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THE DANISH TAX ON SATURATED FAT – SHORT RUN EFFECTS ON CONSUMPTION AND CONSUMER PRICES OF FATS

Jørgen Dejgård Jensen & Sinne Smed

Abstract

Denmark introduced a new tax on saturated fat in food products with effect from October 2011. The objective of this paper is to make an effect assessment of this tax for some of the product categories most significantly affected by the new tax, namely fats such as butter, butter-blends, margarine and oils. This assessment was done by conducting an econometric analysis on weekly food purchase data from a large household panel dataset (GfK ConsumerTracking Scandinavia), spanning the period from January 2009 until December 2011.The econometric analysis suggest that the introduction of the tax on saturated fat in food products has had some effects on the market for the considered products, in that the level of consumption of fats dropped by 10 – 20%. Furthermore, the analysis points at shifts in demand from high-price supermarkets towards low-price discount stores – a shift that seems to have been utilized by discount chains to raise the prices of butter and margarine by more than the pure tax increase. Due to the relatively short data period with the tax being active, interpretation of these findings from a long-run perspective should be done with considerable care. It is thus recommended to repeat – and broaden – the analysis at a later stage, when data are available for a longer period after the introduction of the fat tax.

Keywords: fat tax, demand response, price response, retail sales

1. Introduction

Like many other countries, Denmark is facing an increased prevalence of health problems induced by unhealthy diets, including overweight, obesity and a number of associated co-morbidities (WHO, 2008) and there is an increasing awareness of the needs for public regulations to reverse this trend. Increased health care costs due to diet related illnesses represent a burden to the Danish public sector, and the solution is not to be found in raising public revenues to support these costs; the room for increased income taxation is limited by concerns for international competitiveness (OECD, 2012). Taxation of unhealthy foods and beverages is considered a tool that meets both these challenges to the public sector. Taxation of an unhealthy food is expected to increase the consumer price of this food, thus providing an incentive for the consumer to buy less of this product and at the same time, the revenue generated from such a tax can be used for financing public expenditures or reducing other tax rates.

The issue of food taxation as a health promoting instrument has been considered in a number of scientific papers (see e.g. review by Mytton et al., 2012). As the actual use of food taxation as a health policy instrument has been very limited (see below), these studies are based on model simulations, derived from e.g. econometrically estimated price elasticities. In these studies it is often assumed that the tax rate is perfectly transmitted to the consumer prices. Based on econometrically estimated models of food consumer behavior, Smed et al. (2007) and Jensen & Smed (2007) have investigated the potential effects of alternative health-related food tax models (including a tax on saturated fat, taxes on all fats, tax on sugar or lower taxes on fruits, vegetables and/or dietary fibers) on food consumption. The finding of this is that such tax schemes may constitute a tool to change dietary behaviours, and with the potentially largest effects on lower social groups. In a simulation study, Mytton et al (2007) found that taxing sources of saturated fat may lead to a reduction in the intake of saturated fats and despite an associated increase in salt consumption, would be a tool to avert thousands of cardiovascular deaths per annum in the UK.

In contrast, Chouinard et al. (2006) studied the impact of a fat tax on the consumption of dairy products, based on econometrically estimated price elasticities, and found a rather inelastic demand for these products, suggesting a low impact on consumption, but a high potential to generate tax revenue. A study by Allais et al. (2010) found that a fat tax has small and ambiguous effects on nutrients purchased by French households, leading to a small effect on body weight in the short run and a larger effect in the long run. Tiffin & Arnoult (2011) found that a fat tax will not bring fat intake among UK consumers in line with nutritional recommendations and that potential health impacts of a fat tax will be negligible. And Nordstrom & Thunstrom (2009) found that a tax on saturated fat would be more efficient in changing consumer behavior than a tax on fat, but the impact on consumption would still be minor, assuming politically feasible tax levels.

Recently, some countries have adopted the approach of introducing new taxes on foods or beverages that are considered unhealthy. In France, a tax on sugared soda was introduced in 2011 (Villanueva, 2011), in Hungary taxes on different ready-to-eat foods (candies, soft drinks, energy drinks, savory snacks and seasonings) with specified nutritional characteristics were also introduced in 2011 (Villanueva, 2011, Holt, 2011), Finland has in 2011 reintroduced taxes on sweets, which had been abolished since 1999, and more countries are considering the use of tax instruments in health promotion policies (EPHA, 2012). In Denmark, a new tax on saturated fat in food products was introduced, with effect from October 2011, as a supplement to existing taxation on sugar, chocolate, candy, ice-cream and soft drinks. The fat tax in Denmark distinguishes itself from the taxes mentioned above by targeting a nutrient instead of specific groups of food and as such this is the first tax of its kind in the world.

An aspect that has hardly been investigated in relation to such food taxation schemes is the taxes' impacts on the formation of consumer prices. As mentioned, most previous (prospective) studies have assumed a one-to-one transmission of the tax rate to the consumer price without taking into account possible market imperfections, due to e.g. imperfect competition or transaction costs. The objective of this paper is to make a first assessment of some of the market effects of the Danish saturated fat tax, i.e. we consider the impact on consumption, the impact on market shares for different shop types (discount and high-end supermarkets) as well as the impact of the tax on the formation of consumer prices of some of the product categories presumed to be most affected by the new tax: butter, butter-blends, margarine and oils.

The rest of this paper is organized as follows. The next section provides a description of the Danish fat taxation scheme, and the subsequent two sections provide a theoretical framework and a description of data and empirical methodology. After these methodological sections, results of the analysis are presented, and finally the paper is rounded off with a discussion and questions for further research.

2. The Danish tax on saturated fat

The tax on saturated fat was part of a larger tax reform taking place in Denmark in 2010. The overall aim of this reform was to reduce the pressure of income taxation rates for all people actively participating in the labour market and to finance this by, among other things, increased energy and environmental taxes and increased taxes to reduce adverse health behaviour.[1] The so-called health taxes included upward adjustments in existing taxes on sweet products, soft drinks, tobacco and alcohol. Taxes on sweets, chocolate, sugar-products and ice-cream were increased by 3.57 DKK (0.48 €) per kg added sugar for sugar-products, by 0.81 DKK (0.11 €) per litre for ice-cream, and by 0.30 DKK (0.04 €) per litre for soft drinks with added sugar, whereas the taxation of soft drinks with artificial sweeteners was decreased by 0.30 DKK/litre.

A novelty in the tax reform was the introduction of a tax on saturated fat in foods. The fat tax is a tax paid on the weight of saturated fat in foods, if the content of saturated fat exceeds 2.3 grams per 100 gram.[2] The threshold of 2.3 grams saturated fat per 100 gram implies that all kinds of drinking milk are exempt from taxation. The tax is levied on food manufacturers and food importers, but is expected to be transmitted to the consumer prices. Foods determined for

[1] For more on the overall tax-system change see http://www.skm.dk/public/dokumenter/engelsk/Danish%20Tax%20Reform_2010.pdf

[2] The fat tax is described in Smed (2012) and in https://www.skat.dk/SKAT.aspx?oId=1950194&vId=0 (in English)

exports or animal fodder are exempt from the tax. The tax is set at 16 DKK (2.15 €) per kg saturated fat, which is topped up by 25 per cent VAT. The tax came into force on the 1st of October 2011.

Fatty products, such as butter and margarine, are the food commodities for which prices are most affected by the fat tax, due to their high content of saturated fat. Table 1 illustrates the magnitudes of the tax rate, relative to the average market prices of different types of fats in 2009-2011.

Table 1: Consumption, tax rates and price changes for selected types of fats under the fat tax law (average Oct. 1, 2010-Oct. 1, 2011)

	Annual consumption Kg/individual	Discount stores[3], market share (volume %)	Average saturated fat content (g/100 g)	Saturated fat tax rate (DKK/kg)	Current price (DKK/kg)[1]	Price change (including 25% VAT) DKK	%
Butter	1.95	57%	51.9	8.30	46.72	10.38	22.22%
Butter blends	1.89	47%	40.2	6.43	44.00	8.04	18.27%
Margarine	1.11	50%	21.4	3.42	20.80	4.28	20.58%
Oil	4.02	59%	12.3	1.97	29.91	2.46	8.22%

1) 1€ = 7.43 DKK (exchange rate accessed the 2/7 2012)
2) Compared to total volume purchased in supermarkets and discount stores, together these two types of store account for more than 90% of all fats purchased.

3. Theoretical model

In order to examine and illustrate the market reactions to the new tax, we establish a theoretical framework in terms of an economic price discrimination model, where retailers behave as (local) monopolists, when it comes to their supply of fat products, such as butter, butter-blends, margarine and oils. As these types of products normally constitute a minor share of the shopping baskets of consumers – this implies that the prices of these products (relative to e.g. transaction costs induced by changing shops) may be assumed not to play a crucial role in the consumers' choice of shop – this is considered to be a reasonable approximation. In particular, we consider a model with two retail chains – one with "high-end" supermarkets supplying their products at above-average prices and one with discount stores, supplying

[3] A discount store is a store with prices in the low end of the scale and a typical sales area at 400 – 1000 m^2. The variety of products in the store is limited compared to higher end supermarkets.

their products at below-average prices (for a definition of a discount store, see footnote 2). This setting can be considered as a price discrimination model, with one chain appealing to one group of consumers, and another chain aiming at another group of consumers.

We assume a linear marginal cost (mc_r) function of retailer r (with Q_r representing the quantity supplied and γ's representing parameters in this marginal cost function)

$$mc_r = \gamma_0 + \gamma_1 \cdot Q_r \tag{1}$$

Household number h is assumed to follow the demand function

$$Q^h = \varsigma_0^h + \varsigma_1^h \cdot P, \qquad \begin{pmatrix} \varsigma_0^h \\ \varsigma_1^h \end{pmatrix} \sim G\left(\begin{pmatrix} \bar{\varsigma}_0 \\ \bar{\varsigma}_1 \end{pmatrix}, \Sigma \right) \tag{2}$$

where Q^h is quantity demanded and P is price. ς_0^h and ς_1^h are parameters in this function, and they are assumed to be distributed according to the distribution function G , with the vector of mean values $(\bar{\varsigma}_0, \bar{\varsigma}_1)'$ and the variance-covariance matrix Σ [4].

Aggregating the household-level demand functions leads to the aggregate market demand function (where $g_0(h), g_1(h)$ are density functions for the two ς parameters)

$$Q = \varsigma_0 + \varsigma_1 \cdot P = \int g_0(h) \cdot \varsigma_0^h \cdot dh + \int g_1(h) \cdot \varsigma_1^h \cdot P \cdot dh \tag{3}$$

The distribution function G of household-level demand functions yields the possibility for market segmentation, for example into a “high-end” and a “discount” segment, with separate distributions of demand parameters (G^H, G^L), and with different retail chains targeting the different segments.

