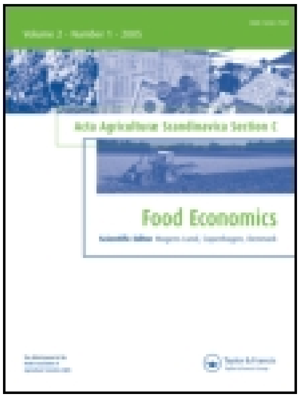

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The marginal willingness to pay for health-related food characteristics

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ORIGINAL ARTICLE

The marginal willingness to pay for health-related food characteristics

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Abstract
Food consumers often face a trade-off between taste and nutrition. This paper examines how consumers value food characteristics that simultaneously affect taste and nutritional value. As a case study, we focus on Swedish consumer preferences for food characteristics in breakfast cereals, hard bread, and potato products. We estimate the value attached to fat, fiber, salt, and sugar and the value of easily accessible nutritional information provided by a nutrition symbol. The results suggest consumers have context-dependent preferences for food characteristics; consumers who prefer nutrition over taste for some ingredient in a specific product may prefer taste over nutrition for other products. Consumer values of food characteristics also seem sensitive to changes in the mix of characteristics in a product. For instance, additional fiber may be positively valued for products high in taste enhancers, such as salt. Consumers may therefore prefer nutrition over taste as long as the product is tasty.

Keywords: *Consumer economics, food characteristics, health, hedonic pricing, willingness to pay.*

JEL Classification: *D12, I10.*

Introduction

Being overweight or obese may contribute to serious health problems, such as diabetes, heart disease, several types of cancer, and muscle disorders, as well as social exclusion, causing individual suffering and imposing costs on individuals and society.[1] Around the world, overweight and obesity have risen dramatically in recent decades. While the cause has been debated, several studies point to altered eating habits, i.e. greater intake of calories (Putnam et al., 2002; Cutler et al., 2003).

In industrialized societies, a trade-off often exists between taste and health for certain food characteristics. Taste encourages consumption of fatty, salty, and sweet foods, whereas health awareness discourages consumption of the same foods. Which effect dominates is an empirical question. The value consumers attach to food characteristics also affects food supply, by providing firms with incentives or disincentives to supply healthy food. Availability of unhealthy food has been argued to be one of the main drivers behind the rise in unhealthy eating and obesity (Chou et al., 2004). The trade-off consumers face, and hence the producer incentives provided by consumers, is therefore important to address if society wants to better understand why obesity is a problem today.

The paper examines how consumers value health-related food characteristics. We explore how consumers value food characteristics associated with obesity, e.g. fat, salt, and sugar, and those with health improving characteristics, e.g. fiber and transparent nutritional information provided by a nutrition symbol. The relationship between these characteristics and over-consumption of food has become an increasing focus of the literature.

MacInnis and Rausser (2005) suggest the ability of modern food supply to exploit consumer preferences for energy-dense food has led to increased intake of calories. Birch (1999) and Smith (2004) argue that preferences for food are shaped both by genetics and the food environment. In particular, our preferences for sweet and salty food seem to be

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genetically determined. In addition, Kern et al. (1993) show that young children quickly learn to prefer food rich in fat, over non-fatty substitutes. These intrinsic preferences have been helpful in the past. Fat is energy-dense, sweet foods (e.g. fruits and berries) contain important vitamins and antioxidants, and salt is vital to maintain chemical balance in the body. Modern technology in food production, however, has taken fattiness, sweetness, and saltiness to new levels. At the same time, nutritional value is often lost in food processing. In contrast to pre-industrialized societies, relying on taste as the sole source of nutritional information today can be the foundation for health risk. In addition, food processing has made nutritional information less transparent. Consumers cannot observe directly what is contained in the refined product. Although nutritional information is available on the food package, collecting information is costly. It takes time to compare the nutritional information on products and to assimilate the information. Consumers act on incomplete information, which increases consumption of unhealthy foods (Kin et al., 2000). The easily accessible information provided by nutrition symbols, however, can help guide healthier consumption (Neuhouser et al., 1999).

We use a hedonic price approach to estimate the value consumers attach to fat, fiber, salt, sugar and a nutrition symbol for breakfast cereals, hard bread, and potato products.[2] These three product groups were chosen for two reasons: they constitute key parts of a modern diet, and each group contains a wide variety of products that differ substantially in their nutritional content, while still being close substitutes.[3]

Stanley and Tschirhart (1991) and Shi and Price (1998) use the hedonic price method to estimate how consumers value characteristics in breakfast cereals. Stanley and Tschirhart focus on the estimation of a hedonic price function for a non-durable good, using nutritional data on breakfast cereals. Shi and Price analyze how socio-demographic variables (income, level of education, number of children, and age) affect the values attached by consumers to characteristics of breakfast cereals, including non-nutrient characteristics such as type of grain. They find energy (calories) is positively valued by all consumer groups, whereas fat is negatively valued, as is fiber. Both Stanley and Tschirhart and Shi and Price find a positive effect of sugar on the price of breakfast cereals, while Stanley and Tschirhart find a negative effect of fiber.

In our analysis we go beyond breakfast cereals by including other goods – breads and potatoes. Secondly, product characteristics are combined with national average prices for the specific products, and thus provide a more accurate measure of the dependent variable than Stanley and Tschirhart, who collected the prices for their study from a limited number of supermarkets.

The paper proceeds as follows. The section "Theoretical model" outlines the theory behind hedonic models. Sections "Data and expected effects of food characteristics" and "Empirical method" describe the data and the empirical methodologies. The final section reports the results and conclusions.

Theoretical model

Suppose consumers derive utility from breakfast cereals, hard bread, or potato products (in this section referred to the "staple good," although processed potato products are not staples) and a composite good (all other consumption). Following the modification by Stanley and Tschirhart (1991) of the work done by Rosen (1974), assume the utility derived from consumption of the staple good depends on the "services" it provides, rather than the quantity consumed. The services provided by staple food are considered to be taste, nutrition, and convenience, where convenience is generally treated as being inversely related to preparation time of the food. The utility function of the representative consumer can then be written as:

$$U = \tilde{U}(s_1, s_2, s_3, X), \qquad (1)$$

where S_1, S_2, and S_3 are the taste, nutrition, and convenience services of the staple good, and X is the composite good. Utility is assumed to increase in each argument and to be strictly concave. The services associated with the staple good are, in turn, assumed to be determined by the n characteristics of the particular food product: content of berries, fruit, nuts, and vitamins; grams of carbohydrates, fat, fiber, protein, salt, and sugar; and as well as the number of calories or kilojoules, presence of the nutrition symbol, and preparation time. Let $\mathbf{z} = z_1, \ldots, z_n$ denote these characteristics. We can define $s_h = s_h(\mathbf{Z})$, for $h = 1, 2, 3$. Each characteristic can affect several services simultaneously and oppositely, e.g. fat might affect taste positively, but the nutritional value negatively. The utility function is rewritten as:

$$\tilde{U}(s_1(\mathbf{z}), s_2(\mathbf{z}), s_3(\mathbf{z}), X) = U(\mathbf{z}, X). \qquad (2)$$

Although utility is assumed to be increasing in all services, it can either increase or decrease in particular characteristics. If, for instance, the negative effect of fat on the nutritional value outweighs its positive effect on taste, utility will decrease in fat.

