy intake without increasing their food and beverage budgets. For another 5 percent, this current energy level can be achieved with a budget increase less than 0.5 €/day and less than 10 per cent of the consumers will have to increase their food budget more than 1 €/day to maintain their current energy intake.

But maintaining the current energy intake does not necessarily imply that the consumers' utility level is unchanged, because nutritionally recommended foods with high scores on health attributes may have lower scores than non-recommended goods on other product attributes, such as hedonistic (taste, appearance etc.) or convenience properties. Hence, the average compensation per day to maintain the current utility level subject to compliance with the dietary recommendations is calculated to be 1.4 €.

The distribution of the compensating variation is illustrated in figure 1. Whereas about 85 per cent of the consumers are able to maintain their current energy intake at an additional cost below 0.5 €/day, only about 45 per cent of the consumers are able to maintain their current utility level at this cost (and with an average daily food budget of 5 €, this corresponds to about 10 per cent of the current food budget). And a considerable share of the consumers (approximately 30 per cent) face a utility loss corresponding to a compensation requirement of more than 1 €/day (20 per cent of the food budget).

Subtracting the iso-energy compensation requirement from the iso-utility compensation requirement yields the "quantity" effect, which constitutes the value of the change in total energy intake that the individual requests to maintain the original level of utility, when she has to give up more preferred non-recommended foods or drinks for recommended ones. This quantity effect is in general positive, implying that increased total food consumption is requested in the restricted/recommended setting in order to maintain the current utility level.

Socio-demographic patterns in the individual compensation requirements have been investigated, and some general patterns seem to emerge. Individuals in the age span 30-50 years tend to show a higher compensation requirement than older individuals, male individuals tend to have a higher compensation requirement than females, households with two or more children tend to have a higher compensation requirement, and individuals with long educations tend to show higher compensation requirement than individuals with shorter educations. Some of these patterns are in line with a priori expectations, as they are fairly correlated with observed patterns of non-compliance with dietary recommendations (Groth et al., 2001, Groth & Fagt, 2003, Fagt et al., 2007). Household income level does not appear to affect the compensation requirement systematically, according to the present analysis.

In order to investigate the importance of the individual recommendations, it is possible to calculate the contributions from each of the recommendations to the compensation requirement by means of the constructed economic model. The shadow prices (cf. expression 4) provide a marginal measure of the recommendations, i.e. the effect of relaxing the recommendations/restrictions marginally. Another approach is to calculate the total contribution from each recommendation by solving the analytical model with all recommendations except one, and calculate the difference between the compensating variation with and without this recommendation. We use the latter approach in the following. It should be noted that this is still a partial approach, and these partial effects do not necessarily add up exactly to the total effects displayed in figure 1, du to interactions and overlaps between the effects of the individual recommendations.

In figure 2, the distributions of the partial effects of five of the recommendations are shown. The recommendations regarding specific foods (fruits, vegetables, seafood, grain-based products) tend to lie in the range between 0 and 1.50 €/day, whereas the recommendations regarding E% of sugar and fats tend to be lower.

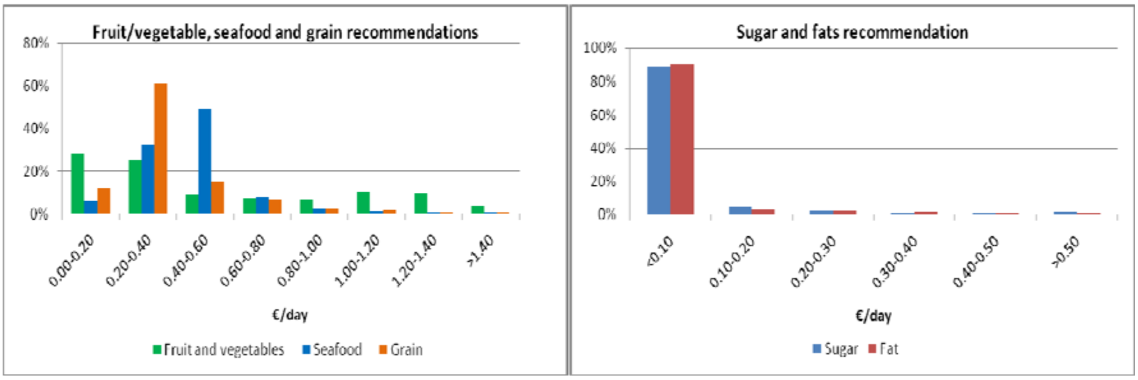

Figure 2. Distribution of marginal utility for individual recommendations (iso-utility setting)

Regarding the partial adjustment cost related to the fruit and vegetable recommendation, a little more than one quarter of the consumers face a daily cost at or below 0.20 €/day, and another quarter face a daily cost in the range 0.20-0.40€/day. But it should also be noted that for almost 20 per cent of the consumers, the partial cost related of complying with this recommendation is more than 1 €/day. With regard to the recommendations of increased intakes of seafood and grain-based foods, the partial utility loss is more focused in the range between 0.20 and 0.60 €/day, with a higher average cost regarding fish than for grain based products.

