

Scotland's Rural College

## Demand for fresh fruits in Scotland: potential implications from Brexit

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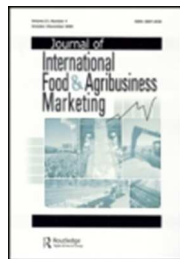
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**The Demand for Fresh Fruits in Scotland: Potential Implications from Brexit**

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## The Demand for Fresh Fruits in Scotland: Potential Implications from Brexit

### Abstract

The need to improve the quality of the diet of Scottish consumers has increased the interest and efforts to understand the determinants of fruit and vegetables, as they may help to prevent a range of diet-related health problems. The purpose of this paper is to analyse the demand for fresh fruit in Scotland, with particular emphasis on the contribution of Mediterranean areas. A further motivation comes from depreciation of the GB Pound with respect to the Euro and the US Dollar following the United Kingdom's decision to exit the European Union (Brexit). This is particularly important in the case of fruit because about 80 per cent of the fruit consumed in the UK is of foreign origin and therefore depreciation of the currency may increase the price of imported fruit. The demand for fruit was modelled as a two-stage budget in order to include fruit origin. The results indicate that the demand for fresh fruit is sensitive to changes in prices and the pass-through of GBP depreciation may impact negatively on the Scottish demand for fruit and the country's nutrition goals.

**Keywords:** Fresh fruits, Demand analysis, Scotland, Mediterranean fruits, Brexit.

### 1. Introduction

Developed countries are facing an obesity epidemic with increasing numbers of overweight and obese adults and, particularly worrisome, the growing prevalence of childhood obesity. According to OECD statistics (OECD 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 covering 2000 to 2010. In the United Kingdom, the high prevalence of overweight and obesity in 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 years old (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 (Scottish Government, 2009, 2010 and 2014), Scotland has one of the highest rates of obesity in all the OECD and the 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 age of 16 are obese and 30 per cent of Scottish children are overweight (ibid).

The described situation has increased the efforts to understand the quality of consumers' diets as regards its content on fruits and vegetables, particularly in deprived neighbourhoods (e.g., Wrieden, 1996; Cox et al., 1996; Cummins et al., 2009; Cummins et al., 2010; Anderson and Dowler, 2010; Weatherspoon et al., 2013; Revoreda-Giha, and Florkowski, 2013), since consumption of a diet rich in fruit and vegetables may help prevent a range of diet-related health problems including cardio-vascular diseases, cancer and stroke.

On June 23rd 2016 the United Kingdom (UK) voters chose to exit the European Union (EU), by 52 per cent to 48 per cent. Whilst the effects of the UK's decision to exit the European Union (Brexit) are still to be felt, the immediate impact has been a depreciation of the GB

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2  
3 Pound with respect to the Euro and the US Dollar (the pound has fallen over 11 per cent  
4 against a basket of currencies since Brexit). This is particularly important in the case of fruit  
5 because about 80 per cent of the fruit in the UK is of foreign origin, and therefore,  
6 depreciation of the currency may increase the price of imported fruit and also the cost of  
7 imported inputs such as fertilisers for domestic production.  
8

9  
10 Thus, the contribution of this paper is to analyse the demand for fresh fruit in Scotland  
11 considering the origin in order to provide evidence about their sensitivity to changes in prices.  
12 Since, from a sustainability point of view (e.g., impact on food miles and local food  
13 consumption, e.g., Revoredo-Giha, 2011) it is useful to provide more disaggregated evidence  
14 about the demand for particular fruits, six fresh fruit categories were considered using time  
15 series for the period 2006 to 2014, namely: apples and pears, bananas, citrus, grapes, soft fruit  
16 and tropical fruits.  
17

18  
19 The structure of the paper is as follows: first, we present an overview of the demand for fresh  
20 fruit in Scotland; second, we proceed with the empirical section, which briefly presents the  
21 data used in the statistical analysis, followed by the methodology used; third, the results are  
22 presented and discussed. Finally, conclusions are presented.  
23

## 24 **2. The demand for fresh fruit in the UK and Scotland**

25  
26 The Scottish diet has traditionally been described as low in cereals, fruit and vegetables and  
27 rich in confectionery, fat-enriched meat products, sweet and salty snacks, baked goods of  
28 inappropriate composition accompanied by excessive amounts of sugary drinks and alcohol  
29 (Marshall et al., 1995). Therefore, increasing the consumption of fruit and vegetables has been  
30 part of every campaign to improve the Scottish diet (Scottish Government, 2009, 2014).  
31

32  
33 The described diet patterns have motivated a significant amount of research destined to  
34 describe and understand the determinants of the quality of consumers' diets, particularly in  
35 deprived neighbourhoods (e.g., Wrieden, 1996; Cox et al., 1996; Cummins et al., 2009;  
36 Cummins et al., 2010; Anderson and Dowler, 2010; Revoredo-Giha, 2011; Weatherspoon et  
37 al., 2013; Revoredo-Giha, and Florkowski, 2013).  
38

39  
40 A number of economic, social, psychological and cultural factors have been pointed out as  
41 important determinants of the consumption of fruit (and vegetables as they normally have  
42 been studied together). In the west of Scotland, for example, more healthy dietary patterns  
43 have been found among women (compared to men), higher income households and non-  
44 manual household (Anderson and Dowler, 2010). Availability and access also play some role  
45 and the lack of fresh fruit and vegetable markets has been highlighted in some areas in  
46 Scotland (Marshall et al., 1995). Seasonal factors have also been mentioned as affecting  
47 consumption (Revoredo-Giha, 2011).  
48

49  
50 The lower socio-economic grades, the under 35s, the over 55s and Scottish males, have been  
51 pointed out as groups unlikely to consume adequate quantities of fruit and vegetables.  
52 Moreover, the cost of adopting a healthy diet is often cited as a major problem for low income  
53 families, although sustained decreases have not always translated into increases in the  
54 consumption of fruits (Anderson and Dowler, 2010).  
55

56  
57 Figures 1 to 3 provide some trends in the demand for fruit in the UK and Scotland. They are  
58 based on data from Defra's Family Food (Defra, 2016). Figure 1 presents the average weekly  
59  
60

per capita consumption of fruit in the UK and Scotland. Despite promotion efforts, the consumption of fruit in Scotland remains below WHO recommendations and slightly below the UK average (WHO, 1989). Moreover, neither the UK nor Scotland indicate that the target of 400g per day has been reached.

**Figure 1 here**

Figure 2 shows the average weekly per capita consumption of fresh fruit in Scotland. The consumption of fresh fruit has remained approximately constant, although it has seen a slight decrease since 2007. Moreover since 2011 the consumption of fresh fruit in Scotland is again below the UK's average.

**Figure 2 here**

Figure 3 presents the evolution of the weekly per capita purchases of the studied categories in Scotland. In general, except for 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 reverted during the subsequent years.

**Figure 3 here**

### **3. Empirical analysis**

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

#### **3.1 The data used in the analysis**

The Kantar Worldpanel dataset for Scotland (part of the UK Worldpanel) is a survey that contains weekly purchases of food and drink purchases for consumption at home for 3,003 households covering the period 2006 to 2014.