The “high-end” retail chain (chain H) is assumed to be facing the demand function

[4] In this simplified representation of the demand function - which is used for illustrating the theoretical arguments about price formation and demand effects - there are no substitute products. In the empirical implementation below, we introduce such substitutes.

$$
\begin{aligned}
&Q_H = \alpha_H + \beta_H \cdot P_H \\
&where \\
&\alpha_H = \int g_0^H(h) \cdot \varsigma_0^h \cdot dh \\
&\beta_H = \int g_1^H(h) \cdot \varsigma_0^h \cdot dh
\end{aligned}
\tag{4}
$$

and keeping in mind the assumption that the retail chain can act as a monopolist, the marginal revenue function can be derived as

$$
mr_H = \frac{2}{\beta_H} \cdot Q_H - \frac{\alpha_H}{\beta_H}
\tag{5}
$$

Utilizing the first-order condition of equality between marginal cost and marginal revenue, we can then derive retailer H's profit maximizing supply as

$$
Q_H = \frac{\gamma_0 + \alpha_H / \beta_H}{2/\beta_H - \gamma_1}
\tag{6}
$$

And the corresponding price as

$$
P_H = \frac{1}{\beta_H} \cdot Q_H - \frac{\alpha_H}{\beta_H}
\tag{7}
$$

Taking the supply and price of retailer H as given, retailer L (discount chain) faces the demand function

$$
\begin{aligned}
&Q_L = \alpha_L + \beta_L \cdot P_L - Q_H \\
&where \\
&\alpha_L = \int g_0^L(h) \cdot \varsigma_0^h \cdot dh \\
&\beta_L = \int g_1^L(h) \cdot \varsigma_0^h \cdot dh
\end{aligned}
\tag{8}
$$

With the associated marginal revenue function

$$
mr_L = \frac{2}{\beta_L} \cdot Q_L + \frac{1}{\beta_L} \cdot Q_H - \frac{\alpha_L}{\beta_L}
\tag{9}
$$

Like for retailer H, we can now derive retailer L's conditional (on Q_H) profit maximizing supply and price

$$Q_L = \frac{\gamma_0 + \alpha_L / \beta_L}{2/\beta_L - \gamma_1} - \frac{1/\beta_L}{2/\beta_L - \gamma_1} \cdot Q_H \tag{10}$$

$$P_L = \frac{1}{\beta_L} \cdot (Q_H + Q_L) - \frac{\alpha_L}{\beta_L} \tag{11}$$

Introducing a tax (τ) on the product affects the profit maximizing supplies of the two chains:

$$\begin{aligned} \Delta Q_H &= \frac{1}{2/\beta_H - \gamma_1} \cdot \tau \\ \Delta Q_L &= \frac{1}{2/\beta_L - \gamma_1} \cdot \tau \end{aligned} \tag{12}$$

and the corresponding price effects

$$\begin{aligned} \Delta P_H &= \frac{1}{\beta_H} \cdot \frac{1}{2/\beta_H - \gamma_1} \cdot \tau = \frac{1}{2 - \beta_H \cdot \gamma_1} \cdot \tau \\ \Delta P_L &= \frac{1}{\beta_L} \cdot \frac{1}{2/\beta_L - \gamma_1} \cdot \tau = \frac{1}{2 - \beta_L \cdot \gamma_1} \cdot \tau \end{aligned} \tag{13}$$

Hence, if the slope of the demand function differs between the two types of suppliers, the tax will influence their price setting differently. For example, if a concave shape of the market demand function is anticipated, reflecting higher price responsiveness for the high-end demand relative to the discount demand, the response in quantity demanded will be largest in the high-end supermarkets, and the profit maximizing price increase will be higher in the discount chains than in the more high-end supermarket chains. This may be the case, if price increases in the high-end supermarket chain trigger consumers' looking for lower priced alternatives in other stores (which indeed are available in the discount stores), thus partly relaxing the local monopoly assumption above, for example due to positive, but non-prohibitive, transaction costs associated with changing shops. As many Danish consumers actually do their shopping in different stores (of which some are discount stores and some are more high-end stores), this is likely to happen. On the other hand, if prices in discount stores increase, there are fewer lower-priced alternatives available, so the demand in those stores may tend to be less price responsive than the demand in the higher-end stores, at least when it comes to fairly standard products such as butter or margarine.

Hence, if the demand functions for fats are differently (but negatively) sloped for supermarkets and discount stores, respectively, the theoretical model leads to the following (alternative) research hypotheses:

> *H1) An introduction of a fat tax will reduce the demand for fat products in both types of stores*
>
> *H2) An introduction of a fat tax will lead to higher price increases in retail chains facing a steep demand curve than in chains facing a "flatter" – and more price responsive - demand curve*
>
> *H3) An introduction of a fat tax will tend to shift market shares towards retail chains facing relatively steep demand functions*

4. Data and empirical models

The data used in this paper originates from Scandinavian Consumer tracking (GfK) that among other things maintains a demographically representative consumer panel from all the different regions of Denmark. The data used covers the years 2009-2011 and is an unbalanced panel that contains approximately 3000 households[5], with about 20 per cent of the households replaced by similar types of households each year. Panel households keep detailed diaries of shopping on a weekly basis. For each shopping trip, the diary-keeper reports purchases of foods and other staples including the date and time of the purchase, the name of the store and the total expenditure on the shopping trip. For almost all goods in all periods, the value and quantity of the product is recorded. For this model purchases are aggregated to cover weekly aggregates and due to the rather short post-tax data period we consider only demand for foods that are heavily taxed, i.e. butter, butter-blends, margarine and oil. Descriptive statistics of the panel are given in table 2.

Compared to equivalent numbers from Statistics Denmark, the panel consists of more households located in urban communities (defined as communities containing cities with more than 10.000 inhabitants) and furthermore the main shopper is older than the average Dane. Concerning education, the distribution described in the table refers to the education of the main shopper and it shows that there are more main shoppers with a short education compared to Statistics Denmark. The main concern is, however not the representativeness of the panel, but a potential

[5] For more information on GfK Denmark see http://www.gfk.dk/, Andersen (2008) or Smed (2008).

extended focus from panel members on prices and food purchases due to the membership of a food panel. This might lead to a larger price sensitivity than is average for the Danish population.

Table 2: Descriptive statistics of panel (average Jan. 1, 2009-Dec. 31, 2011)

Variable	Description	Mean	Std dev	Danish population[c]
Residence				
Capital	1 = household located in Capital	0.21	0.41	0.25
Urban-east[a]	1 = household located in urban East	0.03	0.17	0.43
Urban-west[a]	1 = household located in urban West	0.25	0.43	
Rural-east	1 = household located in rural East	0.31	0.46	0.32
Rural-west	1 = household located in rural West	0.20	0.40	
Further education[b]				
None	1 = Main buyer no further education	0.20	0.28	0.43
Vocational	1 = Main buyer vocational education	0.39	0.49	0.32
Short	1 = Main buyer short tertiary education	0.15	0.35	0.05
Medium	1 = Main buyer medium tertiary education	0.20	0.40	0.14
Long	1 = Main buyer long tertiary education	0.06	0.23	0.06
Family composition				
Age	Age of main shopper	58.8	14.12	40.4
Kids06	= 1 if kids between 0 and 6 years in hh	0.09	0.37	
Kids714	= 1 if kids between 7 and 14 years in hh	0.13	0.46	0.27
Kids1520	= 1 if kids between 15 and 20 years in hh	0.09	0.35	
No kids	= 1 of there is no kids in the household	0.69		0.73

[a] Urban communities are defined as communities containing cities with more than 10.000
[b]Vocational (e.g. carpenter, nursing aide), short education (e.g. policeman, technical education), medium education (e.g. nurse, primary school teacher), long education (e.g. university degree)
[c] Data are from statistics Denmark

Relaxing the above local monopoly assumption a bit by assuming that change of shop involves positive although not necessarily prohibitive transaction costs to the consumer (thus leaving the stores with some market power vis-a-vis the consumers), we specify augmented empirical model equations for prices and demanded quantities for four categories of fat products: butter, butter blends, margarine and vegetable oils.

Price setting model

Based on equation (13), the model describing the price setting mechanisms in supermarkets and discount stores[6] represents price as a function of the tax dummy T, the pre-tax dummy v, and Christmas and

[6] Other types of stores (e.g. bakeries or corner stores) are left out of the analysis as discount stores and supermarkets account for more than 90% of all sales of fats.

monthly dummies. Data is aggregated to time series for individual stores, 65 in total. We estimate the model as a fixed effects linear regression model to take account of store unobserved heterogeneity.

$$p_{irt} = b_{\kappa ir} \cdot \kappa_{ir} + b_{Tir} \cdot T_t + b_{\nu ir} \cdot \nu_t + b_{T\kappa ir} \cdot T_t \cdot \kappa_{ir} + b_{\nu\kappa ir} \cdot \nu \cdot_t \kappa_{ir} + \sum_h b_{zirh} \cdot z_{ht} + \mu_s + \varepsilon_{pirt}$$

$$i \in \{\text{butter}, \text{butter blend}, \text{margarine}, \text{oil}\}, r \in \{\text{supermarket(H)}, \text{discount(L)}\} \tag{14}$$

Where

- The variable T is a dummy variable representing the presence of the tax, taking the value 1 from October 2011 and onwards
- Due to the heated debated prior to the introduction of the tax there may be a pre-tax effect in terms of e.g. retail chains making a priori price adjustments to the tax, represented by the dummy variable v, which assumes the value 1 in the last two weeks of September 2011 preceding the introduction of the tax
- Inclusion of other explanatory variables z : 11 monthly dummy variables ($z_{feb} \ldots z_{dec}$) to account for seasonal variation, and a Christmas dummy ($z_{christmans}$) for the last three weeks of the year
- Furthermore, we included a dummy variable for retailers defined as discount stores, κ_{ij} as well as interaction terms between this discount dummy and the tax and pre-tax dummies.
- ε_{ijt} is an i.i.d. error term and μ_s is unobserved (fixed effect) heterogeneity for each store.

Consumption quantity model.

Two versions of the model for demanded quantity were specified, each with separate strengths and weaknesses. In one model, we consider the individual households' demands for the individual fat products, measured as grams purchased per week, as single-equation panel data models using a Tobit model specification, based on equation (2). In the second model, we consider the average demanded quantity for these fat products in the two store types on a weekly basis, taking departure in expressions (4) and (8). Whereas the first consumption model represents the consumer perspective taking into account the heterogeneity among consumers, the latter model can be considered as a retailer perspective viewing the consumers' average purchases in the respective store types.

