Implications of increasing fruits and vegetable consumption in Scotland

Abstract
The food system is a major cause of global warming contributing between 9 - 29 per cent of global carbon emissions. In addition, diet is believed to be a major cause of non-communicable diseases in Scotland, resulting in about 24 per cent of deaths and a reduction in life expectancy to 62.3 years. There is therefore the need to change consumer behaviour towards more sustainable lifestyles. The literature argues for diets high in fruit and vegetable but low in red meat and fat/sugar-based foods. To increase the consumption of fruits and vegetables in the UK i.e., Scotland, the government launched the "five-a-day" campaign in 2003 to increase fruit and vegetable consumption to 400 g/day through education and advertisement. However, after 18 years of its implementation, 2020 DEFRA food consumption data shows that Scottish consumption of fruits and vegetables was 23 per cent below the recommended daily intake. The goal of the present analysis is to simulate the price change required to increase fruit and vegetable consumption by 10 per cent in Scotland. The study relied on monthly food purchase data from 2013 – 2020 collated by Kanter Worldpanel for Scotland. This data was used to estimate unconditional food demand elasticities using an EASI demand model. The elasticities were introduced into a model that calculates the shadow prices that must prevail for consumers to increase their purchase of fruit and vegetables without changing the taste or utility of diets. Results suggest that, for the average person, a 10 per cent increase in purchases of fruits and vegetables would require subsidies between 8.36 per cent and 56.35 per cent for Processed fruit and fruit products and Fresh fruits, respectively. The post-policy diet was higher in the following food products: non-carcase meat and meat products, Butter, margarine, vegetable oils, cakes, buns and pastries, and confectionery. Unintended effects of the policy are 1) increase in average GHGe per person per day, and 3) increase in saturated fats and total fat purchases. The distributional analysis shows that 1) different income groups respond differently to subsidies, 2) persons earning above 30 K would reduce their emissions, and 3) households earning below 30 K would increase their sugar, saturate fat, and total fat purchases. In summary, though the policy would increase fruits and vegetable consumption, there will be unintended negative consequences.

Keywords: EASI, Fruits and vegetables, Subsidies, Carbon emission, five-a-day

1. Introduction

Diet is believed to be a major cause of non-communicable diseases (NCDs) such as cardiovascular diseases and diabetes (Anand et al., 2015; Willett, 2012). In Scotland, noncommunicable diseases contribute to 24 per cent of deaths and have reduced healthy life expectancy to 62.3 years – the lowest so far in western Europe. In addition, the food system is a major cause of poor population and environmental health (Clark et al., 2019; Reisch et al., 2013; Ridoutt et al., 2017). The food system contributes between 19 per cent and 29 per cent of global carbon emissions (Vermeulen et al., 2012) and about 70 per cent of global freshwater use (Whitmee et al., 2015). Environmental problems associated with unsustainable diets and food production include climate change, water pollution, loss of habitats and biodiversity etc. (Reisch et al., 2013). In addition,

From above, it is clear that individual consumption decisions have major implications for both climate and human health (Pape et al., 2011). Therefore, there is a need for behavioral change and nutritional policies towards more sustainable lifestyles (Jackson, 2009). However, efforts are largely minimal toward integrated sustainable policies that tackle both environmental and health-related problems (Reisch et al., 2017).

Healthy diets are widely considered as those high in fruit and vegetables (Agudo and F. A.O. Joint, 2005). These foods are considered essential in dietary guidance because they concentrated on vitamins, especially vitamins C and A; minerals, and more recently phytochemicals, especially antioxidants (Slavin and Lloyd, 2012). Antioxidant compounds have been found to reduce the risk of chronic diseases such as diabetes and cancers (Harasym and Oledzki, 2014). For instance, an increase in consumption of fruit and vegetables to 400 g or five portions a day has been advocated by national and international bodies on the assumption that such a change would reduce the incidence of both cancer and cardiovascular diseases (James, 1988; Motulsky and Council, 1989; World Health Organization (WHO), 1990). Also, people who eat more servings of fruit each day have lower Body Mass Index (BMI); as higher BMI is associated with certain cardiovascular diseases and diabetes (Lin and Morrison, 2002).

Despite the substantial evidence that diets rich in fruit and vegetables could reduce the incidence of cardiovascular diseases (CVD) and cancers of the upper gastrointestinal tract (IARC, 2003; Block et al., 1992; Key, 2011; Ness and Powles, 1997), fruit and vegetable intakes in Scotland remain below-recommended levels. The latest data by DEFRA suggest that between 2001 and 2019, the highest consumption of fruits and vegetables was 309 g per person per day (Department for Environment, Food & Rural Affairs (DEFRA), 2020). This makes Scotland’s average intakes no more than three servings a day (Gregory et al., 1990). Also, according to the 2018 Scottish Health Survey, only 22 per cent of adults met the five a day recommendation of fruit and vegetables (Cheong et al., 2020). National and international agencies such as Health Education Board for Scotland and World Health Organization have therefore promoted the “five-a-day” message as a means for helping to reduce those diseases (World Health Organization (WHO), 1991). Empirical studies by Capacci and Mazzochi showed that the “five-a-day” campaign message was able to increase fruits and vegetables consumption by 0.3 portions between 2003 and 2006 (Capacci and Mazzocchi, 2011). However, this has been unsustainable due to the continuous rise in the prices of fruit and vegetables in the UK.

Food consumption does not only reflect nutritional needs but also preferences for taste, odour, and texture as well as culture and ethics. According to Carlsson-Kanyama sustainable dietary goals should not only be considered from the context of environmental degradation, but also for all their immaterial qualities as well as their cultural acceptance (Carlsson-Kanyama, 1998), a term described as “taste of change” (Irz et al., 2015).

A major impediment to dietary change is related to “taste of change”, which is described as the utility forgone as a result of the dietary change to induce long term health goals and short-term pleasure and hedonistic rewards (Irz et al., 2015). This suggests that consumers are unable to comply with national and regional dietary goals because these recommendations impose changes in the palatability of diets.

A substantial body of research shows that diets high in fruit and vegetables are protective of health and have a relatively low environmental impact (Clark et al., 2019). According to Capacci & Mazzocchi, fruits and vegetable consumption increased by 8.2 per cent between 2002 and 2006 as a result of the government’s “five-a-day” campaign (Capacci and Mazzocchi, 2011). However, regional studies targeted at Scottish consumers is yet to be undertaken. Family and Food data by DEFRA in 2020 shows that fruit and vegetable consumption in Scotland has been below the five-a-day recommendation hovering between 264 g in 2011 and 309 in 2005/6. To raise consumption levels to the recommended level of 400 g of fruit and vegetables a day, consumption must increase between 23 and 34 per cent. The goal of the present paper is to estimate the prices that must prevail for consumers to increase their consumption to the recommended levels. We go further to model the implications for the overall diet composition and environmental footprint.

Most studies addressing dietary recommendations use restrictive methods like linear programming to estimate the least-cost diets when complying with a list of nutritional or environmental constraints (Macdiarmid et al., 2012). Other strands of studies have relied on empirically estimated complete and incomplete demand systems to simulate the influence of government policies like taxes on food consumption and nutrient intakes (Briggs et al., 2017; Edjabou and Smed, 2013). The former has been proven to have the following limitations: 1) the model produces unrealistic diets which are extremely cheap and made up of a few food items or ingredients, and 2) the diets produce from LP models are not compatible with consumer taste and preferences. Following these limitations, Henson used a linear programming model that considers consumers taste and preferences i.e. palatability, however, the number of constraints imposed was unrealistic (Henson, 1991).

A major limitation of using demand models is that the estimation of nutrient-based recommendations can only be assessed ex-post rather than through the price modifications required to comply with nutritional or food constraints.

Considering the above limitations, in this paper we use the approach proposed by Irz et al. which considers consumers' preferences and required substitutions to achieve a given norm (Irz et al., 2015). According to Votruba, this is important because the desirability of a nutritional policy often centers on the magnitude of taste cost (Votruba, 2010). Second, it permits the assessment of the effectiveness of the policy on improving diet quality and health goals as well as environmental health. Finally, the model applied here can identify the optimal set of taxes that should be implemented, and the optimal income transfers required to achieve given nutritional objectives.

Hence, this paper contributes to the literature on sustainable diets in Scotland by estimating the shadow prices at which fruits and vegetable consumption can be increased; 2) using a model that takes into account taste cost or constant utility, and assessing the effect that higher quantities of fruit and vegetable in the Scottish diet have on nutrient purchases and the environment (represented by carbon footprint).

The remainder of the article is structured as follows. Sections 2 present a brief literature review. Section 3 describe the data and the methodological framework used in this study. Section 4 shows and discusses the main results. The paper ends with some concluding remarks and limitations.

2. Literature review

Worldwide obesity has nearly tripled between 1975 and 2016; in the latter, 39 per cent and 40 per cent of men and women were obese (WHO, 2019). Within the UK, according to the OECD, more women than men were obese in 2020. The Scottish Health Survey 2018 suggest that 65 per cent of adults were overweight, including 28 per cent who were obese, with both trends remaining the same since 2008 (Cheong et al., 2020). On the contrary, only 33 per cent of adults had a normal body mass index i.e., a BMI of 18.5 to less than 25 kg/m^2. Such a growing trend is worrisome and requires policy interventions that can reduce the prevalence of obesity. In addition, the number of persons in Scotland who reported having cardiovascular diseases was 16 per cent in 2018. The number of those who reported having "good" or "very good" health for adults fell from 77 per cent in 2009 to 71 per cent in 2018. The lowest to be recorded in Scotland. This trend can partly be attributed to unhealthy food consumption behavior among the populace.

Treatment of obesity and related diseases has resulted in a higher cost of achieving a better quality of life, as well as increased government expenditure on health care (Thiele and Roosen, 2018). For instance, Allender & Rayner estimated the direct cost of overweight and obesity to the National Health Service (NHS) to be £3.2 billion(Allender and Rayner, 2007). As a result, various researchers have advocated for the use of fiscal policies to internalize the cost of obesity and related diseases (Dogbe and Gil, 2020). However, WHO recommends the consumption of 400 grams of fruit and vegetables per day to reduce overweight and obesity, and the incidence of non-communicable diseases (Aune et al., 2017; Hartley et al., 2013).

2.1. Fresh fruit and vegetable consumption in Scotland

Despite the interest in increasing the consumption of fruits and vegetables in Scotland, the latest data show that total average consumption (excluding potatoes) has been below the recommended weekly intakes since 2001 (see Figure 1). The highest consumption of fruit and vegetables recorded in Scotland was 309 grams per person per day in 2005. Capacci and Mazzochi (Capacci and Mazzocchi, 2011) attributed this figure to the UK government's "five-a-day" campaign message. However, this level could not be sustained, falling to 290 grams per person per day in 2019.

Figure 1 also shows the different groups of fruit and vegetable consumed in Scotland. Among the vegetables and fruits, fresh ones are consumed more than processed ones. However, consumption has not been constant, showing both upward and downward trends. The falling rate in the consumption of fruit and vegetables requires stringent policy interventions that favor both fruit and vegetable consumption and diet palatability.

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Figure 2 shows the average price per gram and weight per pence of the different groups of fruit and vegetable purchased from 2001 to 2019. The weight per pence of fruit and vegetables has fallen from 2001 to 2019. For instance, in 2001 consumers bought 7 grams of fruit and vegetable for 1 penny whilst in 2019 they paid the same price for 4.4 grams. This phenomenon may be an important cause of the low consumption of fruit and vegetable in Scotland. Similarly, the average prices of fruit and vegetables about doubled from 0.14 pence per gram in 2001 to 0.25 pence per gram in 2018. However, the average price of fresh green vegetables is higher than the total average. In addition, the price of processed fruits and fruit products is lower than the average total price. Such trends suggest some groups would require larger price decreases to increase their consumption.

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2.4. Food Consumption and CO_2 equivalent emission

Agricultural production is the third-largest emission producer in Scotland, contributing about 7.5 $MtCO_2e$ in 2019. Studies by Berners-Lee et al. (Berners-Lee et al., 2012) and Garnett (Garnett, 2009) suggest that food consumption in the UK is responsible for approximately 20 per cent of all greenhouse gas (GHG) emissions produced in a year. However, foods containing animal products are known to generally have much greater emissions than plant-based products per unit weight (Audsley et al., 2010; González et al., 2011; Steinfeld et al., 2006). Animal production relies on cereal crops produced from mostly inefficient systems and produce a high amount of methane responsible for global warming (Steinfeld et al., 2006). Due to the lack of data for Scotland, we present the trend in CO_2-eq emission from food, and alcoholic and non-alcoholic beverages in the UK (Figure 3). The average CO2-eq emission from beverages has been on the decline since 1990 suggesting marginal gains in emission reduction. However, emission from food consumption compared to the national average has been cyclical. The lowest emission of 10.43 per cent was recorded in 2007, after which emission began to increase. The latest data, in 2017, shows that the average emission from food consumption was 12.71 per cent of total UK emission. According to Vieux et al. change in national dietary levels towards healthy low GHGe is feasible in Europe (Vieux et al., 2018) through increased consumption of fruit and vegetables and low consumption of animal proteins.

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Methods

3.1. Consumers purchase data

The data is monthly Kantar Worldpanel data for Scotland covering the period 2013 to 2020. The dataset also consists of household food purchases as well as demographic information such as income levels. Personal expenditure per capita was calculated using the sample size for each year.

The purchases made by households were first categorized into Food and beverages, and alcoholic drinks categories. In the second stage, food and beverages were disaggregated into 10 main groups comprising of Milk, cheese and eggs; Meat and fish; Fats; Fruits; Sugars; Starches; Vegetables; Beverages; Soft drinks; and Other foods. In the third stage, the 10 food groups were further disaggregated into their main products. Thirty-five main food products were analyzed in the third stage (see Table 1).

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Table 2 shows the summary of the data used for estimating the demand model. Food and beverages make up 84 per cent of the total household expenditure on food and drinks. In the second stage, the highest amount of expenditure (26 per cent) was spent on Meat and Fish, this is followed by Starchy foods (17 per cent) and Sugars (14 per cent). The food aggregates with the lowest expenditure shares are Beverages (2 per cent) and Fats (2 per cent). In the third stage, the food product with the highest expenditure share was Non-carcass meat (also among the animal protein aggregate) whilst that with the lowest expenditure share was Malt drinks and chocolate versions of malted drinks. Fresh fruits (6.1 per cent) have a higher expenditure share compared to Fresh vegetables (4.4 per cent). However, processed vegetable (3.4 per cent) has a higher expenditure share than processed fruits (3.1 per cent). Other cereals and cereal products have the highest expenditure share among the starchy food aggregates. Similarly, Butter has the highest expenditure share among the fat aggregates.

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3.2. Ex-ante evaluation of increasing fruits and vegetables

The approach for the ex-ante evaluation of increasing fruit and vegetable used in this paper is from Irz et al. (2015). It is based on the conventional neoclassical consumer theory assuming that consumers choose the consumption of bundle of H goods in quantities $q = (q_1, \dots, q_H)$ to maximise a strictly increasing utility, quasi-concave, twice differentiable utility function $U(q_1, \dots, q_H)$, subject to a linear budget constraint $p.q \leq M$, where p and M are price and income vectors. We also assume here that the consumer operates under a set of linear nutritional constraints and food-based constraints i.e. N maximum nutrients or food intakes based on the government's "five a day" policy. In this study, the constraints are fruits and vegetables. Mathematically, the nutritional constraints are expressed by $\sum_{i=1}^{H} a_i^n q_i \leq r_n, \quad \forall n = 1, \dots, N$. We rely on the notion of shadow prices to solve our modified version of the utility maximization problem. We used the duality theory to relate the unconstrained Hicksian demand function $h_i(p, U)$to the constrained food-based model $\tilde{h}_i(p, U, A, r)$. Where A is the N X H matrix of nutritional coefficients, and r is the N vector of maximum nutritional amounts.