Households remain in the survey for a maximum period of three years. On average, the number of households that is available per week is 1,567 with a standard deviation of 73. Purchases are accompanied by a weight number that allows them to be expanded to the Scottish population (aggregated series). Kantar organises the purchase year in 13 months of 4 weeks each. For the period of analysis, that gave a total of 117 observations.

Six fresh fruit categories were studied using time series for the period 2006 to 2014: apples and pears, bananas, citrus, grapes, soft fruits and tropical fruits. The origins were aggregated as: UK, Mediterranean (ME), Other European (OE), America and Caribbean (AC), Africa (AF), Oceania (OC), and Other (not specified). Since the information has relatively short (monthly) periodicity, one has to consider seasonality in the series. This creates a problem due to the number of available observations for the analysis. In addition, the seasonality parameters plus the demand model parameters (considering fruits and their origins) is beyond the 117 available observations.

**Table 1 here**

### 3.2 The model

The demand system used in this paper is the linearised version of the almost ideal demand system (LA/AIDS model)<sup>1</sup>. The reason for using this model was due to the fact that evidence indicates that the Engel curves are approximately linear. In the LA/AIDS model, the share equations are given by (1):

$$(1) \quad \omega_{i,t} = \alpha_{0it} + \sum_{j=1}^k \alpha_{ij} \cdot \log(P_{j,t}) + \alpha_{ik+1} \cdot \log\left(\frac{E}{P}\right)_t + \mu_{i,t}$$

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  $\log(P) = \sum_{i=1}^k \omega_i \cdot \log(P_i)$ . Note that the intercept  $\alpha_{0i,t}$  is variable; this is due to the fact that it includes deterministic variables such as seasonal dummies and trend variables for each one of the considered products. In order to obtain a consistent estimation of the elasticities, the method by Alston et al. (2001) was followed, although slightly modified due to the lack of degrees of freedom.

$$(2) \quad \omega_i = \frac{P_i c_i}{E} + \frac{E^*}{E} \left( \alpha_i + \sum_{j=1}^k \alpha_{ij} \cdot \log(P_j) + \alpha_{ik+1} \cdot \log\left(\frac{E^*}{P}\right) \right) + \mu_i$$

where  $E^* = E - \sum_{i=1}^k P_i c_i$  and  $c_i = \lambda_0 + \sum_{j=1}^{11} \lambda_j d_j + \lambda_{\text{trend}} \cdot t$ . The parameters  $\lambda_0$ ,  $\lambda_j$  and  $\lambda_{\text{trend}}$

were estimated from the regression  $\omega_i = \lambda_0 + \sum_{j=1}^{11} \lambda_j d_j + \lambda_{\text{trend}} \cdot t$  and then the expenditure shares were redefined as in (3) (where '^' stands for estimate):

$$(3) \quad \omega^*_i = \frac{E}{E^*} \left( \omega_i - \frac{P_i \hat{c}_i}{E} \right)$$

The model then was redefined as in (4):

$$(4) \quad \omega^*_{i,t} = \alpha_{0i} + \sum_{j=1}^k \alpha_{ij} \cdot \log(P_{j,t}) + \alpha_{ik+1} \cdot \log\left(\frac{E^*}{P}\right)_t + \mu_{i,t}$$

Model (4) needs to satisfy a number of constraints in order to be consistent with the economic theory. These are given in (5):

<sup>1</sup> A similar model was used for an analysis of the food demand in Scotland by Mainland (1998).

$$\begin{aligned}
 & \sum_{i=1}^k \alpha_{ik+1} = 1; \sum_{i=1}^k \alpha_{ij} = 0 \text{ (Adding-up)} \\
 (5) \quad & \sum_{j=1}^k \alpha_{ij} = 0 \text{ (Homogeneity)} \\
 & \alpha_{ij} = \alpha_{ji} \text{ (Symmetry)}
 \end{aligned}$$

The Marshallian elasticities, expenditure elasticity and Hicksian elasticities are given by (6) and (7). The Marshallian (i.e., uncompensated) elasticities are given by  $\varepsilon_{ii}$  (own price elasticity),  $\varepsilon_{ij}$  (cross-price elasticity) and  $\eta_i$  (expenditure elasticity):

$$\begin{aligned}
 \varepsilon_{ii} &= -1 + \frac{\alpha_{ii}}{\omega_i} - \alpha_{ik+1} \\
 (6) \quad \varepsilon_{ij} &= \frac{\alpha_{ij}}{\omega_i} - \alpha_{ik+1} \frac{\omega_j}{\omega_i} \\
 \eta_i &= 1 + \frac{\alpha_{ik+1}}{\omega_i}
 \end{aligned}$$

The own ( $\tilde{\varepsilon}_{ii}$ ) and cross-price Hicksian (i.e., compensated) elasticities ( $\tilde{\varepsilon}_{ij}$ ) are given by (7)

$$\begin{aligned}
 (7) \quad \tilde{\varepsilon}_{ii} &= -1 + \frac{\alpha_{ii}}{\omega_i} - \omega_i \\
 \tilde{\varepsilon}_{ij} &= \frac{\alpha_{ij}}{\omega_i} + \omega_j
 \end{aligned}$$

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.

In order to consider the different origins the following demand tree was applied, as shown in Figure 4.

**Figure 4 here**

In order to estimate the elasticities, the formulas of Carpentier and Guyomard (2001) were applied. They are based on the following diagram where G and H are the composite groups and there are respectively  $I_G$  and  $I_H$  groups in the second stage.

The unconditional Hicksian cross-price elasticity for commodity i that belongs to G with respect to the price of commodity j that belongs to H, and H is different to G, is given by (8):

$$(8) \quad \tilde{\Sigma}_{ij} = w_{(H)j} \cdot \tilde{\Sigma}_{GH} \cdot \eta_{(G)i} \cdot \eta_{(H)j}$$

where  $\tilde{\Sigma}_{ij}$  = unconditional Hicksian cross-price elasticity of commodity i (in G) with respect to the price of commodity j (in H),  $w_{(H)j}$  = share of commodity j within the expenditure of group H,  $\tilde{\Sigma}_{GH}$  = Hicksian cross-price elasticity of aggregated good G (1<sup>st</sup> stage),  $\eta_{(G)i}$  = expenditure elasticity of commodity i in the system G (2<sup>nd</sup> stage),  $\eta_{(H)j}$  = expenditure elasticity of commodity j in the system H (2<sup>nd</sup> stage)



The unconditional Hicksian cross-price elasticity for commodity  $i$  that belongs to  $G$  with respect to the price of commodity  $j$  that belongs to  $H$ , and  $H$  is different to  $G$ , is given by (9):

$$(9) \quad \tilde{\Sigma}_{ij} = \tilde{\varepsilon}_{ij} + w_{(G)j} \cdot \tilde{\Sigma}_{GG} \cdot \eta_{(G)i} \cdot \eta_{(G)j}$$

where  $\tilde{\Sigma}_{ij}$  = unconditional Hicksian cross-price elasticity of commodity  $i$  (in  $G$ ) with respect to the price of commodity  $j$  (in  $G$ ),  $\tilde{\varepsilon}_{ij}$  = Hicksian elasticity of commodity  $i$  with respect to price of  $j$  (2<sup>nd</sup> stage),  $w_{(G)j}$  = share of commodity  $j$  within the expenditure of group  $G$  (2<sup>nd</sup> stage),  $\tilde{\Sigma}_{GH}$  = Hicksian cross-price elasticity of aggregated good  $G$  (1<sup>st</sup> stage).  $\eta_{(G)i}$  = expenditure elasticity of commodity  $i$  in the system  $G$  (2<sup>nd</sup> stage),  $\eta_{(G)j}$  = expenditure elasticity of commodity  $j$  in the system  $G$  (2<sup>nd</sup> stage).