Consumption model 1 – consumer perspective

The first model is based on data on a household level. In this model, we specify the purchased quantity of fats (butter, butter-blends, margarine and oils) consumed per person in each household *h* as a function of the tax dummy T_t, the pre-tax dummy v_t, consumer price (including tax) variables for all four fat types p_{it} and the z_{ht}-vector of additional explanatory variables containing total food expenditure, monthly dummy variables, a Christmas dummy, linear and quadratic trend terms, as well as dummy variables representing socio demographic characteristics as educational level and residence (for descriptive statistics regarding these variables, see table 2).

$$q_{iht} = c_{qi} + c_{pi} \cdot p_{it} + c_{Ti} \cdot T_t + c_{vi} \cdot v_t + \sum_h c_{zih} \cdot z_{ht} + \mu_{qh} + \omega_{iht} \tag{15}$$

$$i \in \{butter, butter\ blend, margarine, oil\}$$

- ω_{iht} is an i.i.d. error term and μ_{qh} is individual heterogeneity

The estimated parameter c_{Ti} corresponds to the parameter $\bar{\varsigma}_1$ in expression (2). The data are aggregated to monthly consumption of fats in grams per person in the household on individual household level, in order to reduce the influence of short-run fluctuations in households' timing of purchasing fatty products as these can be stored. The model is estimated with a Tobit specification to account for zero consumption as a "corner solution" in the households' utility maximization. We use the correlated random effects (CRE) estimator, also known as the Chamberlain-Mundlak device, following Mundlak (1978) and Chamberlain (1984), to account for the panel structure in the data, as fixed effects are not appropriate in a Tobit model (Green, 2002). As well as being consistent when used for the unobserved effects models, the CRE estimator allows us to measure the effects of time-constant independent variables, just as in a traditional random-effects environment. The resulting estimates can be interpreted in line with the parameters from a fixed effects estimation, since the CRE estimator explicitly specifies a function for unobserved heterogeneity μ_{qh}, (and hence assumes that the remaining unobserved heterogeneity is uncorrelated with the explanatory varaibles. Furthermore, the average partial effects are identified under non-parametric restrictions on the distribution of heterogeneity given the covariate process (Wooldridge, 2005; Papke and Wooldridge, 2008).

The approach can also be applied to unbalanced panels, where it is assumed that sample selection is not correlated with the error term (Wooldridge 2010), and it is thus suitable for the current dataset. In the current application we model the unobserved heterogeneity as a linear function of the time varying variables averaged over individuals $\bar{z}_h$. We assume that the remaining unobserved heterogeneity is normally distributed and independent of the other explanatory variables[7], hence $\mu_{qh} = \theta_q \bar{z}_h + u_h$ and $u_h \sim N(0, \sigma_u^2)$. Since we have an unbalanced panel, any time varying variable, including time dummies, should be part of $\bar{z}_h$, since they change across *i* (Wooldridge 2010). Models are estimated for each type of fats separately.

Consumption model 2 – retailer perspective

In the second model for consumed quantity (substitution model), data are aggregated to weekly observations and an eight equations model is estimated that describes the substitution between different fat commodities and store types. The model is estimated using seemingly unrelated regression in STATA 11.

$$Q_{irt} = d_{ir} + d_{pir} \cdot p_{irt} + d_{Tir} \cdot T_t + d_{vir} \cdot v_t + \sum_k d_{zkir} \cdot z_{kt} + \psi_{irt} \tag{16}$$

$$(i, j) \in \{\text{butter}, \text{butter blend}, \text{margarine}, \text{oil}\}, r \in \{\text{supermarket } (H), \text{discount } (L)\}$$

In this model, demand is represented by the fat types' respective weekly quantities per household in the average households, and is modelled as a function of the tax and pre-tax dummies, price variables for each fat commodity in each store type, p_{irt}, month and Christmas dummies and a linear trend, all included in z_{kt}. We account for only supermarkets and discount stores as the vast majority of all types of fats are bought in these two types of stores (cf. table 1). The estimated parameters d_{pir} correspond to the β-parameters in the above expressions (4) and (8). As equation (16) relates to averages (of which some of the underlying observations are zero both before and after the introduction of the fat tax), this model is expected to yield lower coefficient estimates (in absolute value) related to price and tax responses than those estimated in the tobit model in equation (15), but equation (16) yields important insights into the distribution of the demand responses to the fat tax on different store types.

[7] The CRE adjustment and the inclusion of the number of socio-demographic variables mentioned in table are assumed to a satisfactory degree to control for the unobserved heterogeneity in the dataset especially because the literature shows that there is a large degree of correlation between the included socio-demographic variables and the type of foods consumed .

5. Results

In the following, estimation results for the three empirical models outlined are given.

Price effects

Table 3 shows selected results of the price model estimation (equation 14) for the four fat product types (parameter estimates for all variables in the model are shown in appendix A). The models estimated have R^2 equal to 0.054, 0.037, 0.025, 0.003 , respectively. The coefficient related to the "tax effect" (b_{Ti}) variable represents the effect of the fat tax on the respective prices, given by the shift in the constant term of the price function in the last three months of 2011, compared with the other months of the period 2009-2011, adjusted for monthly seasonal variation. For example, the price level of butter was 11.26 DKK/kg higher in these three months than in the rest of the period, and the price of margarine was 3.70 DKK/kg higher. In the model, we distinguish between price effects in supermarkets and price effects in discount stores. Hence, the parameter related to the variable "tax/discount interaction" ($b_{T\kappa i}$) represents the difference in tax-induced price level effect between discount stores and supermarkets. For butter, for example, the average price in discount stores increased by 2.12 DKK/kg more than the average price in supermarkets.

Tabel 3. Price effects of the tax (Equation 14)[8]

	Butter price		Butter blend price		Margarine price		Oil price	
	Coef	P>z	Coef	P>z	Coef	P>z	Coef	P>z
Tax effect (b_{Ti})	11.255	0.000	7.418	0.000	3.703	0.000	2.469	0.382
Pre-tax effect(b_{vi})	0.589	0.749	-0.144	0.941	-1.533	0.219	-6.289	0.273
Tax /discount interaction ($b_{T\kappa j}$)	2.120	0.075	0.730	0.536	2.469	0.002	0.618	0.870
Pre_tax/discount interaction($b_{v\kappa i}$)	4.249	0.113	-1.644	0.556	2.760	0.121	7.506	0.370
R^2	0.054		0.037		0.025		0.003	
Expected tax* (DKK)	10.38		8.04		4.28		2.46	
Test**, b_{Ti} supermarket = Expected tax value	0.3228		0.473		0.3223		0.997	
Test**, b_{Ti} discount= Expected tax value	0.001		0.692		0.000		0.974	

* The expected tax is calculated based on the average content of saturated fat in the different products times 20 DKK (= 16 DKK+ 25% VAT).

**Test of if the estimated price increase in the particular store type is equal to the expected price increase due to the tax. The results shown here is probability values (see appendix A for all test values)

[8] Parameter estimates are given in appendix A

As explained, the model also included a dummy variable representing the last weeks prior to the introduction of the tax, v_i, in order to capture adjustments in prices just before the tax became effective, as well as a dummy representing the interaction between this effect and discount stores, thus representing the difference in pre-tax effect for discount stores and supermarkets (represented by the parameter $b_{v\kappa i}$). However, none of these pre-tax variables turned out to be statistically significant, suggesting that the consumer prices of these fat products were not significantly affected before the tax was implemented on October 1, 2011, but that the prices of butter, butter blend and margarine increased significantly after the tax was introduced.

Assuming the fat contents in the four product categories are as listed in table 1, we can determine the theoretically expected price effect of the fat tax which will imply price increases of 10.38 DKK/kg, 8.04 DKK/kg, 4.26 DKK/kg and 2.46 DKK/kg for butter, butter blend, margarine and oil, respectively.

We have tested (t-tests), whether the estimated price changes differed significantly from these theoretical price changes in supermarkets and discount stores, respectively, i.e. if the tax was perfectly transmitted into the consumer price. These test results are shown in the bottom of table 3 and full tests are shown in appendix A. The test results show that the fat tax was perfectly transmitted to the consumer prices in supermarkets for all four categories of fats**.** Furthermore, the tests could not reject a perfect transmission for butter blends and vegetable oils in discount stores, but for butter and margarine, the tests suggest that the prices in the discount stores increased more than what could be directly justified by the tax on saturated fat

Consumption effects, the consumer

Table 4 shows the calculated partial effects based on the estimation of the Tobit models. Two versions of the model were estimated for each product category – one version where the effect of the tax was modeled purely as a shift in demand level, and another model version, where the effect of the tax was modeled as the combination of a price change effect and a residual (demand shift) effect. In addition to the variables shown in table 4, both models also included linear and quadratic trend variables as well as seasonal dummies. (Parameter estimates are presented in Appendix B).

Table 4. Unconditional partial Effects on the Average of tax, tobit model (Equation 15)

	Butter		Butter blend		Margarine		Oils		Total fats	
	dy/dx	P>z	dy/dx	P>z	dy/dx	P>z	dy/dx	P>z	dy/dx	P>z
Model without prices										
Tax dummy (c_{Ti})*	-10.281	0.000	-1.887	0.239	-5.173	0.044	2.269	0.151	-18.716	0.000
Pre-tax (c_{vi})	6.176	0.010	14.841	0.000	60.858	0.000	7.675	0.006	107.585	0.000
Pseudo R^2	0.0126		0.0117		0.0143		0.0135		0.0126	
Model with prices*										
Price index fat									-0.451	0.000
Butter price	-1.913	0.000	0.628	0.000	-0.047	0.743	0.003	0.964		
Butter blend price	0.264	0.000	-2.425	0.000	-0.014	0.916	0.099	0.174		
Margarine price	-0.506	0.017	-0.562	0.018	-3.529	0.000	-0.498	0.019		
Oil price	-0.165	0.006	-0.233	0.001	-0.512	0.000	-0.238	0.000		
Tax (c_{Ti})	4.859	0.011	-0.595	0.758	10.032	0.005	4.375	0.032	-7.278	0.092
Pretax (c_{vi})	-1.287	0.540	3.052	0.257	43.786	0.000	4.998	0.061	110.648	0.000
Pseudo R^2	0.0139		0.0136		0.0145		0.0136		0.0127	

*For the model with prices all estimation parameters are shown in appendix B. In the current table we only show partial effects for the prices and tax parameters.