For simplicity, also assume the consumer only purchases one unit of the staple good. Normalizing the price of the composite good to one, the individual budget constraint then becomes:

$$M = P(\mathbf{z}) + X, \quad (3)$$

where M is income, measured in units of the composite good and $P(\mathbf{z})$ is the market price of the staple good, assumed to be a function of the specified characteristics. The price function, $P(\mathbf{z})$, is continuously differentiable in the elements of $\mathbf{z}$. Since the staple good is differentiated (for example, there are several types of breakfast cereals with different combinations of characteristics), the market price of the good varies over different types of the staple good. The consumer is presumed to choose the levels of characteristics in the good. The market price function itself, however, cannot be influenced by the actions of a particular consumer. The utility maximizing consumer chooses the level of characteristic i, such that:

$$p_i = U_{z_i}/U_X \qquad i = 1, \ldots, n \quad (4)$$

where $p_i = \partial P(\mathbf{z})/\partial z_i$, $U_{z_i} = \partial U/\partial z_i$, and $U_X = \partial U/\partial X$.

Equation (4) reveals that the increase in the price of the staple good from adding another unit of characteristic, i, is equal to the marginal rate of substitution between characteristic i and the composite good. In other words, the consumer chooses a combination of characteristics so the change in the product price, from a marginal increase in a particular characteristic, equals the marginal willingness to pay for that characteristic.

As mentioned above, the marginal utility of the composite good is positive, but the marginal utility of characteristic i can be either positive or negative, since the characteristic can enter several services simultaneously and in opposing ways. The marginal implicit price of characteristic i can be either positive or negative; signing the marginal implicit price of a characteristic is an empirical question.

Data and expected effects of food characteristics

Data on characteristics (ingredients, nutritional information, and the presence or not of a nutrition symbol) have mostly been collected manually from packages at supermarkets in Sweden, but also from producer websites, and sometimes from producers directly. The data set are, therefore, limited to include only observations of products which were either found in the stores when gathering ingredients and nutritional values, or for which the characteristics were available from producers. In total, there are 86 observations on breakfast cereals, 71 observations on hard bread, and 44 observations on potato products.

Average national prices of top-selling Swedish processed potato products (potato chips, frozen potato products, and mashed potato products) were calculated from scanner data, provided by AC Nielsen Sweden, on weekly total national volume and value sold, week 1–42, in 2004. Growth from Knowledge (GfK), Sweden provided data on prices of breakfast cereals and hard bread from their 2003 household panel (daily observations throughout the full year). Average yearly prices for breakfast cereal and hard bread products are calculated from this data. The price data contained in the GfK household panel reflect the prices faced by panel members when making their purchases. It is worth mentioning that prices are not quality-adjusted, i.e. adjusted for place of purchase or package size, for instance. Moreover, since the price data consist of prices faced by consumers, it could be affected by the mix of households in the panel. Note that people of age 65 and over are slightly overrepresented. Unfortunately, the data contain no information on geographic representation.

The national Swedish nutrition symbol; the "Keyhole," is certified by the Swedish Food Administration, based on certain criteria (see SLVFS 1989:2 and LIVSFS 2005:9). There are no potato products certified with the Keyhole symbol in our sample. The Keyhole symbol, however, was found on a sizeable share of both breakfast cereal products and hard bread. For breakfast cereals, the certification criteria of the Keyhole cover fat, fiber (or whole grain), salt, and sugar content; for bread, the criteria cover fat, fiber, and salt content.[4]

The level of detailed nutritional information varies substantially over products. The Appendix 1 presents summary statistics on the characteristics of all the three food groups, and other information that appeared on the product package. All characteristics are measured per 100 grams. For all products, information was recorded on energy density (kilojoules[5]), fat, carbohydrates, and protein. For breakfast cereals and hard bread, sugar and fiber content were recorded as well. This information was unavailable for potato products, however, for this product group both the sugar and fiber content is low and vary little over individual products. The main unhealthy ingredients in potato products are fat and salt, which were recorded. For breakfast cereals, the presence of berries, fruits, and nuts were collected. For potato products, the time required to prepare the food in the oven was recorded for consistency, even in the cases where other cooking alternatives existed (such as microwaving or frying).

Table I shows the expected effect on services of each food characteristic included in the regression analysis of particular relevance for health.

Most of the characteristics in Table I are expected to affect more than one service, and in opposing ways. The exceptions are vitamins and the nutrition symbol. Vitamins do not affect taste, and are therefore expected to have a positive effect on overall utility, by affecting both nutrition and convenience positively. Following Stanley and Tschirhart (1991), they are assumed to affect convenience positively since consuming vitamins as part of food is more convenient than consuming vitamin supplements separately. The nutrition symbol informs consumers about the nutritional (i.e. health) status of the product and, by representing easily accessible nutritional information, affects convenience positively. The nutrition symbol is expected to have no effect on taste or nutrition, since it only reflects the content of other characteristics.[6] For the rest of the characteristics, an expected sign of the effect on utility, and thus the willingness to pay, cannot be determined a priori. Given the potential offsetting effects, for most consumers fat, salt, and sugar are all assumed to affect taste positively, due to our underlying preferences for sweet, salt, and fatty food, and to simultaneously affect nutrition negatively. Fiber, on the other hand, is expected to affect nutrition positively, while the taste effect is less clear. We make the simplifying assumption that fat affects nutrition negatively, since the average Swedish consumer should limit her intake of total fat (SNR, 2005). However, not all types of fat affect nutrition negatively, and breakfast cereals and hard bread are especially likely to partly contain healthy fat. In the data, we only have information on the total amount of fat in the product, and cannot separate healthy fat (non-saturated fat, such as for instance omega 3) from unhealthy fat (trans fat and saturated fat).

Reported preparation time may have an impact on convenience. However, the impact may be positive or negative, dependent on the preferences of the consumers. Although it is tempting to assume that most consumers prefer a shorter preparation time, those who find pleasure in cooking might prefer a longer preparation time.