The Marshallian Unconditional cross-price elasticity of commodity in different groups is given by (10)

$$(10) \quad \Sigma_{ij} = w_{(H)j} \cdot (\Sigma_{GH}) \cdot \eta_{(G)i} \cdot \eta_{(H)j} + w_{(H)j} \cdot w_H \cdot \eta_G \cdot \eta_{(G)i} \cdot (\eta_{(H)j} - 1)$$

where  $\Sigma_{ij}$  = unconditional Marshallian cross-price elasticity of commodity  $i$  (in  $G$ ) with respect to the price of commodity  $j$  (in  $H$ ),  $\Sigma_{GH}$  = Marshallian crossprice elasticity of good  $G$  with respect to price of good  $H$  (1<sup>st</sup> stage),  $\varepsilon_{ij}$  = Marshallian elasticity of commodity  $i$  with respect to price of  $j$  (2<sup>nd</sup> stage),

The Unconditional Marshallian elasticities for two commodities in the same food group is given by (11):

$$(11) \quad \Sigma_{ij} = \varepsilon_{ij} + w_{(G)j} \cdot \left( \frac{1}{\eta_{(G)j}} + \Sigma_{GG} \right) \cdot \eta_{(G)i} \cdot \eta_{(G)j} + w_{(G)j} \cdot w_G \cdot \eta_G \cdot \eta_{(G)i} \cdot (\eta_{(G)j} - 1)$$

where  $\Sigma_{ij}$  = Unconditional Marshallian cross-price elasticity of commodity  $i$  (in  $G$ ) with respect to the price of commodity  $j$  (in  $G$ ),  $\varepsilon_{ij}$  = Marshallian elasticity of commodity  $i$  with respect to price of  $j$  (2<sup>nd</sup> stage).

Finally, the unconditional expenditure elasticities are given by (12)

$$(12) \quad \eta_i = \eta_{(G)i} \cdot \eta_G$$

where  $\eta_i$  = Unconditional expenditure elasticity of commodity  $i$ ,  $\eta_{(G)i}$  = expenditure elasticity of commodity  $i$  in the system  $G$  (2<sup>nd</sup> stage),  $\eta_G$  = expenditure elasticity of good  $G$  (1<sup>st</sup> stage)

### 3.3 Results and discussion



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3 This section presents three results: first, it shows the importance of the Mediterranean area on  
4 the purchases of fruit in Scotland. Second, it presents the Marshallian, Hicksian and  
5 expenditure elasticities from the demand estimation. Third, it considers the result of a  
6 simulation that increases the price of all the fruit of foreign origin due to the depreciation of  
7 the UK currency.  
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9

### 10 **Importance of the Mediterranean area on Scotland's fruit purchases**

11  
12 The purpose of this section is to provide an overview of the market share trends of the  
13 sales/purchases of Mediterranean fruit in Scotland. Note that it excludes bananas due to the  
14 fact that there are no imports from the Mediterranean areas. Figure 5 shows that since 2006  
15 the share of Mediterranean apples and pears (mostly France and Italy) has remained  
16 approximately constant at around 20 per cent of the total sales.  
17  
18

19 **Figure 5 here**

20  
21 As shown in Figure 6, with visible seasonality, the Mediterranean area's market share  
22 fluctuates between 40 per cent to 68 per cent of the total purchases of citrus in Scotland.  
23 Therefore, it is a key supplier of citrus.  
24  
25

26 **Figure 6 here**

27  
28 In contrast with apples and pears and citrus, as shown in Figure 7, the share of grapes from  
29 the Mediterranean area has decreased, particularly since 2012. This is due to the expansion of  
30 grapes from other origins such as South America (besides Chile) and also from South Africa.  
31  
32

33 **Figure 7 here**

34  
35 Soft fruits like apples and pears are an important domestically produced fruit in the UK  
36 (Figure 8). Although the share of UK fruit has remained approximately the same (with strong  
37 seasonality), the Mediterranean share has clearly been partially displaced by soft fruits from  
38 other origins, particularly South America.  
39  
40

41 **Figure 8 here**

42  
43 Figure 9 shows the market shares for tropical fruits. Similar to soft fruits, the share of  
44 Mediterranean tropical fruits has been decreasing over time.  
45  
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47 **Figure 9 here**

### 48 **Elasticities by fruit and origin**

49  
50 Table 2 presents the first stage of the Marshallian and expenditure elasticities, which provide  
51 information about the substitution of fruit categories and the impact of increases in  
52 expenditure for fruit on their demand. The own price elasticities, i.e., the bordered diagonal  
53 elements in the table elasticity matrix, show that all the six elasticities are between zero and  
54 one in absolute value (i.e., inelastic). These results indicate that price movements are of  
55 importance for the demand of fruits.  
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4 The fact that the elasticity for soft fruit is greater than one is of some importance for Scotland  
5 because soft fruit can be considered the fruit flagship of Scotland, whilst all other fruits are  
6 mostly brought from the rest of the UK (mostly England) or from abroad.  
7

8  
9 In addition, whilst all the expenditure elasticities were positive, confirming that all are normal  
10 goods, all the elasticities except for bananas were greater than one. This would imply that for  
11 most of the categories, an increase in the total expenditure for fresh fruit would more than  
12 proportionally increase the demand for all the fruits except for bananas.  
13

14 The Marshallian elasticities show very few statistically significant cross-price elasticities. One  
15 of the few significant cross-price elasticities is between apples and bananas, which indicates  
16 complementarity. Substitution and complementary relationships due to changes in price are  
17 better discussed based on the Hicksian elasticities, which are presented in Table 3 (although  
18 note that the full effect of a change in prices is given by the Marshallian elasticities, which not  
19 only incorporate the substitution effect but also the income effect generated by a change in  
20 prices). In contrast with the Marshallian elasticities, the Hicksian ones show that all  
21 significant relationships are of substitution. Moreover, no relationship seems to exist between  
22 apples and pears and bananas as stated by the Marshallian elasticities. The fact that the  
23 Hicksian elasticity between apples and pears and bananas is not statistically significant  
24 indicates that the complementarity was generated by the income effect generated by a price  
25 change.  
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28 **Table 2 here**

29  
30 **Table 3 here**

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34 Table 4 provides the Marshallian and expenditure elasticities for fruit categories from  
35 different origins. In addition to providing these elasticities, the purpose of Table 4 is to  
36 evaluate the potential impact of an increase in domestic prices of fruits of foreign origin due  
37 to a depreciation of the GB Pound.  
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39 **Table 4 here**  
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3 Figure 10 presents the change in prices of fruit up to January 2017. Although some of the  
4 prices show positive trends, these started well before the GBP depreciation after Brexit.  
5 Moreover, it should be expected that the pass-through of the depreciation to retail prices will  
6 take a while since retailers have the capacity to control (at least in the short term) how much  
7 of the increase in import prices is passed on to consumers.  
8