Partial effects express the change in purchased grams per week per head as the result of a change in the associated explanatory variable. In the simple model (without explicit modeling of price effects) the tax dummy variable, representing weeks where the tax is active, has a negative coefficient for butter, butter blend, margarine and total fat purchase, suggesting that the tax reduced total consumption of these fat products by about 18.7 g/week per individual, with the main effect originating from decrease in the consumption of butter and margarine. In the more detailed model, where the price effects are modeled explicitly, we see that the effect of the saturated fat tax has two components: a price effect, which has a depressing effect on the consumption, and a residual effect (which may represent shifts in awareness, preferences, attitudes, etc. triggered by the tax and the heated debate about the tax), which tends to counteract the price effect to some extent (which may therefore perhaps be interpreted as a "protest" reaction). Multiplying the price parameters with the tax-induced price changes (cf. table 3), leads to the price effect of the tax. For example, the butter price in supermarkets increases by 11.26 DKK/kg, so the own-price effect on butter consumption is -1.91*11.26 g/week, i.e. a decrease of about 21.5 g/week per individual. Combining the own- and cross-price effects of the saturated fat tax leads to a reduction in total consumption of the four types of fats of between 50 and 70 g/week, depending on, whether we consider price changes in supermarkets or discount stores. Taking into account the shift effect of the tax, this is reduced to between 30 and 50 g/week, corresponding to about 5-7 g/day. These numbers could be compared with the average daily intake of these fat products from table 1 (which amount to about 25 g/day per individual) or dietary surveys from the Danish National Food Institute (Pedersen et al., 2010), which suggest that Danish adults on average consume 35 g fat products (butter, margarine, oils, mayonnaise etc.) per day. It should however be noted that the results in table 4 represent effects in the first three month of fat taxation in Denmark, and that more long-term adjustments to the tax – which are not included in the effects reported in table 4 - might occur.

It is interesting to note the sign and magnitude of the pre-tax dummy coefficient, which tends to be positive in both model versions. This suggests a huge hoarding effect prior to the introduction of the saturated fat tax. It should be noted that this dummy variable refers to the two weeks immediately preceding the introduction of the tax, and hence represents a temporary effect, as opposed to the tax dummy, which is assumed to be more permanent in nature. However this size of this “hoarding” might also be a part of the explanation for the observed decrease in consumption of fats, at least in the period following right after the introduction of the tax.

Consumption effects, the retailer

Turning now to a retailer’s perspective on the consumption, table 5 shows the demand effects in different store types, distinguishing between supermarket and discount chains.

Table 5. Effects of fat tax on store types' market shares, average weekly volume purchased per household

	Market share variables							
	$butter_{super}$	$blend_{super}$	$marg_{super}$	oil_{super}	$butter_{disc}$	$blend_{disc}$	$marg_{disc}$	oil_{disc}
$Price\_butter_{super}$	-2.659**	0.218	-2.414**	-0.144	-0.327	-0.310	-0.775**	-0.089
$Price\_blend_{super}$	-4.537**	-3.184**	-8.369**	-0.620**	-0.075	0.088	-0.075	-0.132
$Price\_margarine_{super}$	-6.757**	-2.446**	-19.368**	-2.054**	-0.275	1.226**	2.386**	0.564**
$Price\_oil_{super}$	0.091	-0.228	0.118	-0.240**	0.001	-0.152	-0.299	-0.125*
$Price\_butter_{disc}$	1.485	1.812**	3.234	0.754**	-4.090**	1.089**	-0.246	-0.190
$Price\_blend_{disc}$	2.647**	0.848	4.672**	0.246	-0.055	-3.475**	-0.442	-0.078
$Price\_margarine_{disc}$	1.507	2.952	7.621	0.657	0.174	1.077	-1.160*	-0.494
$Price\_oil_{disc}$	0.861	-0.643	0.319	0.078	0.172	-0.104	0.083	-0.152
Tax (η_{ij})	61.021**	-21.146	79.057	1.064	34.467**	-4.136	1.162	6.120
Pretax (ϕ_{ij})	28.796	20.348	47.343	21.634**	-3.380	-2.107	39.321**	3.660
R^2	0.741	0.538	0.438	0.710	0.516	0.124	0.589	0.208

**= significant on 5% level, * =significant on 10% level

An increase in the price of butter in supermarkets leads to a reduction in the purchase of butter in supermarkets. In particular, a 1 DKK/kg price increase reduces households' average butter purchase from supermarkets by 2.66 g/week. The results suggest an interesting block structure in the price responses, in that a price increase for one fat product in supermarkets tends to reduce the purchase of all fats in supermarkets, but to increase the purchases in discount stores - and vice versa. Hence, the results suggest some complementarity between the fat products within store types, but a substitution between store types. Although there are exceptions, the overall picture from table 5 is that demand is more priceresponsive in supermarkets than in discount stores, which is in line with the assumptions underlying the above theoretical model and also with the estimated price responses in table 3.

According to the results in table 5, the tax also induced a demand shift - on top of the price effects of the tax. For butter purchases in supermarkets, this demand shift was estimated as a positive shift of 61 g/week per household, and in discount store it was about 34 g/week.

If we combine these effects with the predicted price effects from table 3, we can estimate the demand effects of the saturated fat tax for different store types. Such calculation suggests an overall price-induced decrease in the purchase of butter and margarine, and a modest increase in the purchase of butter blends. However, if the estimated preference shift effect is taken into account, this picture becomes more unclear, as these preference shifts tend to offset some of the price effects. Supplementary estimations of different fat products' share of the total market for fats (not reported) suggest that supermarkets especially loose market shares for types of fats with relatively high unit prices (butter and oils), whereas they seem to gain market shares for fat products with relatively lower unit prices (butter blends and margarine).

6. Discussion and conclusion

The above econometric analyses suggest that the introduction of a tax on saturated fat in food products in Denmark has had some effects on the market for fats, such as butter, butter-blends, margarine and oils – at least in the short run. In particular, the analysis shows decreases in the consumption of these products in the range about 10 – 20%, compared with the intake levels before the introduction of the tax . Hence, the present study yields some (but perhaps not full) support for previous simulation analyses suggesting that a fat tax has an effect on consumption (Smed et al., 2007, Jensen & Smed, 2007, Mytton et al., 2007). For example, Jensen & Smed (2007) estimated a 15% decrease in butter and fats consumption as a consequence of a saturated fat tax rate comparable to that of the actual tax in real terms, whereas Smed et al. (2007) estimated a 9% decrease in intake of saturated fat as result of a tax rate about 8 DKK/kg (in year 2000-price level). Furthermore, the analysis points at some interesting structural effects in the food retailing sector, with some shifts in demand from high-end supermarkets towards low-end discount stores – a shift that seems to have been utilized by discount chains to raise the prices of butter and margarine by more than the pure tax increase, while still maintaining – and even improving the market share for butter.

The analysis is based on a relatively short period after introduction of the tax (three months, corrected for seasonality effects), and hence interpretation of these findings from a long-run perspective should be done with considerable care. On the one hand, hoarding prior to the introduction of the tax may have affected purchases in the beginning of the taxation period. On the other hand, economic reasoning might suggest larger behavioural adjustments and reductions in fat consumption in the longer run, both on the consumer demand side, for example because formation of new dietary patterns in response to a price change takes time, but also on the supply side, for example in terms of product reformulation towards lower product content of saturated fats, changed marketing strategies with more emphasis on lower-taxed products, etc. So even if the presented short-run results may provide a biased estimate of long-run effects, there is some ambiguity about the direction of such bias.

Given the relatively short post-tax data period, the empirical analysis has focused on the consumption of fats, which are some of the products most heavily affected by the tax on saturated fat. But it should be kept in mind that also a range of other food products, including especially other dairy products and meat products, are directly affected by the fat tax – but also a whole range of processed foods, e.g. ready-meals, bread, pastries, processed foods, snacks, etc. are indirectly affected, because they are based upon ingredients, which are subject to taxation. Further, the tax may give rise to substitution effects with regards to products that do not contain fats subject to the tax. The fat tax however also provides manufacturers of processed foods containing saturated fat with an economic incentive to reformulate products, in order to reduce the content of ingredients subject to taxation and thereby lower prices.

An important extension of the present study is to analyze the impact of the fat tax on overall food consumption, given that the tax is motivated by its ability to create incentives for people to choose a healthier diet. It should be kept in mind that higher prices on fat products may lead to substitution with other food groups, as also suggested in the above-mentioned previous studies, which may influence the health promotion effects of the fat tax. When longer data periods become available, an important extension of the present study would be to investigate the effects of the fat tax scheme on the overall composition of consumers' diets, including the substitution between products affected directly by the saturated fat tax and products that are not subject to this taxation.

Due to the nature of the data, the analysis in this paper addresses substitution between “high-end” and “discount” product varieties based on the type of retail store, where the fat products are purchased. It should however be kept in mind that many of the retail chains operating in Denmark offer both brand and discount varieties within the same store. Hence, the above results may underestimate the extent of substitution between "high-end" and discount product varieties induced by the fat tax.

Several representatives of political parties and industry lobbies are making the point that increased food taxation has led to increased border trade, and that such border trade offsets the direct consumption reduction effect of the tax. Economic theory would suggest a substitution effect between purchases domestically and across the border, if the price of domestically sold products increases ceteris paribus. Although this may be a valid point for citizens living close to the border, most citizens in Denmark would face considerable transaction costs to go outside the country to buy fats. And supplementary estimations in the above data also suggest that supermarkets and discount stores together only loose marginal market shares to other types of outlets, including outlets outside Denmark. However, this could be an issue worthy of further investigation in future research.

Previous studies of food taxation have emphasized the potential regressive effects of taxes aimed at promoting a healthy diet, because low-income households tend to spend a larger share of their budgets on foods - and often also a larger share of their food budget on unhealthy commodities. Hence, a food tax may be financially more burdensome for low-income households. On the other hand, some of these households would also be among those with the highest prevalence of diet related illnesses. With respect to health, low-income households may therefore benefit the most from the economic incentives created by taxes on unhealthy food. The distributional effects of the fat tax over different consumer groups are not analyzed in this study, but provide an important topic for future empirical research.

References

Allais O., Bertail P. & Nichele V. (2010) The effects of a Fat Tax on French Households' Purchases: A Nutritional Approach, American Journal of Agricultural Economics, 92(1) pp. 228-245

Andersen L.M. (2008) Information Provision to Consumers as an Instrument of Environmental Regulation. PhD dissertation. University of Copenhagen PhD, series no. 130

Chamberlain G. (1984) Panel data. In Grilliches, Z., Intriligator, M.D., eds. *Handbook of Econometrics*, Vol. 2 North Holland, Amsterdam. pp. 1247-1318.

