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AN ANALYSIS OF THE DEMAND FOR FRESH FRUIT IN SCOTLAND[1]

ANALIZA POPYTU NA ŚWIEŻE OWOCE W SZKOCJI

Key words: fresh fruits, demand analysis, Scotland, price change sensitivity, LA/AIDS model
Słowa kluczowe: świeże owoce, analiza popytu, Szkocja, wrażliwość na zmianę cen, model LA/AIDS

Abstract. The purpose of this study is to analyse the demand for fresh fruits in Scotland in order to provide evidence about their sensitivity to changes in prices and income. Six fresh fruit categories were studied using time series for the period 2006 to 2011: citrus, apples and pears, bananas, grapes, soft fruit, a residual category and other fruits. The series were constructed from a consumer panel that reports weekly purchases by approximately 1300 households and which allowed to construct thirteen periods of four weeks each year. The demand for fruits was modelled using a dynamic version of the Almost Ideal Demand System. Short term and long term conditional elasticities (Marshallian, Hicksian and expenditure) were estimated. The results from the long term elasticities indicated the demand for all the categories were sensitive to changes in prices. Grapes and soft fruits were the most price elastic fruits. In addition, whilst all the expenditure elasticities were positive, the elasticity of citrus was greater than one, apple and pears, bananas and grapes were approximately one and soft fruit and other fresh fruits were less than one.

Introduction

Developed countries are facing an obesity epidemic with an increasing number of overweight and obese adults and, what is particularly worrisome, the growing prevalence of childhood obesity. According to OECD statistics [*Health Data*… 2012], the rate of overweight and obese people in Germany, France, The Netherlands, the United Kingdom and the United States increased from 44 per cent to 53 per cent during the period 2000 to 2010. In the United Kingdom, the high prevalence of overweight and obese adults is indeed alarming, with national averages of over 67 per cent in males and 63 per cent in females, when considering ages above 15 [*The WHO*… 2010].

Within the UK, Scotland has one of the worst overweight and obesity records, with 68 per cent of males and 62 per cent of females being overweight or obese. According to the Scottish health survey [*Overweight and Obesity*… 2010], Scotland has one of the highest rates of obesity in all the OECD and European countries with a prevalence of 29 per cent for females and 27 per cent for males. Furthermore, the rates for child obesity in Scotland are not less alarming, results from the Scottish health survey indicate that over 15 per cent of Scottish boys and almost 13 per cent of Scottish girls under the 16 year age are obese and 30 per cent of Scottish children are overweight [*Overweight and Obesity*… 2010].

The described situation has increased efforts to understand determinants of the quality of consumers' diets, particularly in deprived neighbourhoods [Cummins et al. 2009, Durham, Eales 2010, Weatherspoon et al. 2013], as consumption of a diet rich in fruit and vegetables may help prevent a range of diet-related health problems including cardiovascular diseases, cancer and strokes [Cummins et al. 2009]. Given the climate of economic recession and increase in food prices, an important point of study has been to analyse the sensitivity of fruit purchases to prices, particularly with the purpose of either finding out what the effect that rises in prices might have had on the purchases of fruits and vegetables or designing strategies (e.g., fat taxes) that would reallocate expenditure towards healthier products [Tiffin et al. 2011].

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The contribution of this paper is to analyse the demand for fresh fruits in Scotland in order to provide evidence about their sensitivity to changes in prices and income. Although, the most recent report estimating elasticities for the UK [Tiffin at al.2011] also considers price and expenditure elasticities for Scotland, these are for aggregated categories only (i.e., dairy and eggs, meat, fish, fruits and nuts, vegetables, fat and starches, and alcohol).