9  
10 **Figure 10 here**

11  
12 Finally, it is illustrative to consider the effect of an increase in the price of fruit of foreign  
13 origin by 10 per cent on the demand for fruit (Figure 11). The results clearly indicate that  
14 apart from a few exceptions, the demand for fruit decreases to around 10 per cent. It is  
15 interesting that although there is a favourable effect in the case of fruits of domestic origin,  
16 this is really minor and will not compensate for the decrease of fruit of foreign origin.  
17

18  
19 **Figure 11 here**

20  
21 Note that there are high chances that the price of fruit of domestic origin will not remain  
22 constant (as it is assumed in the above simulation) due to the fact that fruit's input costs may  
23 be affected by the currency depreciation.  
24

#### 25 **4. Conclusions**

26  
27 The purpose of this study has been to analyse the demand for fresh fruit in Scotland in order  
28 to provide evidence about its sensitivity to changes in prices and income. This information is  
29 useful as evidence when designing campaigns to increase the consumption of healthy food.  
30

31  
32 The data show the diversity of fruits purchased in Scotland, which is well beyond what is  
33 produced in the country. Six fresh fruit categories (i.e., apples and pears, bananas, citrus,  
34 grapes, soft fruit and a residual category, other fruits) were studied using time series  
35 constructed from a consumer panel that reports weekly purchases by approximately 1,300  
36 households, covering the period 2006 to 2014.  
37

38  
39 The results show the importance of Mediterranean fruit on the demand for fruit in Scotland.  
40 Of particular importance is citrus from the Mediterranean area. The shares of Mediterranean  
41 fruit have decreased particularly in grapes, soft fruits and tropical fruits. This is due to the  
42 interest of supermarkets to reduce their dependency on one supplier. In addition, all the  
43 expenditure elasticities were positive. Grapes and tropical fruits were the ones that showed the  
44 greatest impact of an increase in expenditure. They were followed by apples and pears and  
45 citrus. Soft fruits were only in the price inelastic category.  
46

47  
48 The results show the importance of Mediterranean fruits (and foreign fruits in general) in the  
49 Scottish diet. Given the decision of leaving the EU, it is key (if UK/Scotland want to maintain  
50 its consumption patterns) to establish trade agreements that allow to preserve the fruit  
51 availability at affordable prices because the UK is reliant on imports to satisfy high consumer  
52 demand, as well as out-of-season products.  
53

54  
55 The exact impact of the Brexit decision cannot be anticipated since it will depend on the  
56 decisions that the UK takes as regards free movement of goods, services and labour with the  
57 EU and the trade agreement established with other countries. Therefore, there are a high range  
58 of possibilities in trade terms that the UK can follow; they may imply increases in the  
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3 importing costs and also less smooth trade (if the UK adopts legislation that is different to the  
4 EU's).

5  
6 Although so far prices of fruit at the retail level have not shown an increase, they may do so if  
7 the depreciation of the GBP remains in the long term. Thus, the effect of an increase in the  
8 price of fruit of foreign origin clearly indicates that with few exceptions, the demand for fruit  
9 is bound to decrease. Moreover, although there is a favourable effect in the case of fruit of  
10 domestic origin, this is really minor and will not compensate for the decrease of fruit of  
11 foreign origin, which may have implications in terms of attaining nutritional goals.

12  
13  
14 In summary, in terms of food security, Brexit may bring up issues in terms of fruit availability  
15 (lower production or less expensive imports), which could imply higher fruit prices  
16 (affordability). This is particularly important for families with fewer economic resources,  
17 who have poorer dietary patterns.

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Table 1: Descriptive statistics

Variable	Observations	Mean	Standard deviation	Variance	Min	Max	Coefficient of variation
<b>Expenditure shares</b>							
Apples and pears	117	0.220	0.031	0.001	0.154	0.276	0.142
Bananas	117	0.155	0.022	0.000	0.102	0.206	0.139
Citrus	117	0.153	0.044	0.002	0.086	0.258	0.284
Grapes	117	0.143	0.024	0.001	0.086	0.185	0.171
Soft fruits	117	0.243	0.105	0.011	0.097	0.440	0.432
Tropical fruits	117	0.085	0.010	0.000	0.062	0.113	0.112
<b>Per capita consumption (kg/period)</b>							
Apples and pears	117	1.522	0.217	0.047	1.163	2.125	0.143
Bananas	117	0.842	0.053	0.003	0.675	1.014	0.063
Citrus	117	1.661	0.212	0.045	1.353	2.265	0.128
Grapes	117	2.777	0.563	0.316	1.789	3.827	0.203
Soft fruits	117	4.245	0.940	0.883	2.932	6.718	0.221
Tropical fruits	117	1.237	0.175	0.030	0.949	1.717	0.141
<b>Prices (£/kg)</b>							
Apples and pears	117	0.750	0.103	0.011	0.543	0.955	0.137
Bananas	117	0.944	0.093	0.009	0.658	1.113	0.099
Citrus	117	0.470	0.101	0.010	0.296	0.712	0.214
Grapes	117	0.270	0.047	0.002	0.186	0.387	0.174
Soft fruits	117	0.348	0.237	0.056	0.077	0.836	0.680
Tropical fruits	117	0.366	0.091	0.008	0.212	0.621	0.249

Source: Own elaboration based on Kantar Worldpanel data.

Table 2: Results from the AIDS model Marshallian and expenditure elasticities – stage 1

Demands	Marshallian elasticities						Expenditure elasticities
	Apples and pears	Bananas	Citrus	Grapes	Soft fruits	Tropical fruits	
Apples and pears	-0.847 *	-0.116 *	-0.063	-0.053	0.013	0.036	1.030 *
Bananas	-0.114 *	-0.618 *	-0.030	0.043	-0.037	-0.047	0.801 *
Citrus	-0.095	-0.069	-0.884 *	0.022	0.008	-0.032	1.051 *
Grapes	-0.077	0.014	0.030	-0.924 *	-0.029	-0.024	1.009 *
Soft fruits	0.008	-0.062	0.005	-0.027	-0.968 *	-0.002	1.028 *
Tropical fruits	0.079	-0.826 *	-0.065	-0.052	-0.023	-0.904 *	1.096 *

Source: Own elaboration based on Kantar Worldpanel data.

Notes: \* indicates statistical significance at 5 per cent.



Table 3: Results from the AIDS model Hicksian elasticities – stage 1

Demands	Hicksian elasticities					
	Apples and pears	Bananas	Citrus	Grapes	Soft fruits	Tropical fruits
Apples and pears	-0.621 *	0.044	0.095 *	0.094 *	0.263 *	0.124 *
Bananas	0.063	-0.493 *	0.093 *	0.157 *	0.158 *	0.022 *
Citrus	0.136 *	0.094 *	-0.723 *	0.172 *	0.263 *	0.057
Grapes	0.145 *	0.171 *	0.185 *	-0.780 *	0.216 *	0.062
Soft fruits	0.238 *	0.101 *	0.166 *	0.127 *	-0.718 *	0.085 *
Tropical fruits	0.320 *	0.040	0.103	0.104	0.243 *	-0.810 *

Source: Own elaboration based on Kantar Worldpanel data.

Notes: \* indicates statistical significance at 5 per cent.

