LAND ECONOMY WORKING PAPER SERIES

Number: 49 **Wheat Prices, Bread Consumption and Health in Scotland**

Corresponding Author:

Cesar Revoredo-Giha
Land Economy Research Group
SAC Research Division
SAC Edinburgh

EH9 3JG
Tel: 0131-535-4344
Email: Cesar.Revoredo@sac.ac.uk

WHEAT PRICES, BREAD CONSUMPTION AND HEALTH IN SCOTLAND

Cesar Revoredo-Giha, Philip Leat, Luiza Toma, Chrysa Lamprinopoulou,
Beata Kupiec-Teahan, and Luca Cacciolatti

ABSTRACT

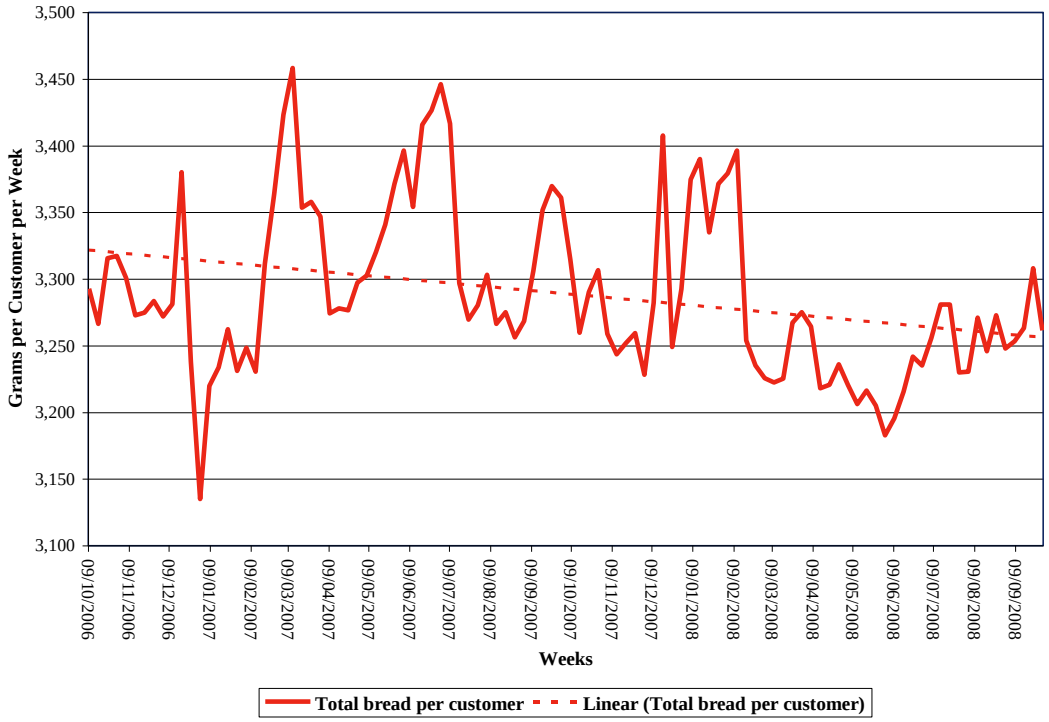
The relative recent rise in food prices has increased concern about the choice of a healthy food basket, especially in the context of the formulation of a National Food Policy for Scotland. This concern has revived interest in food price and expenditure demand systems as they provide information about consumers' food decisions. The paper focuses on the consumption of brown and white bread, as they are the most typical forms of cereals use in the UK. Moreover, nutritionists recommend the consumption of wholemeal or brown bread in contraposition to white bread as part of an appropriate diet due to its health benefits. The overall purpose of the paper is to measure the impact that the increase in the price of cereals during the period 2005 to 2008 would have had on the purchase of brown and white bread. This is undertaken in two stages: the first measures the effect of changes in milling wheat prices on brown and white bread prices, and the second measures the elasticities of the purchases of brown and white bread with respect to changes in their prices through the estimation of two conditional demand systems for bread.

KEYWORDS: Bread consumption models; Scotland; Food prices.

I. Introduction

All over the world there is a growing concern about the increase in food prices and how this may affect the access to and affordability of food, and, ultimately, consumers' well being. Recent official figures for UK inflation (ONS, 2008b) indicate that the largest contribution to the change in the consumer price index (CPI) over the past year comes from the food and non-alcoholic beverages category. Although traditionally a category with prices growing at a rate below the average for all the items in the economy, bread inflation since January 2005 has grown above the overall inflation rate following the upward trend in the price of cereals. Thus, whilst the retail price index (RPI) for all items grew by 13 per cent between January 2005 and September 2008, the RPI for bread rose by 33 per cent over the same period. Furthermore, if one considers specific average prices of major products within the bread category, the price of the 800 grams sliced white loaf has grown by 102 per cent and the 800 grams sliced wholemeal loaf by 58 per cent during the same period (ONS, 2008b). As regards total bread purchases in Scotland, Figure 1, using supermarket data, shows a decreasing trend in the purchases per customer.

Figure 1: Scotland - Total Bread Purchased per Customer, Oct 2006 to Sept 2008



Source: Based on data provided by the Centre for Value Chain Research (VCR[2]), Kent Business School.

The choice of bread prices and consumption as the focus of this paper is associated, first, to the fact that bread is a traditional key food item and represents a significant part, almost 5 per cent, of the household expenditure on food and non-alcoholic drinks (ONS, 2008b). Furthermore, according to the Flour Advisory Bureau (2008), bread remains one of the UK's favourite foods, with 99 per cent of households buying bread, of which white bread accounts for 70 per cent of consumption. The increasing importance of so called "premium bread"[1],

[1] Premium breads are those made with higher protein flour than the standard loaf of bread.

should also be noted. According to the Flour Advisory Bureau, when introduced in the early 1990s, premium bread proved extremely successful, and currently accounts for around 21 per cent of the plant white bread market. This popularity was reinforced by the launch in late 1998 of premium brown and wholemeal loaves.

The second reason for choosing to study bread is due to its nutritional importance. Thus, nutritionists' recommendations make a clear distinction between the consumption of wholemeal or brown bread in contrast to white bread as part of an appropriate diet (e.g., Mooney, 1990). Furthermore, the former is part of the recommendation that regular consumption of wholegrain foods should be encouraged as it has been associated with a reduction in the incidence of cardiovascular disease and diabetes, reductions in cancer mortality and an overall reduction in premature death (Lang and Jebb, 2003). Another nutritional aspect that makes bread an interesting product to study is that it is one of the main contributors of salt to the diet more due to the quantities consumed than to the quantities of salt contained in it (FSA, 2005). Furthermore, the FSA targeted premium breads due to the fact that because they are made with higher protein flour, they fact require greater salt levels to maintain an acceptable shape, texture and colour of the bread (Eyre, 2008).