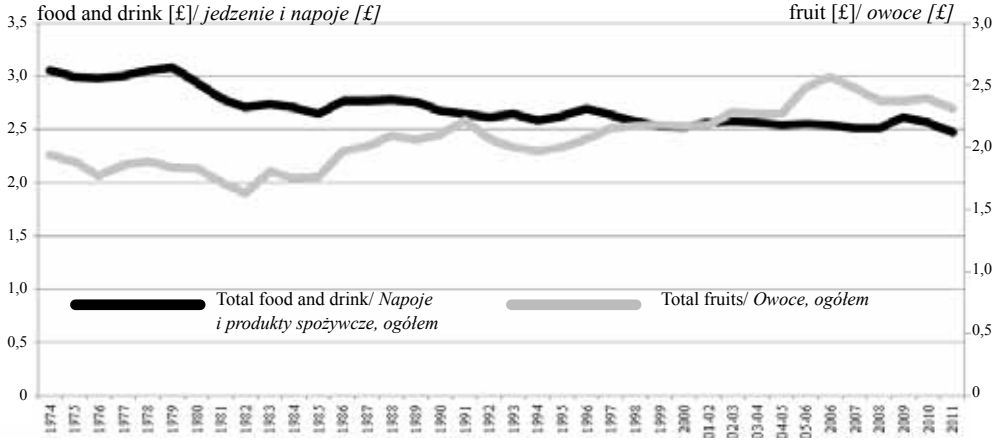
Moreover, from the point of view of sustainability (e.g., impact on food miles and local food consumption), it is useful to provide more disaggregated evidence about the demand for particular fruits. Hence, in this study six fresh fruit categories were studied using time series for the period 2006 to 2011, namely: citrus, apples and pears, bananas, grapes, soft fruit, a residual category, and other fruits.

The structure of the paper is as follows: firstly, we present an overview of the demand for fresh fruits in Scotland; secondly, we proceed with the empirical section, which, briefly presents the data used in the statistical analysis, followed by the methodology used; thirdly, the results are presented and discussed. Finally, conclusions are presented.

The demand for fresh fruit in the UK and Scotland

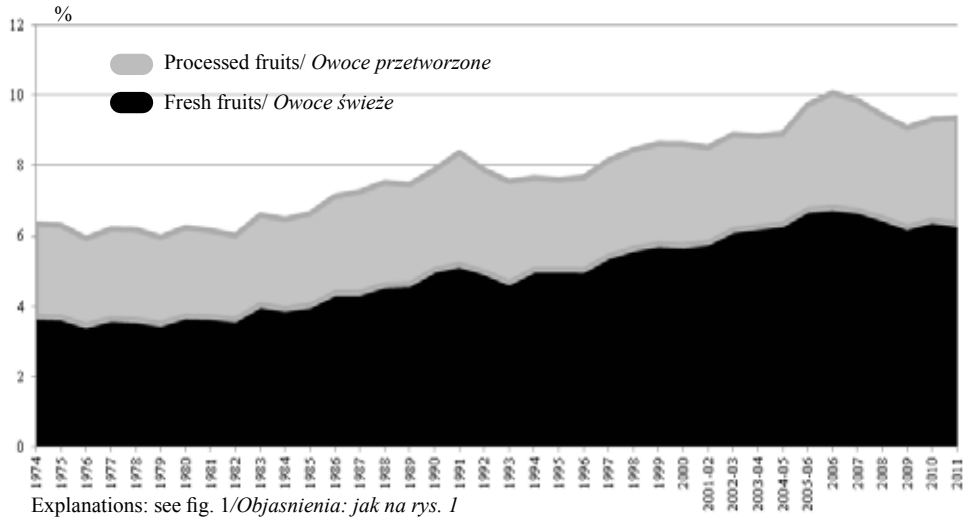
Figures 1 to 3 provide some trends on the demand for fruits in the UK and Scotland. They are based on data from Defra's Family Food [*Family food*… 2012]. Real expenditure on fruits (right axis of Fig.1) has been increasing since the 1980s, in contrast with real expenditure on food and drinks (left axis of Fig. 1) indicating a probable increasing interest in the category due to health reasons. However, the recession and prices seem to have stopped the growth in 2007.

Figure 2 shows that whilst the share of processed fruits in total food and drink expenditure in the UK remained relatively constant (2.7%), the share of fresh fruits increased steadily (from 3.7% in 1974 to 6.8% in 2006) until the 2007 food price, indicating a reallocation of expenditure within the category.