Shadow prices are calculated by maximizing $\tilde{C}_i(p, U, A, r)$ subject to $\sum_{i=1}^{H} a_i^n q_i \leq r_n, \quad \forall n = 1, \dots, N$.

The Lagrangian of the virtual price problem is expressed by

$$L = C(\tilde{p}, U) + \sum_{j=1}^{H} (p_j - \tilde{p}_j) h_j + \sum_{n=1}^{N} \mu_n \left(r_n - \sum_{j=1}^{H} a_j^n h_j\right) \text{ .... (1)}$$

μ_n is the Lagrangian multiplier associated with the *n*th nutritional or food-based constraints.

We derived the Kuhn-Tucker conditions for (1) based on the assumption of non-satiation and strictly positive virtual prices as:

$$\frac{\partial C}{\partial \tilde{p}_i} - h_i + \sum_{j=1}^{H} (p_j - \tilde{p}_j) \frac{\partial h_j}{\partial \tilde{p}_i} - \sum_{n=1}^{N} \mu_n \sum_{j=1}^{H} a_j^n \frac{\partial h_j}{\partial \tilde{p}_i} = 0, i = 1, \dots, H \text{.......... (2.1)}$$

$$\mu_n \left(r_n - \sum_{j=1}^{H} a_j^n h_j\right) = 0 \text{.. (2.2)}$$

$$\mu_n \geq 0, n = 1, \dots, N \text{... (2.3)}$$

By applying shepherd's lemma and replacing $\frac{\partial h_j}{\partial \tilde{p}_i}$ by s_{ij}, equation 2.1 reduces to:

$$\sum_{j=1}^{H} \left[(p_j - \tilde{p}_j) - \sum_{n=1}^{N} \mu_n a_j^n\right] s_{ij} = 0, \text{ i=1,...,H .... (3)}$$

Assuming that all N equations are binding, our virtual price problem reduces to:

$$\tilde{p}_i = p_i - \sum_{n=1}^{N} \mu_n a_j^n, i, \dots, H \text{... (4.1)}$$

$$\sum_{i=1}^{H} a_i^n h_i (\tilde{p}_i, U) = r_1 \text{... (4.2)}$$

According to Irz et al., equation 4.1 implies that deviations between shadow prices and market prices are proportional to the nutritional coefficients of the goods entering the single nutritional constraint (Irz et al., 2015). Whereas the second set of equations (4.2) suggest that the nutritional constraints are binding.

Finally, a change in the shadow price because of a change in the nutritional/food constraints can be expressed as

$$\frac{\partial \tilde{p}_i}{\partial r_1} = \frac{a_i^1}{\sum_{i=1}^{H}\sum_{i=1}^{H} s_{ij} a_i^1 a_j^1}, \quad i, \ldots, H \ldots \ldots \quad (5)$$

Also, a change in product k due to a change in the nutritional/food constraints is expressed by

$$\frac{\partial \tilde{h}_k}{\partial r_1} = \frac{\sum_{i=1}^{H} s_{ki} a_i^1}{\sum_{i=1}^{H}\sum_{i=1}^{H} s_{ij} a_i^1 a_j^1}, \quad k = 1, \ldots, H \ldots \ldots \quad (6)$$

Equations (5) and (6)[1] suggest that a change in the nutritional constraint has an impact on the entire diet of the consumer through substitution and complementary relationships across food products. Equation (6) is therefore used to evaluate how consumers react to a change in nutritional norms like reducing saturated intake towards the recommended level. Equation 6 is estimated by combining a matrix of Hicksian demand parameters to a set of nutritional coefficients. We derived the Hicksian demand parameters from an approximate Exact Affine Stone Index Demand System (EASI) using monthly Kantar Worldpanel data from 2013 - 2020.

3.3. Estimation of demand elasticities

As stated above, the demand system estimation is based on the Exact Affine Stone Index (EASI) model (Lewbel and Pendakur, 2009). Following Molina, (1994), we assumed weak separability of preferences which is a necessary and sufficient condition for our three-stage budgeting process. In the first stage, consumers decide how much to spend on food and beverages, and alcoholic drinks. Secondly, they decide how much of the 10 different types of food aggregates to spend on determined by their price and total expenditure from the first stage. Next consumers select among the 10 food aggregates from the second stage considering their prices.

We estimated the linear approximate version of the EASI demand model. The estimated static EASI model in the second stage was specified as:

[1] See the appendix of (Irz et al., 2015) for complete derivation.

$$w_t = \sum_{r=0}^{5} b_r y_t^r + \mathrm{A}p_t + \mathrm{C}z + u_{jt} \quad (7)$$

where $\mathrm{w_t}$ is the vector of budget share of each food group at time t, p is a vector of log prices of each food group, and z is a vector of demographic characteristics replaced by time trend and monthly dummies to capture seasonal effects on food consumption.

And y_t[2] is the real expenditure derived by

$$y_t = ln(x_t) - \mathrm{p}' w_t \quad (8)$$

The variable x_t is a vector of nominal expenditure. Parameters to be recovered are matrices and vectors of b, A, and C.

The system of N equations of the form in Equation 7 satisfies adding-up and homogeneity restriction if

$$1_n' = 1, \quad 1_n' b_r = 0, \quad \forall r = 0 \quad (9.1)$$

and

$$1_n' A = 0 \quad (9.2)$$

Where symmetry of the Slutsky matrix is ensured by the symmetry of the nxn matrix A.

The static model implicitly assumes that there is no difference between consumers' short-run and long-run behaviour. However, Klonaris & Hallam (2003) suggest that this is inappropriate where there is habit persistence, imperfect information, incorrect expectations, adjustment costs, and misinterpreted real price changes often prevent consumers from adjusting their prices and expenditures instantaneously. In addition, the static demand model does not pay attention to the statistical properties of the data as well as the dynamic specification arising from the data (Li et al., 2016). Moreover, the static demand model does not produce accurate short-run forecasts (Chambers and Ben Nowman, 1997). This makes it necessary to augment the long-run equilibrium relationship with the short-run adjustment mechanism.

To circumvent the limitations of the static or long-run demand model, Deaton & Muellbauer, (1980) proposed including lag of the budget shares as explanatory variables. (Molina, 1994) used this approach to estimate the food demand model in Spain. Similarly, (Shukur, 2002) used the same approach to estimated three-stage demand for milk and other beverages in Sweden. (Mazzocchi, 2003) perform empirical appraisal of the AIDS that allows for time-varying

[2]The polynomial of y_t was constrained to 1 to make the already complex model easier to estimate.

coefficients (TVC/AIDS) and the simple dynamic AIDS model which includes time trend, seasonal dummies, and lag of the budget shares as explanatory variables. The author concluded that TVC/AIDS did not outperform the dynamic AIDS model, apart from improved short run forecast.

Based on these premises, we estimated the simple dynamic EASI model specify below:

$$w_t = +\alpha.time + \sum_{s=1}^{12} A.s_t + \sum_{r=0}^{5} b_r.y_t^r + \mathrm{B}.p_t + C.y_t + D.w_{t-1} + u_{jt} \qquad (10)$$

where w_t is the vector of budget share of each food group at time t, *p* is a vector of log prices of each food group, *time* is the time trend, and *s* is a vector of demographic characteristics replaced by monthly dummies to capture seasonal effects on food consumption and $t-1$ represent lags of the variable. Parameters to be recovered are matrices and vectors of b, A, B, C, D, and α.

Given that y is a function of the budget shares, we have endogeneity. Additionally, (8) appears on the right-hand side of the budget share equations. Lewbel and Pendakur proposed the use of non-linear GMM or an iterated linear approximation for the estimation of the parameters (Lewbel and Pendakur, 2009). We estimated another Stone deflated real expenditure where budget shares, w_t has been replaced with their sample average $\bar{w}_t$ leading to: $\tilde{y}_t = \ln{(x_t)} - p_t'\bar{w}_t$ to instrument for food group expenditure (x_t). Similar to Reaños and Wölfing, we adopted an iterated three-stage technique to estimate the final model (Reaños and Wölfing, 2018).

Given that we estimated a multi-stage demand model, the elasticities computed from the demand systems is conditional on the budgeting level. Unconditional elasticities are more relevant since they better measure the detailed reaction of the consumption of the food groups on economic variables such as taxes and subsidies. The unconditional elasticities are estimated from the conditional counterpart using the method applied by Bouamra-Mechemache et al. (2008):

The conditional Hicksian price elasticity of demand for good *i* and *j* belonging to commodities *r* can be defined as:

$$\varepsilon = \bar{w}^{-1}(B) + \Omega\bar{w} - I \qquad (11)$$

where ε is an *n x n* matrix of compensated demand elasticities, $\overline{w}$ is an identity matrix where the ones have been replaced by the group mean budget shares, Ω is an *n x n* matrix of ones and I is an identity matrix.

The vector of expenditure elasticities $\boldsymbol{\vartheta}$ were subsequently derived by

$$\vartheta = (\overline{w})^{-1}(\mathrm{I} + Ap')^{-1}A + 1_n \qquad (12)$$

where ϑ is the *J X 1* vector of estimated expenditure elasticities, *b* is the expenditure semi-elasticity coefficients which is $\sum_{r=0}^{5} b_r y^r$ [3], *p* is a vector of mean prices and 1_j is a $J \times 1$ vector of ones.

The matrix of conditional Marshallian elasticities, *e*, were derived from the Slutsky equation given by

$$e = \varepsilon - \overline{w}\vartheta \qquad (13)$$

To estimate the unconditional elasticities, we used the equation derived by Bouamra-Mechemache et al., (2008) who followed the method suggested by Carpentier and Guyomard, (2001).

For the three-stage budget allocation, denoting *i* and *j* two commodities belonging, respectively, to sub-groups of commodities r and s that belong, respectively, to the groups *a* and *b*, unconditional price elasticities at the third stage are defined as:

$$e_{ij} = \delta_{rs} \text{ x } e_{(a)(r)ij} + w_{(b)(s)j} \text{ x } \left[\frac{\delta_{rs}}{E_{(b)(s)j}} + e_{(r)(s)}\right] \text{x } E_{(a)(r)(i)} \text{ x } E_{(a)(r)(j)} + w_{(b)(s)j} \text{x } w_{(b)s} \text{ x } E_{(a)r}$$
$$\text{x } E_{(a)(r)i} \text{ x } E_{(b)(s)j} - 1 + w_{(b)(s)j} \text{ x } w_{(b)s} \text{ x } \left[\frac{\delta_{ab}}{E_{(b)(s)j} \text{ x } E_{(b)s}} + e_{(a)(b)}\right] \text{x } E_{(a)(r)i} \text{ x } E_{(a)r}$$
$$\text{x } E_{(b)(s)j} \text{ x } E_{(b)s} \text{ x } w_{(b)(s)j} \text{ x } w_{(b)s} \text{ x } w_b \text{ x } E_{(a)(r)i} \text{ x } E_{(a)r} \text{ x } E_a \text{ x } (E_{(b)(s)j} \; x \; E_{(b)s} - 1) \qquad (14)$$

The unconditional expenditure elasticity for good *i* that belongs to the sub-group *r* that belongs to group *a*, is given by

$$E_i = E_{(a)(r)i} \; x \; E_{(a)r} \; x \; E_{(a)} \qquad (15)$$

Finally, the Hicksian price elasticities were estimated using

$$e_{ij} = \delta_{rs} \text{ x } e_{(a)(r)ij} + w_{(b)(s)j} \text{ x } e_{(r)(s)} \; x \; E_{(a)(r)i} \; x \; E_{(a)(r)j}$$
$$+ w_{(b)(s)j} \; x \; w_{(b)s} \; x \; e_{(a)(b)} \; x \; E_{(a)r} \text{ x } E_{(a)(r)j} \text{ x } E_{(b)s} \qquad (16)$$

[3] To simplify the model, which is already complicated by its time series nature, r was restricted to 1 since this does not change the expenditure elasticity significantly. Moreover, our interest is not in deriving Engel curves for the various foods.

where δ_{rs} is a dummy equal to 1 if r = s and 0 else,

$e_{(a)(r)ij}$ is the conditional price elasticity of good I with respect to good j

$w_{(b)(s)j}$ the budget share of good j in commodity group s,

$E_{(b)(s)j}$ is the conditional expenditure elasticity of good j (conditional *w.r.t.* expenditure of group s)

$e_{(r)(s)}$ is the conditional price elasticity of sub-group r with respect to sub-group s,

$E_{(a)(r)(i)}$ is the conditional expenditure elasticity of good i (conditional *w.r.t.* expenditures of group r),

$w_{(b)s}$ is the budget share of sub-group s in group b,

$E_{(a)r}$ is the conditional expenditure elasticity of sub-group r (conditional *w.r.t.* expenditures of group a),

$E_{(b)s}$ is the conditional expenditure elasticity of sub-group s (conditional *w.r.t.* expenditures of group b),

w_b is the budget share of group b,

E_a is the expenditure elasticity of group a.

3.4. Information on CO2-eq emission

Due to the lack of comprehensive GHG emission data for Scotland, we used emission estimates from the SHARP Indicator Database (SHARP-ID) compiled by Mertens et al. (2019) for the EU. The database contains greenhouse gas emissions and Land use data of reported food intake from four European countries i.e., Denmark, Czech Republic, Italy and France. According to the (Mertens et al., 2019)authors, the two indicators relate to at least four of the planetary boundaries identified by Rockström et al., (2009).

The methodology for assessing the environmental impacts of food products was based on the Life Cycle Analysis principle using current production practices (Ekvall et al., 2016). The construction of the SHARP-ID was based on a total of 182 primary products using various publicly accessible data sources, e.g. Agri-footprint (Europe) (BV, 2015) Ecoinvent (Global, Swiss Confederation) (Weidema et al., 2013), and primary production reports (Kool et al., 2012) combined with European production, trade and transport data (FAOstat, BACI World Trade Database, and GTAP).

For each food item, the LCA[4] contained the whole product's life cycle (Guinée and Lindeijer, 2002; Tillman and Baumann, 2004), from cultivations of (feed) crop to consumption at home, i.e. including primary production, use of primary packaging, transport, food losses and waste, and food preparations (such as boiling, frying, oven baking, roasting and microwaving). Due to the limited availability of data, the authors excluded the contributions of industrial food processing (such as grinding, cutting, centrifuging and washing), storage, and transport from retail to home. A study by Foster et al., (2007) shows that these phases contribute up to 32% to the environmental impact measures for highly processed foods such as pizza.

Table 3 provides a summary of the GHGe for the various food products considered for our analysis. Carcase meat (26.43 kg/kg) has the highest GHGe whilst Malt drinks and chocolate versions of malted drinks (0.12 kg/kg) have the lowest GHGe. Food products with GHGe above 10 kg/kg of food are Carcase meat, All other fats, Non-carcass meat, and Cheese. Fish and seafood, and Soups have GHGe between 5 and 10 kg/kg. Food products with emission below 1 kg/kg of food are Biscuits and crispbreads, Bread, Fresh green vegetables, Fresh fruits, Fresh and processed potatoes, Flour, Tea, Coffee, Cocoa and chocolate drinks, Malt drinks and chocolate versions of malted drinks, Mineral or spring waters, Soft drinks, concentrated, not low calorie, Soft drinks, not concentrated, not low calorie, and Soft drinks, not concentrated, low calorie. The remaining food products have the GHGe between 1 and 5 kg/kg.

Paste Table 3 here

3.5. Simulation

The goal of the present analysis is to simulate the price at what fruit and vegetable consumption can be increased from the current level towards the government's "five-a-day" policy level without disturbing the utility of the diet. Family Food data released by DEFRA in 2020 shows that fruit and vegetable consumption in Scotland has been below the five-a-day recommendation, hovering between 264 g (lowest) in 2011 and 309 g (highest so far) in 2005/6. This is about 34 and 23 per cent[5] below the required 400 g per person per day. First, we model the price that must prevail for consumers to increase their fruit and vegetable consumption by 10 per cent. Second, we measured the unintended effects of the increase on the remaining food

[4]Refer to Mertens (2019) for further explanation on how the database was constructed.