The main motivation behind the paper is the discussion around the formulation of a National Food Policy for Scotland. One of the aspects of the discussion is related to food education – supporting consumers and the food and drink industry in making healthier and more environmentally sustainable choices. Thus, analysing how consumers respond to prices, in choosing healthy or not healthy options, contributes to providing background information for the discussion. In addition, in the case of the Scottish nutritional policy bread has a special importance as it was targeted by the 1996 Scottish Diet Action Plan to increase its intake to by 45 per cent from the daily intake of 106g in 1995, mainly using wholemeal and brown breads. However, the 2003 Scottish Health Survey pointed out that fewer people consumed at least two slices of any bread a day in 2003 than in 1995 (Scottish Executive, 2005). Hence, it is natural to ask whether the rise of bread prices might have made the target of increasing bread consumption even more challenging.

The overall purpose of the paper is to measure the impact that the increase in the price of cereals during the period 2005 to 2008 has had on the purchase of brown and white bread. This is achieved in two stages: the first measures the effect of changes in bread milling wheat prices on brown and white bread prices, and the second measures the elasticities of the purchases of brown and white bread with respect to changes in their prices through the estimation of two conditional demand systems for bread.

The structure of the paper is as follows. First, an overview of the methodology is presented, comprising the estimation of the response of bread prices to changes in wheat prices, a description of the supermarket data used in the demand analysis and the estimated models. In total two models were used for comparison: the Rotterdam demand system (Theil, 1965 and Barten, 1967) and the dynamic versions of the Linear Approximation of the Almost Ideal Demand System (LA/AIDS) (Edgerton et al., 1996). This is followed by a discussion of the results and their implications in terms of nutrition.

II. Methodology and results

This section presents the paper's empirical component. It starts with the analysis of the impact of wheat prices on bread prices, followed by a description of the data used in the demand analysis and the models estimated, and ends with a presentation of the results and discussion.

III.1 Impact of wheat prices on brown and white bread prices

The purpose of this section is to explore the impact that the recent increase in the price of cereals has had on the price of white and brown bread. The methodology used consisted of estimating a two price transmission equation, one for each type of bread. The data used consisted of a series of monthly bread milling wheat prices from the Home Grown Cereals Authority (HGCA) and also monthly brown and white prices from National Statistics.

The first step of the methodology involved testing the stationarity of the data (i.e., to test the presence of unit roots in the prices of wheat, and bread). For that purpose we used the Augmented Dickey Fuller test. As is typical in averaged time-series, all the prices were found to have a unit root.

In order to reach the final error correction equations, linking the price of wheat with the price of each bread type, we started the econometric work estimating an autoregressive distributed lag model and using the general to specific methodology (Charemza and Deadman, 1997) to reduce the number of parameters in the equations. The resulting parsimonious equations were transformed into error correction forms. The equations for the two types of bread are as follows:

Brown bread price equation

$$\Delta \ln PBB_t = \underset{(1.373)}{0.0577}\,\Delta \ln PW_{t-1} + \underset{(2.067)}{0.0988}\left[\ln PBB_{t-1} - \underset{(6.427)}{2.6278} - \underset{(1.602)}{0.5093}\,D_{02/2008} - \underset{(4.662)}{0.4330}\ln PW_{t-1}\right]$$

White bread price equation

$$\Delta \ln PWB_t = \underset{(2.091)}{0.0943}\,\Delta \ln PW_t + \underset{(2.1420)}{0.0666}\left[\ln PWB_{t-1} - \underset{(3.464)}{2.2278} - \underset{(1.851)}{1.4481}\,D_{02/2008} - \underset{(3.6048)}{0.5229}\ln PW_{t-1}\right]$$

Where PBB is the brown bread price, PWB is the white bread price and PW is the price of wheat. The numbers below the coefficients are the t-statistics. The residuals of both equations were tested for normality (Jarque-Bera test), presence of autocorrelation (Breusch-Godfrey Lagrange Multiplier test) and incidence of autoregressive conditional heteroscedasticity (ARCH) terms, without any problems being found. In the error correction form, the equation for brown bread explains 34 per cent of the variance (98.3 per cent of the variable in levels) and 43 per cent in the case of white bread (98.6 per cent of the variable in levels).

Three issues are interesting to note from the estimated error correction equations. First, the short term dynamics given by the right hand side terms expressed in first differences; second, the speed of adjustment of the bread prices to disequilibrium, and third, the long term effect given by the equation inside the brackets.

With respect to the short term behaviour, according to the equations, only in the case of white bread is an increase in the price of wheat readily translated into the price of bread, whilst in the case of brown bread it takes one period. The unexpected negative sign in both equations may be associated with a process of adjustment of inventories, although the values of the coefficients are small and only significant for the white bread equation.

The error correction terms in the equation indicate that the speed of adjustment to movements outside the equilibrium is quite slow. In the case of brown bread prices, only 0.098 per cent of 1 per cent disequilibrium is translated into the bread price in the first period. In the case of white bread prices that response is even lower and equal to 0.067 per cent.

The long term equations that are inside the brackets indicate that the elasticity of the price of brown bread and white bread with respect to changes in the price of wheat are 0.433 and 0.522.[2]

III.2 Demand models

Data

The information used in the paper for the demand analysis, i.e., Scottish prices and purchases, was provided by the Centre for Value Chain Research (VCR[2]) at the Kent Business School for the project "Assessing the Effect of the Rise in Food Prices on the Purchasing Power of Consumers in Scotland" (Revoredo-Giha et al., 2008). The dataset provides information about the evolution of the total weekly purchases from a panel of loyalty customers from one of the "big-4" supermarkets in the UK.[3]

It should be noted that the available consumer surveys for the estimation of demand systems are UK based with only a small number of observations for Scotland (e.g., Expenditure and Food Survey). This situation makes it difficult to analyse the consumption behaviour of regions and socio-economic groups within the country. Due to this reason, data from supermarket scanners were used in this study. In addition, although supermarket scanner information is a really promising data source for demand analysis (see Cotterill, 1994 for an overview) supermarket data are not perfect, as they do not include all of the consumption outside the household, which has grown over time. Furthermore, according to the Flour Advisory Bureau, the consumption of bread, e.g., in the form of sandwiches, is a category that has grown significantly in recent years in the UK.

The data consisted of information on the value of bread purchases in GBP (£), number of units purchased, number of customers and prices (£) per gram; with all variables at the product level (a total of 244 bread products). Two main bread categories were considered: brown (e.g., brown, wholemeal, multigrain) and white bread. This was due to the requirement of studying their reaction to price changes and whether their consumption is somewhat related (i.e., the presence of a substitution or complementarity effect). These categories were further subdivided into non-premium and premium. Therefore, a total of four categories were considered in the analysis, namely: brown bread, premium brown bread, white bread and premium white bread.

As regards the data availability, it consisted of 104 points of weekly data starting at the week of the 9th of October 2006 and ending at the 29th of September 2008, for three Scottish TV

[2] To our knowledge there are no estimates of the impact of the price of wheat on the price of bread to compare the obtained elasticities. Anecdotal evidence indicates that an increase on the price of flour by £40 per tonne brings an increase in the price of a large loaf of bread (800g) of 4 to 5 pence (Higham, 2007).