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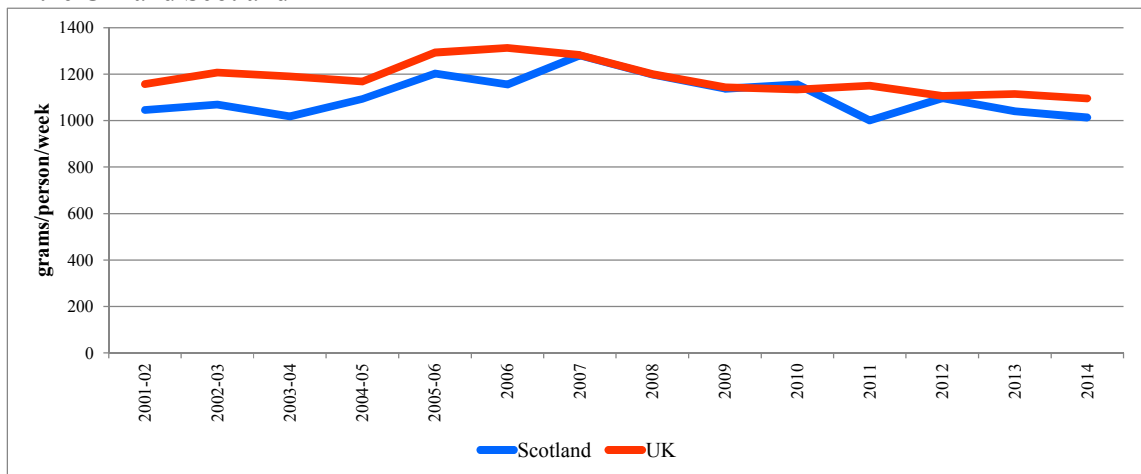
Table 4: Marshallian and expenditure elasticities for fruit categories by destination – stage 2

	Apples and pears							Bananas			Citrus			Grapes					Soft Fruit					Tropical fruits				Expenditure elasticities	
	UK	ME	OE	AC	AF	OC	NE	NE	ME	AC	AF	NE	UK	ME	AC	AF	NE	UK	ME	OE	AC	AF	NE	ME	AF	OC	NE		
Apples and pears - UK	-1.18	0.10	-0.02	0.06	0.11	-0.07	0.16	-0.11	-0.03	0.00	-0.01	-0.02	0.00	-0.01	-0.01	0.00	-0.03	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.02	1.01	
Apples and pears - ME	0.05	-1.20	0.00	0.19	0.12	-0.01	0.00	-0.12	-0.03	0.00	-0.02	-0.02	0.00	-0.01	-0.01	0.00	-0.03	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.02	1.03	
Apples and pears - OE	-0.03	0.00	-0.89	-0.05	-0.03	0.07	-0.05	-0.13	-0.04	0.00	-0.02	-0.02	0.00	-0.01	-0.01	0.00	-0.04	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.03	1.19	
Apples and pears - AC	0.12	0.67	-0.06	-1.63	0.64	0.39	-0.89	-0.11	-0.03	0.00	-0.01	-0.02	0.00	-0.01	-0.01	0.00	-0.03	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.95	
Apples and pears - AF	0.08	0.15	-0.01	0.25	-1.38	-0.03	0.05	-0.12	-0.03	0.00	-0.02	-0.02	0.00	-0.01	-0.01	0.00	-0.03	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.03	1.09	
Apples and pears - OC	-0.12	-0.02	0.11	0.37	-0.08	-1.39	0.36	-0.10	-0.03	0.00	-0.01	-0.02	0.00	-0.01	-0.01	0.00	-0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.93	
Apples and pears - NE	0.10	0.00	-0.02	-0.29	0.05	0.12	-0.77	-0.11	-0.03	0.00	-0.01	-0.02	0.00	-0.01	-0.01	0.00	-0.03	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.98	
Bananas - NE	-0.02	-0.03	-0.01	-0.01	-0.02	-0.01	-0.02	-0.62	-0.01	0.00	-0.01	-0.01	0.00	0.02	0.01	0.01	0.01	-0.01	-0.02	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	-0.03	0.80	
Citrus - ME	-0.01	-0.02	-0.01	-0.01	-0.02	-0.01	-0.02	-0.07	-1.02	0.01	0.11	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	0.00	0.00	-0.02	1.04	
Citrus - AC	-0.01	-0.02	-0.01	-0.01	-0.01	-0.01	-0.02	-0.05	0.86	-1.13	0.44	-0.85	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	0.00	0.00	-0.02	0.81	
Citrus - AF	-0.01	-0.02	-0.01	-0.01	-0.02	-0.01	-0.02	-0.07	0.21	0.01	-1.03	-0.09	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	0.00	0.00	-0.02	1.06	
Citrus - NE	-0.01	-0.02	-0.01	-0.01	-0.02	-0.01	-0.02	-0.07	0.03	-0.03	-0.08	-0.82	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	0.00	0.00	-0.02	1.06	
Grapes - UK	0.00	-0.01	0.00	0.00	0.00	0.00	-0.01	0.01	0.01	0.00	0.00	0.00	-0.82	-1.50	-0.15	0.77	1.36	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.38
Grapes - ME	-0.01	-0.02	-0.01	-0.01	-0.01	-0.01	-0.02	0.02	0.02	0.00	0.01	0.01	-0.02	-1.10	0.14	-0.06	-0.02	-0.01	-0.02	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	-0.02	1.16
Grapes - AC	-0.01	-0.02	-0.01	-0.01	-0.01	-0.01	-0.02	0.01	0.01	0.00	0.01	0.01	0.00	0.24	-1.17	-0.14	0.17	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	1.00
Grapes - AF	-0.01	-0.02	-0.01	-0.01	-0.01	-0.01	-0.02	0.02	0.02	0.00	0.01	0.01	0.03	-0.15	-0.20	-0.95	0.15	-0.01	-0.02	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	-0.02	1.23
Grapes - NE	-0.01	-0.02	0.00	-0.01	-0.01	-0.01	-0.02	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.05	0.03	-0.92	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	0.91
Soft Fruit - UK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-1.16	0.03	0.05	-0.07	0.08	0.09	0.00	0.00	0.00	0.00	1.05	
Soft Fruit - ME	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	0.03	-0.84	0.02	0.05	-0.04	-0.12	0.00	0.00	0.00	0.00	0.95	
Soft Fruit - OE	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	0.26	0.09	-1.24	-0.09	0.04	-0.10	0.00	0.00	0.00	0.00	1.10	
Soft Fruit - AC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.34	0.26	-0.07	-0.95	0.04	0.21	0.00	0.00	0.00	0.00	0.92	
Soft Fruit - AF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	0.52	-0.31	0.05	0.05	-1.01	-0.20	0.00	0.00	0.00	0.00	0.96	
Soft Fruit - NE	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	0.12	-0.21	-0.03	0.06	-0.05	-0.98	0.00	0.00	0.00	0.00	1.14	
Tropical Fruits - ME	0.01	0.02	0.01	0.00	0.02	0.00	0.01	-0.13	-0.03	0.00	-0.02	-0.02	0.00	-0.01	-0.01	0.00	-0.03	-0.01	-0.01	0.00	0.00	0.00	0.00	-0.13	-0.99	-0.02	0.01	-0.02	1.14
Tropical Fruits - AF	0.01	0.02	0.01	0.00	0.02	0.00	0.01	-0.12	-0.03	0.00	-0.01	-0.02	0.00	-0.01	-0.01	0.00	-0.03	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	-0.03	-0.99	-0.05	0.31	1.04
Tropical Fruits - OC	0.01	0.02	0.01	0.00	0.02	0.00	0.01	-0.14	-0.03	0.00	-0.02	-0.02	0.00	-0.01	-0.01	0.00	-0.04	-0.01	-0.01	0.00	0.00	0.00	0.00	0.07	-0.03	-1.28	0.27	1.18	
Tropical Fruits - NE	0.01	0.02	0.01	0.00	0.02	0.00	0.01	-0.13	-0.03	0.00	-0.02	-0.02	0.00	-0.01	-0.01	0.00	-0.03	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	-0.92	1.08	

Source: Own elaboration based on Kantar Worldpanel data.