[5] Increasing consumption to by 23 and 34 per cent, required price reduction outside of the natural variation of price change. As a result, we modelled the implication for price when fruits and vegetables increase by 10 per cent.

products whose prices remained constant. Third, based on the overall changes in food purchases, we analyzed the expected changes in CO_2-equivalent emissions for the average consumer and based on income levels. Finally, the impact of the policy on diets was estimated in terms of changes in macronutrient purchases.

4. Results and discussion

4.1 Average person

4.1.1 Price and Expenditure Elasticities

Table 4 shows that all unconditional compensated own-price elasticities are negative and significant at the one per cent level. All own price elasticities were below one except for All other fats, Soft drinks, not concentrated, not low calorie, Cocoa and chocolate drinks, Soft drinks, not concentrated, low calorie, Processed fruit and fruit products, Other take away and meals, Bread, Tea, Carcase meat, and Processed vegetables. The implication is that those food groups are less responsive to price changes (Huang and Lin, 2000; Park et al., 1996; Tiffin and Tiffin, 2008) and that any policy aimed at increasing consumption must be huge to have a significant impact (Dong and Lin, 2009). Of interest are Processed fruits and fruits products and Processed vegetables which are price elastic. This implies that a small price subsidy could lead to a big change in quantity demand. The cross-price elasticities show the degree of substitution and complementarity between the food groups. This has implications for the policy to increase fruit and vegetable consumption. For instance, all types of vegetables and fruits are a complement to animal proteins (Carcase meat, Non-Carcase meat, and Fish) suggesting that lower prices for vegetable and vegetable products will increase the consumption of these food groups (not encouraging from the climate perspective). This confirms the findings of Dong and Lin, (2009) that subsidies for vegetables i.e. lettuce and tomatoes might encourage households to purchase more ground beef and bread.

The estimated expenditure elasticities are all positive and significant at the one per cent level (see Table 4). All types of fruits and vegetables are expenditure inelastic suggesting that buyers consider these products as normal goods (Theil, 1980). The least responsive to expenditure changes among these two groups are fresh fruits whilst the most responsive are processed fruits. Among the animal proteins, Carcase meat was found to be expenditure elastic whilst the rest are expenditure inelastic. Among the soft drinks group, soft drinks, not concentrated and not low calorie is the most price elastic (1.192) whilst Mineral water is the least price responsive (0.056). Finally, all fat types are price elastic except for the butter.

4.1.2. Price Adjustments

We first considered the effect of increasing fruit and vegetable consumption by 10 per cent (equivalent to an increase of 29 grams per day[6]) on prices. The model considers the substitution and complementary relationship across all food groups. The estimated results suggest that, for the average person, there is the need to reduce the prices by 12.51 per cent, 33.76 per cent, 11.14 per cent, 56.35 per cent, and 8.36 per cent for Fresh green vegetables, Other fresh vegetables, Processed vegetables, Fresh fruit and Processed fruit and fruit products, respectively. Comparing our results to that found by Irz et al. (2015) for increasing fruits and vegetables by 5 per cent suggest that the price changes are lower. More importantly, our results confirm that food price subsidies have positive implications for consumption (Blakely et al., 2020; Siegel, 2019; Thow et al., 2014). Even though the subsidies (difference between actual and shadow prices) required to achieve the recommended intakes are relatively high, especially for Fresh fruits, previous literature has shown that the consumption of fruit and vegetables are both beneficial for personal and environmental health. A diet rich in a variety of fruits and vegetables have been shown to prevent cancers of the upper gastrointestinal tract ((IARC), 2003; Steinmetz and Potter, 1996), coronary heart disease (Liu et al., 2000), mental health (Głąbska et al., 2020; Liu et al., 2016; Saghafian et al., 2018) and diabetes mellitus (Ford and Mokdad, 2001). In addition, the consumption of diets high in fruits and vegetables has been associated with a lower prevalence of obesity (Epstein et al., 2001; McCrory et al., 2000).

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4.1.3. Consumption of other foods

By assuming 100 per cent for the baseline consumption, we compared consumption before and after the implementation of the policy for the remaining 30 food products. Figure 4 indicates the baseline consumption levels by doted lines. Significant changes in dietary composition are observed at the same utility level.

The following foods: Non-carcass meat and meat products; Butter; Confectionery; Fresh fruit; Processed vegetables; Fresh green vegetable; Other fresh vegetables; Processed fruit and fruit

[6] This figure is based on average daily consumption per person in 2019 in Scotland

products; Cakes, buns and pastries; Margarine; Vegetable and salad oils had increase in purchases whilst the remaining food products had reduction in purchases. Specifically, the graph shows that Soft drinks, not concentrated, not low calorie recorded the highest reduction in purchase whilst Non-carcase meat and meat products had the highest increase in purchase. The increased demand for Non-carcase meat and meat products and butter has implications for climate goals as these food products tend to be carbon-intensive.

We compared our results to those obtained for France by Irz et al. (Irz et al., 2015). The changes in consumption were found to be comparable. First, like Irz et al. (2015), our results show decreases in the purchase of Carcase meat products. Also, our results show that purchases of fish and seafood will decrease by 0.4 per cent, but Irz et al. estimated a 10 per cent increase in the consumption of fish. The differences are, of course, due to the peculiar preferences in both countries and differences in data aggregation.

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4.1.4. Impact on greenhouse gas emission and nutrient purchases

We went further to estimate the unintended impact of the policy on greenhouse gas emissions and nutrient purchases. Figure 3 shows the effect of the policy on energy and macronutrient purchases and GHGe. The percentage changes in emissions are equivalent to the changes in the quantities of each food product. Contrary to results by Dogbe and Revoredo-Giha (2020) for the UK, the overall net change in emissions is higher (3 per cent), indicating a more negative effect of the policy on GHG emissions for Scotland. This could be attributed to a significant increase in carbon-intensive food products like non-carcass meat and butter.

From Figure 3, carbohydrate purchases decreased by 6.1 per cent; dietary sugar purchases decreased by 2.1 per cent, and fibre purchases decreased by 5.6 per cent. However, protein and lipid or total fats increased by 2.5 and 1.7 per cent, respectively. Similarly, sodium and saturated fats increased by 0.9 and 0.6 per cent, respectively. In conclusion, subsidizing fruits and vegetable consumption is likely to have negative consequences on diet and climate health. This is contrary to the results found by Eustachio Colombo et al. (2021) for the UK that meeting the "5-a-day" target for fruits and vegetables would reduce emissions.

4.2 Income groups

4.2.1 Price and Expenditure Elasticities

Figure 6 shows variations in the own-price elasticities for three different income groups[7]. Figure 5 shows that some food products show high levels of variations in elasticities. For instance, All other fats have price elasticity ranging from -0.60 for persons earning between 30 – 50 K to -2.94 for persons earning above 50 K. This suggests that persons earning higher income are more responsive to price changes in the All other fats product than persons earning a lower income. The lowest variation in own-price elasticity was estimated for Pickles and sauces, ranging from -0.839 for persons earning between 30 – 50 K and -0.898 for persons earning below 30 K. Among the vegetables, processed vegetables have the lowest variation in price elasticities (between -0.20 for persons earning above 50 K and 0.46 for persons earning below 30 K). Also, processed vegetable has a higher price elasticity across all income groups than fresh green and other vegetables. For fruits, persons earning higher than 50 K are more responsive to price changes in Processed fruits whilst persons earning between 30 K – 50 K are the most responsive to price changes in fresh fruits. For carcass and non-carcass meat, persons earning 50 K and above are the most responsive to price changes whilst those earning below 30 K are the most responsive to price changes. For soft drinks, people earning below 30 K and those earning above 50 K are more sensitive to price changes in Soft drinks, not concentrated, not low calorie; and Soft drinks, not concentrated, low calorie.

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Figure 7 shows the variations in income elasticities among different income groups. Variations in elasticities suggest how different income groups respond differently to the same level of change in food expenditure. Persons earning between 30-50 K (3.363) are more responsive to expenditure changes in flour whilst persons earning less than 30 K (0.183) are the least responsive. Among the vegetables, the largest variation in expenditure elasticity was estimated for other fresh vegetables (0.83 – 1.05). Specifically, persons earning less than 30 K were more responsive to price changes in fresh green vegetables and other fresh vegetables than the remaining income groups. However, persons earning between 30 – 50 K were more price responsive to price changes in the processed vegetables than the remaining groups. Among the fruit group, Processed fruits have the largest variation in expenditure elasticity, ranging from 0.08 for persons earning between 30 – 50 K and 1.03 for persons earning below 30 K. Person earning below 30 K were more responsive to price changes in Fresh fruits than the remaining groups.

[7] Income group 1 = households earning less than 30, 000 pounds per annum; Income group 2 = households earning between 30, 000 and 50, 000 pounds per annum; and Income group 3 = households earning above 50,000 pounds per annum.

Paste Figure 6 here

4.2.2. Price Adjustments

Table 5 presents the percentage changes in prices for different income levels and the variation when compared to the average person. For Fresh green vegetables, a 13.1 per cent reduction in price is required to meet the policy goal for persons earning less than 30 K (0.6 per cent lower than the average household). However, for the same food product, a 20.93 per cent increase in prices (8.43 per cent lower than the average household) is required to the policy goals for persons earning above 50 K. For Other fresh vegetables, a 24.5 per cent reduction in price is required to increase its consumption for persons earning less than 30 K (9.2 per cent higher than the average person). However, for the same food product, a 68.9 per cent reduction in price is required to increase its consumption for persons earning above 50 K (35.2 per cent higher than the average person). For processed vegetables, 13.9 per cent (2.46 per cent lower than average population) and 9.16 per cent (2.3 per cent above average) is required by persons earning between 30 – 50 K and persons earning above 50 K, respectively, to increase consumption by 10 per cent.

For fruits, in general, the price change for Fresh fruits is higher than the average population but lower for Processed fruits. For the former, 37.7 per cent (18.7 per cent higher than average) reduction in price is required to meet the policy goal for persons earning less than 30 K. However, for persons earning between 30- 50 K, a 10.3 per cent reduction (46.1 per cent higher than average) is required to achieve this target. For Processed fruits and fruit products, 10.13 per cent reduction (1.8 per cent lower than average) is required to increase consumption by 10 per cent for persons earning below 30 K whilst for the same level of consumption, 8.5 per cent (0.2 per cent lower than average) reduction in price is required for persons earing between above 50 K.

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4.2.3 Changes in Consumption

Figure 8 compares the reductions in purchases across different income groups. The following food products reduced across all income groups: Cheese, Egg, Carcase meat, Fish, All other fats, Sugar and preserves, Fresh and processed potatoes, Bread, Flour, Biscuits and crispbreads Other cereals and cereal products, Spreads and dressings, Tea, Coffee, Cocoa and chocolate drinks, Malt drinks and chocolate versions of malted drinks, Mineral or spring waters, Soft drinks, concentrated, not low calorie, Soft drinks, not concentrated, not low calorie, and Soft drinks, not concentrated, low calorie. The consumption of Carcase meat increased for persons earning below 30K and between 30 – 50 K but reduced for persons earning above 50 K. Purchases of Butter and Margarine increased for persons earning below 30 K and between 30 -50 K but reduced for persons earning above 50 K. Also, purchases of Soups, Pickles and sauces, and Other take away and meals increased for persons earning between 30 – 50K but reduced for persons below 30 K and above 50 K. In effect, the impact of the policy on consumption varies significantly across different income groups.

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4.2.4. Impact on greenhouse gas emission and macronutrient purchases

Figure 8 shows the percentage change in energy, macronutrient, and GHG emissions following the policy. Emissions increased for persons earning below 30 K but reduced for persons earning more than 30 K. A better understanding of the consumption pattern of lower-income households is required to improve overall nation climate health. For instance, persons earning below 30 K increased their emission from consumption by 3.6 per cent whilst those earning between 30-50 K and those above 50 K decreased by 1.2 per cent and 1.3 per cent, respectively. Also, Figure 8 shows the changes in nutrient purchases due to the policy. Energy purchases increased for persons earning below 30 K but reduced for persons earning above 30 K. Protein purchases increased for persons earning below 30 K and above 50 K but decreased for persons earning between 30 -50 K. Fiber purchases increased for all income groups. Sugar, saturated fats, and lipids purchases increased for persons earning below 30 K but reduced for the remaining income groups. Finally, sodium purchases increased for persons earning above 50 K but reduced for all other income groups. The increase in saturated fats and sugar shows the negative unintended effects of the policy if implemented on lower-income households.

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5. Conclusion

In Scotland, fruit and vegetable consumption has been unstable and significantly below the recommended daily consumption of 400 g. As such, the goal of the present study was to estimate the prices (shadow prices) at which consumer can increase their intake of fruits and vegetable purchases by 10 per cent (29 g higher than the average consumed in 2019) without changing the overall taste of diet (utility).

The results suggest that to increase the purchases of fruits and vegetables by 10 per cent, there is the need for prices to decline between 8.36 (Processed fruits) and 56.35 per cent (Fresh fruits). The changes in the consumption of fruits and vegetables have implications for overall food choices shown by the increase in purchases for carbon-intensive foods like non-carcass meat and butter, macronutrients like lipids and sugar, and an increase in overall CO_2-eq emission.

First, the impact of the policy varied across all income groups. Lower-income households were more affected by showing a positive change in average GHGe and increased purchases for sugar and saturated fats.

From the policy perspective, the large difference between the estimated shadow prices and actual prices of fruits and vegetables has implications for fiscal policies. In effect, large subsidies are required for the policies to be effective especially for Fresh fruits. Policymakers should also consider the unintended effects created by the policy before going ahead to implement it.

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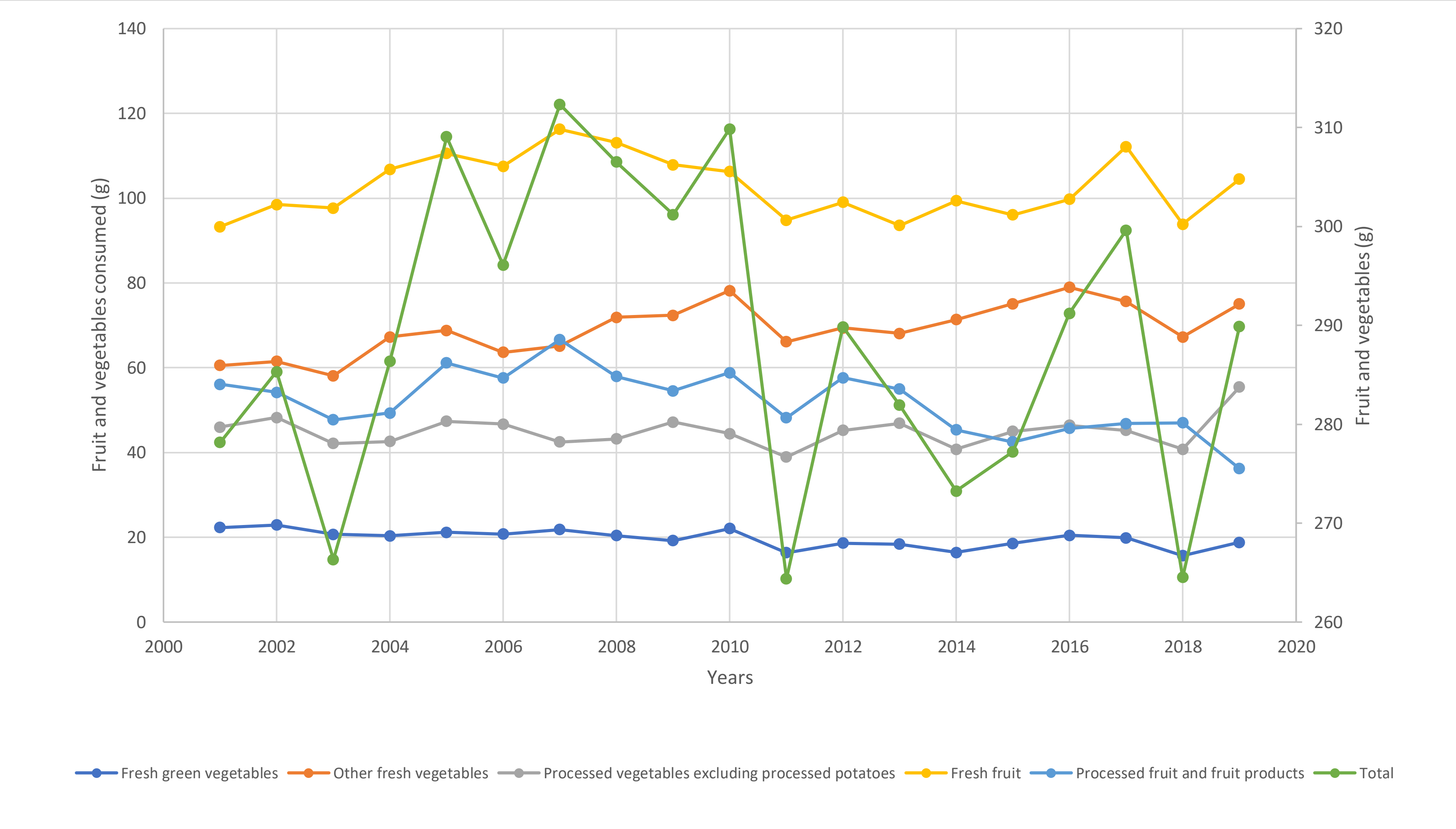

Figure 1. Average weekly consumption of fruits and vegetables in Scotland. Source: Authors' computation based on National Dietary and Nutritional Survey Data.