[3] The "big-4" supermarkets in the UK are Tesco, Asda, Sainsbury's and Morrisons. They represent approximately 75 per cent of the sales in the groceries market (Judge, 2008)

advertising regions (i.e., Borders, Central and North Scotland), and by ten socio-economic groupings (i.e., using CAMEO-UK, a geo-demographic classification system for assessing the socio-economic and demographic characteristics of residential neighbourhoods[4]). Due to the sparse information for some of the socioeconomic groups, the ten groups were merged into three groups (Group A=affluent group, Group B=middle group, and Group C=poorer group). The descriptive statistics of the data are presented in Table 1.

As shown in Table 1, the purchases of bread per customer are relatively similar amongst the different groups, although in all cases the most affluent group shows the highest purchase levels per customer.

Estimation

For comparison purposes two demand systems were estimated in the paper: the Rotterdam demand system and dynamic version of the so-called Linear Approximation of the Almost Ideal Demand System (LA/AIDS). This section presents the models briefly, as they are well-known models in the economic literature and extensive information about their characteristics can be found elsewhere (e.g., Deaton and Muellbauer, 1991).

The choice of these two models was due to the fact that they have been previously used in the literature for demand systems estimation using supermarket scanner data.[5] The Rotterdam demand system was used, for instance, by Capps and Love (2002) to study the demand for chilled and shelf stable fruit juices and drinks.[6] The equation for each sub-category within the demand system is given by equation (1):

$$\bar{\omega}_i \cdot d\log Q_i = \alpha_i \left(d\log E - \sum_{i=1}^{k} \omega_k \cdot d\log P_k \right) + \sum_{j=1}^{k} \alpha_{ij} \cdot d\log P_j + \mu_i \quad (1)$$

Where $d\log x$ represents the differential of the logarithm, approximated (for any variable x) by $d\log x_t = \log x_t - \log x_{t-1}$, t is time sub-index and $\omega_k = \frac{P_k \cdot Q_k}{E}$ is the expenditure share (E) share of the sub-category within the category. P_k denotes the price of the k sub-category (e.g., brown bread), Q_k is the quantity purchased of k.

[4] More information about the CAMEO-UK groups can be found at http://www.eurodirect.co.uk/pages/cameo-analysis.

[5] Other demand systems used with supermarket scanner data are the double- double log model (e.g., Capps, 1989) and the LA/AIDS model (e.g., Cotterill, 1994).

[6] Other applications are Nayga and Capps (1994) on the demand for meat products; Seo and Capps (1997) and Capps, Seo and Nichols (1997), both papers on the demand for spaghetti sauces.

Table 1: Scotland - Descriptive statistics of selected supermarket bread data, October 2006 to September 2008 1/ 2/ 3/

	Scotland - CAMEO Groups			
	Group A	Group B	Group C	All
Bread quantities (grams per week)				
Brown	932.8	898.8	883.0	906.7
Std. Dev.	25.4	25.6	25.4	23.5
Min	870.4	836.7	837.3	850.8
Max.	1,015.4	988.2	958.0	986.9
Premium brown	712.7	677.2	659.7	688.5
Std. Dev.	29.8	33.5	34.2	29.7
Min	664.3	629.0	617.3	649.6
Max.	801.7	800.0	796.3	789.8
White	1,048.4	1,005.4	1,023.5	1,029.2
Std. Dev.	25.1	21.3	24.5	22.5
Min	983.5	934.7	960.5	964.0
Max.	1,137.9	1,062.7	1,130.5	1,121.8
Premium white	678.4	661.5	649.0	664.5
Std. Dev.	23.1	23.6	21.6	21.3
Min	630.6	625.7	612.4	633.4
Max.	750.1	734.8	714.4	733.1
Bread prices (pence/10 gr.)				
Brown	1.11	1.12	1.11	1.11
Std. Dev.	0.10	0.17	0.10	0.10
Min	0.92	0.90	0.92	0.92
Max.	1.28	1.52	1.29	1.28
Premium brown	1.24	1.25	1.23	1.24
Std. Dev.	0.18	0.17	0.18	0.18
Min	0.92	0.90	0.90	0.91
Max.	1.52	1.52	1.51	1.51
White	1.08	1.10	1.07	1.08
Std. Dev.	0.11	0.12	0.12	0.12
Min	0.91	0.93	0.90	0.91
Max.	1.31	1.33	1.31	1.32
Premium white	1.30	1.30	1.26	1.29
Std. Dev.	0.15	0.15	0.15	0.15
Min	1.08	1.09	1.04	1.07
Max.	1.55	1.53	1.52	1.53

Source: Based on data provided by the Centre for Value Chain Research (VCR^2), Kent Business School.

Notes:

1/ The quantities are per customer.

2/ The first row for each product is the mean of the variable.

3/ Group A= affluent, group B=middle, group C=poorer.

In order to be consistent with the theory, the system has to satisfy the following constraints (in addition to the negative semi-definitiveness of the Hessian matrix on prices):

$$\sum_{i=1}^{k} \alpha_i = 1; \quad \sum_{i=1}^{k} \alpha_{ij} = 0 \quad \text{Adding up} \tag{2}$$

$$\sum_{j=1}^{k} \alpha_{ij} = 0 \quad \text{Homogeneity}$$

$$\alpha_{ij} = \alpha_{ji} \quad \text{Symmetry}$$

The Marshallian (i.e., uncompensated) elasticities in the Rotterdam demand system are given by (4), where ε_{ij} is the own and cross price elasticity and η_i is the expenditure elasticity.

$$\varepsilon_{ij} = \frac{\alpha_{ij} - \omega_j \alpha_i}{\omega_i} \tag{3}$$

$$\eta_i = \frac{\alpha_i}{\omega_i}$$

The own (ε_{ii}) and cross price Hicksian (i.e., compensated) elasticities (ε_{ij}) are given by (4)

$$\varepsilon_{ij} = \frac{\alpha_{ij}}{\omega_i} \tag{4}$$

The dynamic version of the LA/AIDS model can be found, for instance, in Edgerton et al. (1996) applied to food demand in the Nordic Countries. The reason for using the dynamic version of the LA/AIDS model and not the static version is that the results from the estimation of the latter showed significant autocorrelation problems. In the LA/AIDS model the share equations are given by (5):

$$\omega_{i,t} = \alpha_0 + \sum_{j=1}^{n} \phi_j \omega_{j,t-1} + \sum_{j=1}^{k} \alpha_{ij} \cdot \log P_{j,t} + \alpha_{ik+1} \cdot \log \frac{E}{P_t} + \mu_{i,t} \tag{5}$$

Where P is a geometric price index (Stone price index) defined as $\log P = \sum_{i=1}^{k} \omega_i \cdot \log P_i$. Similar to the Rotterdam demand system, the dynamic LA/AIDS needs to satisfy a number of constraints in order to be consistent with the economic theory. These are given in (6):

$$\sum_{i=1}^{k} \alpha_{ik+1} = 1; \quad \sum_{i=1}^{k} \alpha_{ij} = 0 \quad \text{Adding up} \tag{6}$$

$$\sum_{j=1}^{k} \alpha_{ij} = 0 \quad \text{Homogeneity}$$

$$\alpha_{ij} = \alpha_{ji} \quad \text{Symmetry}$$

In addition, in order to identify the parameters of the lagged shares in the model, additional constraints to those presented in (6) need to be imposed to it. In this paper, we follow Edgerton et al. (1996) and use $\sum_{j=1}^{n} \phi_j = 0$.