It is worth noting that the service taste is solely determined by the ingredients in Table I, as assumed by the model in the Section "Theoretical model." Taste could, however, also be affected by factors and contents that are missing in the data, such as the preparation method and chemical taste enhancers.

Table I. Expected effects of selected food characteristics on food services.

	Service		
Food characteristic	Taste	Nutrition	Convenience
Fat	+	–	No effect
Fiber	+/–	+	No effect
Salt	+	–	No effect
Sugar	+	–	No effect
Vitamins	No effect	+	+
Nutrition symbol	No effect	No effect	+
Preparation time	No effect	No effect	+/–

Note: + indicates that the characteristic has a positive effect on a specific service; – indicates the opposite.

Empirical method

Based on the theoretical model in the Section "Theoretical model," the marginal implicit prices of food characteristics can be estimated from a hedonic price function. The functional form of the hedonic price function is an open question, since economic theory provides no guidance here. Semi-log regressions, or linear or quadratic functional forms of Box–Cox transformed variables, have often been used in hedonic regressions. Cropper et al. (1988) find that the performances of various model specifications in hedonic regressions depend on the quality of the data. They conclude that a linear function of Box–Cox transformed variables performs best under perfect information about relevant characteristics. In the case of omitted variables or proxies, the linear function of Box–Cox transformed variables is outperformed only by a hedonic price function with untransformed variables. In contrast, Cassel and Mendelsohn (1985) argue the results from the Box–Cox transformation are both hard to interpret and unstable. Moreover, even a general form of the Box–Cox transformation is restrictive because it requires the functional form to be the same for all transformed exogenous variables. The quadratic model provides a flexible functional relationship and, in addition, encompasses the linear-in-variables model as a special case.

The quadratic specification is employed here because of a need for a more flexible form than imposed by the Box–Cox transformation. As with many quadratic specifications, multicollinearity can be a serious obstacle if both linear and quadratic terms of the same variables are included in the regression. As a result, the square of the difference between the measured value of a characteristic and the mean value for that characteristic is used instead of a quadratic term of the characteristic.[7] Specifically, the following hedonic price function is estimated for product group j (where j = breakfast cereals, hard bread, or potato products):

$$P_j^k = \alpha_j + \boldsymbol{\beta}_j \mathbf{z}_j^k + \boldsymbol{\delta}_j (\mathbf{z}_j^k - \bar{\mathbf{z}}_j)^2 + \boldsymbol{\gamma}_j \tilde{\mathbf{z}}_j^k + \phi_j \mathbf{D}_j^k + \varepsilon_j^k \qquad (5)$$

where P_j^k is the price per 100 gram of product k (where $k = 1,\ldots,K$) in group j, $\mathbf{z}_j^k$ is a vector of the m continuous characteristics in the product (of a total of n characteristics); and $\bar{\mathbf{z}}_j$ is a vector of mean contents for each continuous characteristic i in group j, i.e. $\bar{\mathbf{z}}_j = \Sigma_k z_{ij}^k / K$. The vector $\mathbf{D}_j^k$ contains dummy variables for discrete characteristics (indicators of the nutrition symbol, berries, fruits, nuts, and vitamins) as well as indicators of the q brands in the data on product group j. Included in the specification is also a vector of interaction terms, defined as $\tilde{\mathbf{z}}_j^k = (z_{j1}^k z_{j2}^k, z_{j1}^k z_{j3}^k, z_{j1}^k z_{j4}^k, z_{j2}^k z_{j3}^k, z_{j2}^k z_{j4}^k, z_{j3}^k z_{j4}^k)$, where characteristics 1, 2, 3, and 4 are fiber, salt, sugar, and fat, respectively. These terms show how combinations of characteristics particularly associated with the nutritional status of the product that may be valued by consumers. For example, although fiber alone might not be valued highly, fiber in combination with salt might be, meaning consumers only value additional fiber highly if the product at the same time contains a high amount of salt.[8]

The functional relationship between the product price and characteristics is determined by the statistical significance of the effects of the linear, quadratic, and interaction variables. After estimating the hedonic regressions for each product group as specified by Equation (5), F tests were performed to determine whether otherwise statistically non-significant parameter estimates jointly contribute to the explanatory power of the model. If they did not, as a group, contribute to the explanatory power of the model, they were excluded.[9]

For hard bread, there are values missing on salt and sugar for 22 out of 71 observations. Using the information provided in the data set, conditional means were imputed, based on all other independent variables; missing values were estimated by regressing salt and sugar on the remaining independent variables. While admittedly raising the problem of multicollinearity, filling in missing values with the imputed ones produces consistent estimates (Little, 1992). Note that the results from the imputation differed little from estimates produced by replacing missing values with mean values of the available levels of the characteristics.

The Cook–Weisberg test for heteroscedasticity was performed (Cook & Weisberg, 1983). For breakfast cereals and hard bread, the null hypothesis of homoscedasticity cannot be rejected. For potato products, it can be rejected, however. As a result, White's heteroscedasticity-consistent estimator of the variance–covariance matrix was used when testing hypotheses for potato products.[10]

Differentiating Equation (5) with respect to the ith characteristic gives the marginal implicit price of characteristic i in product group j, which we denote p_{ji}. The marginal implicit price of (continuous) characteristic i is then:

$$p_{ji}^k = \beta_{ji} + 2\delta_{ji}(z_{ji}^k - \bar{z}_{ji})(1 - 1/K) + \sum_{h=1}^{H} \gamma_{jh} z_{jh}^k \quad i \neq h, \tag{6}$$

where $-1/K$ represents the inner derivative of the parenthesis and $z_1,\ldots,z_H$ are the contents of the H continuous characteristics by which characteristic i interacts. The marginal implicit prices are evaluated at the mean content of the characteristics in the product group. However, only analyzing marginal implicit prices calculated at the mean contents of the product means missing valuable information on how the willingness to pay for a food characteristic depends on the level of the characteristic contained in the product, and also on the level of other characteristics. Sensitivity analysis has been performed to provide transparent information on the change in the marginal implicit price of selected characteristics from changes in the content of characteristics. Such analyses provide insight into how the trade-off between the taste and health effect from one characteristic can be affected both by the level of the characteristic itself and by the contents of other characteristics.

Results

In this section, we first present the results from the estimations of the hedonic price function. Thereafter, we analyze the mean marginal implicit prices, i.e. the marginal implicit prices evaluated at the mean product content, and how they change as the product content (marginally) changes.