Note: UK=United Kingdom, ME=Mediterranean area, OE=Other Europe, AC=America and the Caribbean, AF=Africa, OC=Oceania, and NE=Not specified.

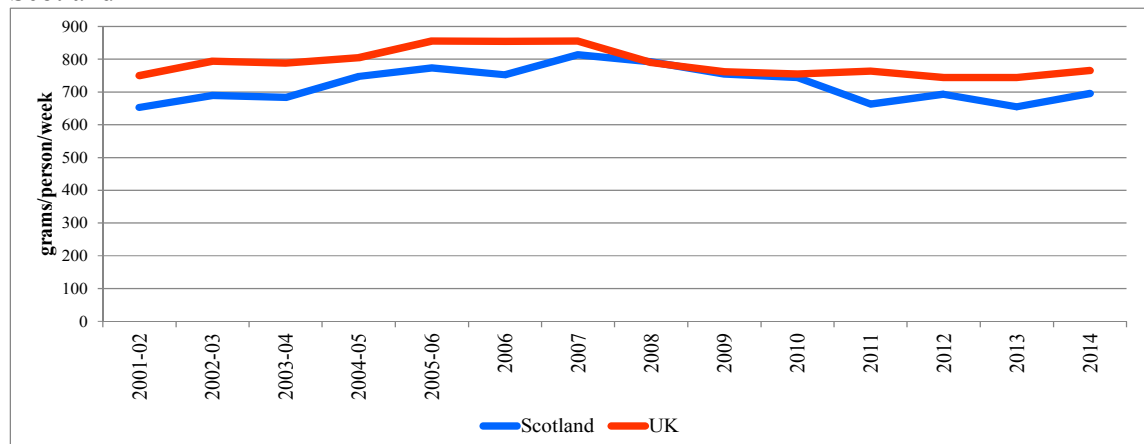
Figure 1: Average weekly per capita total consumption of fruit (fresh and processed) in the UK and Scotland



Source: Own elaboration based on Defra's Family Food data

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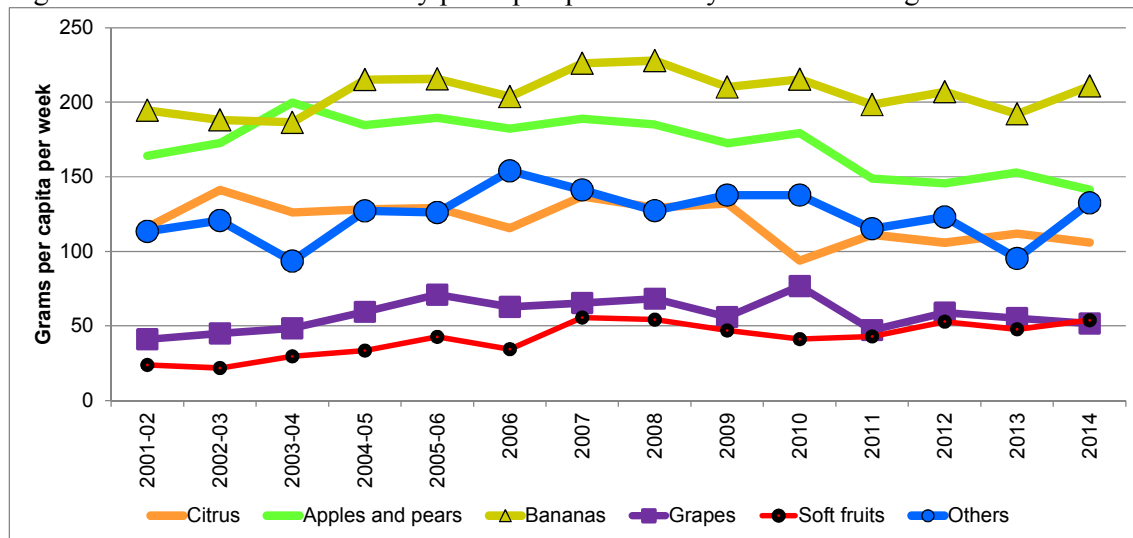
Figure 2: Average weekly per capita consumption of fresh fruits in the UK and Scotland



Source: Own elaboration based on Defra's Family Food data

Peer Review Only

Figure 3: Scottish market - Weekly per capita purchases by fresh fruit categories



Source: Own elaboration based on Defra's Family Food data.

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Figure 4: Demand tree by fruit and origin

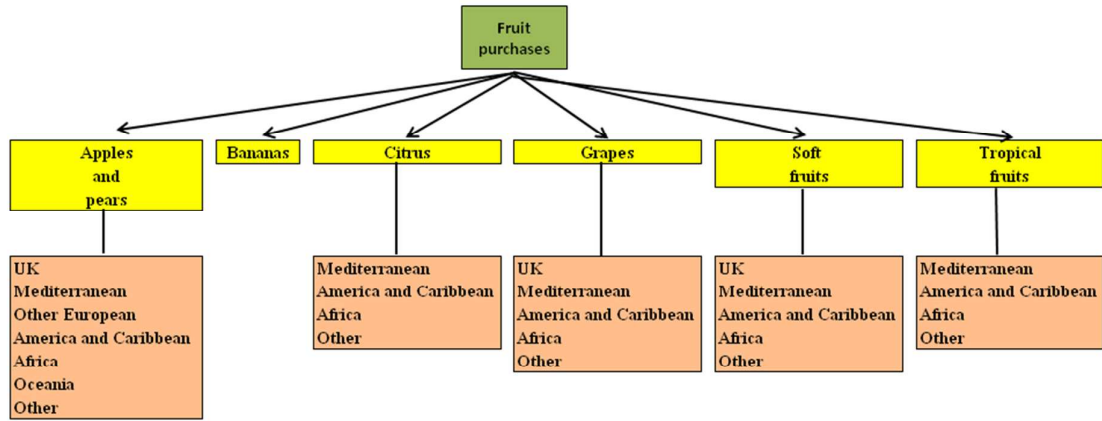
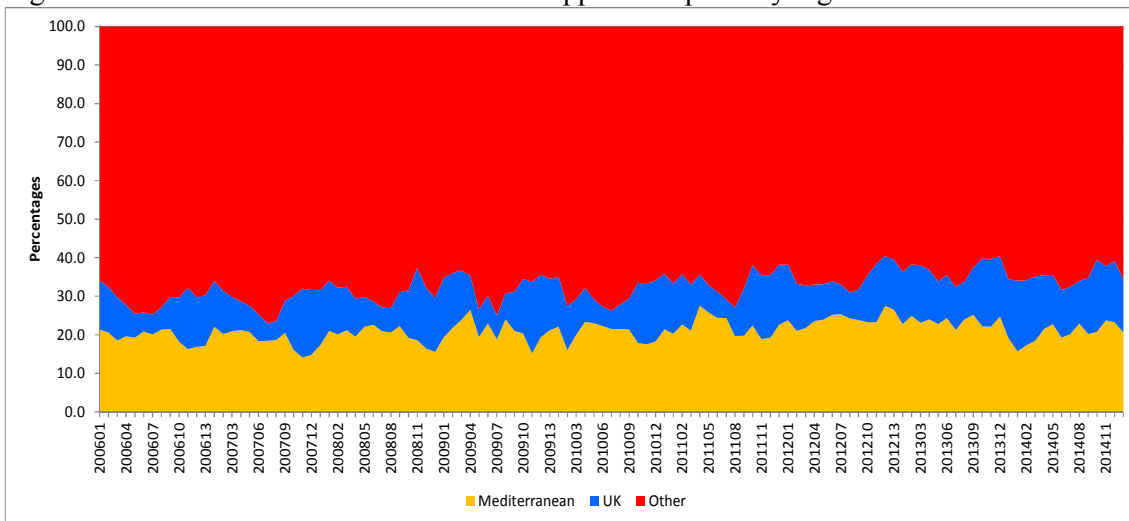