The Marshallian elasticities are given by ε_{ii} (own price elasticity), ε_{ij} (cross price elasticity and η_i (expenditure elasticity) in (7) :

$$\varepsilon_{ii} = -1 + \frac{\alpha_{ii}}{\omega_i} - \alpha_{ik+1} \qquad (7)$$

$$\varepsilon_{ij} = \frac{\alpha_{ij}}{\omega_i} - \alpha_{ik+1}\frac{\omega_j}{\omega_i}$$

$$\eta_i = 1 + \frac{\alpha_{ik+1}}{\omega_i}$$

The own (ε^{*}_{ii}) and cross price Hicksian (i.e., compensated) elasticities (ε^{*}_{ij}) are given by (8):

$$\varepsilon^{*}_{ii} = -1 + \frac{\alpha_{ii}}{\omega_i} - \omega_i \qquad (8)$$

$$\varepsilon^{*}_{ij} = \frac{\alpha_{ij}}{\omega_i} + \omega_j$$

The previously described models were estimated using Iterative Seemingly Unrelated Regressions (SURE).

III.3 Demand models results and discussion

Although the specific results from the models are of interest and they are available from the authors upon request, for brevity purposes we only present the estimated Marshallian or uncompensated elasticities and their degree of significance. These are shown in Table 2, which gives the elasticities for Scotland and by socioeconomic group.

All the estimated models produced own-price elasticities for the socio-economic groups that were not only statistically significant at 1 per cent, but also with the anticipated sign (i.e., negative sign). Moreover, most of the expenditure elasticities were significant and positive. However, the previous statement does not mean that all the models showed similar results. Actually they differed and the final results of the effect of the rise of wheat prices on the bread prices depends on the model chosen.

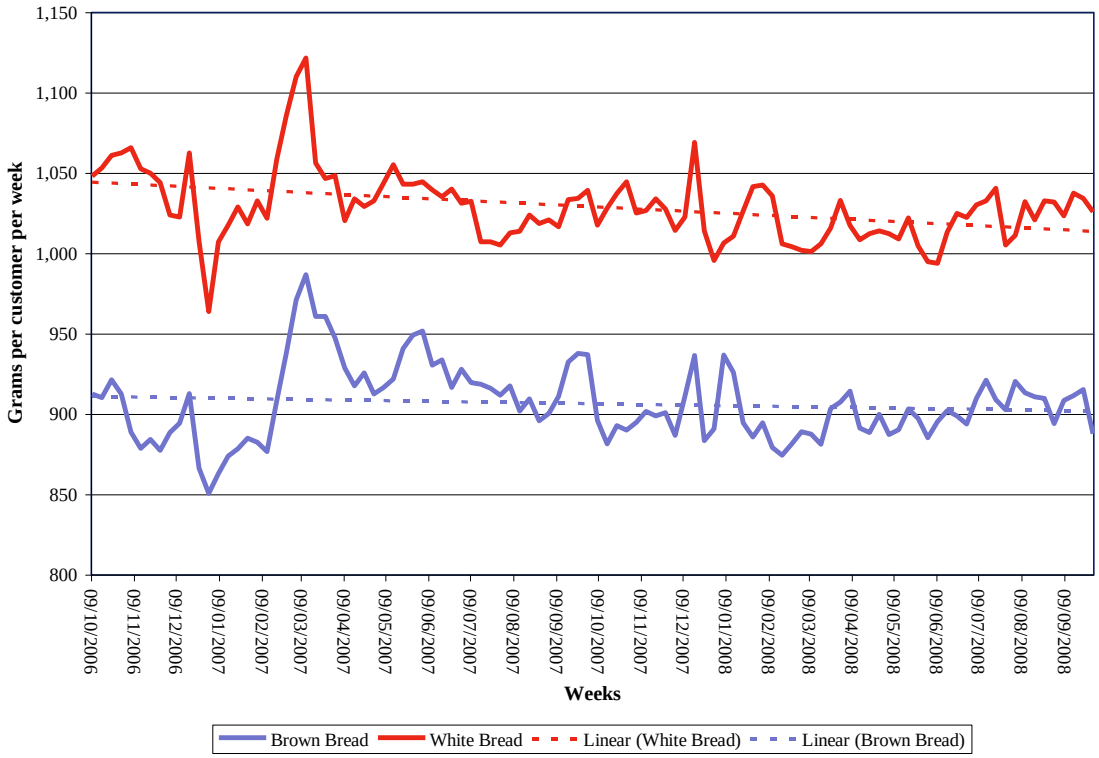
In terms of the results by socio-economic groups (i.e., results for groups A, B, and C), these were quite similar to those observed for Scotland overall. As regards the results by model, the double log, the Rotterdam models and the dynamic LA/AIDS model all provided relatively close results (except for the premium white bread where the dynamic LA/AIDS gave quite high own price elasticities close to those observed for

the static LA/AID). In contrast, the static LA/AIDS model predicted elasticities that were higher than those from the other models.

The results regarding the cross-price elasticities for the different models and socio-economic groups were interesting and in some ways puzzling. Many of the cross price elasticities were significant, however, in contrast with what one may have expected, they indicated that the different types of bread were complements instead of substitutes. This type of result is not new and can be found in Cotterill (1994) in his study of carbonated soft drinks using scanner data. He found complementary demand relationships between competing soft drinks. Furthermore, observing his Table 1 (pp. 137) one can realise that several of the cross price elasticities with negative signs (complementary products) were significant. He explained this in the following way: "complementary demand relationships were not expected among these ostensibly competing regular soft drink products [Coke and Sprite]. Intuitively what seems to occur is that when Coke, for example, lowers its price shoppers are attracted to the aisle and pickup some Sprite as a complementary product to provide "variety" or a clear soda for the uncola crowd" (pp. 135). Similarly, it may be that many shoppers purchase premium bread along with ordinary bread, or brown bread with white. However, it is also possible to attribute this result to the aggregation problem, as expenditure recorded every period considers a number of different customers buying different products at the same time. If one considers this aggregate as a representative individual, then one may obtain spurious cross price elasticities (although they might be useful to predict aggregate consumption).[7] Figure 2 shows that the purchases of brown and white bread evolved similarly during the sample period, which is reflected in the cross price elasticities.