Chouinard H.H., Davis D.E., LaFrance J.T. & Perloff J.M. (2006) Fat Taxes: Big Money for Small Change, Department of Agricultural and Resource Economics and Policy, Division of Agricultural and Natural Resources, University of California at Berkeley, Working paper no. 1007 (http://are.berkeley.edu/~jeffrey_lafrance/working%20papers/WP-1007.pdf)

EPHA (2012) European Public Health Alliance, Update October 2012, Food taxation in Europe: Evolution of the legislation (http://www.epha.org/a/4814, accessed November 1, 2012)

Holt E. (2011) Hungary to introduce broad range of fat taxes, The Lancet, 378 pp.75

Green W. (2002) The bias of the fixed effects estimator in nonlinear models. Economic Working paper. Stern School of Business. No EC-02-05 http://people.stern.nyu.edu/wgreene/nonlinearfixedeffects.pdf

Jensen J. & Smed S. (2007) Cost-effective design of economic instruments in nutrition policy. International Journal of Behavioral Nutrition and Physical Activity, 4(19) (doi:10.1186/1479-5868-4-10)

Mundlak Y. (1978) On the pooling of time series and cross-section data. Econometrica, 46(1), pp. 69-85

Mytton O., Gray A., Rayner M. & Rutter H (2007). Could targeted food taxes improve health? Journal of Epidemiology and Community Health, 61, pp. 689–694.

Mytton O.T., Clarke D. & Rayner M. (2012) Taxing unhealthy food and drinks to improve health, British Medical Journal (doi: 10.1136/bmj.e2931)

Nordström J. & Thunström L. (2009) The Impact of Tax Reforms Designed to Encourage a Healthier Grain Consumption, Journal of Health Economics, 28(3), pp. 622-634

OECD (2012), OECD Economic Outlook, 2012/1 (http://www.oecd.org/eco/economicoutlookanalysisandforecasts/50381170.pdf, accessed September 19, 2012)

Papke, L.E. & J.M. Wooldridge (2008) Panel Data Methods for Fractional Response Variables with an Application to Test Pass Rates. Journal of Econometrics, 145(1-2), pp. 121-133

Pedersen A.N., Fagt S., Groth M.V., Christensen T., Biltoft-Jensen A., Matthiesen J., Andersen N.L., Kørup K., Hartkopp H., Ygil K.H., Hinsch H-J., Saxholt E. & Trolle E. (2010) Danskernes kostvaner 2003-2008 – Hovedresultater, Rapport, DTU Fødevareinstituttet

Smed S., Jensen J.D. & Denver S. (2007) Socio-economic characteristics and the effect of taxation as a health policy instrument, Food Policy, 32, pp. 624-639

Tiffin R. & Arnoult M. (2011) The public health impacts of a fat tax, European Journal of Clinical Nutrition, 65, pp. 427-433.

Smed S. (2008) Empirical studies on "Health, Information and Consumer Behaviour. PhD dissertation. University of Copenhagen PhD, series no. 128

Smed S. (2012) Financial penalties on foods: the fat tax in Denmark, Nutrition Bulletin, 37, pp. 142-147

Villanueva T. (2011) European nations launch tax attack on unhealthy foods, Canadian Medical Association Journal, 183 (17), (doi: 10.1503/cmaj.109-4031)

WHO (2008) WHO European Action Plan for Food and Nutrition Policy 2007-2012 (http://www.euro.who.int/data/assets/pdf_file/0017/74402/E91153.pdf , accessed September 19, 2012)

Wooldridge, J.M. (2005) Unobserved Heterogeneity and Estimation of Average PartialEffects, in D.W.K. Andrews and J.H. Stock eds. *Identification and Inference for* Econometric Models: Essays in Honor of Thomas Rothenberg, pp. 27-55 Cambridge: Cambridge University Press,.

Wooldridge, J.M. (2010) Correlated random effects model with unbalanced panels. Manuscript Version July, 2010. Michigan State University.

Appendix A: Parameter estimates for price setting model

Table A1: Price model butter

Fixed-effects (within) regression	Number of obs = 3855			
Group variable: shop	Number of groups = 65			
R-sq: within = 0.0975	Obs per group: min = 1			
between = 0.0001	avg = 59.3			
overall = 0.0541	max = 187			
	F(16,3774) = 25.48			
corr(u_i, Xb) = -0.0272	Prob > F = 0.0000			
Butter	Coef.	Std. Err.	t	P>t
Tax effect (b_{Ti})	11.2551	0.8849	12.7200	0.0000
Pre-tax effect(b_{vi})	0.5894	1.8413	0.3200	0.7490
Tax /discount interaction ($b_{T\kappa j}$)	2.1204	1.1909	1.7800	0.0750
Pre_tax/discount interaction($b_{\nu\kappa i}$)	4.2485	2.6837	1.5800	0.1130
z_{feb}	0.0181	0.8076	0.0200	0.9820
z_{mar}	0.9277	0.7840	1.1800	0.2370
z_{apr}	0.1687	0.7849	0.2100	0.8300
z_{may}	0.6914	0.7753	0.8900	0.3730
z_{june}	1.8858	0.7867	2.4000	0.0170
z_{july}	2.3405	0.7902	2.9600	0.0030
z_{aug}	0.5955	0.7791	0.7600	0.4450
z_{sep}	1.0206	0.8035	1.2700	0.2040
z_{oct}	0.0800	0.7980	0.1000	0.9200
z_{nov}	-0.5574	0.8138	-0.6800	0.4930
z_{dec}	1.9570	0.9885	1.9800	0.0480
$z_{christmas}$	-2.7921	1.0752	-2.6000	0.0090
Constant	48.3959	0.5513	87.7800	0.0000
sigma_u	14.5213			
sigma_e	9.8855			
rho	0.68332			

Tests:

$$H_0 : b_{Ti} = 10.38 \quad \textit{F-value=0.98 P\_value=0.3228},$$

$$H_0 : b_{Ti} + b_{T\kappa j} = 10.38 \quad \textit{F-value=10.39 P\_value=0.0013}$$

Table A2: Price model butter blends

Fixed-effects (within) regression	Number of obs = 3621			
Group variable: shop	Number of groups = 64			
R-sq: within = 0.0507	Obs per group: min = 1			
between = 0.0189	avg = 56.6			
overall = 0.0366	max = 186			
	F(16,3541) = 11.81			
corr(u_i, Xb) = -0.0098	Prob > F = 0.0000			

Butterblends	Coef.	Std. Err.	t	P>t
Tax effect (b_{Ti})	7.4179	0.8676	8.5500	0.0000
Pre-tax effect(b_{Vi})	-0.1436	1.9484	-0.0700	0.9410
Tax /discount interaction ($b_{T\kappa j}$)	0.7298	1.1799	0.6200	0.5360
Pre_tax/discount interaction($b_{\nu\kappa i}$)	-1.6437	2.7903	-0.5900	0.5560
z_{feb}	-0.6932	0.7679	-0.9000	0.3670
z_{mar}	-1.3356	0.7533	-1.7700	0.0760
z_{apr}	-0.8278	0.7587	-1.0900	0.2750
z_{may}	-0.7665	0.7507	-1.0200	0.3070
z_{june}	-0.6324	0.7578	-0.8300	0.4040
z_{july}	1.6450	0.7418	2.2200	0.0270
z_{aug}	0.4188	0.7546	0.5500	0.5790
z_{sep}	0.5444	0.7812	0.7000	0.4860
z_{oct}	-2.0301	0.7756	-2.6200	0.0090
z_{nov}	-0.8599	0.7890	-1.0900	0.2760
z_{dec}	1.4954	0.9680	1.5400	0.1220
$z_{christmas}$	-4.6600	1.0500	-4.4400	0.0000
Constant	48.6626	0.5317	91.5300	0.0000
sigma_u	11.2008			
sigma_e	9.2351			
rho	0.5953			

Tests:

$H_0 : b_{Ti} = 8.04 \quad \text{F-value=0.51 P\_value=0.4734}$,

$H_0 : b_{Ti} + b_{T\kappa j} = 8.04 \quad \text{F-value=0.16 P\_value=0.6919}$

Table A3: Price model margarine

Fixed-effects (within) regression		Number of obs =	3928
Group variable: shop		Number of groups =	58
R-sq: within = 0.0413		Obs per group: min =	1
between = 0.0010		avg =	67.7
overall = 0.0246		max =	187
		F(16,3854) =	10.38
corr(u_i, Xb) = -0.0386		Prob > F =	0.0000

Margarine	Coef.	Std. Err.	t	P>t
Tax effect (b_{Ti})	3.7033	0.5825	6.3600	0.0000
Pre-tax effect(b_{vi})	-1.5325	1.2462	-1.2300	0.2190
Tax /discount interaction ($b_{T\kappa j}$)	2.4693	0.7818	3.1600	0.0020
Pre_tax/discount interaction($b_{v\kappa i}$)	2.7596	1.7801	1.5500	0.1210
z_{feb}	-0.5752	0.5289	-1.0900	0.2770
z_{mar}	-0.7647	0.5213	-1.4700	0.1420
z_{apr}	0.0183	0.5272	0.0300	0.9720
z_{may}	-0.4694	0.5141	-0.9100	0.3610
z_{june}	0.0850	0.5263	0.1600	0.8720
z_{july}	1.3261	0.5209	2.5500	0.0110
z_{aug}	0.6473	0.5217	1.2400	0.2150
z_{sep}	-0.4140	0.5393	-0.7700	0.4430
z_{oct}	-0.7983	0.5328	-1.5000	0.1340
z_{nov}	-1.3176	0.5399	-2.4400	0.0150
z_{dec}	0.3064	0.6628	0.4600	0.6440
$z_{christmas}$	-1.5144	0.7212	-2.1000	0.0360
Constant	22.8086	0.3637	62.7100	0.0000
sigma_u	9.0649			
sigma_e	6.6898			
Rho	0.6474			

Tests:

$H_0 : b_{Ti} = 4.28 \quad F\text{-value}=0.98\ P\_value=0.3223$,

$H_0 : b_{Ti} + b_{T\kappa j} = 4.28 \quad F\text{-value}=7.47\ P\_value=0.0063$

Table A4: Price model oil

Fixed-effects (within) regression	Number of obs = 2813			
Group variable: shop	Number of groups = 48			
R-sq: within = 0.0054	Obs per group: min = 1			
between = 0.0386	avg = 58.6			
overall = 0.0031	max = 184			
	F(16,2749) = 0.94			
corr(u_i, Xb) = -0.0041	Prob > F = 0.5243			