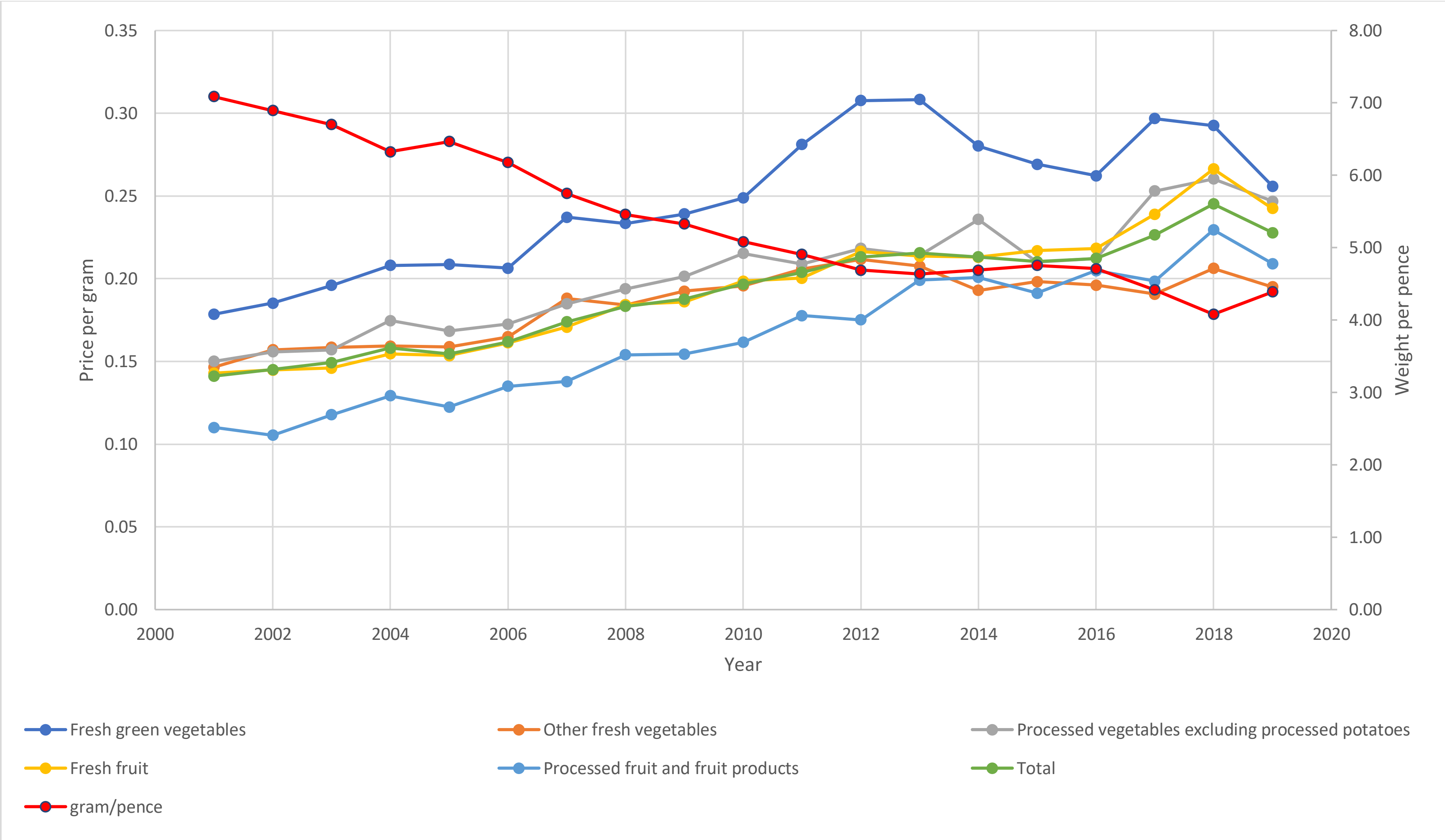

Figure 2. Average expenditure per person per week and average prices on/of fruits and vegetables in Scotland. *Source: Authors' computation based on National Dietary and Nutritional Survey Data*

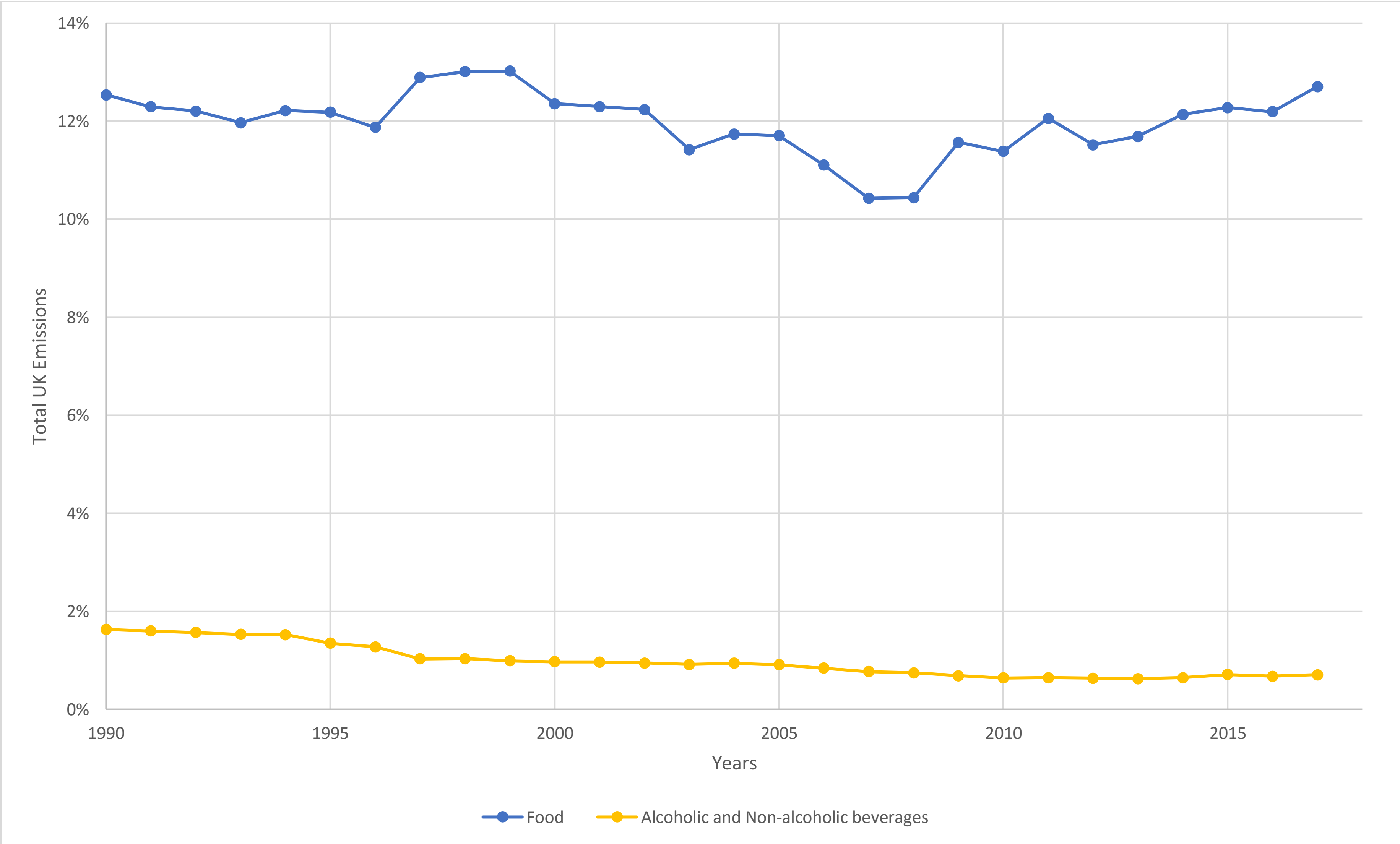

Figure 3. Evolution of emission from food and alcoholic and non-alcoholic beverages in the UK. Source: Authors' computation based on DEFRA data on consumption emissions

Table 1. utility tree used to estimate the food demand model for Scotland

First stage	Second stage	Third stage
1 – Food and Beverages	1.1 - Milk, cheese and eggs	1.1.1 - Milk and milk products excluding cheese
		1.1.2 - Cheese
		1.1.3 - Eggs
	1.2 - Meat and fish	1.2.1 - Carcase meat
		1.2.2 - Non-carcase meat and meat products
		1.2.3 - Fish
	1.3 - Fats	1.3.1 - Butter
		1.3.2 - Margarine
		1.3.3- Vegetable and salad oils
		1.3.4 - All other fats
	1.4 - Fruits	1.4.1 Fresh Fruits
		1.4.2 Processed Fruits
	1.5 - Sugars	1.5.1 - Sugar and preserves
		1.5.2 - Cakes, buns and pastries
		1.5.3 - Confectionery
	1.6 - Starches	1.6.1 - Fresh and processed potatoes
		1.6.2 - Bread
		1.6.3 - Flour
		1.6.4 - Biscuits and crispbreads
		1.6.6 - Other cereals and cereal products
	1.7 - Vegetables	1.7.1 - Fresh green vegetables
		1.7.2 - Other fresh vegetables
		1.7.3 - Processed vegetables excluding processed potatoes
	1.8 - Other foods	1.8.1 - Soups
		1.8.2 - Spreads and dressings
		1.8.3 - Pickles and sauces
		1.8.4 - Other take away and meals
	1.9 - Beverages	1.9.1 - Tea
		1.9.2 - Coffee
		1.9.3 - Cocoa and chocolate drinks
		1.9.4 - Malt drinks and chocolate versions of malted drinks
	1.10 – Soft drinks	1.10.1 - Mineral or spring waters
		1.10.2 - Soft drinks, concentrated, not low calorie
		1.10.3 - Soft drinks, not concentrated, not low calorie
		1.10.4 - Soft drinks, not concentrated, low calorie

Table 2. Summary of data used for the analysis

	Expenditure shares		**Prices**		**Expenditure**	
First stage	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Food and Beverages	0.84	0.02	1.64	0.05	2055.02	223.47
Alcoholic Drinks	0.16	0.02	5.31	0.49	395.11	102.54
Food Aggregates						
Vegetables	0.08	0.01	2.01	0.11	160.84	19.34
Fruits	0.09	0.01	2.00	0.14	188.35	23.03
Milk, cheese and eggs	0.11	0.00	0.72	0.02	236.22	26.25
Meat and fish	0.26	0.01	6.13	0.16	531.90	52.25
Fats	0.02	0.00	3.38	0.30	46.83	6.72
Sugars	0.14	0.02	1.12	0.13	292.45	58.29
Starches	0.17	0.00	1.72	0.06	353.40	34.32
Other foods	0.05	0.00	2.76	0.18	95.77	13.67
Beverages	0.02	0.00	10.07	0.51	48.10	5.96
Soft drinks	0.05	0.01	0.72	0.05	101.16	19.40
Food Products						
Fresh green vegetables	0.021	0.002	1.913	0.153	42.277	5.445
Other fresh vegetables	0.024	0.002	1.825	0.141	48.716	6.173
Processed vegetables excluding processed potatoes	0.034	0.002	2.251	0.107	69.842	8.366
Fresh Fruits	0.061	0.009	2.049	0.156	125.470	19.576
Processed Fruits	0.031	0.001	1.914	0.143	62.877	7.200
Milk and milk products excluding cheese	0.069	0.003	0.875	0.033	142.368	15.459
Cheese	0.034	0.001	6.569	0.221	70.950	8.722
Eggs	0.011	0.001	0.147	0.008	22.897	3.295
Carcase meat	0.039	0.004	7.251	0.215	79.376	9.988
Non-carcase meat and meat products	0.190	0.007	5.691	0.141	389.200	38.205
Fish	0.031	0.001	8.553	0.626	63.323	7.460
Butter	0.013	0.001	5.132	0.596	26.877	5.386
Margarine	0.004	0.001	2.333	0.099	8.532	1.308
Vegetable and salad oils	0.004	0.000	2.155	0.161	7.859	1.146
All other fats	0.002	0.000	2.667	0.142	3.566	0.605
Sugar and preserves	0.008	0.001	1.717	0.105	17.175	2.714
Cakes, buns and pastries	0.047	0.004	1.387	0.104	96.974	15.488
Confectionery	0.086	0.015	0.977	0.158	178.303	43.816
Fresh and processed potatoes	0.036	0.003	1.549	0.089	74.764	7.300
Bread	0.047	0.002	0.936	0.041	96.030	9.379
Flour	0.001	0.000	0.700	0.047	2.213	0.718
Biscuits and crispbreads	0.006	0.001	5.436	0.167	12.720	1.941
Other cereals and cereal products	0.082	0.002	3.463	0.159	167.676	18.403
Soups	0.009	0.002	2.182	0.120	18.969	3.807
Spreads and dressings	0.001	0.000	3.582	0.222	2.145	0.662
Pickles and sauces	0.022	0.001	3.238	0.097	45.582	5.600
Other take away and meals	0.014	0.003	2.583	0.475	29.073	8.074
Tea	0.006	0.001	5.926	0.282	12.119	1.556
Coffee	0.016	0.001	15.095	0.715	31.990	4.751

Cocoa and chocolate drinks	0.002	0.000	6.680	0.630	3.428	0.758
Malt drinks and chocolate versions of malted drinks	0.000	0.000	6.591	0.825	0.567	0.192
Mineral or spring waters	0.006	0.001	0.381	0.020	12.473	1.663
Soft drinks, concentrated, not low calorie	0.006	0.001	1.028	0.042	12.161	1.784
Soft drinks, not concentrated, not low calorie	0.018	0.003	0.946	0.122	37.839	8.324
Soft drinks, not concentrated, low calorie	0.019	0.003	0.703	0.060	38.687	9.346

Source: Authors' computation based on Kantar Worldpanel Data.