[7] See Deaton and Muellbauer (1991), pp. 80 about a discussion on consumption across individuals and commodities.

Figure 2: Scotland - Bread Purchases per Customer - Oct 2006 to Sept 2008



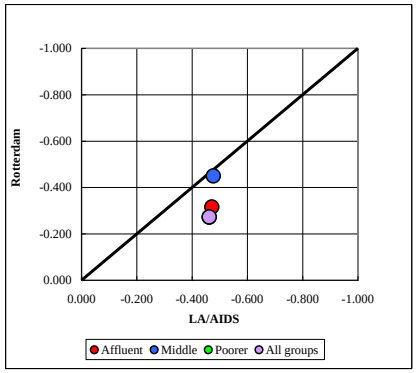
Source: Based on data provided by the Centre for Value Chain Research (VCR[2]), Kent Business School.

What are the implications of the results in nutritional terms? In other words, what is it possible to say in relation to the consumption of brown and white bread, based on the estimated models? Given the difference in the elasticities obtained from the models, certainly the answer depends on which one is considered.

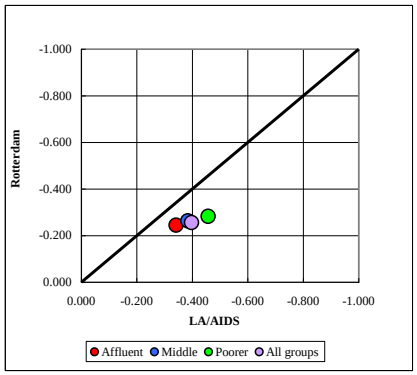
Table 3 presents the results of the overall change in the bread purchases due to the change in the price of wheat. The table evaluates the effect of an increase in the price of brown bread by 31.2 per cent and in white bread by 37.7 per cent. These percentages were the results of multiplying the long term elasticity of bread prices with respect to wheat prices (0.43 and 0.52 for brown bread and white bread, respectively) by 72.4 per cent, i.e., the change in the milling wheat price in Great Britain during the period January 2005 to September 2008. The prices for brown bread and white bread were also applied to the premium categories.

Figure 1 – Comparison of Hicksian own price elasticities and expenditure elasticities