Figure 5: Scottish market – Market shares of apples and pears by region



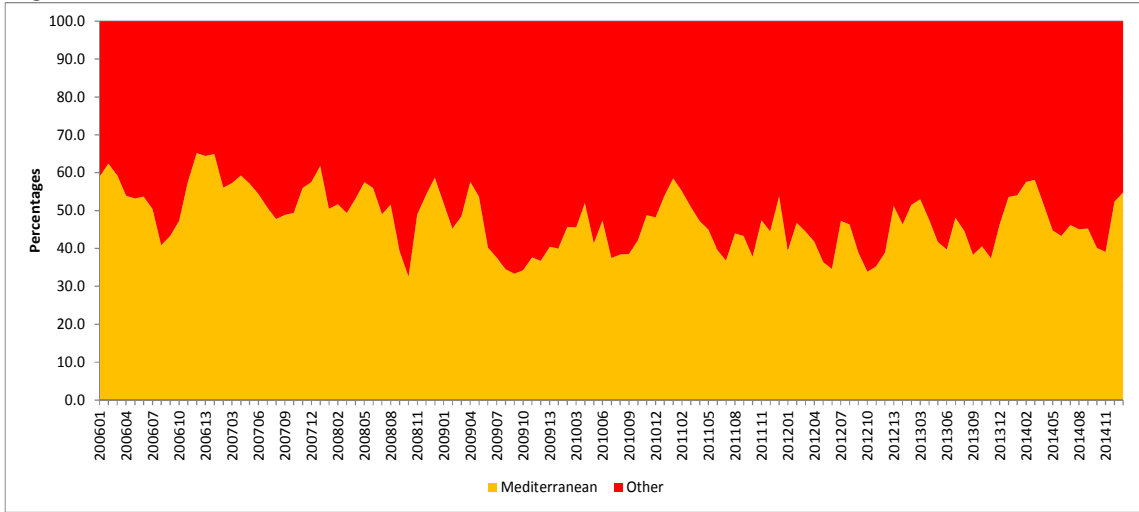
Source: Based on Kantar Worldpanel data.

Peer Review Only



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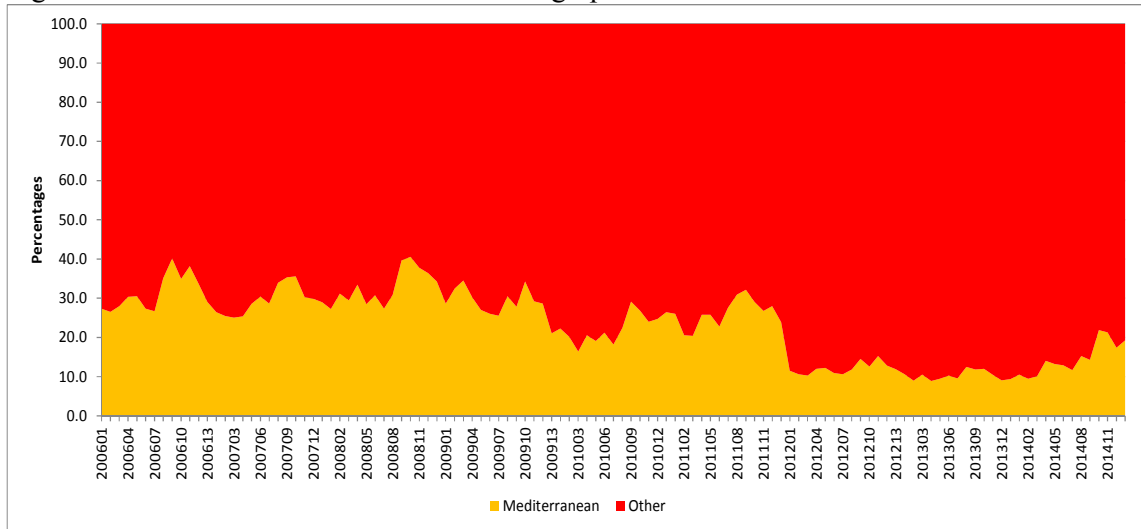
Figure 6: Scottish market – Market shares of citrus



Source: Based on Kantar Worldpanel data.

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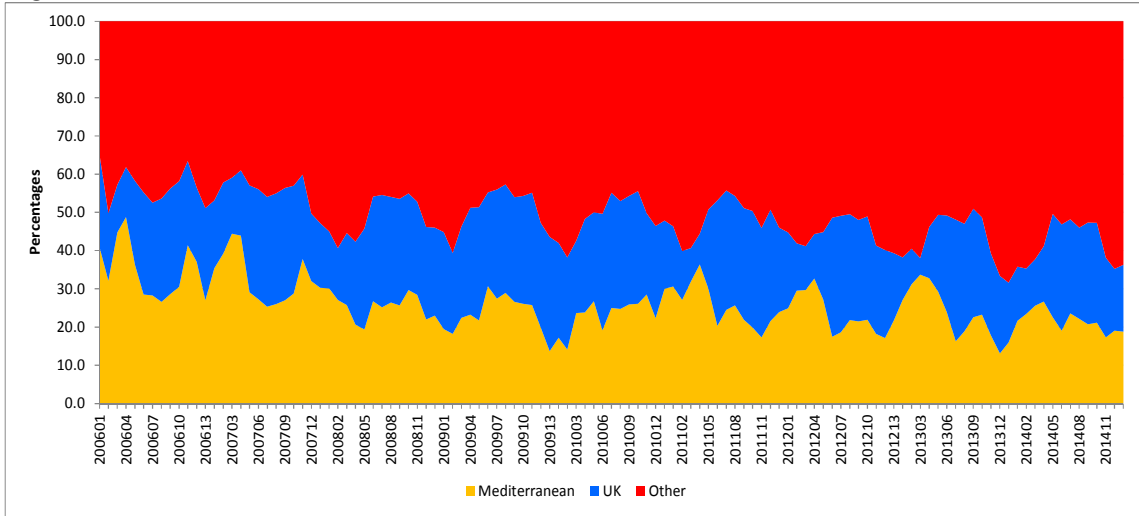
Figure 7: Scottish market – Market shares of grapes



Source: Based on Kantar Worldpanel data.