Explanations: total food and drink excludes alcoholic drinks and confectionery/*Objaśnienia: zestawienie napoje i produkty spożywcze ogółem nie obejmuje napojów alkoholowych ani wyrobów cukierniczych*

Figure 1. UK market – weekly real expenditure on food and drink and fruits (since January 1974 till 2011)
Rysunek 1. Rynek UK – faktyczne tygodniowe wydatki na jedzenie, napoje oraz owoce (od stycznia 1974 r. do 2011 r.)
Source: own elaboration based on Defra's *Family Food*... 2012
Źródło: opracowanie własne na podstawie Family Food... 2012



Explanations: see fig. 1/*Objasnienia: jak na rys. 1*

Figure 2. UK market – share of fresh and processed fruits in total food and drink expenditure
Rysunek 2. Rynek UK – udział świeżych i przetworzonych owoców w całkowitych wydatkach na jedzenie i napoje
Source: see fig. 1
Źródło: jak na rys. 1

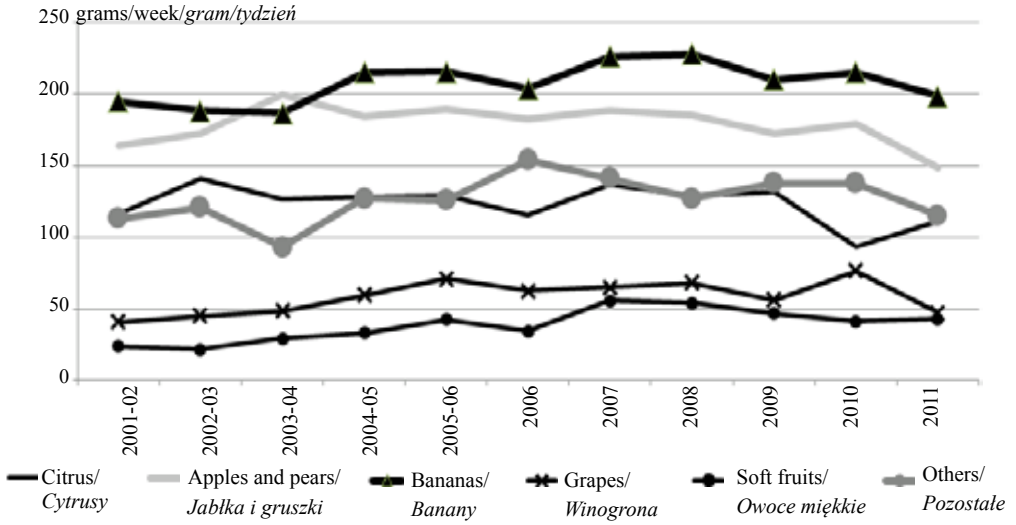


Figure 3. Scottish market – weekly per capita purchases by fresh fruits categories
Rysunek 3. Rynek szkocki – tygodniowe zakupy per capita według gatunków świeżych owoców
Source: see fig. 1
Źródło: jak na rys. 1

Figure 3 presents the evolution of the weekly per capita purchases of the studied categories in Scotland. In general, apart from soft fruit, none of the categories show a marked increasing trend. The purchases of some of the categories seemed to grow during part of the period (approximately from 2001 to 2006 or 2007) (e.g., bananas, grapes and other fruits); however, this growth was reverted during the subsequent years.

This section starts with a description of the data used, followed by a brief presentation of the methodology.

The data used in the analysis

The Kantar Worldpanel dataset for Scotland is a survey that contains weekly acquisition data of food and drink purchases for consumption at home for 3003 households covering the period January 2006 to December 2011. It is part of the UK Worldpanel, which also includes information for England and Wales (Northern Ireland is not sampled). It is important to note that the data do not include consumption out of the household; therefore the data cannot give a full overview of Scottish consumption. All participating households (i.e., panelists) register grocery purchases through the use of bar codes and scanners. However, they do not record non bar-coded items as Kantar seeks to make the task as simple as possible for them and improve compliance. These are collected by means of a combination of further research in the form of internet-based questionnaires and by the panelist sending their receipts which are matched to their purchases.

For the analysis in the paper, the time series were constructed considering that approximately each year had 13 periods of 4 weeks each (i.e., approximately monthly). This implied a total of 78 observations. The survey also comprises population weights, which allow the expansion of the information to represent the entire Scottish population (except Shetland, where no information is collected).