Oil	Coef.	Std. Err.	t	P>t
Tax effect (b_{Ti})	2.4691	2.8216	0.8800	0.3820
Pre-tax effect(b_{vi})	-6.2895	5.7403	-1.1000	0.2730
Tax /discount interaction ($b_{T\kappa j}$)	0.6182	3.7820	0.1600	0.8700
Pre_tax/discount interaction($b_{v\kappa i}$)	7.5058	8.3636	0.9000	0.3700
z_{feb}	0.3888	2.5161	0.1500	0.8770
z_{mar}	3.6879	2.5050	1.4700	0.1410
z_{apr}	3.1876	2.4396	1.3100	0.1910
z_{may}	3.9934	2.4231	1.6500	0.0990
z_{june}	2.7569	2.4743	1.1100	0.2650
z_{july}	5.8394	2.4649	2.3700	0.0180
z_{aug}	2.1354	2.4597	0.8700	0.3850
z_{sep}	1.9455	2.5615	0.7600	0.4480
z_{oct}	0.7765	2.5516	0.3000	0.7610
z_{nov}	-0.0224	2.6149	-0.0100	0.9930
z_{dec}	-1.4450	3.2300	-0.4500	0.6550
$z_{christmas}$	1.1501	3.5202	0.3300	0.7440
Constant	34.1836	1.7702	19.3100	0.0000
sigma_u	89.5871			
sigma_e	26.3045			
rho	0.9206			

Tests:

$H_0 : b_{Ti} = 4.28$ *F-value=0.98 P_value=0.3223*,

$H_0 : b_{Ti} + b_{T\kappa j} = 2.46$ *F-value=0.00 P_value=0.9740*

Appendix B: Parameter estimates for consumption model, consumer perspective

Table B1: Consumption model: total fat (model with prices)

Number of obs = 216641			Pseudo R2 = 0.0127	
LR chi2(39) = 17406.17			Log likelihood = -729055	
	Coef.	Std.Err	t- value	p-value
Price index fat	-1.224	0.210	-5.830	0.000
Tax effect (C_{Ti})	-20.033	12.037	-1.660	0.096
Pre-tax effect(C_{Vi})	252.119	16.335	15.430	0.000
Z_{feb}	33.109	8.768	3.780	0.000
Z_{mar}	10.861	8.552	1.270	0.204
Z_{apr}	-19.546	8.814	-2.220	0.027
Z_{may}	-24.769	8.702	-2.850	0.004
Z_{june}	-52.425	8.775	-5.970	0.000
Z_{july}	-26.168	8.809	-2.970	0.003
Z_{aug}	19.760	8.788	2.250	0.025
Z_{sep}	31.309	8.828	3.550	0.000
Z_{oct}	-19.033	9.130	-2.080	0.037
Z_{nov}	45.552	9.108	5.000	0.000
Z_{dec}	13.876	11.779	1.180	0.239
$Z_{christmas}$	71.603	12.448	5.750	0.000
Z_{t}	-0.300	0.160	-1.870	0.061
$Z_{t-squared}$	0.000	0.001	0.360	0.717
Z_{tot_exp}	0.006	0.000	108.620	0.000
$Z_{capital}$	-131.106	5.465	-23.990	0.000
$Z_{urbaneast}$	-45.447	10.457	-4.350	0.000
$Z_{ruraleast}$	-71.267	4.919	-14.490	0.000
$Z_{urbanwest}$	-73.862	5.136	-14.380	0.000
Z_{long_edu}	-152.446	8.544	-17.840	0.000
Z_{medium_edu}	-142.829	5.471	-26.110	0.000
Z_{short_edu}	-80.883	5.914	-13.680	0.000
Z_{Voc_edu}	-62.239	4.668	-13.330	0.000
Z_{female}	34.633	4.397	7.880	0.000
Z_{age}	-0.086	2.001	-0.040	0.966
Z_{kid06}	17.692	8.144	2.170	0.030
Z_{kid714}	2.599	6.667	0.390	0.697
$Z_{kid1520}$	-26.814	6.865	-3.910	0.000
Constant	-702.164	73.423	-9.560	0.000

CRE-parameters				
$\bar{z}_{age}$	4.730	2.005	2.360	0.018
$\bar{z}_{tot\_exp}$	-0.002	0.000	-22.140	0.000
$\bar{z}_{t}$	0.050	0.129	0.390	0.699
$\bar{z}_{feb}$	383.628	135.657	2.830	0.005
$\bar{z}_{mar}$	505.949	112.076	4.510	0.000
$\bar{z}_{apr}$	-34.804	118.588	-0.290	0.769
$\bar{z}_{may}$	132.152	107.880	1.220	0.221
$\bar{z}_{june}$	393.147	107.178	3.670	0.000
$\bar{z}_{july}$	488.276	102.742	4.750	0.000
$\bar{z}_{aug}$	240.074	107.800	2.230	0.026
$\bar{z}_{sep}$	505.949	102.550	4.930	0.000
$\bar{z}_{oct}$	448.363	103.099	4.350	0.000
$\bar{z}_{nov}$	-98.080	115.957	-0.850	0.398
$\bar{z}_{dec}$	392.763	117.619	3.340	0.001
Sigma	672.789	1.858		

Table B2: Consumption model: butter (model with prices)

Number of obs = 216641 Pseudo R2 = 0.0139
LR chi2(39) = 6627.59 Log likelihood = -274381.88

	Coef.	Std.Err	t- value	p-value
Price butter	-15.305	0.567	-26.980	0.000
Price blend	2.111	0.580	3.640	0.000
Price margarine	-4.051	1.691	-2.400	0.017
Price oil	-1.324	0.486	-2.720	0.006
Tax effect (c_{Ti})	37.035	13.817	2.680	0.007
Pre-tax effect(c_{vi})	-10.465	17.344	-0.600	0.546
z_{feb}	25.370	9.117	2.780	0.005
z_{mar}	16.247	9.036	1.800	0.072
z_{apr}	-8.263	9.219	-0.900	0.370
z_{may}	-14.361	9.179	-1.560	0.118
z_{june}	-15.256	9.285	-1.640	0.100
z_{july}	24.591	9.068	2.710	0.007
z_{aug}	-2.899	9.300	-0.310	0.755
z_{sep}	-13.778	9.436	-1.460	0.144
z_{oct}	-14.327	9.618	-1.490	0.136
z_{nov}	28.395	9.539	2.980	0.003

Z_{dec}	26.617	12.092	2.200	0.028
$Z_{christmas}$	40.149	12.557	3.200	0.001
Z_{t}	-0.147	0.182	-0.810	0.419
$Z_{t-squared}$	0.007	0.001	6.990	0.000
Z_{tot_exp}	0.003	0.000	58.380	0.000
$Z_{capital}$	44.006	5.602	7.860	0.000
$Z_{urbaneast}$	3.045	10.985	0.280	0.782
$Z_{ruraleast}$	8.971	5.188	1.730	0.084
$Z_{urbanwest}$	-4.262	5.438	-0.780	0.433
Z_{long_edu}	14.229	8.609	1.650	0.098
Z_{medium_edu}	14.595	5.612	2.600	0.009
Z_{short_edu}	7.086	6.144	1.150	0.249
Z_{Voc_edu}	-3.428	4.916	-0.700	0.486
Z_{female}	20.788	4.495	4.620	0.000
Z_{age}	1.802	2.096	0.860	0.390
Z_{kid06}	82.473	8.369	9.850	0.000
Z_{kid714}	46.797	6.940	6.740	0.000
$Z_{kid1520}$	-27.356	7.356	-3.720	0.000
Constant	-385.570	87.635	-4.400	0.000
CRE-parameters				
$\overline{Z}_{age}$	3.077	2.101	1.460	0.143
$\overline{Z}_{tot\_exp}$	-0.001	0.000	-8.870	0.000
$\overline{Z}_{t}$	0.227	0.133	1.710	0.088
$\overline{Z}_{feb}$	-70.530	139.822	-0.500	0.614
$\overline{Z}_{mar}$	133.598	113.100	1.180	0.238
$\overline{Z}_{apr}$	-344.373	125.787	-2.740	0.006
$\overline{Z}_{may}$	-118.397	111.024	-1.070	0.286
$\overline{Z}_{june}$	103.188	109.852	0.940	0.348
$\overline{Z}_{july}$	252.871	105.090	2.410	0.016
$\overline{Z}_{aug}$	-75.856	111.089	-0.680	0.495
$\overline{Z}_{sep}$	181.522	104.675	1.730	0.083
$\overline{Z}_{oct}$	267.740	105.229	2.540	0.011
$\overline{Z}_{nov}$	-687.658	118.953	-5.780	0.000
$\overline{Z}_{dec}$	59.594	121.174	0.490	0.623
Sigma	527.594	2.629		

Table B3: Consumption model: butter blends (model with prices)

Number of obs = 216641			Pseudo R2 = 0.0136	
LR chi2(39) = 7164.33			Log likelihood = -263452.14	
	Coef.	Std.Err	t- value	p-value
Price butter	5.333	0.718	7.430	0.000
Price blend	-20.606	0.682	-30.210	0.000
Price margarine	-4.779	2.018	-2.370	0.018
Price oil	-1.982	0.584	-3.390	0.001
Tax effect (C_{Ti})	-5.088	16.613	-0.310	0.759
Pre-tax effect(C_{Vi})	25.081	21.425	1.170	0.242
Z_{feb}	18.203	10.914	1.670	0.095
Z_{mar}	-8.722	10.734	-0.810	0.416
Z_{apr}	-12.839	11.010	-1.170	0.244
Z_{may}	4.188	10.792	0.390	0.698
Z_{june}	-22.675	11.062	-2.050	0.040
Z_{july}	71.694	10.815	6.630	0.000
Z_{aug}	28.605	11.075	2.580	0.010
Z_{sep}	20.063	11.250	1.780	0.075
Z_{oct}	-2.735	11.400	-0.240	0.810
Z_{nov}	14.684	11.505	1.280	0.202
Z_{dec}	14.996	14.808	1.010	0.311
$Z_{christmas}$	20.700	15.336	1.350	0.177
Z_{t}	-2.099	0.216	-9.730	0.000
$Z_{t-squared}$	0.009	0.001	7.060	0.000
Z_{tot_exp}	0.004	0.000	57.020	0.000
$Z_{capital}$	-63.551	6.689	-9.500	0.000
$Z_{urbaneast}$	26.512	12.436	2.130	0.033
$Z_{ruraleast}$	-41.670	5.983	-6.960	0.000
$Z_{urbanwest}$	-37.577	6.237	-6.030	0.000
Z_{long_edu}	-128.605	10.632	-12.100	0.000
Z_{medium_edu}	-137.473	6.829	-20.130	0.000
Z_{short_edu}	-45.496	7.168	-6.350	0.000
Z_{Voc_edu}	-22.809	5.653	-4.040	0.000
Z_{female}	-4.895	5.435	-0.900	0.368
Z_{age}	-0.234	2.449	-0.100	0.924
Z_{kid06}	40.129	9.372	4.280	0.000
Z_{kid714}	22.907	7.720	2.970	0.003