Table 3 Summary of GHGe for food products consumed in Scotland

Food Products	GHGE kg/kg CO_2eq
Fresh green vegetable	0.815
Other fresh vegetables	1.489
Processed vegetables	1.934
Fresh fruit	0.811
Processed fruit and fruit products	1.415
Milk and milk products excluding cheese	4.391
Cheese	13.154
Egg.	1.904
Carcase meat	26.430
Non-carcase meat and meat products	13.893
Fish	7.239
Butter	4.343
Margarine	4.083
Vegetable and salad oils	2.143
All other fats	22.607
Sugar and preserves	1.442
Cakes, buns and pastries	4.623
Confectionery	3.252
Fresh and processed potatoes	0.691
Bread	0.943
Flour	0.568
Biscuits and crispbreads	0.966
Other cereals and cereal products	2.241
Soups	6.218
Spreads and dressings	2.293
Pickles and sauces	3.612
Other take away and meals	1.894
Tea	0.699
Coffee	0.421
Cocoa and chocolate drinks	0.572
Malt drinks and chocolate versions of malted drinks	0.118
Mineral or spring waters	0.273
Soft drinks, concentrated, not low calorie	0.515
Soft drinks, not concentrated, not low calorie	0.515
Soft drinks, not concentrated, low calorie	0.515

Table 4. Unconditional Marshallian price and expenditure elasticities

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	-0.922	0.136	0.175	0.012	0.016	-0.003	-0.004	-0.004	-0.040	-0.030	-0.038	-0.092	-0.133	-0.106	-0.111	-0.046	-0.030	-0.036
	(0.061)	(0.072)	(0.035)	(0.022)	(0.018)	(0.013)	(0.015)	(0.018)	(0.012)	(0.009)	(0.011)	(0.031)	(0.041)	(0.033)	(0.034)	(0.011)	(0.007)	(0.012)
2	0.067	-0.352	-0.128	0.014	0.018	-0.003	-0.004	-0.004	-0.046	-0.035	-0.043	-0.106	-0.154	-0.123	-0.128	-0.054	-0.034	-0.042
	(0.094)	(0.087)	(0.037)	(0.023)	(0.019)	(0.014)	(0.016)	(0.020)	(0.013)	(0.010)	(0.012)	(0.032)	(0.044)	(0.035)	(0.036)	(0.012)	(0.007)	(0.014)
3	0.288	-0.186	-1.010	0.016	0.022	-0.006	-0.008	-0.009	-0.063	-0.048	-0.059	-0.141	-0.205	-0.164	-0.171	-0.074	-0.047	-0.058
	(0.057)	(0.052)	(0.062)	(0.039)	(0.029)	(0.021)	(0.024)	(0.029)	(0.020)	(0.016)	(0.019)	(0.050)	(0.067)	(0.053)	(0.055)	(0.019)	(0.011)	(0.021)
4	0.024	0.024	0.022	-0.229	0.014	-0.048	-0.063	-0.068	-0.076	-0.057	-0.071	-0.590	-0.857	-0.684	-0.714	-0.140	-0.090	-0.110
	(0.062)	(0.055)	(0.065)	(0.161)	(0.123)	(0.042)	(0.049)	(0.058)	(0.059)	(0.040)	(0.042)	(0.136)	(0.164)	(0.126)	(0.163)	(0.040)	(0.027)	(0.059)
5	0.024	0.024	0.022	0.013	-1.248	-0.025	-0.033	-0.035	-0.042	-0.032	-0.040	-0.390	-0.566	-0.452	-0.472	-0.083	-0.053	-0.065
	(0.028)	(0.026)	(0.028)	(0.061)	(0.118)	(0.009)	(0.010)	(0.012)	(0.017)	(0.013)	(0.016)	(0.050)	(0.052)	(0.047)	(0.042)	(0.012)	(0.008)	(0.016)
6	-0.010	-0.010	-0.009	-0.042	-0.056	-0.470	-0.525	-0.150	0.024	0.018	0.023	0.073	0.106	0.085	0.089	-0.133	-0.085	-0.104
	(0.042)	(0.040)	(0.042)	(0.046)	(0.018)	(0.120)	(0.185)	(0.630)	(0.028)	(0.025)	(0.027)	(0.094)	(0.117)	(0.095)	(0.088)	(0.033)	(0.020)	(0.030)
7	0.002	0.002	0.002	-0.021	-0.028	-0.271	-0.631	0.635	0.026	0.020	0.024	0.057	0.082	0.066	0.069	-0.075	-0.048	-0.059
	(0.024)	(0.022)	(0.023)	(0.026)	(0.010)	(0.098)	(0.168)	(0.656)	(0.017)	(0.015)	(0.016)	(0.053)	(0.066)	(0.053)	(0.049)	(0.019)	(0.012)	(0.016)
8	0.001	0.001	0.001	-0.007	-0.009	-0.021	0.205	-0.511	0.010	0.007	0.009	0.020	0.029	0.024	0.025	-0.025	-0.016	-0.020
	(0.009)	(0.009)	(0.009)	(0.010)	(0.004)	(0.101)	(0.210)	(0.155)	(0.007)	(0.006)	(0.006)	(0.020)	(0.025)	(0.020)	(0.019)	(0.007)	(0.004)	(0.007)
9	-0.071	-0.071	-0.065	-0.036	-0.048	0.018	0.024	0.026	-1.011	0.119	-0.089	-0.059	-0.086	-0.069	-0.072	-0.023	-0.015	-0.018
	(0.021)	(0.020)	(0.021)	(0.031)	(0.023)	(0.016)	(0.018)	(0.021)	(0.368)	(0.065)	(0.182)	(0.042)	(0.051)	(0.043)	(0.041)	(0.011)	(0.008)	(0.018)
10	-0.297	-0.299	-0.273	-0.162	-0.215	0.032	0.042	0.046	0.543	-0.623	0.561	-0.253	-0.368	-0.294	-0.307	-0.136	-0.087	-0.107
	(0.086)	(0.079)	(0.089)	(0.112)	(0.097)	(0.065)	(0.074)	(0.089)	(0.321)	(0.096)	(0.305)	(0.185)	(0.216)	(0.187)	(0.169)	(0.048)	(0.037)	(0.072)
11	-0.054	-0.055	-0.050	-0.028	-0.038	0.012	0.016	0.017	-0.073	0.096	-0.914	-0.046	-0.066	-0.053	-0.055	-0.019	-0.012	-0.015
	(0.016)	(0.015)	(0.017)	(0.019)	(0.018)	(0.012)	(0.013)	(0.016)	(0.145)	(0.049)	(0.249)	(0.034)	(0.039)	(0.034)	(0.030)	(0.008)	(0.007)	(0.013)
12	-0.057	-0.058	-0.053	-0.123	-0.163	0.014	0.018	0.020	-0.021	-0.016	-0.020	-0.447	0.449	0.200	0.162	-0.016	-0.010	-0.013
	(0.019)	(0.018)	(0.019)	(0.028)	(0.021)	(0.017)	(0.019)	(0.023)	(0.014)	(0.012)	(0.014)	(0.081)	(0.127)	(0.095)	(0.166)	(0.009)	(0.007)	(0.010)
13	-0.025	-0.026	-0.023	-0.056	-0.075	0.008	0.010	0.011	-0.008	-0.006	-0.008	0.146	-0.711	-0.003	-0.125	-0.005	-0.003	-0.004
	(0.008)	(0.008)	(0.008)	(0.011)	(0.007)	(0.007)	(0.008)	(0.009)	(0.005)	(0.005)	(0.005)	(0.041)	(0.189)	(0.100)	(0.272)	(0.003)	(0.002)	(0.004)
14	-0.019	-0.019	-0.018	-0.042	-0.055	0.005	0.007	0.007	-0.007	-0.005	-0.006	0.059	-0.003	-0.403	-0.107	-0.005	-0.003	-0.004
	(0.006)	(0.005)	(0.006)	(0.008)	(0.006)	(0.005)	(0.006)	(0.007)	(0.004)	(0.004)	(0.004)	(0.028)	(0.092)	(0.097)	(0.114)	(0.003)	(0.002)	(0.003)
15	-0.009	-0.009	-0.008	-0.020	-0.027	0.003	0.003	0.004	-0.003	-0.002	-0.003	0.022	-0.053	-0.049	-1.693	-0.002	-0.001	-0.002
	(0.003)	(0.003)	(0.003)	(0.004)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.022)	(0.115)	(0.052)	(0.230)	(0.001)	(0.001)	(0.002)
16	-0.016	-0.016	-0.015	-0.015	-0.020	-0.013	-0.017	-0.019	-0.003	-0.002	-0.003	-0.008	-0.011	-0.009	-0.009	-0.204	0.033	-0.032
	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.002)	(0.003)	(0.004)	(0.002)	(0.001)	(0.001)	(0.005)	(0.006)	(0.005)	(0.005)	(0.213)	(0.039)	(0.025)
17	-0.071	-0.071	-0.065	-0.063	-0.084	-0.060	-0.079	-0.085	-0.026	-0.019	-0.024	-0.040	-0.058	-0.046	-0.049	0.169	-0.641	0.193
	(0.011)	(0.011)	(0.012)	(0.020)	(0.014)	(0.009)	(0.012)	(0.015)	(0.009)	(0.007)	(0.008)	(0.024)	(0.026)	(0.024)	(0.025)	(0.221)	(0.146)	(0.078)
18	-0.141	-0.142	-0.130	-0.128	-0.171	-0.118	-0.157	-0.169	-0.039	-0.030	-0.037	-0.074	-0.108	-0.086	-0.090	-0.349	0.362	-0.703
	(0.044)	(0.042)	(0.044)	(0.076)	(0.047)	(0.028)	(0.034)	(0.045)	(0.029)	(0.024)	(0.028)	(0.072)	(0.079)	(0.073)	(0.078)	(0.253)	(0.137)	(0.114)

Table 4. Unconditional Marshallian price and expenditure elasticities cont'd

	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1	0.002	0.001	0.000	0.000	0.001	-0.006	-0.005	-0.007	-0.008	-0.006	-0.004	-0.006	-0.004	0.010	0.048	0.219	0.130	0.914
	(0.013)	(0.012)	(0.005)	(0.005)	(0.010)	(0.030)	(0.016)	(0.021)	(0.056)	(0.037)	(0.037)	(0.054)	(0.061)	(0.027)	(0.037)	(0.075)	(0.047)	(0.059)
2	0.002	0.002	0.000	0.001	0.001	-0.007	-0.006	-0.008	-0.009	-0.007	-0.004	-0.007	-0.005	0.012	0.056	0.255	0.151	0.919
	(0.014)	(0.013)	(0.006)	(0.006)	(0.011)	(0.032)	(0.017)	(0.023)	(0.060)	(0.039)	(0.039)	(0.058)	(0.066)	(0.029)	(0.039)	(0.078)	(0.049)	(0.059)
3	0.000	0.000	0.000	0.000	0.000	-0.012	-0.009	-0.013	-0.014	-0.012	-0.008	-0.012	-0.009	0.015	0.073	0.330	0.195	0.840
	(0.021)	(0.019)	(0.009)	(0.009)	(0.017)	(0.050)	(0.027)	(0.035)	(0.093)	(0.061)	(0.061)	(0.089)	(0.101)	(0.045)	(0.060)	(0.123)	(0.077)	(0.071)
4	-0.025	-0.019	-0.005	-0.007	-0.016	-0.056	-0.043	-0.061	-0.068	0.410	0.267	0.425	0.298	0.015	0.071	0.325	0.192	0.712
	(0.055)	(0.041)	(0.057)	(0.047)	(0.034)	(0.128)	(0.107)	(0.071)	(0.208)	(0.121)	(0.135)	(0.176)	(0.167)	(0.139)	(0.164)	(0.275)	(0.164)	(0.090)
5	-0.006	-0.005	-0.001	-0.002	-0.004	-0.030	-0.023	-0.033	-0.037	0.287	0.187	0.298	0.208	0.011	0.050	0.229	0.135	0.947
	(0.013)	(0.010)	(0.016)	(0.013)	(0.009)	(0.040)	(0.022)	(0.027)	(0.058)	(0.029)	(0.033)	(0.037)	(0.032)	(0.027)	(0.040)	(0.085)	(0.053)	(0.128)
6	-0.019	-0.014	-0.004	-0.005	-0.012	0.065	0.050	0.071	0.080	0.021	0.014	0.022	0.015	0.005	0.025	0.112	0.066	0.876
	(0.033)	(0.030)	(0.014)	(0.013)	(0.026)	(0.080)	(0.035)	(0.060)	(0.152)	(0.087)	(0.093)	(0.114)	(0.089)	(0.021)	(0.048)	(0.174)	(0.108)	(0.051)
7	-0.001	-0.001	0.000	0.000	0.000	0.051	0.039	0.056	0.063	0.026	0.017	0.027	0.019	0.004	0.019	0.085	0.050	1.160
	(0.019)	(0.017)	(0.007)	(0.007)	(0.015)	(0.046)	(0.020)	(0.035)	(0.087)	(0.049)	(0.052)	(0.064)	(0.049)	(0.012)	(0.027)	(0.098)	(0.061)	(0.068)
8	0.001	0.001	0.000	0.000	0.000	0.018	0.014	0.020	0.022	0.010	0.006	0.010	0.007	0.001	0.007	0.030	0.018	1.249
	(0.007)	(0.007)	(0.003)	(0.003)	(0.006)	(0.018)	(0.008)	(0.013)	(0.033)	(0.019)	(0.020)	(0.025)	(0.018)	(0.005)	(0.011)	(0.038)	(0.024)	(0.095)
9	0.008	0.006	0.002	0.002	0.005	-0.022	-0.016	-0.023	-0.026	-0.008	-0.005	-0.008	-0.006	-0.007	-0.034	-0.157	-0.093	1.062
	(0.016)	(0.014)	(0.007)	(0.007)	(0.013)	(0.042)	(0.018)	(0.031)	(0.079)	(0.040)	(0.043)	(0.051)	(0.040)	(0.029)	(0.039)	(0.092)	(0.054)	(0.104)
10	-0.018	-0.014	-0.004	-0.005	-0.012	-0.114	-0.087	-0.124	-0.139	-0.079	-0.052	-0.082	-0.058	-0.029	-0.137	-0.625	-0.370	0.798
	(0.070)	(0.061)	(0.036)	(0.033)	(0.055)	(0.178)	(0.076)	(0.133)	(0.340)	(0.172)	(0.186)	(0.220)	(0.178)	(0.130)	(0.173)	(0.399)	(0.241)	(0.054)
11	0.004	0.003	0.001	0.001	0.003	-0.018	-0.013	-0.019	-0.021	-0.008	-0.005	-0.008	-0.006	-0.006	-0.026	-0.119	-0.070	0.995
	(0.012)	(0.011)	(0.006)	(0.006)	(0.010)	(0.032)	(0.013)	(0.024)	(0.060)	(0.030)	(0.033)	(0.039)	(0.031)	(0.023)	(0.030)	(0.070)	(0.043)	(0.093)
12	0.037	0.028	0.008	0.010	0.024	0.102	0.078	0.111	0.124	0.022	0.014	0.023	0.016	0.004	0.019	0.085	0.050	0.896
	(0.015)	(0.014)	(0.006)	(0.007)	(0.012)	(0.040)	(0.021)	(0.030)	(0.078)	(0.045)	(0.048)	(0.059)	(0.041)	(0.032)	(0.046)	(0.106)	(0.066)	(0.119)
13	0.019	0.015	0.004	0.005	0.012	0.049	0.037	0.053	0.060	0.012	0.008	0.013	0.009	0.002	0.009	0.042	0.025	1.301
	(0.007)	(0.006)	(0.003)	(0.003)	(0.005)	(0.015)	(0.008)	(0.011)	(0.028)	(0.018)	(0.019)	(0.024)	(0.016)	(0.013)	(0.018)	(0.040)	(0.024)	(0.159)
14	0.013	0.010	0.003	0.004	0.008	0.035	0.027	0.038	0.043	0.008	0.005	0.009	0.006	0.001	0.006	0.030	0.017	1.038
	(0.005)	(0.004)	(0.002)	(0.002)	(0.004)	(0.012)	(0.006)	(0.009)	(0.022)	(0.013)	(0.014)	(0.018)	(0.012)	(0.010)	(0.014)	(0.031)	(0.019)	(0.125)
15	0.006	0.005	0.001	0.002	0.004	0.017	0.013	0.018	0.021	0.004	0.003	0.004	0.003	0.001	0.003	0.014	0.008	1.084
	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.005)	(0.003)	(0.004)	(0.009)	(0.006)	(0.006)	(0.008)	(0.005)	(0.004)	(0.006)	(0.013)	(0.008)	(0.196)
16	-0.006	-0.005	-0.001	-0.002	-0.004	0.001	0.000	0.001	0.001	-0.023	-0.015	-0.024	-0.017	0.002	0.011	0.051	0.030	1.304
	(0.002)	(0.002)	(0.004)	(0.003)	(0.002)	(0.004)	(0.002)	(0.003)	(0.009)	(0.004)	(0.003)	(0.005)	(0.005)	(0.002)	(0.003)	(0.007)	(0.004)	(0.159)
17	-0.040	-0.030	-0.008	-0.011	-0.025	-0.010	-0.008	-0.011	-0.013	-0.101	-0.066	-0.105	-0.074	0.008	0.037	0.168	0.099	0.835
	(0.012)	(0.009)	(0.021)	(0.016)	(0.008)	(0.020)	(0.012)	(0.014)	(0.042)	(0.020)	(0.019)	(0.026)	(0.030)	(0.011)	(0.013)	(0.034)	(0.020)	(0.093)
18	-0.068	-0.052	-0.014	-0.018	-0.043	-0.009	-0.007	-0.009	-0.011	-0.203	-0.132	-0.210	-0.147	0.018	0.086	0.390	0.231	1.023
	(0.036)	(0.027)	(0.054)	(0.042)	(0.024)	(0.071)	(0.055)	(0.046)	(0.151)	(0.068)	(0.069)	(0.088)	(0.079)	(0.056)	(0.068)	(0.108)	(0.066)	(0.102)