For the study, six fresh fruit categories were considered, namely: citrus (oranges, tangerines and grapefruit), apples and pears, bananas, grapes, soft fruit (strawberries, raspberries, blackberries and blueberries), a residual category, and other fruits. Table 1 presents the descriptive statistics for the dataset.

Table 1. Descriptive statistics
Tabela 1. Statystyki opisowe

Variable/*Zmienna*	Observations/ *Obserwacje*	Mean/ *Średnia*	Standard deviation/ *Odchylenie standardowe*	Variance/ *Wariancja*	Min/ *Minimum*	Max/ *Maksimum*	Coefficient of variation/ *Współczynnik zmienności*
Expenditure shares/*Udział w wydatkach*							
Citrus/*Cytrusy*	78	0.097	0.036	0.001	0.032	0.190	0.369
Apples and pears/ *Jabłka i gruszki*	78	0.298	0.024	0.001	0.252	0.371	0.081
Bananas/*Banany*	78	0.281	0.027	0.001	0.211	0.349	0.095
Grapes/*Winogrona*	78	0.237	0.023	0.001	0.176	0.286	0.098
Soft fruits/*Owoce miękkie*	78	0.051	0.017	0.000	0.017	0.096	0.338
Other fruits/*Inne owoce*	78	0.037	0.040	0.002	0.000	0.148	1.076
Per capita consumption [kg/period]/*Konsumpcja per capita [kg/okres]*							
Citrus/*Cytrusy*	78	0.18	0.07	0.01	0.07	0.37	0.39
Apples and pears/ *Jabłka i gruszki*	78	0.62	0.06	0.00	0.49	0.75	0.09
Bananas/*Banany*	78	0.98	0.09	0.01	0.71	1.11	0.09
Grapes/*Winogrona*	78	0.28	0.05	0.00	0.19	0.39	0.18
Soft fruits/*Owoce miękkie*	78	0.02	0.01	0.00	0.00	0.04	0.51
Other fruits/*Inne owoce*	78	0.02	0.03	0.00	0.00	0.11	1.28
Prices/*Cena [£/kg]*							
Citrus/*Cytrusy*	78	1.55	0.21	0.04	1.15	2.06	0.14
Apples and pears/ *Jabłka i gruszki*	78	1.40	0.10	0.01	1.14	1.59	0.07
Bananas/*Banany*	78	0.84	0.06	0.00	0.68	1.01	0.08
Grapes/*Winogrona*	78	2.52	0.46	0.21	1.79	3.62	0.18
Soft fruits/*Owoce miękkie*	78	9.92	2.07	4.30	6.00	16.97	0.21
Other fruits/*Inne owoce*	78	6.67	3.34	11.13	2.30	21.20	0.50

Source: own study based on Kantar Worldpanel data
Źródło: opracowanie własne na podstawie danych Kantar Worldpanel

The model

The demand system used in this paper is the dynamic version of the linearized version of the almost ideal demand system (LA/AIDS model), which can be found, for instance, in the analysis of food demand in Nordic Countries [Edgerton et al. 1996] or for the demand of fish in Great Britain [Fousekis, Revell 2005]. The reason for using a dynamic version of the LA/AIDS model and not a static one is that the results from the estimation of the latter normally show significant autocorrelation and although this can be overcome by correcting the problem, it may also imply the need to use a dynamic model which takes into account many factors present in the time series such as habit, persistence, imperfect information and incorrect expectation, which often cause the consumer to be out of equilibrium until full adjustment takes place [Anderson, Blundell 1984].

In the dynamic LA/AIDS model the share equations are given by (1):

$$\omega_{i,t} = \alpha_0 + \sum_{j=1}^{n} \phi_j \omega_{j,t-1} + \sum_{j=1}^{k} \alpha_{ij} \cdot \log\left(P_{j,t}\right) + \alpha_{ik+1} \cdot \log\left(\frac{E}{P}\right)_t + \mu_{i,t} \tag{1}$$