$z_{kid1520}$	15.218	7.984	1.910	0.057
Constant	144.046	102.223	1.410	0.159
CRE-parameters				
$\bar{z}_{age}$	-0.625	2.454	-0.250	0.799
$\bar{z}_{tot\_exp}$	-0.001	0.000	-8.510	0.000
$\bar{z}_{t}$	-0.251	0.155	-1.620	0.104
$\bar{z}_{feb}$	51.007	161.308	0.320	0.752
$\bar{z}_{mar}$	131.173	135.263	0.970	0.332
$\bar{z}_{apr}$	-304.784	141.348	-2.160	0.031
$\bar{z}_{may}$	148.372	127.068	1.170	0.243
$\bar{z}_{june}$	124.053	127.794	0.970	0.332
$\bar{z}_{july}$	-7.959	120.797	-0.070	0.947
$\bar{z}_{aug}$	187.496	127.949	1.470	0.143
$\bar{z}_{sep}$	382.547	121.741	3.140	0.002
$\bar{z}_{oct}$	10.408	123.164	0.080	0.933
$\bar{z}_{nov}$	88.604	138.125	0.640	0.521
$\bar{z}_{dec}$	-284.845	140.192	-2.030	0.042
Sigma	614.220	3.17976		

Table B4: Consumption model: margarine (model with prices)

Number of obs = 216641 Pseudo R2 = 0.0145
LR chi2(39) = 9484.28 Log likelihood = -354677.39

	Coef.	Std.Err	t- value	p-value
Price butter	-0.297	0.906	-0.330	0.743
Price blend	-0.092	0.866	-0.110	0.916
Price margarine	-22.484	2.548	-8.820	0.000
Price oil	-3.259	0.732	-4.450	0.000
Tax effect (C_{Ti})	61.025	20.963	2.910	0.004
Pre-tax effect(C_{vi})	228.703	25.354	9.020	0.000
z_{feb}	9.376	13.505	0.690	0.488
z_{mar}	-20.780	13.390	-1.550	0.121
z_{apr}	-63.306	13.765	-4.600	0.000
z_{may}	-56.238	13.617	-4.130	0.000
z_{june}	-69.838	13.784	-5.070	0.000
z_{july}	-52.022	13.627	-3.820	0.000
z_{aug}	-23.553	13.874	-1.700	0.090
z_{sep}	38.719	13.840	2.800	0.005
z_{oct}	-43.443	14.161	-3.070	0.002

Z_{nov}	26.363	14.155	1.860	0.063
Z_{dec}	-4.529	18.124	-0.250	0.803
$Z_{christmas}$	-25.762	19.279	-1.340	0.181
Z_t	-0.851	0.273	-3.120	0.002
$Z_{t-squared}$	0.003	0.002	1.940	0.052
Z_{tot_exp}	0.005	0.000	64.400	0.000
$Z_{capital}$	-334.253	8.725	-38.310	0.000
$Z_{urbaneast}$	-161.057	16.397	-9.820	0.000
$Z_{ruraleast}$	-119.829	7.344	-16.320	0.000
$Z_{urbanwest}$	-134.376	7.724	-17.400	0.000
Z_{long_edu}	-333.848	14.190	-23.530	0.000
Z_{medium_edu}	-280.871	8.532	-32.920	0.000
Z_{short_edu}	-173.918	9.075	-19.160	0.000
Z_{Voc_edu}	-127.589	6.966	-18.320	0.000
Z_{female}	37.872	6.882	5.500	0.000
Z_{age}	0.615	3.055	0.200	0.841
Z_{kid06}	64.862	12.895	5.030	0.000
Z_{kid714}	41.647	10.372	4.020	0.000
$Z_{kid1520}$	41.501	10.492	3.960	0.000
Constant	-1162.09	140.544	-8.270	0.000
CRE-parameters				
$\overline{Z}_{age}$	6.320	3.062	2.060	0.039
$\overline{Z}_{tot\_exp}$	-0.002	0.000	-11.180	0.000
$\overline{Z}_t$	0.017	0.206	0.080	0.935
$\overline{Z}_{feb}$	812.278	223.869	3.630	0.000
$\overline{Z}_{mar}$	1038.985	184.667	5.630	0.000
$\overline{Z}_{apr}$	642.193	192.938	3.330	0.001
$\overline{Z}_{may}$	255.870	179.179	1.430	0.153
$\overline{Z}_{june}$	733.424	175.168	4.190	0.000
$\overline{Z}_{july}$	877.578	169.841	5.170	0.000
$\overline{Z}_{aug}$	20.583	179.471	0.110	0.909
$\overline{Z}_{sep}$	836.066	168.085	4.970	0.000
$\overline{Z}_{oct}$	869.194	169.811	5.120	0.000
$\overline{Z}_{nov}$	230.630	189.487	1.220	0.224
$\overline{Z}_{dec}$	1554.378	194.900	7.980	0.000
Sigma	848.2560	3.7396		

Table B5: Consumption model: oil (model with prices)

Number of obs = 216641			Pseudo R2 = 0.0136	
LR chi2(39) = 2949.93			Log likelihood = -108996.94	

	Coef.	Std.Err	t- value	p-value
Price butter	0.085	1.857	0.050	0.964
Price blend	2.406	1.771	1.360	0.174
Price margarine	-12.065	5.160	-2.340	0.019
Price oil	-5.771	1.517	-3.800	0.000
Tax effect (c_{Ti})	98.089	42.568	2.300	0.021
Pre-tax effect(c_{vi})	109.571	53.251	2.060	0.040
z_{feb}	-13.993	27.647	-0.510	0.613
z_{mar}	-27.804	27.360	-1.020	0.310
z_{apr}	-16.343	27.668	-0.590	0.555
z_{may}	-21.864	27.446	-0.800	0.426
z_{june}	-10.847	27.597	-0.390	0.694
z_{july}	-13.653	27.343	-0.500	0.618
z_{aug}	53.898	27.532	1.960	0.050
z_{sep}	-9.103	28.410	-0.320	0.749
z_{oct}	-77.122	28.999	-2.660	0.008
z_{nov}	-129.339	29.706	-4.350	0.000
z_{dec}	-196.950	39.383	-5.000	0.000
$z_{christmas}$	35.480	42.435	0.840	0.403
z_{t}	0.499	0.553	0.900	0.367
$z_{t-squared}$	-0.004	0.003	-1.270	0.205
z_{tot_exp}	0.006	0.000	39.400	0.000
$z_{capital}$	13.844	17.228	0.800	0.422
$z_{urbaneast}$	-9.171	33.772	-0.270	0.786
$z_{ruraleast}$	-38.368	15.893	-2.410	0.016
$z_{urbanwest}$	-6.106	16.433	-0.370	0.710
z_{long_edu}	100.808	26.084	3.860	0.000
z_{medium_edu}	113.048	17.475	6.470	0.000
z_{short_edu}	74.526	19.204	3.880	0.000
z_{Voc_edu}	44.897	15.626	2.870	0.004
z_{female}	54.288	13.821	3.930	0.000
z_{age}	-4.794	6.581	-0.730	0.466
z_{kid06}	-38.996	25.470	-1.530	0.126

z_{kid714}	78.203	19.901	3.930	0.000
$z_{kid1520}$	95.012	20.184	4.710	0.000
Constant	-2098.18	263.164	-7.970	0.000
CRE-parameters				
$\bar{z}_{age}$	6.012	6.593	0.910	0.362
$\bar{z}_{tot\_exp}$	0.000	0.000	-0.810	0.416
$\bar{z}_{t}$	-0.568	0.404	-1.410	0.160
$\bar{z}_{feb}$	318.778	422.046	0.760	0.450
$\bar{z}_{mar}$	-1179.845	351.525	-3.360	0.001
$\bar{z}_{apr}$	374.119	363.389	1.030	0.303
$\bar{z}_{may}$	-465.576	336.213	-1.380	0.166
$\bar{z}_{june}$	241.147	333.133	0.720	0.469
$\bar{z}_{july}$	395.463	309.794	1.280	0.202
$\bar{z}_{aug}$	631.963	322.890	1.960	0.050
$\bar{z}_{sep}$	372.655	307.697	1.210	0.226
$\bar{z}_{oct}$	-72.755	314.321	-0.230	0.817
$\bar{z}_{nov}$	235.288	358.770	0.660	0.512
$\bar{z}_{dec}$	322.895	360.189	0.900	0.370
Sigma	1151.196	10.408		

Appendix C: Parameter estimates for consumption model, retailer perspective

Equation	Obs	Parms	RMSE	R-sq	chi2	p-value
Supermarket_butter_g/hh	182	22	43.844	0.741	520.420	0.000
Supermarket_margarine_g/hh	182	22	30.423	0.438	141.830	0.000
Supermarket_olie_g/hh	182	22	87.793	0.710	445.710	0.000
Super_bland_g/hh	182	22	12.304	0.538	212.320	0.000
Discount_butter_g/hh	182	22	16.312	0.516	193.980	0.000
Discount_margarine_g/hh	182	22	14.183	0.589	260.840	0.000
Discount_olie_g/hh	182	22	22.491	0.208	47.680	0.001
Discount_bland_g/hh	182	22	7.212	0.124	25.680	0.266