Compared with the recommendations of minimum intake of specific food categories, the calculated partial costs of complying with the recommended upper limits to fats' and sugar's share of total energy intake appear to be more moderate, with the vast majority of consumers facing a compensation requirement below 0.10 €/day. There are two possible explanations for the relatively lower cost related to these recommendations. On the one hand, a larger share of the Danish consumers currently complies with this recommendation, and hence the need for adjustment in this area is smaller. On the other hand, as these recommendations relate to more than one good, there is larger flexibility in the individuals' room for adapting to these requirements than is the case with regard to recommendations related to one food category (e.g. fish or fruits/vegetables).

4. Discussion

The above estimates are based on the assumption that preferences remain unchanged, and that prices also remain the same. Changed price relations may alter these cost estimates. Assume, for example, that recommended foods are taxed at a lower VAT-rate than other foods. Such a food tax reform would reduce the consumers' economic welfare loss related to compliance with recommendations and thus reduce the economic dis-incentive to comply. As an example, exempting the consumption of fish and seafood from the current 25% Danish VAT was calculated to reduce the average CV by 0.40 €/day to about 1 €/day.

The analysis is based on data from 2001-2004. Changes in price relations since then may have had some impacts, if the results should be interpreted in a 2010-setting. Largely, the price trends do not seem to have influenced the incentives to comply with recommendations significantly (Statistics Denmark, consumer price statistics). On the other hand, there is only little knowledge about the development in preferences since the beginning of the century, but one of the mega-trends is an increased interest in healthy diets (Groth et al., 2009).

In the above model setting, consumer preferences may be modified in two ways: by affecting the marginal utility of various commodity categories, e.g. by promotion activities, information about positive or negative health effects, gastronomic education, image creation etc., or by changing the substitutability between healthy and less healthy products (elasticities of substitution) by means of new recipes, product innovation etc. If the marginal utility with respect to healthy goods can be increased relative to that with respect to less healthy goods, or if the substitutability between these categories can be increased – for instance by providing healthy products with some of the attributes that make less healthy products attractive to consumers, the costs of compliance may be reduced.

This suggests some important directions for further research and development in food innovation activities and in the understanding of consumer demand and preferences.

As was mentioned in the methodology section, it is necessary to 'close' the economic simulation model with an assumption regarding the change in marginal utility of one numeraire good (milk). In the calculation, the marginal utility of milk was assumed to remain constant. Sensitivity analysis with the model has shown that the results are insensitive to this assumption.

As elasticities of substitution applied on individuals were estimated on the basis of household purchase data, there is a potential risk of inconsistency in the model, especially for individuals living in very heterogeneous households. However, the overall patterns of the elasticity matrix for different types of households are quite similar across socio-demographic categories, so this potential problem is considered to be of minor importance.

The analysis of this paper is based on neoclassical economic consumption theory, where consumers are rational in the sense that their decisions lead to the highest possible utility level. This fundamental assumption can be discussed. One issue is, whether consumers actually do attempt to maximize utility or if they pursue completely other fundamental objectives for their decision making. If the assumption of utility maximization is accepted, a second issue is what this utility depends on: material goods, good health, social acceptance, pursuit of personal values, etc., and to which extent these aspects are related to the individual's consumption of material goods. Thirdly, it is worth considering, which limitations on the choices that should be taken into account. In classical economic theory, a budget constraint is normaly taken into consideration, but also other types of constraints may be relevant, e.g. time constraints, availability constraints, constraints issued by social norms, etc. Aspects like these may all be incorporated in the neoclassical theory of the consumer, and hence make the theory more closely related to 'real life', while still maintaining classical properties such as responsiveness to prices and utility losses induced by intervening in consumer decision making.

5. Conclusions

The above analysis uses economic methodology to assess the magnitude of perceived barriers for consumers' compliance with official nutritional recommendations. The results suggest that such barrieres have a magnitude that is equivalent to about 1.4 €/day on average per adult consumer, corresponding to 10-20 per cent of the average current food expenditure.

An average cost of 1.4 €/day is equivalent to an annual cost of about 500 € per adult, and presumably a somewhat lower number for children. A major part of this figure represents that consumers' utility of a diet complying with nutritional recommendations is lower than for the current diet, whereas the rest reflects a different average price per calorie in a recommended diet than in the current diet. When considering the potential economic costs and benefits of policy interventions to promote healthier nutrition, these costs should be taken into account.

The marginal cost of compliance is an increasing function of the level of 'restrictiveness' of the nutritional recommendations in the model presented in this paper. If it is assumed that the marginal benefits is a decreasing function of this 'restrictiveness', economic considerations may lead to a concept of 'optimal recommendations'. However, the formulation of such optimal recommendations – as well as assessments, whether the current official recommendations are above or below the optimal level of restrictiveness – will require further research.

Although it is recognized that an economic framework may be too narrow to provide a full understanding of consumers' non-compliance with nutritional recommendations, results like those in the present study may shed light on the size of the barriers that may have to be surpassed in order to improve the populations' compliance with dietary recommendations, and hence provide some input to the improvement of existing policies in the field. In particular, information of use to guide policy recommendations may include answers to questions like:

- Which nutritional recommendations are most difficult to meet for the consumers?
- Which consumers have the most difficulty in meeting which recommendations?
- How might changed price relations affect the incentives for different consumer groups?

Acknowledgements

The research presented in this paper has been conducted as part of the activities within the Danish Obesity Research Centre (www.danorc.dk), financed by a grant from the Danish Strategic Research Council.

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