Where $\omega_{i,t} = \frac{P_{i,t} \cdot Q_{i,t}}{E_t}$ is the expenditure (E) share of the sub-category i within the category in period *t*, $P_{i,t}$ denotes the price of the i sub-category in period *t*. *P* is the Stone price index defined as $\log(P) = \sum_{i=1}^{k} \omega_i \cdot \log(P_i)$. Model (1), needs to satisfy a number of constraints in order to be consistent with the economic theory. These are given in (2):

$$\begin{gathered} \sum_{i=1}^{k} \alpha_{ik+1} = 1; \sum_{i=1}^{k} \alpha_{ij} = 0 \ (\text{Adding} - \text{up}) \\ \sum_{j=1}^{k} \alpha_{ij} = 0 \ (\text{Homogeneity}) \\ \alpha_{ij} = \alpha_{ij} \ (\text{Symmetry}) \end{gathered} \tag{2}$$

In addition to the above restrictions, for identification purposes the model requires additional constraints. In this paper, we follow Edgerton et al. (1996) and use $\sum_{j=1}^{n} \phi_j = 0$.

The Marshallian elasticities, expenditure elasticity and Hicksian elasticities are given by (3) and (4) and the long term elasticities can be estimated by computing the steady-state version of the model (i.e., when $\omega_{i,t} = \omega_{j,t} - 1$) and the same elasticity formulas. The Marshallian (i.e., uncompensated) elasticities are given by $\varepsilon_{i,i}$ (own price elasticity), $\varepsilon_{i,j}$ (cross price elasticity) and η_i (expenditure elasticity) in (3):

$$\begin{aligned} \varepsilon_{ii} &= -1 + \frac{\alpha_{ii}}{\omega_i} - \alpha_{ik+1} \\ \varepsilon_{ij} &= \frac{\alpha_{ij}}{\omega_i} - \alpha_{ik+1} \frac{\omega_j}{\omega_i} \\ \eta_i &= 1 + \frac{\alpha_{ik+1}}{\omega_i} \end{aligned} \tag{3}$$

The own ($\widetilde{\varepsilon}_{ii}$) and cross price Hicksian (i.e., compensated) elasticities ($\widetilde{\varepsilon}_{ij}$) are given by (4)

$$\begin{aligned} \widetilde{\varepsilon}_{ii} &= -1 + \frac{\alpha_{ii}}{\omega_i} - \omega_i \\ \widetilde{\varepsilon}_{ij} &= \frac{\alpha_{ij}}{\omega_i} + \omega_j \end{aligned} \tag{4}$$

Once the model (1) has been estimated, it is possible to compute the long term parameters of the model, which correspond to the steady state solution of the model (i.e.,) and to apply formulas (3) to (4) to compute the long term elasticities. The model was estimated using Iterative Seemingly Unrelated Regressions (SURE). Due to space constraints estimation results are not presented in this paper but only the resulting elasticities. The econometric estimations are available from the authors upon request.

Results and discussion

Table 2 presents short and long term Marshallian elasticities and expenditure elasticities. The own price elasticities, i.e., the bordered diagonal elements in the table elasticity matrix, show that four out of six elasticities are between zero and one in absolute value (i.e., inelastic), except the cases of grapes and soft fruit, which are greater than one (i.e., elastic). These results indicate that price movements are of importance for the demand of fruits.

The fact that the elasticity for soft fruit is greater than one is of some importance for Scotland because soft fruit can be considered the fruit flagship of Scotland, whilst all the other fruits are mostly brought from the rest of the UK (mostly England) or from abroad.

In addition, whilst all the expenditure elasticities were positive, confirming that all are normal goods, the elasticity of citrus was found greater than one, the elasticities for apple and pears, bananas and grapes were approximately one, and the elasticities of soft fruit and other fresh fruits were less than one. This would imply that an increase in the expenditure for fresh fruit would more than proportionally be allocated to citrus and less to soft fruits.