Table 4 Unconditional Marshallian price and expenditure elasticities cont'd

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
19	0.013	0.013	0.012	0.002	0.003	0.000	0.000	0.000	0.014	0.010	0.013	0.113	0.164	0.131	0.137	-0.030	-0.019	-0.023
	(0.024)	(0.022)	(0.024)	(0.027)	(0.015)	(0.018)	(0.020)	(0.024)	(0.017)	(0.014)	(0.016)	(0.047)	(0.060)	(0.048)	(0.046)	(0.016)	(0.012)	(0.022)
20	0.005	0.005	0.004	-0.004	-0.006	-0.008	-0.010	-0.011	0.004	0.003	0.004	0.103	0.150	0.119	0.125	-0.041	-0.026	-0.032
	(0.027)	(0.025)	(0.027)	(0.029)	(0.018)	(0.020)	(0.023)	(0.028)	(0.019)	(0.016)	(0.018)	(0.053)	(0.066)	(0.053)	(0.050)	(0.020)	(0.014)	(0.022)
21	-0.001	-0.001	-0.001	0.000	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	0.000	0.000	0.000	0.000	-0.001	-0.001	-0.001
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)
22	-0.003	-0.003	-0.003	-0.003	-0.004	-0.003	-0.004	-0.005	-0.003	-0.003	-0.003	0.002	0.002	0.002	0.002	-0.006	-0.004	-0.005
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.004)	(0.005)	(0.004)	(0.004)	(0.002)	(0.002)	(0.003)
23	-0.004	-0.004	-0.003	-0.015	-0.019	-0.021	-0.028	-0.031	-0.006	-0.005	-0.006	0.139	0.202	0.162	0.169	-0.075	-0.048	-0.059
	(0.042)	(0.039)	(0.041)	(0.043)	(0.029)	(0.030)	(0.035)	(0.042)	(0.028)	(0.025)	(0.028)	(0.083)	(0.101)	(0.083)	(0.076)	(0.032)	(0.022)	(0.035)
24	-0.003	-0.003	-0.003	-0.007	-0.009	0.009	0.011	0.012	-0.006	-0.005	-0.006	0.072	0.105	0.084	0.087	-0.003	-0.002	-0.002
	(0.013)	(0.012)	(0.013)	(0.017)	(0.012)	(0.012)	(0.013)	(0.016)	(0.010)	(0.009)	(0.010)	(0.028)	(0.034)	(0.028)	(0.026)	(0.004)	(0.004)	(0.008)
25	0.000	0.000	0.000	-0.001	-0.001	0.001	0.001	0.001	-0.001	-0.001	-0.001	0.006	0.009	0.007	0.007	-0.001	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.000)	(0.000)	(0.001)
26	-0.006	-0.007	-0.006	-0.017	-0.023	0.024	0.032	0.034	-0.015	-0.011	-0.014	0.190	0.276	0.221	0.231	-0.005	-0.003	-0.004
	(0.023)	(0.021)	(0.023)	(0.024)	(0.021)	(0.021)	(0.024)	(0.028)	(0.018)	(0.016)	(0.018)	(0.051)	(0.059)	(0.050)	(0.045)	(0.006)	(0.006)	(0.012)
27	-0.003	-0.003	-0.003	-0.011	-0.015	0.018	0.024	0.026	-0.009	-0.007	-0.008	0.135	0.197	0.157	0.164	-0.002	-0.001	-0.001
	(0.038)	(0.035)	(0.038)	(0.048)	(0.027)	(0.032)	(0.036)	(0.044)	(0.029)	(0.026)	(0.029)	(0.082)	(0.093)	(0.081)	(0.071)	(0.012)	(0.011)	(0.022)
28	0.000	0.000	0.000	0.043	0.057	0.004	0.005	0.006	0.000	0.000	0.000	0.012	0.017	0.014	0.015	-0.016	-0.010	-0.013
	(0.010)	(0.009)	(0.010)	(0.012)	(0.005)	(0.007)	(0.008)	(0.010)	(0.006)	(0.005)	(0.006)	(0.020)	(0.026)	(0.021)	(0.020)	(0.003)	(0.002)	(0.005)
29	-0.003	-0.003	-0.003	0.070	0.093	0.003	0.003	0.004	-0.004	-0.003	-0.004	0.016	0.024	0.019	0.020	-0.034	-0.021	-0.026
	(0.027)	(0.025)	(0.027)	(0.033)	(0.015)	(0.021)	(0.023)	(0.028)	(0.017)	(0.015)	(0.017)	(0.057)	(0.071)	(0.058)	(0.054)	(0.007)	(0.006)	(0.012)
30	0.000	0.000	0.000	0.013	0.017	0.001	0.002	0.002	0.000	0.000	0.000	0.004	0.005	0.004	0.004	-0.005	-0.003	-0.004
	(0.004)	(0.004)	(0.004)	(0.005)	(0.002)	(0.003)	(0.003)	(0.004)	(0.002)	(0.002)	(0.002)	(0.007)	(0.009)	(0.008)	(0.007)	(0.001)	(0.001)	(0.002)
31	0.000	0.000	0.000	0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	-0.001	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
32	-0.001	-0.001	-0.001	-0.002	-0.002	-0.004	-0.005	-0.005	-0.006	-0.005	-0.006	-0.002	-0.004	-0.003	-0.003	-0.005	-0.003	-0.004
	(0.009)	(0.008)	(0.009)	(0.015)	(0.006)	(0.002)	(0.002)	(0.003)	(0.004)	(0.004)	(0.004)	(0.015)	(0.019)	(0.015)	(0.014)	(0.002)	(0.002)	(0.003)
33	0.011	0.011	0.010	0.005	0.006	-0.001	-0.001	-0.002	-0.009	-0.007	-0.009	0.005	0.008	0.006	0.006	0.003	0.002	0.002
	(0.011)	(0.010)	(0.011)	(0.017)	(0.008)	(0.004)	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)	(0.021)	(0.025)	(0.021)	(0.019)	(0.002)	(0.002)	(0.004)
34	0.198	0.199	0.182	0.104	0.139	0.033	0.043	0.047	-0.073	-0.055	-0.068	0.122	0.177	0.142	0.148	0.107	0.069	0.084
	(0.064)	(0.058)	(0.063)	(0.084)	(0.048)	(0.045)	(0.051)	(0.062)	(0.044)	(0.038)	(0.041)	(0.143)	(0.166)	(0.144)	(0.128)	(0.012)	(0.011)	(0.021)
35	0.113	0.114	0.104	0.058	0.077	0.014	0.019	0.020	-0.051	-0.038	-0.047	0.068	0.098	0.079	0.082	0.056	0.036	0.044
	(0.041)	(0.037)	(0.040)	(0.050)	(0.030)	(0.028)	(0.032)	(0.039)	(0.026)	(0.023)	(0.025)	(0.091)	(0.104)	(0.090)	(0.079)	(0.007)	(0.006)	(0.014)

Table 4. Unconditional Marshallian price and expenditure elasticities cont'd

	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
19	-0.828	0.002	-1.058	-0.725	-0.052	0.089	0.068	0.096	0.108	0.081	0.053	0.084	0.059	-0.005	-0.024	-0.111	-0.066	1.235
	(0.104)	(0.062)	(0.323)	(0.270)	(0.058)	(0.043)	(0.020)	(0.031)	(0.081)	(0.050)	(0.052)	(0.069)	(0.061)	(0.015)	(0.029)	(0.105)	(0.063)	(0.153)
20	-0.009	-1.097	2.396	0.520	0.064	0.079	0.061	0.086	0.097	0.068	0.044	0.070	0.049	-0.006	-0.026	-0.120	-0.071	0.948
	(0.082)	(0.139)	(0.721)	(0.533)	(0.071)	(0.048)	(0.022)	(0.035)	(0.092)	(0.052)	(0.057)	(0.072)	(0.065)	(0.017)	(0.033)	(0.118)	(0.072)	(0.076)
21	-0.030	0.051	-0.544	-0.187	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.002	-0.001	0.256
	(0.009)	(0.016)	(0.390)	(0.092)	(0.010)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.002)	(0.001)	(0.305)
22	-0.130	0.067	-1.173	-0.354	0.032	0.001	0.001	0.001	0.001	-0.001	-0.001	-0.001	-0.001	0.000	-0.002	-0.010	-0.006	0.329
	(0.048)	(0.071)	(0.568)	(0.549)	(0.042)	(0.003)	(0.002)	(0.002)	(0.006)	(0.005)	(0.006)	(0.007)	(0.005)	(0.001)	(0.002)	(0.009)	(0.005)	(0.256)
23	-0.146	0.101	0.143	0.442	-0.894	0.106	0.081	0.115	0.129	0.084	0.055	0.087	0.061	-0.009	-0.041	-0.189	-0.112	0.790
	(0.137)	(0.122)	(0.794)	(0.555)	(0.103)	(0.074)	(0.034)	(0.056)	(0.145)	(0.081)	(0.092)	(0.110)	(0.095)	(0.024)	(0.050)	(0.179)	(0.110)	(0.082)
24	0.020	0.015	0.004	0.005	0.013	-0.820	0.378	-0.256	0.261	-0.083	-0.054	-0.086	-0.060	0.000	-0.001	-0.005	-0.003	0.869
	(0.011)	(0.009)	(0.004)	(0.004)	(0.008)	(0.225)	(0.352)	(0.092)	(0.219)	(0.040)	(0.038)	(0.055)	(0.063)	(0.008)	(0.016)	(0.060)	(0.037)	(0.203)
25	0.001	0.001	0.000	0.000	0.001	0.043	-0.023	-0.020	-0.054	-0.008	-0.005	-0.008	-0.006	0.000	0.000	-0.001	0.000	0.665
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.043)	(0.321)	(0.031)	(0.061)	(0.003)	(0.003)	(0.004)	(0.003)	(0.000)	(0.001)	(0.003)	(0.002)	(0.166)
26	0.054	0.041	0.011	0.014	0.034	-0.616	-0.409	-0.541	-0.423	-0.215	-0.140	-0.223	-0.156	-0.001	-0.003	-0.012	-0.007	0.944
	(0.018)	(0.016)	(0.007)	(0.007)	(0.014)	(0.224)	(0.651)	(0.274)	(0.468)	(0.062)	(0.059)	(0.087)	(0.110)	(0.013)	(0.028)	(0.104)	(0.063)	(0.103)
27	0.040	0.030	0.008	0.011	0.025	0.398	-0.707	-0.264	-1.205	-0.150	-0.097	-0.155	-0.109	0.000	-0.001	-0.007	-0.004	1.058
	(0.030)	(0.026)	(0.012)	(0.012)	(0.023)	(0.332)	(0.793)	(0.294)	(0.634)	(0.115)	(0.110)	(0.156)	(0.178)	(0.022)	(0.046)	(0.173)	(0.105)	(0.217)
28	0.014	0.010	0.003	0.004	0.009	-0.051	-0.039	-0.055	-0.062	-1.036	-0.011	-0.158	-0.946	-0.002	-0.009	-0.040	-0.024	1.292
	(0.008)	(0.007)	(0.005)	(0.005)	(0.006)	(0.025)	(0.017)	(0.016)	(0.046)	(0.301)	(0.105)	(0.337)	(0.943)	(0.008)	(0.013)	(0.043)	(0.026)	(0.186)
29	0.018	0.014	0.004	0.005	0.011	-0.091	-0.070	-0.099	-0.111	-0.034	-0.821	0.346	2.056	-0.003	-0.016	-0.074	-0.044	0.841
	(0.021)	(0.018)	(0.015)	(0.012)	(0.016)	(0.062)	(0.045)	(0.040)	(0.118)	(0.273)	(0.175)	(0.493)	(0.992)	(0.023)	(0.037)	(0.115)	(0.069)	(0.112)
30	0.004	0.003	0.001	0.001	0.003	-0.015	-0.011	-0.016	-0.018	-0.045	0.039	-1.392	0.017	-0.001	-0.003	-0.012	-0.007	1.339
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.009)	(0.006)	(0.006)	(0.018)	(0.095)	(0.053)	(0.249)	(0.424)	(0.003)	(0.005)	(0.015)	(0.009)	(0.318)
31	0.000	0.000	0.000	0.000	0.000	-0.002	-0.001	-0.002	-0.002	-0.046	0.038	0.003	-0.026	0.000	0.000	-0.001	-0.001	0.938
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.002)	(0.001)	(0.001)	(0.003)	(0.045)	(0.018)	(0.073)	(1.020)	(0.000)	(0.001)	(0.002)	(0.001)	(0.533)
32	-0.007	-0.005	-0.001	-0.002	-0.004	-0.004	-0.003	-0.005	-0.005	-0.008	-0.005	-0.009	-0.006	-0.238	-0.111	0.201	-0.116	0.056
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.005)	(0.003)	(0.004)	(0.010)	(0.009)	(0.009)	(0.011)	(0.008)	(0.202)	(0.181)	(0.039)	(0.099)	(0.144)
33	-0.009	-0.007	-0.002	-0.002	-0.006	-0.004	-0.003	-0.004	-0.005	-0.014	-0.009	-0.015	-0.010	-0.103	-0.282	0.206	-0.163	0.261
	(0.005)	(0.004)	(0.002)	(0.002)	(0.004)	(0.010)	(0.004)	(0.008)	(0.019)	(0.013)	(0.014)	(0.018)	(0.013)	(0.173)	(0.245)	(0.044)	(0.112)	(0.165)
34	-0.058	-0.044	-0.012	-0.015	-0.037	-0.007	-0.005	-0.008	-0.008	-0.128	-0.083	-0.133	-0.093	0.614	0.644	-1.559	0.030	1.192
	(0.049)	(0.043)	(0.021)	(0.021)	(0.037)	(0.114)	(0.054)	(0.083)	(0.218)	(0.128)	(0.132)	(0.162)	(0.144)	(0.115)	(0.135)	(0.370)	(0.230)	(0.181)
35	-0.043	-0.033	-0.009	-0.011	-0.027	-0.010	-0.007	-0.011	-0.012	-0.085	-0.056	-0.088	-0.062	-0.326	-0.499	0.024	-1.301	0.705
	(0.029)	(0.026)	(0.012)	(0.012)	(0.023)	(0.071)	(0.033)	(0.051)	(0.134)	(0.077)	(0.080)	(0.097)	(0.085)	(0.290)	(0.344)	(0.235)	(0.243)	(0.111)