Results from the hedonic price regressions

Tables II–IV show the results of the hedonic regressions, as specified in Equation (5), with explanatory variables that either individually or jointly (as determined by the F-test) contribute to explaining variations in the product price. In the following, the significance of parameters is assessed at both the 5 and 10% levels. When commenting on the results, focus will be on five characteristics: the nutrition symbol, fat, fiber, salt, and sugar. As noted earlier, brand dummies were included as controls in the model, but the effects of these variables are not presented.[11]

The results from the hedonic regression on *breakfast cereals* reveal a statistically significant negative effect on price, at the 10% level, of the *nutrition symbol*, which contradicts the a priori expectation about consumers valuing easily accessible information the symbol presents. The linear term for *fat* has

Table II. Results from the hedonic regression on breakfast cereals.

Variable	Coefficient	Variable	Coefficient
$Z_{\text{nutrition symbol}}$	−109.01[a]	Z_{salt}	−26.49
	(−1.90)		(−0.09)
Z_{vit}	−51.86	$(z_{\text{salt}} - \bar{z}_{\text{salt}})^2$	−542.99[b]
	(−1.17)		(−2.06)
Z_{berries}	95.06[b]	Z_{sugar}	10.48[b]
	(3.27)		(2.76)
Z_{fruit}	15.55	$(z_{\text{sugar}} - \bar{z}_{\text{sugar}})^2$	−0.50[b]
	(0.39)		(−3.00)
Z_{nuts}	20.95	$Z_{\text{fat}}Z_{\text{fiber}}$	−0.11
	(0.44)		(−0.07)
Z_{carbs}	3.21	$Z_{\text{fat}}Z_{\text{salt}}$	13.64
	(0.49)		(0.67)
$(z_{\text{carbs}} - \bar{z}_{\text{carbs}})^2$	0.33	$Z_{\text{fat}}Z_{\text{sugar}}$	−44.32
			(−0.60)
	(0.80)		
Z_{fat}	10.69	$Z_{\text{fiber}}Z_{\text{salt}}$	8.73
	(0.39)		(0.28)
$(z_{\text{fat}} - \bar{z}_{\text{fat}})^2$	−2.22[b]	$Z_{\text{fiber}}Z_{\text{sugar}}$	−0.99
	(−2.58)		(−1.48)
Z_{fiber}	−17.20	Constant	−154.17
	(−0.88)		(−0.25)
$(z_{\text{fiber}} - \bar{z}_{\text{fiber}})^2$	2.79[b]	R^2: 0.86	
	(2.23)		
Z_{protein}	62.07[b]		
	(4.21)		
$(z_{\text{protein}} - \bar{z}_{\text{protein}})^2$	−14.14[b]		
	(−4.71)		

Note: The dependent variable is price per 100 grams product. [a]Indicates the variable has a statistically significant effect at the 10% level. [b]Indicates the effect is significant at the 5% level; *t* values are in parentheses.

Table III. Results from the hedonic regression on hard bread.

Variable	Coefficient	Variable	Coefficient
$Z_{\text{nutrition symbol}}$	131.31	Z_{sugar}	−360.84
	(1.16)		(−1.10)
Z_{carbs}	41.05[a]	$(z_{\text{sugar}} - \bar{z}_{\text{sugar}})^2$	20.09
	(1.69)		(1.39)
$(z_{\text{carbs}} - \bar{z}_{\text{carbs}})^2$	3.06	$Z_{\text{fat}}Z_{\text{fiber}}$	−15.20
	(1.01)		(−1.56)
Z_{fat}	329.62[a]	$Z_{\text{fat}}Z_{\text{salt}}$	111.30
	(1.83)		(0.56)
$(z_{\text{fat}} - \bar{z}_{\text{fat}})^2$	−28.32[b]	$Z_{\text{fat}}Z_{\text{sugar}}$	−9.65
	(−3.00)		(−0.70)
Z_{fiber}	−83.55	$Z_{\text{fiber}}Z_{\text{salt}}$	215.12
	(−0.71)		(1.20)
$(z_{fiber} - \bar{z}_{fiber})^2$	−2.46	$Z_{\text{fiber}}Z_{\text{sugar}}$	22.03
	(−0.56)		(1.05)
Z_{protein}	35.25	Constant	−2053.77
	(1.00)		(−0.92)
$(z_{\text{protein}} - \bar{z}_{\text{protein}})^2$	−26.59[b]	R^2: 0.63	
	(−2.04)		
Z_{salt}	−3046.31		
	(−1.03)		
$(z_{\text{salt}} - \bar{z}_{\text{salt}})^2$	1293.59		
	(0.30)		

Note: The dependent variable is price per 100 grams product. [a]Indicates the variable has a statistically significant effect at the 10% level. [b]Indicates the effect is significant at the 5% level; *t* values are in parentheses.

no significant effect on the price, but the quadratic term has a highly significant negative effect. The same is true for *salt*. Moreover for *fiber*, the quadratic term has a significant positive effect. Our results also imply *sugar* has a positive and decreasing effect on the price, with the parameters of the linear and quadratic terms being highly significant. None of the interaction terms have significant effects on the price of breakfast cereals.

The positive effect of sugar is consistent with the results in both Stanley and Tschirhart (1991) and Shi and Price (1998). Shi and Price do not have salt as an explanatory variable in their analysis and Stanley and Tschirhart find no statistically significant effect of salt. Our results, however, suggest salt has a negative effect on the price of breakfast cereals. Contrary to the results here, Stanley and Tschirhart find a significant negative effect of fiber.[12]

The explanatory power of the regression on breakfast cereals is high; and the R^2 value being 0.86. Most of the quadratic terms have a significant effect on the price of breakfast cereals, whereas the linear terms do not. In addition, none of the interaction terms have significant effect on the price. An *F*-test value of 2.59 (*P*-value = 0.01) shows, as a group, the linear and interaction terms jointly contribute to the explanatory power of the model.

For *hard bread* products, the coefficient for the *nutrition symbol* has the expected positive sign, but is not statistically significant. A positive effect from *fat* on price is statistically significant at the 10% level. The effect of *fiber* is negative but not statistically

Table IV. Results from the hedonic regression on potato products.

Variable	Coefficient
$Z_{\text{preparation time}}$	−0.04[b]
	(−3.14)
Z_{carbs}	−0.07
	(−1.52)
Z_{fat}	0.14[b]
	(2.37)
$(z_{\text{protein}} - \bar{z}_{\text{protein}})^2$	−0.14
	(−1.54)
Z_{salt}	4.29[b]
	(8.58)
$Z_{\text{fat}}Z_{\text{salt}}$	−0.47[b]
	(−6.39)
Constant	20.22[b]
	(8.31)
R^2: 0.92	

Note: The dependent variable is price per 100 grams product. [b]Indicates the effect is significant at the 5% level; *t* values are in parentheses.

significant. Similarly, no statistically significant effect is found for *salt* or *sugar*. As with breakfast cereals, none of the interaction terms have statistically significant effects on the price. The large number of non-significant estimates is reflected in the lower explanatory power of the model; R^2 being 0.63.[13] Hard bread is generally healthy, which is shown by the high proportion of hard bread products being certified with the nutrition symbol (see Appendix 1). Variables which individually had no significant effect on the hard bread price jointly increased the explanatory power of the model (F-test = 1.72, P-value = 0.09).