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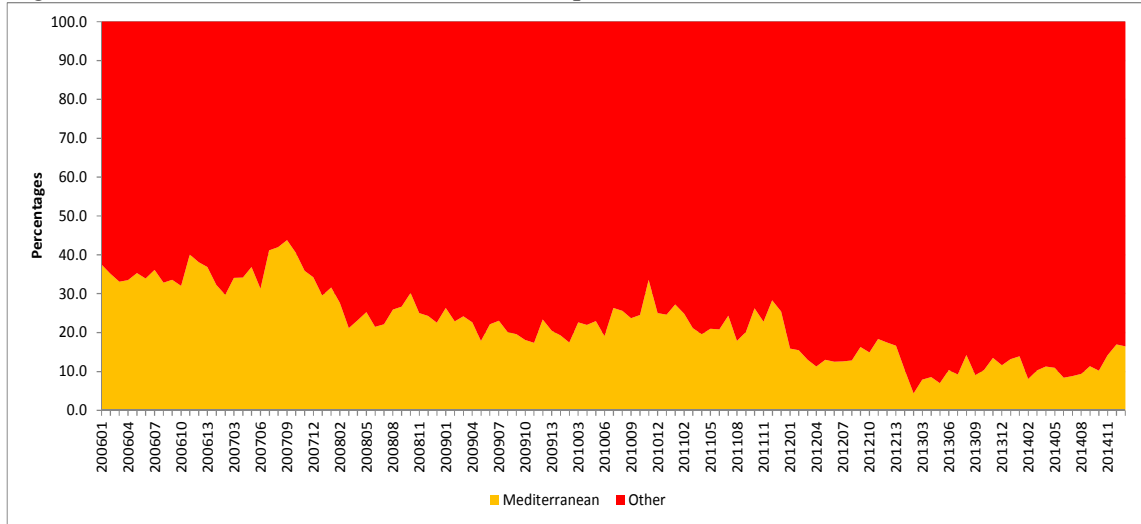
Figure 8: Scottish market – Market shares of soft fruits



Source: Based on Kantar Worldpanel data.

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Figure 9: Scottish market – Market share of tropical fruits

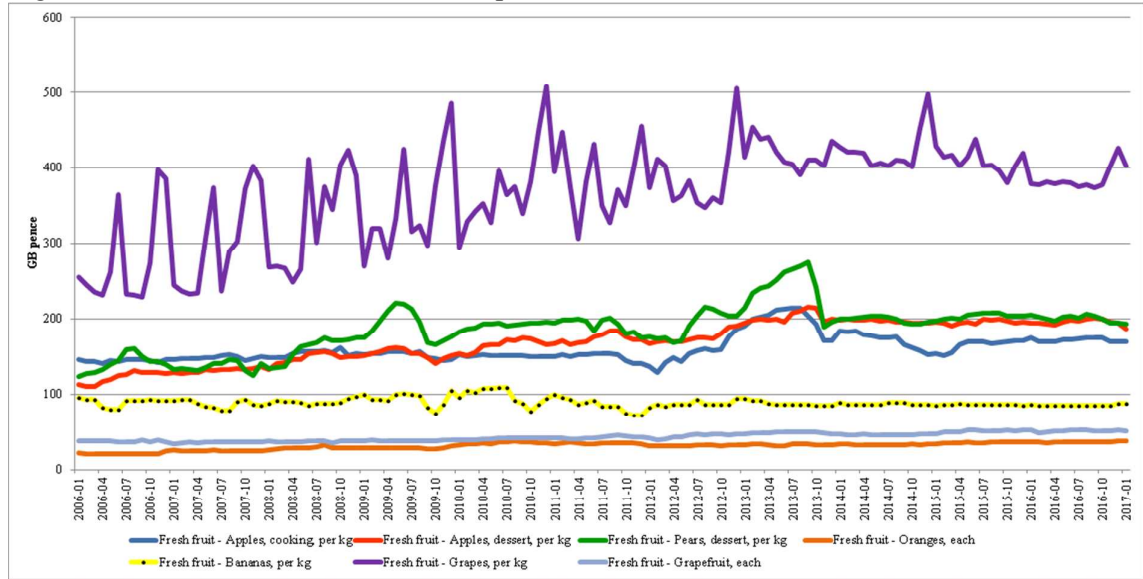


Source: Based on Kantar Worldpanel data.

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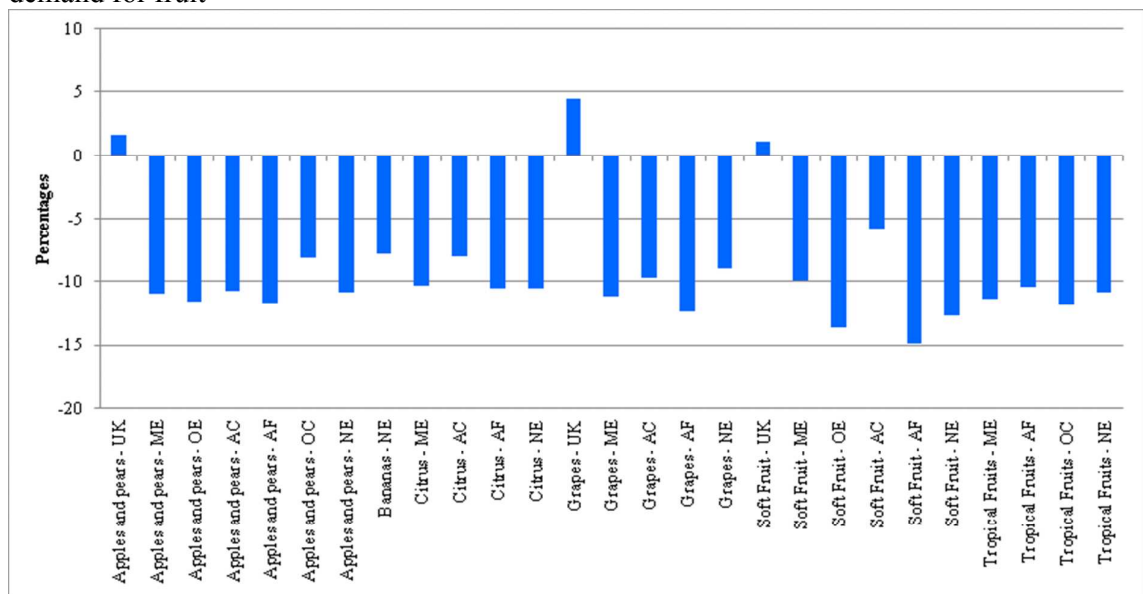
Figure 10: Evolution of retail fresh fruit prices 2006-2017



Source: UK, Office for National Statistics.

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Figure 11: Results of the simulation of GB Pound depreciation by 10 per cent on the demand for fruit



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