Fresh green vegetables (1); Other fresh vegetables(2); Processed vegetables excluding processed potatoes (3);Fresh Fruits (4); Processed Fruits (5);Milk and milk products excluding cheese (6); Cheese (7); Eggs (8);Carcase meat (9); Non-carcase meat and meat products (10); Fish (11); Butter (12); Margarine (13); Vegetable and salad oils (14); All other fats (15); Sugar and preserves (16); Cakes, buns and pastries (17); Confectionery (18); Fresh and processed potatoes (19); Bread (20); Flour (21); Biscuits and crispbreads (22); Other cereals and cereal products (23); Soups (24); Spreads and dressings (25); Pickles and sauces (26); Other take away and meals (27); (28) Tea; (29) Coffee; (30) Cocoa and chocolate drinks; (31) Malt drinks and chocolate versions of malted drinks; (32) Mineral or spring waters; (33) Soft drinks, concentrated, not low calorie; (34) Soft drinks, not concentrated, not low calorie; (35) Soft drinks, not concentrated, low calorie; (36) Expenditure. Bootstrap standard errors are in brackets

Table 4. Unconditional Hicksian price and expenditure elasticities

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	-0.906	0.152	0.190	0.024	0.032	0.012	0.016	0.018	-0.022	-0.016	-0.020	-0.076	-0.110	-0.088	-0.092	-0.024	-0.015	-0.019
	(0.063)	(0.072)	(0.035)	(0.022)	(0.019)	(0.013)	(0.015)	(0.018)	(0.012)	(0.009)	(0.010)	(0.031)	(0.041)	(0.033)	(0.033)	(0.009)	(0.006)	(0.012)
2	0.085	-0.334	-0.111	0.028	0.037	0.014	0.019	0.020	-0.025	-0.019	-0.024	-0.088	-0.128	-0.102	-0.107	-0.028	-0.018	-0.022
	(0.095)	(0.089)	(0.038)	(0.023)	(0.020)	(0.014)	(0.016)	(0.020)	(0.013)	(0.010)	(0.011)	(0.033)	(0.044)	(0.035)	(0.035)	(0.009)	(0.006)	(0.013)
3	0.314	-0.160	-0.986	0.037	0.049	0.019	0.025	0.027	-0.033	-0.025	-0.031	-0.116	-0.168	-0.134	-0.140	-0.036	-0.023	-0.028
	(0.058)	(0.054)	(0.063)	(0.038)	(0.031)	(0.022)	(0.025)	(0.030)	(0.019)	(0.016)	(0.018)	(0.051)	(0.067)	(0.053)	(0.054)	(0.015)	(0.010)	(0.019)
4	0.071	0.071	0.065	-0.192	0.063	-0.003	-0.004	-0.004	-0.022	-0.016	-0.020	-0.544	-0.790	-0.631	-0.659	-0.073	-0.047	-0.058
	(0.063)	(0.057)	(0.064)	(0.156)	(0.122)	(0.042)	(0.049)	(0.058)	(0.053)	(0.037)	(0.040)	(0.135)	(0.159)	(0.124)	(0.150)	(0.030)	(0.023)	(0.054)
5	0.047	0.048	0.044	0.032	-1.224	-0.002	-0.003	-0.003	-0.015	-0.011	-0.014	-0.366	-0.532	-0.425	-0.443	-0.049	-0.032	-0.039
	(0.028)	(0.026)	(0.027)	(0.062)	(0.115)	(0.009)	(0.010)	(0.012)	(0.015)	(0.012)	(0.014)	(0.049)	(0.049)	(0.046)	(0.039)	(0.009)	(0.007)	(0.016)
6	0.044	0.044	0.040	0.000	0.000	-0.419	-0.458	-0.077	0.086	0.065	0.081	0.125	0.182	0.145	0.152	-0.057	-0.036	-0.044
	(0.044)	(0.041)	(0.043)	(0.046)	(0.019)	(0.121)	(0.193)	(0.624)	(0.030)	(0.025)	(0.027)	(0.091)	(0.114)	(0.091)	(0.087)	(0.024)	(0.016)	(0.027)
7	0.029	0.029	0.026	0.000	0.000	-0.245	-0.596	0.672	0.057	0.043	0.053	0.083	0.120	0.096	0.100	-0.037	-0.024	-0.029
	(0.025)	(0.023)	(0.025)	(0.026)	(0.011)	(0.096)	(0.172)	(0.647)	(0.018)	(0.014)	(0.016)	(0.052)	(0.065)	(0.052)	(0.049)	(0.014)	(0.010)	(0.016)
8	0.010	0.010	0.009	0.000	0.000	-0.013	0.215	-0.499	0.020	0.015	0.018	0.029	0.042	0.033	0.035	-0.013	-0.008	-0.010
	(0.010)	(0.009)	(0.009)	(0.010)	(0.004)	(0.100)	(0.207)	(0.157)	(0.007)	(0.006)	(0.006)	(0.020)	(0.025)	(0.020)	(0.019)	(0.005)	(0.004)	(0.007)
9	-0.041	-0.041	-0.038	-0.013	-0.017	0.047	0.062	0.066	-0.977	0.145	-0.057	-0.030	-0.044	-0.035	-0.036	0.019	0.012	0.015
	(0.022)	(0.020)	(0.021)	(0.030)	(0.019)	(0.016)	(0.019)	(0.023)	(0.371)	(0.064)	(0.178)	(0.039)	(0.049)	(0.040)	(0.038)	(0.007)	(0.007)	(0.016)
10	-0.151	-0.152	-0.139	-0.048	-0.064	0.172	0.228	0.245	0.712	-0.495	0.720	-0.111	-0.160	-0.128	-0.134	0.072	0.046	0.056
	(0.085)	(0.078)	(0.085)	(0.108)	(0.077)	(0.066)	(0.077)	(0.093)	(0.316)	(0.089)	(0.311)	(0.169)	(0.202)	(0.170)	(0.155)	(0.031)	(0.030)	(0.064)
11	-0.031	-0.031	-0.028	-0.010	-0.013	0.035	0.046	0.050	-0.045	0.117	-0.888	-0.022	-0.033	-0.026	-0.027	0.015	0.009	0.011
	(0.016)	(0.014)	(0.016)	(0.019)	(0.014)	(0.012)	(0.014)	(0.017)	(0.142)	(0.051)	(0.259)	(0.031)	(0.036)	(0.031)	(0.028)	(0.006)	(0.005)	(0.011)
12	-0.048	-0.048	-0.044	-0.115	-0.153	0.024	0.031	0.034	-0.009	-0.007	-0.009	-0.438	0.463	0.211	0.174	-0.002	-0.001	-0.001
	(0.020)	(0.018)	(0.020)	(0.028)	(0.020)	(0.017)	(0.019)	(0.022)	(0.013)	(0.011)	(0.013)	(0.079)	(0.134)	(0.093)	(0.176)	(0.007)	(0.006)	(0.010)
13	-0.022	-0.022	-0.020	-0.054	-0.072	0.011	0.015	0.016	-0.004	-0.003	-0.004	0.149	-0.707	0.001	-0.122	-0.001	-0.001	-0.001
	(0.008)	(0.008)	(0.008)	(0.011)	(0.007)	(0.007)	(0.008)	(0.009)	(0.005)	(0.004)	(0.005)	(0.043)	(0.179)	(0.098)	(0.264)	(0.003)	(0.002)	(0.004)
14	-0.016	-0.016	-0.015	-0.039	-0.052	0.008	0.011	0.011	-0.003	-0.002	-0.003	0.062	0.001	-0.399	-0.103	-0.001	0.000	0.000
	(0.006)	(0.006)	(0.006)	(0.008)	(0.006)	(0.005)	(0.006)	(0.007)	(0.004)	(0.003)	(0.004)	(0.028)	(0.090)	(0.102)	(0.111)	(0.002)	(0.002)	(0.003)
15	-0.008	-0.008	-0.007	-0.019	-0.025	0.004	0.005	0.006	-0.002	-0.001	-0.001	0.024	-0.051	-0.048	-1.692	0.000	0.000	0.000
	(0.003)	(0.003)	(0.003)	(0.004)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.001)	(0.002)	(0.023)	(0.111)	(0.051)	(0.212)	(0.001)	(0.001)	(0.002)
16	-0.010	-0.010	-0.009	-0.010	-0.013	-0.007	-0.009	-0.010	0.005	0.004	0.004	-0.001	-0.002	-0.001	-0.001	-0.194	0.039	-0.025
	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)	(0.005)	(0.005)	(0.004)	(0.004)	(0.213)	(0.040)	(0.026)
17	-0.034	-0.034	-0.031	-0.035	-0.046	-0.025	-0.033	-0.036	0.017	0.013	0.016	-0.004	-0.006	-0.005	-0.005	0.221	-0.608	0.234
	(0.011)	(0.010)	(0.011)	(0.017)	(0.010)	(0.009)	(0.010)	(0.013)	(0.007)	(0.006)	(0.007)	(0.022)	(0.024)	(0.021)	(0.020)	(0.225)	(0.146)	(0.078)
18	-0.076	-0.076	-0.069	-0.077	-0.102	-0.055	-0.073	-0.079	0.037	0.028	0.035	-0.010	-0.014	-0.011	-0.012	-0.255	0.422	-0.629
	(0.043)	(0.041)	(0.042)	(0.070)	(0.040)	(0.027)	(0.033)	(0.042)	(0.026)	(0.023)	(0.025)	(0.068)	(0.076)	(0.069)	(0.071)	(0.266)	(0.142)	(0.115)

Table 4. Unconditional Hicksian price and expenditure elasticities cont'd

	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1	0.023	0.018	0.005	0.006	0.015	0.009	0.007	0.009	0.011	0.016	0.011	0.017	0.012	0.011	0.053	0.240	0.142
	(0.013)	(0.011)	(0.009)	(0.008)	(0.010)	(0.028)	(0.015)	(0.021)	(0.056)	(0.036)	(0.036)	(0.050)	(0.051)	(0.031)	(0.038)	(0.076)	(0.047)
2	0.027	0.021	0.006	0.007	0.017	0.010	0.008	0.011	0.012	0.019	0.012	0.020	0.014	0.013	0.061	0.278	0.165
	(0.014)	(0.012)	(0.010)	(0.008)	(0.011)	(0.030)	(0.016)	(0.022)	(0.060)	(0.038)	(0.038)	(0.053)	(0.054)	(0.033)	(0.041)	(0.079)	(0.050)
3	0.035	0.027	0.007	0.009	0.022	0.013	0.010	0.014	0.016	0.025	0.016	0.026	0.018	0.017	0.080	0.365	0.216
	(0.021)	(0.018)	(0.015)	(0.013)	(0.017)	(0.047)	(0.025)	(0.034)	(0.092)	(0.058)	(0.059)	(0.082)	(0.084)	(0.050)	(0.063)	(0.123)	(0.077)
4	0.038	0.029	0.008	0.010	0.024	-0.011	-0.009	-0.012	-0.014	0.476	0.310	0.494	0.346	0.018	0.085	0.386	0.228
	(0.049)	(0.039)	(0.042)	(0.036)	(0.032)	(0.122)	(0.098)	(0.070)	(0.209)	(0.122)	(0.134)	(0.183)	(0.189)	(0.149)	(0.169)	(0.263)	(0.151)
5	0.026	0.020	0.005	0.007	0.016	-0.008	-0.006	-0.008	-0.009	0.321	0.209	0.332	0.233	0.012	0.057	0.260	0.154
	(0.010)	(0.009)	(0.009)	(0.008)	(0.008)	(0.036)	(0.019)	(0.024)	(0.055)	(0.029)	(0.034)	(0.038)	(0.040)	(0.031)	(0.042)	(0.086)	(0.053)
6	0.053	0.041	0.011	0.014	0.034	0.116	0.089	0.126	0.141	0.096	0.063	0.100	0.070	0.008	0.040	0.182	0.107
	(0.033)	(0.029)	(0.015)	(0.016)	(0.025)	(0.081)	(0.036)	(0.059)	(0.149)	(0.083)	(0.090)	(0.104)	(0.072)	(0.023)	(0.049)	(0.175)	(0.107)
7	0.035	0.027	0.007	0.009	0.023	0.077	0.059	0.083	0.093	0.064	0.041	0.066	0.046	0.006	0.026	0.120	0.071
	(0.018)	(0.016)	(0.009)	(0.009)	(0.014)	(0.047)	(0.021)	(0.034)	(0.086)	(0.047)	(0.052)	(0.060)	(0.042)	(0.013)	(0.028)	(0.100)	(0.061)
8	0.012	0.009	0.003	0.003	0.008	0.027	0.020	0.029	0.032	0.022	0.014	0.023	0.016	0.002	0.009	0.041	0.025
	(0.007)	(0.006)	(0.003)	(0.004)	(0.006)	(0.018)	(0.008)	(0.013)	(0.033)	(0.018)	(0.020)	(0.023)	(0.016)	(0.005)	(0.011)	(0.039)	(0.024)
9	0.048	0.037	0.010	0.013	0.031	0.007	0.005	0.007	0.008	0.034	0.022	0.036	0.025	-0.006	-0.026	-0.118	-0.070
	(0.016)	(0.014)	(0.008)	(0.008)	(0.012)	(0.044)	(0.018)	(0.031)	(0.078)	(0.042)	(0.044)	(0.052)	(0.038)	(0.026)	(0.035)	(0.092)	(0.055)
10	0.179	0.137	0.037	0.048	0.114	0.025	0.019	0.027	0.030	0.127	0.082	0.131	0.092	-0.020	-0.095	-0.435	-0.257
	(0.068)	(0.060)	(0.032)	(0.033)	(0.052)	(0.182)	(0.075)	(0.133)	(0.338)	(0.177)	(0.189)	(0.218)	(0.158)	(0.115)	(0.153)	(0.396)	(0.241)
11	0.036	0.028	0.007	0.010	0.023	0.005	0.004	0.005	0.006	0.026	0.017	0.027	0.019	-0.004	-0.019	-0.088	-0.052
	(0.012)	(0.011)	(0.006)	(0.006)	(0.009)	(0.033)	(0.013)	(0.024)	(0.060)	(0.031)	(0.034)	(0.039)	(0.028)	(0.021)	(0.028)	(0.071)	(0.044)
12	0.050	0.039	0.010	0.013	0.032	0.111	0.085	0.121	0.135	0.036	0.024	0.037	0.026	0.005	0.021	0.098	0.058
	(0.016)	(0.014)	(0.009)	(0.008)	(0.013)	(0.039)	(0.022)	(0.030)	(0.076)	(0.046)	(0.051)	(0.059)	(0.041)	(0.034)	(0.045)	(0.102)	(0.065)
13	0.024	0.018	0.005	0.006	0.015	0.052	0.040	0.057	0.063	0.017	0.011	0.018	0.012	0.002	0.010	0.046	0.027
	(0.007)	(0.006)	(0.004)	(0.003)	(0.005)	(0.015)	(0.009)	(0.011)	(0.026)	(0.018)	(0.020)	(0.023)	(0.016)	(0.013)	(0.017)	(0.039)	(0.024)
14	0.017	0.013	0.004	0.005	0.011	0.038	0.029	0.041	0.046	0.012	0.008	0.013	0.009	0.002	0.007	0.033	0.020
	(0.005)	(0.004)	(0.003)	(0.003)	(0.004)	(0.011)	(0.007)	(0.008)	(0.022)	(0.014)	(0.015)	(0.017)	(0.012)	(0.010)	(0.013)	(0.031)	(0.019)
15	0.008	0.006	0.002	0.002	0.005	0.018	0.014	0.020	0.022	0.006	0.004	0.006	0.004	0.001	0.004	0.016	0.010
	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.005)	(0.003)	(0.003)	(0.009)	(0.006)	(0.006)	(0.008)	(0.005)	(0.004)	(0.005)	(0.013)	(0.008)
16	0.003	0.002	0.001	0.001	0.002	0.007	0.005	0.007	0.008	-0.014	-0.009	-0.014	-0.010	0.003	0.013	0.060	0.035
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.005)	(0.003)	(0.003)	(0.008)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.007)	(0.004)
17	0.010	0.007	0.002	0.003	0.006	0.024	0.019	0.026	0.030	-0.050	-0.032	-0.052	-0.036	0.010	0.047	0.215	0.127
	(0.008)	(0.007)	(0.008)	(0.007)	(0.006)	(0.023)	(0.016)	(0.014)	(0.041)	(0.016)	(0.017)	(0.020)	(0.015)	(0.017)	(0.018)	(0.035)	(0.021)
18	0.021	0.016	0.004	0.006	0.014	0.054	0.041	0.059	0.066	-0.110	-0.072	-0.114	-0.080	0.022	0.104	0.476	0.281
	(0.029)	(0.024)	(0.031)	(0.025)	(0.020)	(0.077)	(0.063)	(0.042)	(0.139)	(0.063)	(0.066)	(0.079)	(0.057)	(0.065)	(0.074)	(0.114)	(0.069)