For *potato products*, the quadratic terms for carbohydrates and fat, as well as the linear term for protein, have no individually significant effects on the product price. An F-test also reveals including these terms, as a group, does not increase the explanatory power of the model.[14] Therefore, they are excluded from the model. For potato products, the positive effect of *fat* on the product price is highly statistically significant. Here, the interaction term between fat and salt is also highly significant, and negative, counteracting the positive effect of fat on the product price. Reported preparation time for potato products seems to have a small but highly statistically significant negative effect on the product price. The explanatory power of the condensed regression on potato products is still high; the R^2 value of the regression amounts to 0.92.[15]

Based on the results shown in Tables II–IV, marginal implicit prices are calculated (Table V). Mean marginal implicit prices are expressed in öre (100 öre = 1 SEK). For each continuous characteristic, the mean marginal implicit price is the amount consumers are willing to pay for a marginal increase of this characteristic above its mean value, all other characteristics being at their mean values. For the nutrition symbol, the marginal implicit price indicates consumers' willingness to pay for having the label on the product.

The mean marginal implicit price of *fat* varies greatly over the three product groups. Consumers seem to value fat in hard bread (149 öre), indicating the positive effect on taste from adding fat outweighs the negative effect on nutrition. The opposite is true for breakfast cereals, shown by its larger negative mean marginal implicit price (−863 öre). In potato products, the outcome of the trade-off between taste and nutritional value concerning fat seems to depend on whether or not the product contains salt. If the product contains salt, consumers on average have a negative marginal willingness to pay for fat, whereas consumers on average have a positive marginal willingness to pay for additional fat if the product does not contain salt. With salt, the positive effect on taste from a marginal increase in fat seems to be outweighed by the negative effect on nutrition from decreasing the fat content. In both cases, however, the mean marginal implicit price of fat in potato products is small.

The mean marginal implicit price of *fiber* is positive, but non-significant, for hard bread, whereas for breakfast cereals it was negative. This could imply that marginally increasing fiber above its mean level in breakfast cereals reduces the taste, and this reduction in taste outweighs the positive effect on the nutrition.

The mean marginal implicit price of *salt* is positive both for breakfast cereals and hard bread, although non-significant for the latter group. For the potato products it is negative, though quite small. The values are not strictly comparable, though, since salt is included as a dummy in the hedonic regression on potato products. The negative marginal implicit price reflects a negative willingness to pay for adding salt to potato products that contain no salt.

Table V. Marginal implicit prices, evaluated at the mean content.

Breakfast cereals		Hard bread		Potato products	
Nutrition symbol	−109.01	Nutrition symbol	131.31	Preparation time	−0.04
Vitamins	−51.86	Carbohydrates	41.05	Carbohydrates	−0.07
Berries	95.06	Fat	149.42	Protein	−0.28
Fruit	15.55	Fiber	17.38	Salt	−3.80
Nuts	20.95	Protein	35.25	Fat	
				If salt	−0.33
				If no salt	0.14
Carbohydrates	3.21	Salt	300.02		
Fat	−862.77	Sugar	−85.50		
Fiber	−34.53				
Protein	62.07				
Salt	128.51				
Sugar	−293.99				

Note: 100 öre = 1 SEK.

The mean marginal implicit price for *sugar* in breakfast cereals is negative and fairly large (−294 öre) so the negative effect on nutrition from a small increase in the sugar content outweighs the positive effect on taste. The marginal implicit price for sugar in hard bread is also negative, though non-significant.

Moreover, note that the marginal implicit price for preparation time regarding potato products is negative, suggesting that the average consumer prefers a shorter preparation time for potato products.

Results from sensitivity analysis

Table VI shows the effect on the marginal implicit price of selected continuous characteristics from a 1% change in the levels of these characteristics. Note that it is important to exercise caution in the interpretation of the results: the only interaction term with an individual statistically significant effect in the hedonic regressions is the interaction term between fat and salt in potato products. The lack of other individually significant parameter estimates means the results from the sensitivity analysis should be seen as an illustration of how marginal implicit prices may vary over levels of characteristics.

By using the point estimates in Tables II, III and IV, we find for breakfast cereals, the marginal implicit price of fat decreases, i.e. becomes more negative, as the level of fat is increased above the mean level. The marginal implicit prices of both salt and sugar in breakfast cereals also decrease as the level of the characteristic itself is increased, suggesting consumers have a diminishing marginal willingness to pay for these characteristics in breakfast cereals. However, the opposite is true for the marginal implicit price of fiber, which increases as the level of fiber increases by 1% above its mean level. Noteworthy is also the percentage change in the marginal implicit price as the characteristic itself is increased by 1% seems to be quite small for fat (−0.03%) and sugar (−0.06%), whereas it is fairly sizeable for fiber (1.21%) and especially for salt (−3.01%) in breakfast cereals.

In hard bread, there is a diminishing marginal willingness to pay for fat and fiber, whereas the marginal willingness to pay for salt and sugar seems to be increasing, as the level of the characteristic itself increases. Moreover here, the percentage changes of the marginal implicit prices are the smallest for fat (−1.20%) and sugar (1.02%), as the content of the characteristic itself is increased by 1% above its mean level, compared to the change in the marginal implicit prices for fiber (−3.88%) and salt (4.00%) in hard bread.

The results from the sensitivity analysis also suggest, in both breakfast cereals and hard bread, consumers value salt more if the fiber content increases, and vice versa. This could be interpreted as consumers appreciating the taste enhancing effect from salt even more when the fiber content is high. Bearing in mind that we are looking at marginal changes, if this result is general, it would mean

Table VI. Marginal implicit price changes from changing levels of health characteristics.