Table 2. Results from the AIDS dynamic model: short and long term marshallian elasticities and expenditure elasticities

Tabela 2. Wyniki według modelu dynamicznego AIDS: długo- i krótkoterminowa elastyczność według Marshalla oraz elastyczność wydatków

Demands/*Popyt*	Marshallian elasticities/ *Elastyczność popytu według Marshalla*						Expenditure elasticities/ *Wydatki*
	citrus/ *cytrusy*	apples and pears/ *jabłka i gruszki*	bananas/ *banany*	grapes/ *winogrona*	soft fruits/ *owoce miękkie*	other fruits/ *pozostałe owoce*	
Short term/*Krótkoterminowa*							
Citrus/*Cytrusy*	-0.899*	-0.028	-0.424*	0.021	0.026	-0.031	1.336*
Apples and pears/ *Jabłka i gruszki*	0.026	-0.734*	-0.265*	0.004*	-0.005*	-0.001*	0.975*
Bananas/*Banany*	-0.110*	-0.278*	-0.578*	-0.033*	0.020*	0.013*	0.965*
Grapes/*Winogrona*	0.035*	-0.023*	-0.068*	-1.032*	0.006*	0.014*	1.068*
Soft fruits/*Owoce miękkie*	0.089*	-0.015*	0.123	0.048	-1.022*	-0.140*	0.537*
Other fruits/*Inne owoce*	0.099*	-0.105*	0.335*	0.258	-0.241*	-0.913*	0.618
Long term/*Długoterminowa*							
Citrus/*Cytrusy*	-0.908*	-0.020*	-0.512*	0.031*	0.018*	-0.011*	1.403*
Apples and pears/ *Jabłka i gruszki*	0.033*	-0.384*	-0.617*	0.024*	0.000*	-0.020*	0.964*
Bananas/*Banany*	-0.134*	-0.267*	-0.600*	-0.040*	0.028*	0.017*	0.994*
Grapes/*Winogrona*	0.025*	-0.426*	0.345*	-1.060*	0.004*	0.034*	1.077*
Soft fruits/*Owoce miękkie*	0.259*	-0.794*	1.022*	0.116*	-1.044*	-0.164*	0.604*
Other fruits/*Inne owoce*	0.053*	-0.909*	0.840*	0.176*	-0.212*	-0.850*	0.901*

* indicates statistically at 5%/*statystycznie wskazuje na 5%*

Source: own study based on Kantar Worldpanel data

Źródło: opracowanie własne na podstawie danych Kantar Worldpanel

Table 3. Results from the AIDS dynamic model: Short and long term Hicksian elasticities
Tabela 3. Wyniki według modelu dynamiki AIDS: krótko- i długofalowa elastyczność Hicksiana

Demands/*Popyt*	Hicksian elasticities/*Elastyczność popytu wg Hicksiana*					
	citrus/ *cytrusy*	apples and pears/ *jabłka i gruszki*	bananas/ *banany*	grapes/ *winogrona*	soft fruits/ *owoce miękkie*	other fruits/ *pozostałe owoce*
Short term/*Króterminowa elastyczność*						
Citrus/*Cytrusy*	**-0.770***	0.370*	-0.049	0.337*	0.093*	0.018
Apples and pears/*Jabłka i gruszki*	0.120*	**-0.444***	0.009*	0.234*	0.044*	0.036*
Bananas/*Banany*	-0.017*	0.010*	**-0.306***	0.196*	0.069*	0.049*
Grapes/*Winogrona*	0.138*	0.295*	0.232*	**-0.779***	0.060*	0.054*
Soft fruits/*Owoce miękkie*	0.178*	0.261*	0.384*	0.281*	**-0.988***	-0.102*
Other fruits/*Inne owoce*	0.048	0.286*	0.369*	0.344*	-0.157*	**-1.036***
Long term/*Długoterminowa elastyczność*						
Citrus/*Cytrusy*	**-0.772***	0.398*	-0.118*	0.363*	0.089*	0.041*
Apples and pears/*Jabłka i gruszki*	0.126*	**-0.097***	-0.346*	0.252*	0.048*	0.016*
Bananas/*Banany*	-0.037*	0.030*	**-0.320***	0.196*	0.078*	0.054*
Grapes/*Winogrona*	0.129*	-0.105*	0.648*	**-0.805***	0.059*	0.074*
Soft fruits/*Owoce miękkie*	0.318*	-0.614*	1.192*	0.259*	**-0.885***	-0.141*
Other fruits/*Inne owoce*	0.140*	-0.641*	1.094*	0.390*	-0.166*	**-1.109***

Explanation and source: see tab. 2
Objaśnienia i źródło: jak w tab. 2

Substitution and complementary relationships due to changes in price are better discussed based on the Hicksian elasticities, which are presented in Table 3 (although note that the full effect of a change in prices is given by the Marshallian elasticities, which not only incorporate the substitution effect but also the income effect generated by a change in prices).