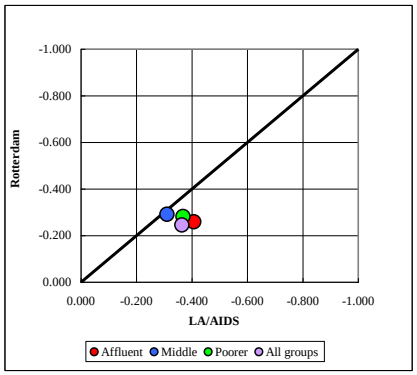
Hicksian own price elasticities



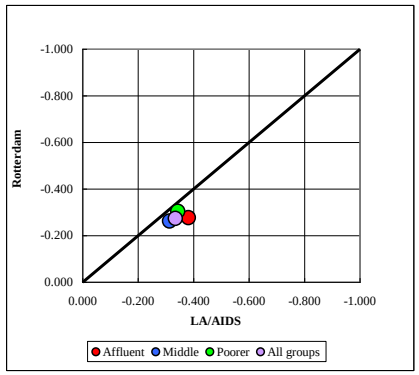
Brown bread



Premium brown bread

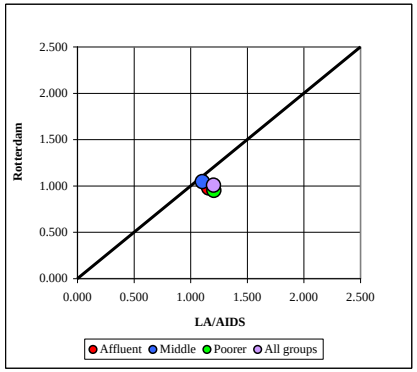


White bread

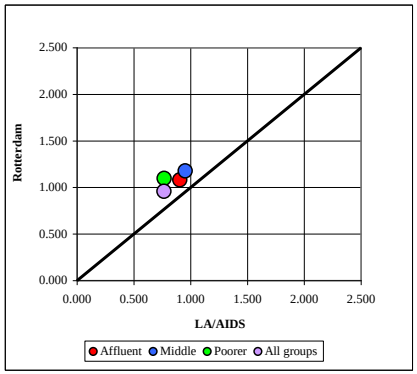


Premium white bread

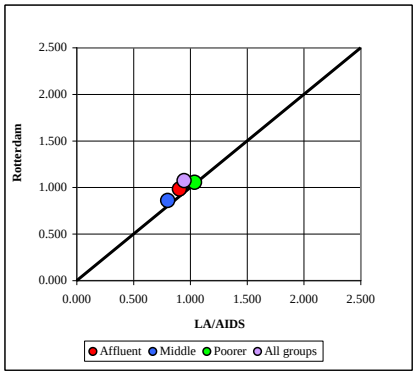
Expenditure elasticities



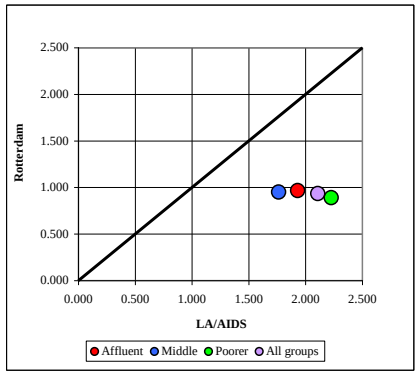
Brown bread



Premium brown bread



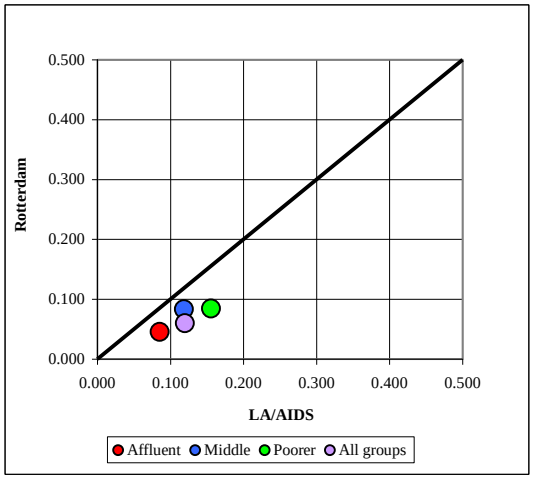
White bread



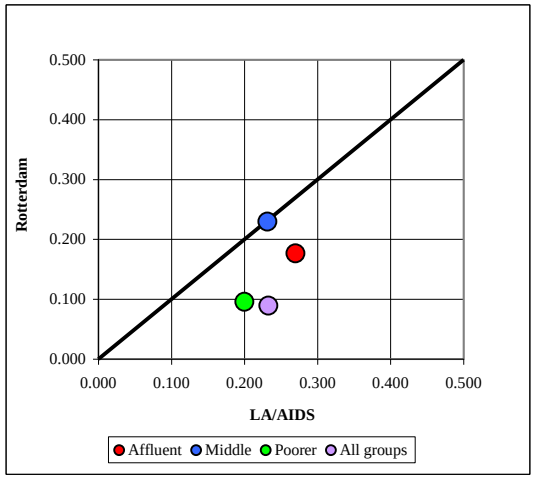
Premium white bread

Figure 2 – Comparison of cross price elasticities

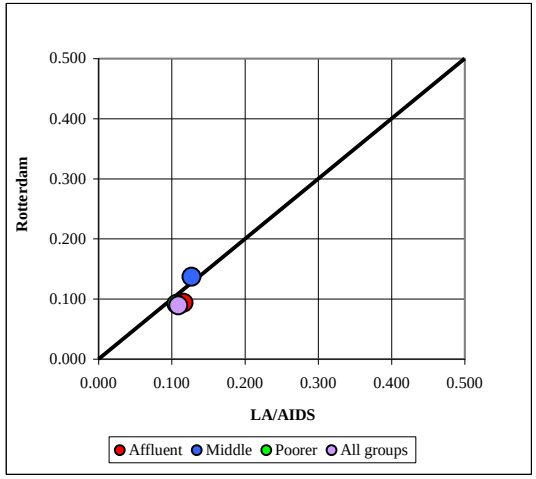
Cross price elasticities



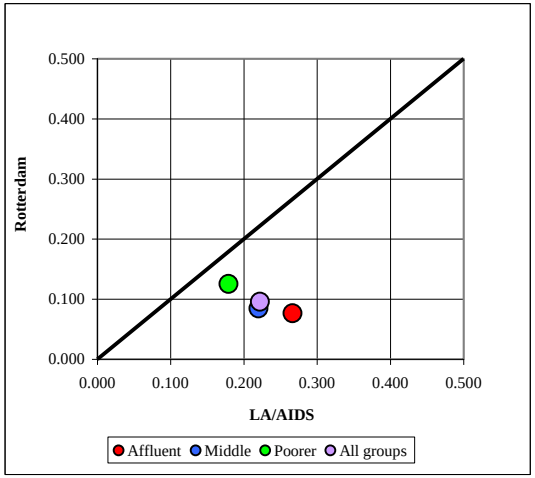
Brown and premium brown bread



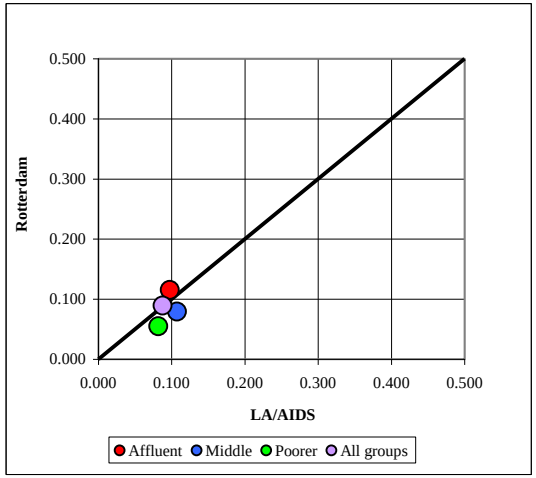
Brown and white bread



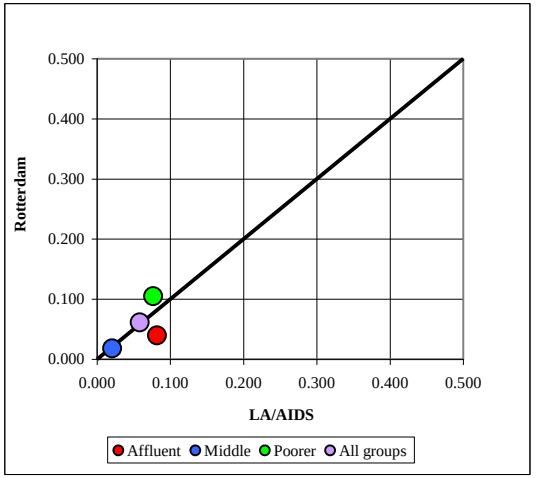
Brown and premium white bread



Premium brown and white bread



Premium brown and premium white bread



White bread and premium white bread

Table 2: Scotland - Simulation of the total effect of an increase in the price of wheat on the purchases of the different types of bread, 2005-08 (%)

	Rotterdam demand system	LA/AIDS Dynamic
Group A		
Brown	0.35	2.52
Premium Brown	-3.29	6.18
White	-4.78	-5.21
Premium White	-3.41	-5.79
Group B		
Brown	-0.20	2.34
Premium Brown	-8.21	4.81
White	-4.46	-2.67
Premium White	-4.86	-2.88
Group C		
Brown	-2.39	2.00
Premium Brown	-0.89	1.47
White	-3.81	-1.90
Premium White	-2.75	-1.57
Altogether		
Brown	-3.28	2.23
Premium Brown	1.21	3.71
White	-4.69	-4.19
Premium White	-1.27	-4.55

With the exception of the results of the static LA/AIDS model, the results of the remaining models seem to be similar in magnitude, most of then fluctuating around 30 per cent and all indicating a decrease in the purchases of bread. However, if one would like to answer the question whether the changes in bread purchases will be the same for all the socioeconomic groups and what type of bread will suffer the highest decrease, the different model provide different results.

As regards the question of whether all the socio-economic groups will have the same response to the increase in prices, the models provide different responses. According to the Rotterdam model and the dynamic LA/AIDS all the socio-economic groups will have a similar response; however the models predict in opposite directions, whilst the remaining two models predict mixed responses by group.

Regarding the purchase of what type of bread was more strongly affected by the rise in the price of wheat, the findings are also mixed. According to the Rotterdam model, white bread in comparison with brown bread is the one with the highest decrease, whilst according to the dynamic LA/AIDS the answer is just the opposite. In other words, according to the former the increase in wheat prices would have had a positive impact on Scottish nutritional intake in all the socio-economic groups, whilst according to the latter the impact would have been negative. According to the double log model, except in the case of the group B, the impact on nutrition would have been negative. The static LA/AIDS also predicts a negative outcome except in the case of the group C (poorer).

If one focuses on the results altogether, excluding the static LA/AIDS model, the models predict a decrease in the purchases on brown bread that ranges from 30.81 per cent to 39.26 per cent and a decrease on the purchase of white bread that goes from 29.88 per cent to 38.23 per cent.

III. Conclusions

The overall purpose of the paper has been to measure the impact that the increase in the price of cereals has had during the period 2005 to 2008 on the purchase of brown and white bread. This has been achieved by first measuring the effect of changes in wheat milling prices on brown and white bread prices, and second by measuring the demand elasticities for brown and white bread with respect to changes in their prices through the estimation of four demand systems.