	Breakfast cereals	Hard bread	Potato products
Effects on the marginal implicit price of fat			
Mean p_{fat}	−862.77	149.42	−0.33/0.14
Percentage change of p_{fat} if increasing fat by 1%	−0.03%	−1.20%	n.a.
Percentage change of p_{fat} if increasing fiber by 1%	−0.001%	−1.41%	n.a.
Percentage change of p_{fat} if increasing salt by 1%	0.01%	0.35%	n.a.
Percentage change of p_{fat} if increasing sugar by 1%	−1.01%	−0.14%	n.a.
Effects on the marginal implicit price of fiber			
Mean p_{fiber}	−34.53	17.38	n.a.
Percentage change of p_{fiber} if increasing fat by 1%	−0.02%	−2.80%	n.a.
Percentage change of p_{fiber} if increasing fiber by 1%	1.21%	−3.88%	n.a.
Percentage change of p_{fiber} if increasing salt by 1%	0.09%	5.80%	n.a.
Percentage change of p_{fiber} if increasing sugar by 1%	−0.57%	2.79%	n.a.
Effects on the marginal implicit price of salt			
Mean p_{salt}	128.51	300.02	−3.79
Percentage change of p_{salt} if increasing fat by 1%	0.69%	1.19%	−2.13%
Percentage change of p_{salt} if increasing fiber by 1%	0.50%	9.96%	n.a.
Percentage change of p_{salt} if increasing salt by 1%	−3.01%	4.00%	n.a.
Effects on the marginal implicit price of sugar			
Mean p_{sugar}	−293.99	−85.50	n.a.
Percentage change of p_{sugar} if increasing fat by 1%	−1.01%	−0.36%	n.a.
Percentage change of p_{sugar} if increasing fiber by 1%	−0.03%	3.58%	n.a.
Percentage change of p_{sugar} if increasing sugar by 1%	−0.06%	1.02%	n.a.

Note: The marginal implicit prices are in öre.

producers have an incentive to add salt to products rich in fiber, which would decrease the health status of products with a high fiber content.

The results also imply consumers value salt more if the fat content raises (at least in breakfast cereals and hard bread) and vice versa. This suggests the dominance of taste over nutrition is even stronger with higher levels of both fat and salt; a possible interpretation is that the taste sensation of the combination of fat and salt is strong.

Since consumers seem to have a diminishing marginal willingness to pay for salt, sugar, and fat in breakfast cereals, it seems that when the level of the unhealthy characteristics are high enough, consumers will provide producers with disincentives to further increase the content, thereby guaranteeing that the supply of breakfast cereals remains relatively healthy. The results from the sensitivity analysis do not imply the same for hard bread, though, where a higher content of fat and fiber seems to decrease the marginal willingness to pay for these characteristics in hard bread, whereas a higher content of salt and sugar increases the marginal willingness to pay for salt and sugar. Consumers thereby continuously provide producers with incentives to increase the content of salt, and the marginal willingness to pay for sugar in hard bread becomes less negative as the content of sugar increases.

Conclusions

A trade-off exists between taste and nutrition, since food rich in particularly unhealthy ingredients (fat, salt, and sugar) may also be tasty. It is an empirical question whether taste or nutrition dominates for consumers when valuing these ingredients. If taste dominates for an ingredient, consumers will have a positive willingness to pay for it. The purpose of this study is to estimate the values attached by consumers to health-related food characteristics; fat, fiber, salt, and sugar and the nutrition symbol. The values consumers attach to health-related characteristics affects availability of unhealthy food, by providing producers with incentives or disincentives to supply healthy food. Availability of unhealthy food has, in turn, been argued to be one of the main drivers behind the rise in unhealthy eating and obesity (Chou et al., 2004). Understanding the trade-off faced by consumers, and thereby the values consumer attach to health-related food characteristics, is therefore important if wanting to better understand the drivers behind the rise in obesity during the last decades.

Calculating mean marginal implicit prices for fat, fiber, salt, and sugar in breakfast cereals, hard bread, and potato products, we find the relative dominance of taste versus nutrition varies both over health characteristics and over food products. Preferences for food characteristics thus seem to be context-dependent. Nutrition dominates taste for fat in breakfast cereals and in potato products that contain salt, whereas taste dominates nutrition for fat in hard bread and in potato products that do not contain salt. Taste also dominates nutrition for salt in breakfast cereals and hard bread, resulting in a positive mean marginal implicit price (or marginal willingness to pay) for salt in these products. However, for salt in potato products, the reverse seems to be true. For sugar in breakfast cereals and hard bread, nutrition seems to dominate over taste, resulting in a negative marginal willingness to pay for sugar in both breakfast cereals and hard bread. As for the one particularly healthy ingredient, fiber, the marginal willingness to pay for fiber in breakfast cereals is estimated to be negative, whereas the reverse is true for the marginal willingness to pay for fiber in hard bread.

In the sample used for the study, consumers have a positive marginal willingness to pay for fat in product groups low in fat (hard bread) whereas consumers have a negative marginal willingness to pay for fat in product groups that are higher in fat (breakfast cereals and especially potato products). This means that the taste enhancing effect from additional fat outweighs the negative effect on nutrition from adding fat, as long as the product is not already rich in fat. The same results are obtained for salt; the marginal willingness to pay for salt is positive for products relatively low in salt (hard bread and breakfast cereals), and negative for products relatively high in salt (potato products). For fat, this result is further supported by the results from the sensitivity analysis, which implies that the marginal willingness to pay decreases as the content of the characteristic increases for all products in the sample. If these results could be generalized, it would mean that consumers provide incentives for producers to add small amounts of fat and salt (and thereby taste) to food products low in fat (as long as the marginal willingness to pay for fat exceeds producer costs of adding fat), but that consumers discourage producers from developing food products high in fat and salt. The producer incentives provided by the results for the other health-related characteristics in the sample are, however, more mixed.

The marginal implicit prices for fat, fiber, salt, and sugar are sensitive to the levels of both the characteristic itself and other food characteristics. A negative marginal willingness to pay for a characteristic that is calculated on the basis of the mean contents of the product might turn positive with another combination of food characteristics in the product. This will affect producer incentives to develop healthy products. If, for instance, the marginal willingness to pay for a healthy ingredient (fiber) is positively affected by adding an unhealthy ingredient (such as salt), producers would have an incentive to add salt to products rich in fiber. However, it is important to exercise caution in interpreting the results of this sensitivity analysis, due to the low statistical significance of some individual parameters in the hedonic regressions. More research is needed to understand consumer preferences for combinations of ingredients.

The nutrition symbol helps consumers judge the nutritional status of a product, thereby reducing consumer search costs. A priori, the symbol was therefore expected to be positively valued by consumers, regardless of the product content. However, the nutrition symbol on breakfast cereals seems to have a negative marginal implicit price, whereas the effect on the price from the nutrition symbol on hard bread could not be statistically confirmed. There are no examples of potato products with the nutrition symbol in our data set. The average consumer seems to provide producers with disincentives to apply for certification for the nutrition symbol. A negative marginal implicit price for the nutrition symbol seems counterintuitive. If, on average, consumers regard the nutrition symbol not only as a source of information but also as a signal for poor taste, such a result could be expected.