Focusing only on long term elasticities, Table 3 indicates Hicksian own price elasticities that are similar to Marshallian ones, indicating a relatively small income effect.

In terms of cross price elasticities (a negative sign indicates a relationship of complementarity and a positive of substitution), the results seem to indicate that citrus are bought together (i.e., they are complementary) to apples and pears, and bananas and they slightly compete with soft fruit and grapes (both elasticities are economically very low).

The demand for apples and pears tend to compete mostly with bananas. However, bananas seem to be complementary to citrus, apples and pear, and grapes (a popularity which is clearly reflected in the fact that it is the fruit with the greatest per capita consumption as shown in Table 1 and in Figure 3). Grapes compete with most of the fruits (mostly with bananas) except with apples and pears. The demand for soft fruits seems to be strongly complementary with apples and pears and the other fruits and competes with citrus, bananas and grapes.

The above results, particularly as regards price elasticities, contrast with those recently estimated for the UK [Tiffin et al. 2011], which show that when considering Hicksian elasticities all the fruit categories are substitute, and they are complementary when Marshallian elasticities are observed, implying high income effects. However, there are several methodological differences that might explain, at least partially, the differences (in addition to the differences in geographic areas), such as the fact that they are working with cross section samples, whilst the data in this paper are the time series for the 2006 to 2011 period, which is characterised by a high variability of prices.

Conclusions

The purpose of this study has been to analyse the demand for fresh fruits in Scotland in order to provide evidence about their sensitivity to changes in prices and income. This information is useful as evidence when designing campaigns to increase the consumption of healthy food.

The data show the diversity of fruits purchased in Scotland, well beyond of what is produced in the country. Six fresh fruit categories (i.e., citrus, apples and pears, bananas, grapes, soft fruit, a residual category and other fruits) were studied using time series constructed from a consumer panel that reports weekly purchases of approximately 1300 households and which covered the period 2006 to 2011.

The results from long term elasticities indicated the demand for all the categories were sensitive to changes in prices and expenditure/income. Grapes and soft fruits were the most price elastic, i.e., sensitive to price changes. In addition, whilst all expenditure elasticities were positive, the elasticity of citrus was greater than one, apple and pears, bananas and grapes were approximately one and soft fruit and other fresh fruits were less than one.

The substitution and complementary effects were also interesting, showing that a product of importance for Scotland, i.e., soft fruits, seem to compete with products from abroad (citrus, bananas and grapes) and be complementary with the category from the rest of the UK (apples and pears). This, to some degree, implies that the reduction in the price of soft fruit would increase the sales of the product, increase the demand for UK produce (apples and pears) and reduce produce from abroad (e.g., citrus).

It should be noted that further research is planned by considering the effect of prices and income on specific areas of Scotland, particularly in deprived areas.

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Streszczenie

Badano popyt na świeże owoce w Szkocji w celu określenia zachowań konsumentów względem zmian cen owoców oraz dochodów. Przeanalizowano ceny sześciu grup świeżych owoców w latach 2006-2011: cytrusów, jabłek i gruszek, bananów, winogron, owoców miękkich oraz pozostałycyh. Bazowano na danych dotyczących tygodniowych wydatków około 1300 gospodarstw domowych, dzięki czemu możliwe było stworzenie trzynastu czterotygodniowych przedziałów czasowych dla każdego roku. Popyt na owoce obliczany był za pomocą dynamicznej wersji Almost Ideal Demand System. Oszacowano krótką i długoterminową elastyczność zależną (Marshallian, Hicksian i wydatki). Wyniki długoterminowej elastyczności wykazały, że popyt zależał od zmian cenowych we wszystkich kategoriach owoców. Winogrona oraz owoce miękkie miały najbardziej elastyczne ceny. Oszacowana elastyczność wydatków była dodatnia i dla cytrusów była większa niż jeden, dla jabłek i gruszek, bananów i winogron wynosiła około jeden, a dla owoców miękkich i pozostałych świeżych owoców była mniejsza niż jeden.

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