Overall, with the exception of the results of the static LA/AIDS model, the results of the remaining models seem to be similar in magnitude, most of them fluctuating around 30 per cent and all indicating a decrease in the purchases of bread. When one considers all the socio-economic groups (i.e., Scotland) and excludes the results of the static LA/AIDS model, the models predict a decrease in the purchases on brown bread that ranges from 30.81 per cent to 39.26 per cent and a decrease in the purchase of white bread that goes from 29.88 per cent to 38.23 per cent. However, as regards what type of bread decreases more, the different demand models provide opposite responses. In general, the implications of these findings include the proposition that during periods of high wheat price escalation and bread price inflation, the health messages associated with whole grain and brown bread consumption need to be maintained.

IV. References

Adams, J.F., and Engstrom, A. (2000). Dietary intake of whole grain versus recommendations, *Cereal Foods World*, 45, 75–79.

Anderson, J.W., Hanna, T.J., Peng, X. and Kryscio, R.J. (2000). Whole grain foods and heart disease risk. *Journal of the American College of Nutrition*, 19, 291–299.

Barten, A.P. (1967). Evidence on the Slutsky conditions for demand equations. *The Review of Economics and Statistics*, 49, 77-84.

Barten, A.P. (1977). The systems of consumer demand functions approach: a review. *Econometrica*. 45, 23–51.

Capps, Jr., O. (1989). Utilizing scanner data to estimate retail demand functions for meat products. *American Journal of Agricultural Economics*, 71, 750–760.

Capps, Jr., O., Seo, S.C., and Nichols, J.P. (1997). On the estimation of advertising effects for branded products: an application to spaghetti sauces. *Journal of Agricultural and Applied Economics*, 29, 291–302.

Capps, Jr., O. and Love, H.A. (2002). Econometric considerations in the use of electronic scanner data to conduct consumer demand analysis. *American Journal of Agricultural Economics*. 84, 807–816.

Capps, Jr.,O., Church, J. R. and Love, H.A. (2002). Specification issues and confidence intervals in unilateral price effects analysis. *Journal of Econometrics*. 113, 3-31.

Charemza, W. and Deadman, D. (1997). New Directions in Econometric Practice: General to Specific Modelling, Cointegration and Vector Autoregression. Edward Elgar Publishing Ltd: UK.

Cotterill, R.W. (1994). Scanner data: New opportunities for demand and competitive strategy analysis. *Agricultural and Resource Economic Review*, 23, 125–139.

Deaton, A. and Muellbauer, J. (1980). An almost ideal demand system. *American Economic Review*, 70, 312–326.

Deaton, A. and Muellbauer, J. (1991). Economics and consumer behaviour. Cambridge University Press: New York.

Edgerton, D., Assarsson, B., Hummelmose, A, Laurila, I., Rickertsen, K., Vale, P. (1996). The Econometrics of Demand Systems: With Applications to Food Demand in the Nordic Countries. Kluwer Academic Publishers: Boston.

Eyre, C. (2008). FSA examines salt reduction in premium bread. Food Production Daily, 18-03-2008. Available online at: http://www.foodproductiondaily.com/content/view/4037

Food Standard Agency (FSA) (2005). UK Salt Intakes: Modelling Salt Reductions – Adults. Available online at: http://www.food.gov.uk/multimedia/pdfs/saltmodelfeb05.pdf

Flour Advisory Bureau (2008). Flour Advisory Bureau Website. Accessed: November 2008. URL: http://www.fabflour.co.uk/content/1/31/facts-about-bread-in-the-uk.html.

Hayes, D. J., Wahl, T. I., Williams, G. W. (1990). Testing Restrictions on a Model of Japanese Meat Demand. *American Journal of Agricultural Economics*, 72, 556-566.

Higham, N. (2007). Food prices on the rise and rise. BBC News 20 July 2007. Available online at: http://news.bbc.co.uk/1/hi/uk/6909469.stm

Jacobs, D.R., Meyer, K.A., Kushi, L.H. and Folsom, A.R. (1998). Wholegrain intake may reduce the risk of ischemic heart disease death in postmenopausal women: the Iowa Women's Health Study, *American Journal of Clinical Nutrition*, 68, 248–257.

Johansson, L., Thelle, D., Slovoll, K., Bjoerneboe, G.E.A. and Drevon, C.H. (1999). Healthy dietary habits in relation to social determinants and lifestyle factors, *British Journal of Nutrition* , 81, 211–220.

Judge, E. (2008). The Competition Commission publishes new proposals for the UK supermarket industry. The Times Online. Available online at: http://business.timesonline.co.uk/tol/business/industry_sectors/retailing/article3377969.ece

Koch-Banerjee, P. and Rimm, E. B. (2003). Whole grain consumption and weight gain: a review of the epidemiological evidence, potential mechanisms and opportunities for future research, *Proceedings of the Nutrition Society*, 62, 25–29.

Lang, R., Thane,C.W., Bolton-Smith, C. and Jebb, S.A. (2001). Wholegrain food consumption by British adults from two national dietary surveys, *Proceedings of the Nutrition Society*, 60, 218.

Lang, R. and Jebb, S. A. (2003). Who consumes whole grains, and how much? *Proceedings of the Nutrition Society*, 62, 123–127

Mooney, C. (1990). Cost and availability of healthy food choices in a London health district. *Journal of Human Nutrition and Dietetics*, 3, 111-120.

Office for National Statistics (ONS, 2008a). Family Spending: 2007 edition: Palgrave MacMillan: Hampshire.

Office for National Statistics (ONS, 2008b). Focus on Consumer Price Indices - Data for September 2008, October 20th.

Pape, S.M., Kracov, D.A., Spokes, J.J., and Boggs, P., (1999). Whole grain foods authoritative statement claim notification. Submitted on behalf of General Mills, Inc. to the Food and Drug Administration, Washington.

Revoredo-Giha, C., Leat, P., Kupiec-Teahan, B., Lamprinopoulou, C. and Cacciolatti, L. (2008). Assessing the Effect of the Rise in Food Prices on the Purchasing Power of Consumers in Scotland. AA211 Special Study Report to RERAD, November. Edinburgh.

Richardson, D.P. (2000). The grain, the wholegrain and nothing but the grain: the science behind wholegrain and the reduced risk of heart disease and cancer. *British Nutrition Foundation Bulletin*, 25, 353–360.

Seo, S.C. and Capps, Jr. (1997). Regional variability of price and expenditure elasticities: the case of spaghetti sauces. *Agribusiness: An International Journal*, 13, 672–695.

Sidhu, G.S., Kabir, Y., and Huffman, F.G. (2007) Functional Foods from Cereal Grains, *International Journal of Food Properties*, 10, 231 – 244.

The Scottish Office Department of Health (1996) Eating for Health: A Diet Action, Plan for Scotland London, HMSO

Scottish Executive (2005). The Scottish Health Survey: summary of key findings. Scottish Executive: Edinburgh.

Stone, R. (1954). Linear expenditure systems and demand analysis: an application to the pattern of British demand. *The Economic Journal*, 64, 511-527.