Consumers having a negative marginal willingness to pay for some characteristics, raises the question of why producers continue offering products with such combinations of characteristics. One reason could be that they have incomplete information on consumer preferences and the marginal willingness to pay for attributes. In addition, consumer preferences change over time, for instance due to new health findings, and producers might be slow to change their products accordingly. In addition, producers often supply a portfolio of products that vary in contents; the profit maximizing portfolio could include products that individually yield varying profits. Moreover, preferences vary over consumers. Even if the average consumer has a negative willingness to pay for a characteristic, there may be sub-groups of consumers with different tastes, constituting niche markets for producers. Such differences in preferences over socio-demographic groups are confirmed by Shi and Price (1998). Their results show the value attached to energy (kilojoule) in food varies over age groups, with the young attaching a higher value to energy than older consumers. People with higher education were also found to attach a lower value to fat than other consumer groups. In a similar way, Larsson et al. (1999) found different consumer groups react differently to the nutrition symbol. If preferences for the nutrition symbol vary, there might be groups with a positive willingness to pay for the nutrition symbol, providing producers with incentives to apply for the certification for the nutrition symbol.

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Notes

1. Definitions of overweight and obesity are usually based on Body Mass Index (BMI), measured as the weight of a person (in kilograms) divided by their squared height (in meters): a BMI of 25–30 is considered overweight and a BMI above 30 is considered obese.
2. Hedonic price models, launched by Lancaster (1966) and further developed and formalized by Griliches (1967) and Rosen (1974), have been widely used to estimate marginal implicit prices of characteristics for which markets do not exist. Hedonic pricing methods have been used to calculate implicit marginal prices for characteristics of housing (see, for example, Mills & Simenauer, 1996; Benson et al., 1998). Other areas of application are computer attributes (Bajari & Benkard, 2005) and lately even the attributes of baseball players (Stewart & Jones, 1998), and the services of prostitutes (Moffatt & Simon, 2004) have been investigated with hedonic models.
3. Potato products might be the weakest group in terms of close substitutes. Even though mashed potatoes can substitute for French fries and French fries can substitute for potato chips, mashed potatoes might not be considered a (close) substitute for chips.
4. The Keyhole certification criteria were revised in 2005 (LIVSFS 2005:9) and then became stricter than they were under the previous criteria (SLVFS 1989:2). However, until end November 2006 for hard bread, and end July 2007 for breakfast cereals (for cereals certified with the Keyhole prior to end November 2006), products were allowed to carry the Keyhole as defined by the old criteria. In practice, the Keyhole certification criteria were therefore the same when the price data were collected (2003), as when characteristics data were collected in stores (end of 2005).
5. Kilojoules are equivalent to "calories," with one calorie equal to 4.184 kilojoules.
6. The nutritional content is determined by the ingredients and the nutrition symbol is just a signal of the content. Since certification of the nutrition symbol (Keyhole) is voluntary

and initiated by producers, there may be products in the market as healthy as those certified with the Keyhole that, however, do not carry the symbol, due to producers not having applied for certification.

7. The downside to the transformation of the quadratic term is the loss of transparency of the results.
8. Our model specification differs from the one used by Stanley and Tschirhart (1991) in that they estimate a hedonic regression specified as a linear Box–Cox function and only for one product group. The main difference from the model chosen by Shi and Price (1998) is that they estimate a linear regression, using more aggregated food product data, and also include interaction terms with household characteristics. Neither Stanley and Tschirhart nor Shi and Price include interaction terms between variables, or control for brand effects, as our model specification does.
9. The groups were defined as follows: individually statistically non-significant linear as well as non-linear continuous variables, interaction terms and dummy variables, respectively.
10. A model with each observation weighted by its market share has also been estimated, as a means of ensuring that popular products found in stores be given greater weightage in the empirical analysis than products rarely found in the stores, since the latter products would often not be part of the choice set faced by consumers. Since food characteristics were collected manually in stores, and we were more likely to find popular products in the store, products with small market shares are likely not to be represented in the data. The results from the weighted regressions are basically the same as those generated from the baseline hedonic regression and are not reported.
11. However, it is worth noting that many of the brand dummies were highly statistically significant.
12. For comparison with Stanley and Tschirhart, a Box–Cox transformation was performed. The qualitative effects of most explanatory variables remained as in Table II, with the exception of sugar and vitamins. Moreover, as shown by an *F*-test, brand dummies strongly enhance the explanatory power of the model. As a comparison, a hedonic price function without brand dummies was also estimated. The signs of parameter estimates statistically significant in the full model were the same, and even the levels of these parameters estimates did not change much, though often the estimates were no longer statistically significant.
13. The *F*-test shows that removing the brand dummies from the model does not significantly reduce the explanatory power of the model. Without them, the signs of the statistically significant parameter estimates in the full model are still the same, except for the quadratic term for protein, which is positive, but non-significant.
14. Brand dummies strongly contribute to the explanatory power of the model. Without them, the parameter estimates that are individual statistically significant in the full model are still the same, both in sign and level. However, the parameter estimates of the effect from carbohydrates and the quadratic terms for carbohydrates, fat, and protein, are statistically significant in the reduced model. All still have the same sign as in the full model, except for the parameter estimate of the effect from carbohydrates. Generally, the estimated effects from carbohydrates and the quadratic term of protein are statistically significant over a range of model specifications. They were therefore separately tested with an *F*-test, which indicate that they jointly contribute to the explanatory power of the full model. We therefore chose to include them in the final model specification.
15. A model linear in all variables (with brand dummies) was estimated for comparison, for all product groups. The main difference in the results from estimating the linear model occurred for breakfast cereals; the individual effects on the price of fiber and sugar turned insignificant. Moreover, the prevalence of multicollinearity is high in all models, although dramatically reduced compared to models where both the linear and quadratic terms of the same variables are included, as indicated by high mean variance inflation factors. However, for breakfast cereals and potato products, in turn removing collinear variables leaves the individual statistically significant parameter estimates almost identical to the estimates provided by the full model. In turn removing the most collinear variables from the hard bread group also leaves the sign of the individual statistically significant parameter estimates the same, but the absolute value of those parameter estimates drop by about one-third.

References

Bajari, P., & Benkard, C. L. (2005). Demand estimation with heterogeneous consumers and unobserved product characteristics: A hedonic approach. *Journal of Political Economy*, 113, 1239–1276.

Benson, E. D., Hensen, J. L., Schwartz, Jr., A. L., & Smersh, G. T. (1998). Pricing residential amenities: The value of a view. *Journal of Real Estate Finance and Economics*, 16, 55–73.

Birch, L. L. (1999). Development of food preferences. *Annual Review of Nutrition*, 19, 41–62.