	supermarket_butter				supermarket_blend			
	coef	Std. Error	t - value	p-value	coef	Std. Error	t - value	p-value
z_t	-0.0809	0.1151	-0.7000	0.4820	-0.1511	0.0798	-1.8900	0.0580
Tax (η_{ij})	61.0209	26.3918	2.3100	0.0210	-21.1459	18.3128	-1.1500	0.2480
Pretax (ϕ_{ij})	28.7959	28.0467	1.0300	0.3050	20.3479	19.4611	1.0500	0.2960
Christmas	61.2280	24.6731	2.4800	0.0130	-14.3974	17.1202	-0.8400	0.4000
$\text{Price\_butter}_{super}$	-2.6592	0.6090	-4.3700	0.0000	0.2185	0.4226	0.5200	0.6050
$\text{Price\_blend}_{super}$	-4.5367	0.7579	-5.9900	0.0000	-3.1842	0.5259	-6.0500	0.0000
$\text{Price\_marg}_{super}$	-6.7572	1.7008	-3.9700	0.0000	-2.4464	1.1801	-2.0700	0.0380
Price_oil_{super}	0.0910	0.4363	0.2100	0.8350	-0.2278	0.3027	-0.7500	0.4520
$\text{Price\_butter}_{disc}$	1.4853	1.1464	1.3000	0.1950	1.8119	0.7954	2.2800	0.0230
$\text{Price\_blend}_{disc}$	2.6474	0.7538	3.5100	0.0000	0.8476	0.5230	1.6200	0.1050
Price_marg_{disc}	1.5069	3.0790	0.4900	0.6250	2.9516	2.1365	1.3800	0.1670
Price_oil_{disc}	0.8610	0.7828	1.1000	0.2710	-0.6428	0.5431	-1.1800	0.2370
z_{feb}	2.8376	14.7827	0.1900	0.8480	12.7634	10.2574	1.2400	0.2130
z_{mar}	8.7029	14.1581	0.6100	0.5390	-3.6381	9.8241	-0.3700	0.7110
z_{apr}	17.3993	14.4163	1.2100	0.2270	4.4423	10.0032	0.4400	0.6570
z_{may}	27.4815	13.9308	1.9700	0.0490	12.8172	9.6663	1.3300	0.1850
z_{june}	9.0890	14.4537	0.6300	0.5290	-2.4064	10.0292	-0.2400	0.8100
z_{july}	33.0198	14.2378	2.3200	0.0200	15.6575	9.8794	1.5800	0.1130
z_{aug}	-6.4354	14.5944	-0.4400	0.6590	-4.5129	10.1268	-0.4500	0.6560
z_{sep}	0.0440	14.6054	0.0000	0.9980	10.2687	10.1344	1.0100	0.3110
z_{oct}	-0.8334	15.8876	-0.0500	0.9580	-1.9361	11.0241	-0.1800	0.8610
z_{nov}	10.1038	20.6075	0.4900	0.6240	17.0157	14.2992	1.1900	0.2340
Constant	274.1858	81.2673	3.3700	0.0010	87.5277	56.3899	1.5500	0.1210

	Supermarket margarine				Supermarket oil			

	coef	Std. Error	t - value	p-value	coef	Std. Error	t - value	p-value
z_t	-0.3264	0.2304	-1.4200	0.1570	-0.0573	0.0323	-1.7800	0.0760
Tax (η_{ij})	79.0566	52.8467	1.5000	0.1350	1.0642	7.4061	0.1400	0.8860
Pretax (ϕ_{ij})	47.3429	56.1604	0.8400	0.3990	21.6339	7.8705	2.7500	0.0060
Christmas	96.2243	49.4052	1.9500	0.0510	9.1964	6.9238	1.3300	0.1840
Price_butter$_{super}$	-2.4136	1.2195	-1.9800	0.0480	-0.1442	0.1709	-0.8400	0.3990
Price_blend$_{super}$	-8.3688	1.5177	-5.5100	0.0000	-0.6197	0.2127	-2.9100	0.0040
Price_marg$_{super}$	-19.3680	3.4056	-5.6900	0.0000	-2.0544	0.4773	-4.3000	0.0000
Price_oil$_{super}$	0.1178	0.8736	0.1300	0.8930	-0.2401	0.1224	-1.9600	0.0500
Price_butter$_{disc}$	3.2338	2.2955	1.4100	0.1590	0.7542	0.3217	2.3400	0.0190
Price_blend$_{disc}$	4.6721	1.5094	3.1000	0.0020	0.2459	0.2115	1.1600	0.2450
Price_marg$_{disc}$	7.6213	6.1653	1.2400	0.2160	0.6567	0.8640	0.7600	0.4470
Price_oil$_{disc}$	0.3189	1.5674	0.2000	0.8390	0.0779	0.2197	0.3500	0.7230
z_{feb}	25.4243	29.6006	0.8600	0.3900	-1.6029	4.1483	-0.3900	0.6990
z_{mar}	12.6534	28.3501	0.4500	0.6550	-2.5775	3.9731	-0.6500	0.5170
z_{apr}	27.5133	28.8671	0.9500	0.3410	1.0830	4.0455	0.2700	0.7890
z_{may}	51.3152	27.8949	1.8400	0.0660	7.6400	3.9093	1.9500	0.0510
z_{june}	13.3776	28.9419	0.4600	0.6440	-0.0662	4.0560	-0.0200	0.9870
z_{july}	56.6349	28.5097	1.9900	0.0470	5.3953	3.9954	1.3500	0.1770
z_{aug}	-3.4349	29.2237	-0.1200	0.9060	-6.4950	4.0955	-1.5900	0.1130
z_{sep}	19.9197	29.2457	0.6800	0.4960	-1.6495	4.0986	-0.4000	0.6870
z_{oct}	6.6923	31.8131	0.2100	0.8330	-7.0807	4.4584	-1.5900	0.1120
z_{nov}	17.5154	41.2643	0.4200	0.6710	0.0186	5.7829	0.0000	0.9970
Constant	505.9019	162.7288	3.1100	0.0020	55.5165	22.8053	2.4300	0.0150

	Discount_butter				Discount_blend			
	coef	Std. Error	t - value	p-value	coef	Std. Error	t - value	p-value
z_t	0.3413	0.0428	7.9700	0.0000	-0.0206	0.0372	-0.5500	0.5810
Tax (η_{ij})	34.4674	9.8189	3.5100	0.0000	-4.1361	8.5376	-0.4800	0.6280
Pretax (ϕ_{ij})	-3.3800	10.4345	-0.3200	0.7460	-2.1066	9.0729	-0.2300	0.8160
Christmas	16.5182	9.1794	1.8000	0.0720	17.9094	7.9816	2.2400	0.0250
Price_butter$_{super}$	-0.3270	0.2266	-1.4400	0.1490	-0.3103	0.1970	-1.5700	0.1150
Price_blend$_{super}$	-0.0754	0.2820	-0.2700	0.7890	0.0878	0.2452	0.3600	0.7200
Price_marg$_{super}$	-0.2748	0.6328	-0.4300	0.6640	1.2256	0.5502	2.2300	0.0260
Price_oil$_{super}$	0.0011	0.1623	0.0100	0.9950	-0.1523	0.1411	-1.0800	0.2800
Price_butter$_{disc}$	-4.0896	0.4265	-9.5900	0.0000	1.0888	0.3708	2.9400	0.0030
Price_blend$_{disc}$	-0.0545	0.2804	-0.1900	0.8460	-3.4751	0.2438	-14.2500	0.0000
Price_marg$_{disc}$	0.1745	1.1455	0.1500	0.8790	1.0766	0.9960	1.0800	0.2800
Price_oil$_{disc}$	0.1723	0.2912	0.5900	0.5540	-0.1039	0.2532	-0.4100	0.6820
z_{feb}	4.8133	5.4998	0.8800	0.3810	3.6714	4.7821	0.7700	0.4430

z_{mar}	11.0199	5.2674	2.0900	0.0360	2.4996	4.5801	0.5500	0.5850
z_{apr}	4.0980	5.3635	0.7600	0.4450	2.8234	4.6636	0.6100	0.5450
z_{may}	-2.3914	5.1828	-0.4600	0.6450	1.4045	4.5065	0.3100	0.7550
z_{june}	1.7203	5.3774	0.3200	0.7490	0.4338	4.6757	0.0900	0.9260
z_{july}	7.0361	5.2971	1.3300	0.1840	3.8143	4.6058	0.8300	0.4080
z_{aug}	-3.2093	5.4297	-0.5900	0.5540	4.1913	4.7212	0.8900	0.3750
z_{sep}	-1.8939	5.4338	-0.3500	0.7270	-0.9802	4.7247	-0.2100	0.8360
z_{oct}	1.4834	5.9108	0.2500	0.8020	4.3031	5.1395	0.8400	0.4020
z_{nov}	2.7093	7.6669	0.3500	0.7240	-0.0736	6.6664	-0.0100	0.9910
Constant	191.0014	30.2349	6.3200	0.0000	108.6804	26.2894	4.1300	0.0000

	Discount_margarine				Discount_oil			
	coef	Std. Error	t - value	p-value	coef	Std. Error	t - value	p-value
z_t	0.0141	0.0590	0.2400	0.8110	0.0266	0.0189	1.4000	0.1600
Tax (η_{ij})	1.1619	13.5385	0.0900	0.9320	6.1196	4.3414	1.4100	0.1590
Pretax (ϕ_{ij})	39.3208	14.3874	2.7300	0.0060	3.6600	4.6137	0.7900	0.4280
Christmas	12.4905	12.6568	0.9900	0.3240	4.7741	4.0587	1.1800	0.2390
$\text{Price\_butter}_{super}$	-0.7746	0.3124	-2.4800	0.0130	-0.0890	0.1002	-0.8900	0.3750
$\text{Price\_blend}_{super}$	-0.0745	0.3888	-0.1900	0.8480	-0.1323	0.1247	-1.0600	0.2890
$\text{Price\_marg}_{super}$	2.3858	0.8725	2.7300	0.0060	0.5643	0.2798	2.0200	0.0440
Price_oil_{super}	-0.2994	0.2238	-1.3400	0.1810	-0.1245	0.0718	-1.7300	0.0830
$\text{Price\_butter}_{disc}$	-0.2456	0.5881	-0.4200	0.6760	-0.1899	0.1886	-1.0100	0.3140
$\text{Price\_blend}_{disc}$	-0.4419	0.3867	-1.1400	0.2530	-0.0777	0.1240	-0.6300	0.5310
Price_marg_{disc}	-1.1595	1.5795	-0.7300	0.4630	-0.4942	0.5065	-0.9800	0.3290
Price_oil_{disc}	0.0833	0.4015	0.2100	0.8360	-0.1522	0.1288	-1.1800	0.2370
z_{feb}	2.6948	7.5832	0.3600	0.7220	0.8310	2.4317	0.3400	0.7330
z_{mar}	10.3215	7.2628	1.4200	0.1550	0.8147	2.3290	0.3500	0.7260
z_{apr}	-0.2083	7.3953	-0.0300	0.9780	0.2331	2.3715	0.1000	0.9220
z_{may}	-7.8187	7.1462	-1.0900	0.2740	-3.1188	2.2916	-1.3600	0.1740
z_{june}	-5.8755	7.4144	-0.7900	0.4280	-1.3597	2.3776	-0.5700	0.5670
z_{july}	-2.4843	7.3037	-0.3400	0.7340	-0.5161	2.3421	-0.2200	0.8260
z_{aug}	10.8736	7.4866	1.4500	0.1460	-1.2875	2.4008	-0.5400	0.5920
z_{sep}	-3.8239	7.4923	-0.5100	0.6100	-5.7198	2.4026	-2.3800	0.0170
z_{oct}	15.8700	8.1500	1.9500	0.0520	-3.7758	2.6135	-1.4400	0.1490
z_{nov}	2.5092	10.5712	0.2400	0.8120	-6.9294	3.3899	-2.0400	0.0410
Constant	112.6724	41.6884	2.7000	0.0070	48.0784	13.3684	3.6000	0.0000