Southgate, D.T., (1995) The structure of dietary fibre. In: Kritchevsky, D., and Bonfield, C., (1995) Dietary Fibre in Health and Disease pp. 25–36, St Paul: Eagan Press.

Theil, H. (1965). The information approach to demand analysis. *Econometrica*, 33, 67–87.

US Department of Health and Human Services, Public Health Service, Office of Disease Prevention and Health Promotion (2000) Healthy People 2010, Vols. I and II, Washington, US Government Printing Office.

Wrieden, W. L., Barton, K. L., Armstrong, J., McNeill, G. (2006). A review of food consumption and nutrient intakes from national surveys in Scotland: comparison to the Scottish dietary targets. Report commissioned by the Food Standards Agency Scotland.

Annex

Table A.1: Scotland – Marshallian price elasticity and expenditure elasticity by geo-demographic group and demand system 1/ 2/

	Rotterdam demand system										LA/AIDS Dynamic (short term elasticities)									
	Brown	Sig.	Premium Brown	Sig.	White	Sig.	Premium White	Sig.	Expendi-ture	Sig.	Brown	Sig.	Premium Brown	Sig.	White	Sig.	Premium White	Sig.	Expendi-ture	Sig.
Group A																				
Brown	-0.572	*	-0.174	*	-0.106		-0.125	*	0.977	*	-0.776	*	-0.174	*	-0.066		-0.143	*	1.159	*
Premium Brown	-0.231	*	-0.487	*	-0.236	*	-0.127	*	1.081	*	-0.138	*	-0.544	*	-0.159	*	0.063		0.904	*
White	-0.098		-0.161	*	-0.544	*	-0.180	*	0.983	*	0.007		-0.123	*	-0.669	*	-0.121	*	0.905	*
Premium White	-0.144	*	-0.101	*	-0.228	*	-0.493	*	0.967	*	-1.308	*	-1.093	*	-1.485	*	-1.613	*	1.931	*
Group B																				
Brown	-0.727	*	-0.148	*	-0.074		-0.098		1.046	*	-0.769	*	-0.125	*	-0.089		-0.121	*	1.104	*
Premium Brown	-0.212	*	-0.523	*	-0.257	*	-0.185	*	1.178	*	-0.110		-0.594	*	-0.056		-0.107		0.953	*
White	-0.018		-0.126	*	-0.541	*	-0.176	*	0.861	*	-0.001		-0.099	*	-0.542	*	-0.159	*	0.801	*
Premium White	-0.090		-0.132	*	-0.253	*	-0.476	*	0.951	*	-1.340	*	-1.105	*	-1.606	*	-1.579	*	1.762	*
Group C																				
Brown	-0.523	*	-0.122	*	-0.186	*	-0.118	*	0.950	*	-0.781	*	-0.107	*	-0.158	*	-0.160	*	1.206	*
Premium Brown	-0.187	*	-0.521	*	-0.200	*	-0.188	*	1.096	*	-0.014		-0.625	*	-0.049	*	-0.088		0.767	*
White	-0.194	*	-0.138	*	-0.596	*	-0.128	*	1.056	*	-0.096		-0.113	*	-0.676	*	-0.153		1.038	*
Premium White	-0.126	*	-0.140	*	-0.123	*	-0.501	*	0.890	*	-1.315	*	-1.074	*	-1.517	*	-1.556	*	2.226	*
Altogether																				
Brown	-0.539	*	-0.164	*	-0.170	*	-0.136	*	1.009	*	-0.779	*	-0.147	*	-0.117	*	-0.159	*	1.202	*
Premium Brown	-0.182	*	-0.469	*	-0.184	*	-0.125	*	0.959	*	-0.059		-0.568	*	-0.001		-0.083		0.766	*
White	-0.171	*	-0.165	*	-0.559	*	-0.178	*	1.073	*	-0.038		-0.115	*	-0.639	*	-0.153	*	0.945	*
Premium White	-0.141	*	-0.119	*	-0.193	*	-0.483	*	0.935	*	-1.332	*	-1.101	*	-1.540	*	-1.572	*	2.108	*

Source: Own elaboration based on Based on data provided by the Centre for Value Chain Research (VCR^2), Kent Business School.

Notes:

1/ "*" stands for statistically significant at 1 per cent.

2/ Elasticities read from left to right in the table.

Table A.2: Scotland – Hicksian price elasticity and expenditure elasticity by geo-demographic group and demand system 1/ 2/

	Rotterdam demand system								LA/AIDS Dynamic (short term elasticities)							
	Brown	Sig.	Premium Brown	Sig.	White	Sig.	Premium White	Sig.	Brown	Sig.	Premium Brown	Sig.	White	Sig.	Premium White	Sig.
Group A																
Brown	-0.315	*	0.045		0.177	*	0.094	*	-0.471	*	0.085	*	0.270	*	0.116	*
Premium Brown	0.053		-0.245	*	0.077		0.115	*	0.100	*	-0.342	*	0.266	*	0.098	*
White	0.160	*	0.059		-0.259	*	0.040		0.245	*	0.080	*	-0.407	*	0.082	
Premium White	0.110	*	0.115	*	0.051		-0.277	*	0.137	*	0.139	*	0.106		-0.382	*
Group B																
Brown	-0.450	*	0.083		0.230	*	0.137	*	-0.477	*	0.119	*	0.232	*	0.127	*
Premium Brown	0.100		-0.264	*	0.084		0.079		0.142	*	-0.384	*	0.220	*	0.108	*
White	0.210	*	0.064		-0.292	*	0.018		0.211	*	0.078	*	-0.310	*	0.021	
Premium White	0.161	*	0.078		0.023		-0.262	*	0.150	*	0.137	*	0.027		-0.313	*
Group C																
Brown	-0.272	*	0.085	*	0.096		0.092	*	-0.462	*	0.156	*	0.200	*	0.106	*
Premium Brown	0.103	*	-0.283	*	0.125	*	0.055		0.189	*	-0.458	*	0.179	*	0.082	*
White	0.085		0.092	*	-0.282	*	0.105	*	0.178	*	0.113	*	-0.368	*	0.077	*
Premium White	0.110	*	0.054		0.141	*	-0.305	*	0.127	*	0.113	*	0.103	*	-0.343	*
Altogether																
Brown	-0.273	*	0.060	*	0.124		0.089	*	-0.462	*	0.120	*	0.233	*	0.109	*
Premium Brown	0.071	*	-0.256	*	0.096	*	0.089	*	0.142	*	-0.398	*	0.222	*	0.088	*
White	0.112		0.073	*	-0.246	*	0.061	*	0.211	*	0.095	*	-0.364	*	0.058	
Premium White	0.105	*	0.089	*	0.080	*	-0.274	*	0.129	*	0.130	*	0.076		-0.334	*

Source: Own elaboration based on Based on data provided by the Centre for Value Chain Research (VCR^2), Kent Business School.
Notes:
1/ "*" stands for statistically significant at 1 per cent.
2/ Elasticities read from left to right in the table.