Cassel, E., & Mendelsohn, R. (1985). The choice of functional forms for hedonic price. Equations: Comment. *Journal of Urban Economics*, 18, 135–142.

Chou, S-Y., Grossman, M., & Saffer, H. (2004). An economic analysis of adult obesity: Results from the behavioral risk factor surveillance system. *Journal of Health Economics*, 23, 565–587.

Cook, D. R., & Weisberg, S. (1983). Diagnostics for heteroscedasticity in regression. *Biometrika*, 70, 1–10.

Cropper, M., Deck, L. B., & McConnell, K. E. (1988). On the choice of functional form for hedonic price functions. *Review of Economics and Statistics*, 17, 668–675.

Cutler, D. M., Glaeser, E. L., & Shapiro, J. M. (2003). Why have Americans become more obese? *Journal of Economic Perspectives*, 17, 93–118.

Griliches, Z. (1967). Hedonic price indexes revisited: Some notes on the state of the art. *Proceedings of the business and economic statistics section of the American Statistical Association*, 324–332.

Kern, D. L., McPhee, L., Fisher, J., Johnson, S., & Birch, L. L. (1993). The postingestive consequences of fat condition preferences for flavors associated with high dietary fat. *Physiology and Behavior*, 54, 71–76.

Kin, S-Y., Nayga, R., & Capps, O. (2000). The effect of food label use on nutrient intakes: An endogenous switching regression analysis. *Journal of Agricultural and Resource Economics*, 25, 215–231.

Lancaster, K. J. (1966). A new approach to consumer theory. *Journal of Political Economy*, 74, 132–157.

Larsson, I., Lissner, L., & Wilhelmsen, L. (1999). The 'Green Keyhole' revisited: Nutritional knowledge may influence food selection. *European Journal of Clinical Nutrition*, 53, 776–780.

Little, R. J. A. (1992). Regression with missing X's: A review. *Journal of the American Statistical Association*, 87, 1227–1237.

Livsmedelsverkets föreskrifter och allmänna råd om användning av viss symbol. SLVFS 1989:2.

Livsmedelsverkets föreskrifter om användning av viss symbol LIVSFS 2005:9.

MacInnis, B., & Rausser, G. (2005). Does food processing contribute to childhood obesity disparities? *American Journal of Agricultural Economics*, 87, 1154–1158.

Mills, E. S., & Simenauer, R. (1996). New hedonic estimates of regional constant quality house prices. *Journal of Urban Economics*, 39, 209–215.

Moffatt, P. G., & Simon, P. A. (2004). Pricing personal services: An empirical study of earnings in the UK prostitution industry. *Scottish Journal of Political Economy*, 51, 675–690.

Neuhouser, M. L., Kristal, A. R., & Patterson, R. E. (1999). Use of food nutrition symbols is associated with lower fat intake. *Journal of the American Dietetic Association*, 99, 45–53.

Putnam, J., Allshouse, J., & Kantor, L. S. (2002). U.S. per capita food supply trends: More calories, refined carbohydrates, and fats. *Food Review*, 25, 2–15.

Rosen, S. M. (1974). Hedonic prices and implicit markets: Product differentiation in pure competition. *Journal of Political Economy*, 82, 34–55.

Shi, H., & Price, D. W. (1998). Impacts of sociodemographic variables on the implicit values of breakfast cereal characteristics. *Journal of Agricultural and Resource Economics*, 23, 126–139.

Smith, T. G. (2004). The McDonald equilibrium, advertising, empty calories, and the endogenous determination of dietary preferences. *Social Choice and Welfare*, 23, 383–413.

Stanley, L. R., & Tschirhart, J. (1991). Hedonic prices for a nondurable good: The case of breakfast cereals. *Review of Economics and Statistics*, 73, 537–541.

Stewart, K. G., & Jones, J. C. H. (1998). Hedonics and demand analysis: The implicit demand for player attributes. *Economic Inquiry*, 36, 192–202.

Svenska Näringsrekommendationer, SNR (Swedish Nutrition Recommendations), (2005). Rekommendationer on näring och fysisk aktivitet. Fjärde upplagan, Livsmedelsverket (National Food Administration), Uppsala.

Appendix 1. Summary statistics for food products.

	Breakfast cereals	Hard bread	Potatoes
Price per 100 grams[a]			
Mean price	4.3 SEK	4.4 SEK	5.3 SEK
Minimum price	1.7 SEK	1.7 SEK	1.3 SEK
Maximum price	9.6 SEK	8.7 SEK	10.2 SEK
Kilo joule per 100 grams			
Mean content	1583 KJ	1395 KJ	1308 KJ
Minimum content	1350 KJ	1103 KJ	240 KJ
Maximum content	1900 KJ	1720 KJ	2321 KJ
Carbohydrates per 100 grams			
Mean content	69.7 grams	64.7 grams	35.2 grams
Minimum content	52.0 grams	45.0 grams	12.0 grams
Maximum content	87.0 grams	80.0 grams	59.0 grams
Fat per 100 grams			
Mean content	6.7 grams	3.2 grams	17.2 grams
Minimum content	0.5 grams	0.3 grams	0.5 grams
Maximum content	18.0 grams	11.0 grams	38.0 grams
Fiber per 100 grams			
Mean content	7.6 grams	13.9 grams	
Minimum content	1.0 grams	3.8 grams	n.a.
Maximum content	20.0 grams	27.1 grams	
Protein per 100 grams			
Mean content	9.0 grams	10.0 grams	4.1 grams
Minimum content	4.5 grams	3.5 grams	1.5 grams
Maximum content	16.0 grams	13.0 grams	6.0 grams
Salt per 100 grams[b]			
Mean content	0.36 grams	0.47 grams	
Minimum content	0 grams	0.20 grams	n.a. (dummy) (32 obs contain salt)
Maximum content	0.95 grams	0.80 grams	
Sugar per 100 grams[b]			
Mean content	19.8 grams	2.2 grams	
Minimum content	0.8 grams	0.1 grams	n.a.
Maximum content	44.0 grams	12.0 grams	
Food preparation time			
Mean time			9 min 20 sec
Minimum time	0 min	0 min	0 min
Maximum time			60 min
Number of obs with nutrition symbol	18	52	n.a.
Number of obs with berries	18	n.a.	n.a.
Number of obs with fruit	26	n.a.	n.a.
Number of obs with nuts	9	n.a.	n.a.
Number of obs showing vitamin info	43	n.a.	n.a.
Number of brands	14	8	6
Total number of obs	86	71	44

[a]On 4 July 2008, USD/SEK = 5.98. [b]For hard bread, there are missing observations of salt and sugar, such that the values presented here are based on both actual and predicted observations of these variables.