Table 4. Unconditional Hicksian price and expenditure elasticities cont'd

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
18	0.041	0.042	0.038	0.024	0.032	0.027	0.036	0.039	0.046	0.035	0.044	0.140	0.204	0.163	0.170	0.010	0.007
	(0.023)	(0.021)	(0.023)	(0.026)	(0.012)	(0.017)	(0.020)	(0.023)	(0.016)	(0.014)	(0.015)	(0.048)	(0.062)	(0.049)	(0.048)	(0.012)	(0.010)
19	0.041	0.041	0.037	0.024	0.031	0.027	0.035	0.038	0.046	0.034	0.043	0.138	0.201	0.160	0.167	0.010	0.007
	(0.025)	(0.024)	(0.025)	(0.028)	(0.014)	(0.020)	(0.022)	(0.027)	(0.018)	(0.015)	(0.017)	(0.054)	(0.068)	(0.056)	(0.052)	(0.014)	(0.011)
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
21	0.002	0.002	0.002	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.006	0.009	0.007	0.008	0.000	0.000
	(0.002)	(0.002)	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.004)	(0.005)	(0.004)	(0.004)	(0.002)	(0.002)
22	0.059	0.059	0.054	0.034	0.046	0.039	0.051	0.055	0.066	0.050	0.062	0.201	0.292	0.233	0.243	0.015	0.010
	(0.040)	(0.037)	(0.040)	(0.041)	(0.022)	(0.030)	(0.034)	(0.041)	(0.027)	(0.024)	(0.026)	(0.085)	(0.103)	(0.086)	(0.078)	(0.021)	(0.017)
23	0.004	0.004	0.004	-0.001	-0.002	0.015	0.020	0.022	0.002	0.001	0.002	0.079	0.115	0.092	0.096	0.007	0.005
	(0.013)	(0.012)	(0.013)	(0.018)	(0.011)	(0.011)	(0.013)	(0.015)	(0.011)	(0.009)	(0.010)	(0.027)	(0.033)	(0.027)	(0.026)	(0.005)	(0.004)
24	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.002	0.000	0.000	0.000	0.007	0.010	0.008	0.008	0.001	0.000
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.000)	(0.000)
25	0.011	0.011	0.010	-0.004	-0.005	0.040	0.053	0.057	0.005	0.004	0.005	0.207	0.301	0.240	0.251	0.019	0.012
	(0.022)	(0.020)	(0.022)	(0.024)	(0.017)	(0.020)	(0.023)	(0.027)	(0.018)	(0.016)	(0.018)	(0.050)	(0.057)	(0.048)	(0.043)	(0.007)	(0.006)
26	0.007	0.008	0.007	-0.003	-0.003	0.028	0.038	0.040	0.003	0.003	0.003	0.146	0.212	0.169	0.177	0.014	0.009
	(0.039)	(0.036)	(0.038)	(0.049)	(0.025)	(0.031)	(0.036)	(0.043)	(0.029)	(0.026)	(0.028)	(0.080)	(0.088)	(0.079)	(0.068)	(0.012)	(0.010)
27	0.005	0.005	0.005	0.047	0.062	0.008	0.011	0.012	0.006	0.004	0.005	0.016	0.024	0.019	0.020	-0.010	-0.006
	(0.010)	(0.009)	(0.010)	(0.012)	(0.006)	(0.007)	(0.008)	(0.010)	(0.006)	(0.006)	(0.006)	(0.021)	(0.026)	(0.021)	(0.020)	(0.002)	(0.002)
28	0.008	0.009	0.008	0.080	0.106	0.014	0.019	0.020	0.010	0.007	0.009	0.028	0.041	0.033	0.034	-0.016	-0.011
	(0.027)	(0.025)	(0.027)	(0.033)	(0.017)	(0.020)	(0.023)	(0.028)	(0.018)	(0.016)	(0.017)	(0.060)	(0.072)	(0.060)	(0.055)	(0.006)	(0.006)
29	0.001	0.001	0.001	0.014	0.018	0.002	0.003	0.003	0.002	0.001	0.002	0.005	0.007	0.006	0.006	-0.003	-0.002
	(0.004)	(0.004)	(0.004)	(0.005)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.007)	(0.009)	(0.008)	(0.007)	(0.001)	(0.001)
30	0.000	0.000	0.000	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
31	0.003	0.003	0.003	0.002	0.002	0.001	0.001	0.001	-0.001	-0.001	-0.001	0.002	0.003	0.002	0.003	0.002	0.001
	(0.009)	(0.008)	(0.009)	(0.015)	(0.006)	(0.002)	(0.002)	(0.003)	(0.004)	(0.004)	(0.004)	(0.015)	(0.019)	(0.016)	(0.014)	(0.001)	(0.002)
32	0.015	0.015	0.014	0.008	0.011	0.003	0.004	0.005	-0.004	-0.003	-0.004	0.010	0.014	0.011	0.012	0.009	0.006
	(0.011)	(0.010)	(0.011)	(0.016)	(0.008)	(0.004)	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)	(0.020)	(0.024)	(0.020)	(0.018)	(0.002)	(0.002)
33	0.212	0.213	0.194	0.115	0.153	0.046	0.061	0.066	-0.057	-0.043	-0.053	0.136	0.197	0.157	0.164	0.127	0.081
	(0.065)	(0.059)	(0.064)	(0.080)	(0.050)	(0.046)	(0.052)	(0.063)	(0.044)	(0.038)	(0.043)	(0.140)	(0.164)	(0.143)	(0.128)	(0.013)	(0.012)
34	0.127	0.128	0.117	0.069	0.092	0.028	0.037	0.040	-0.034	-0.026	-0.032	0.082	0.119	0.095	0.099	0.076	0.049
	(0.042)	(0.038)	(0.041)	(0.046)	(0.032)	(0.028)	(0.033)	(0.039)	(0.027)	(0.024)	(0.026)	(0.090)	(0.104)	(0.091)	(0.080)	(0.008)	(0.007)

Table 4. Unconditional Hicksian price and expenditure elasticities cont'd

	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
19	0.003	0.002	0.001	0.001	0.002	0.007	0.005	0.007	0.008	-0.014	-0.009	-0.014	-0.010	0.003	0.013	0.060	0.035
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.005)	(0.003)	(0.003)	(0.008)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.007)	(0.004)
20	0.010	0.007	0.002	0.003	0.006	0.024	0.019	0.026	0.030	-0.050	-0.032	-0.052	-0.036	0.010	0.047	0.215	0.127
	(0.008)	(0.007)	(0.008)	(0.007)	(0.006)	(0.023)	(0.016)	(0.014)	(0.041)	(0.016)	(0.017)	(0.020)	(0.015)	(0.017)	(0.018)	(0.035)	(0.021)
21	0.021	0.016	0.004	0.006	0.014	0.054	0.041	0.059	0.066	-0.110	-0.072	-0.114	-0.080	0.022	0.104	0.476	0.281
	(0.029)	(0.024)	(0.031)	(0.025)	(0.020)	(0.077)	(0.063)	(0.042)	(0.139)	(0.063)	(0.066)	(0.079)	(0.057)	(0.065)	(0.074)	(0.114)	(0.069)
22	-0.787	0.033	-1.050	-0.714	-0.026	0.115	0.088	0.125	0.141	0.120	0.078	0.125	0.087	-0.003	-0.016	-0.075	-0.044
	(0.103)	(0.063)	(0.320)	(0.277)	(0.063)	(0.040)	(0.019)	(0.029)	(0.075)	(0.051)	(0.052)	(0.071)	(0.071)	(0.020)	(0.030)	(0.102)	(0.061)
23	0.039	-1.060	2.406	0.533	0.095	0.114	0.087	0.124	0.138	0.119	0.077	0.123	0.086	-0.003	-0.016	-0.073	-0.043
	(0.080)	(0.136)	(0.683)	(0.513)	(0.067)	(0.045)	(0.022)	(0.033)	(0.086)	(0.053)	(0.058)	(0.075)	(0.078)	(0.023)	(0.034)	(0.115)	(0.069)
24	-0.029	0.052	-0.544	-0.187	0.002	0.001	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.000	0.000	0.000	0.000
	(0.009)	(0.015)	(0.389)	(0.090)	(0.010)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
25	-0.123	0.072	-1.171	-0.352	0.036	0.005	0.004	0.006	0.006	0.005	0.004	0.006	0.004	0.000	-0.001	-0.003	-0.002
	(0.048)	(0.069)	(0.559)	(0.571)	(0.046)	(0.003)	(0.001)	(0.002)	(0.006)	(0.005)	(0.006)	(0.007)	(0.006)	(0.001)	(0.002)	(0.008)	(0.005)
26	-0.063	0.164	0.160	0.464	-0.842	0.165	0.126	0.180	0.201	0.172	0.112	0.179	0.125	-0.005	-0.023	-0.107	-0.063
	(0.140)	(0.117)	(0.788)	(0.593)	(0.102)	(0.069)	(0.035)	(0.051)	(0.135)	(0.081)	(0.093)	(0.113)	(0.118)	(0.035)	(0.054)	(0.175)	(0.107)
27	0.029	0.023	0.006	0.008	0.019	-0.814	0.383	-0.249	0.270	-0.073	-0.048	-0.076	-0.053	0.000	0.001	0.004	0.002
	(0.010)	(0.009)	(0.005)	(0.004)	(0.008)	(0.212)	(0.358)	(0.092)	(0.208)	(0.039)	(0.038)	(0.054)	(0.060)	(0.009)	(0.017)	(0.054)	(0.034)
28	0.003	0.002	0.001	0.001	0.002	0.044	-0.023	-0.019	-0.053	-0.006	-0.004	-0.007	-0.005	0.000	0.000	0.000	0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.043)	(0.312)	(0.031)	(0.061)	(0.003)	(0.003)	(0.004)	(0.004)	(0.000)	(0.001)	(0.003)	(0.002)
29	0.077	0.059	0.016	0.020	0.049	-0.599	-0.397	-0.523	-0.403	-0.191	-0.124	-0.198	-0.139	0.000	0.002	0.010	0.006
	(0.017)	(0.015)	(0.008)	(0.008)	(0.013)	(0.222)	(0.650)	(0.272)	(0.454)	(0.060)	(0.059)	(0.086)	(0.102)	(0.016)	(0.030)	(0.096)	(0.060)
30	0.054	0.042	0.011	0.014	0.035	0.408	-0.699	-0.253	-1.193	-0.135	-0.088	-0.139	-0.098	0.000	0.002	0.007	0.004
	(0.028)	(0.025)	(0.013)	(0.014)	(0.022)	(0.315)	(0.797)	(0.285)	(0.609)	(0.113)	(0.111)	(0.161)	(0.173)	(0.026)	(0.048)	(0.165)	(0.101)
31	0.020	0.015	0.004	0.005	0.013	-0.047	-0.036	-0.051	-0.057	-1.026	-0.005	-0.148	-0.938	-0.002	-0.008	-0.034	-0.020
	(0.008)	(0.007)	(0.006)	(0.005)	(0.006)	(0.024)	(0.018)	(0.016)	(0.045)	(0.297)	(0.103)	(0.324)	(0.930)	(0.010)	(0.013)	(0.044)	(0.026)
32	0.034	0.026	0.007	0.009	0.022	-0.080	-0.061	-0.087	-0.097	-0.022	-0.814	0.358	2.064	-0.003	-0.013	-0.059	-0.035
	(0.021)	(0.019)	(0.018)	(0.015)	(0.017)	(0.063)	(0.047)	(0.041)	(0.118)	(0.266)	(0.176)	(0.509)	(0.957)	(0.027)	(0.039)	(0.116)	(0.069)
33	0.006	0.004	0.001	0.002	0.004	-0.014	-0.010	-0.015	-0.017	-0.041	0.041	-1.389	0.019	0.000	-0.002	-0.010	-0.006
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.009)	(0.007)	(0.006)	(0.019)	(0.091)	(0.055)	(0.248)	(0.426)	(0.003)	(0.005)	(0.015)	(0.009)
34	0.001	0.001	0.000	0.000	0.000	-0.002	-0.001	-0.002	-0.002	-0.045	0.039	0.003	-0.026	0.000	0.000	-0.001	-0.001
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.001)	(0.001)	(0.003)	(0.045)	(0.017)	(0.074)	(1.025)	(0.000)	(0.001)	(0.002)	(0.001)
35	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.002	-0.001	-0.002	-0.001	-0.237	-0.108	0.211	-0.110
	(0.003)	(0.003)	(0.001)	(0.001)	(0.002)	(0.006)	(0.003)	(0.004)	(0.011)	(0.010)	(0.010)	(0.012)	(0.008)	(0.208)	(0.185)	(0.041)	(0.099)
36	-0.003	-0.002	-0.001	-0.001	-0.002	0.000	0.000	0.000	0.001	-0.008	-0.005	-0.008	-0.006	-0.103	-0.281	0.211	-0.160
	(0.005)	(0.004)	(0.002)	(0.002)	(0.004)	(0.011)	(0.005)	(0.008)	(0.020)	(0.013)	(0.015)	(0.018)	(0.014)	(0.176)	(0.245)	(0.047)	(0.111)
37	-0.039	-0.030	-0.008	-0.010	-0.025	0.006	0.005	0.007	0.008	-0.108	-0.070	-0.112	-0.079	0.615	0.648	-1.539	0.042
	(0.048)	(0.042)	(0.023)	(0.023)	(0.037)	(0.105)	(0.053)	(0.078)	(0.210)	(0.133)	(0.133)	(0.165)	(0.147)	(0.121)	(0.144)	(0.375)	(0.229)
38	-0.023	-0.018	-0.005	-0.006	-0.015	0.004	0.003	0.004	0.005	-0.065	-0.042	-0.068	-0.047	-0.325	-0.496	0.038	-1.292
	(0.029)	(0.026)	(0.014)	(0.014)	(0.023)	(0.066)	(0.033)	(0.049)	(0.131)	(0.080)	(0.081)	(0.099)	(0.090)	(0.292)	(0.344)	(0.233)	(0.235)

Fresh green vegetables (1); Other fresh vegetables(2); Processed vegetables excluding processed potatoes (3);Fresh Fruits (4); Processed Fruits (5);Milk and milk products excluding cheese (6); Cheese (7); Eggs (8);Carcase meat (9); Non-carcase meat and meat products (10); Fish (11); Butter (12); Margarine (13); Vegetable and salad oils (14); All other fats (15); Sugar and preserves (16); Cakes, buns and pastries (17); Confectionery (18); Fresh and processed potatoes (19); Bread (20); Flour (21); Biscuits and crispbreads (22); Other cereals and cereal products (23); Soups (24); Spreads and dressings (25); Pickles and sauces (26); Other take away and meals (27); (28) Tea; (29) Coffee; (30) Cocoa and chocolate drinks; (31) Malt drinks and chocolate versions of malted drinks; (32) Mineral or spring waters; (33) Soft drinks, concentrated, not low calorie; (34) Soft drinks, not concentrated, not low calorie; (35) Soft drinks, not concentrated, low calorie; (36) Expenditure. Bootstrap standard errors are in brackets

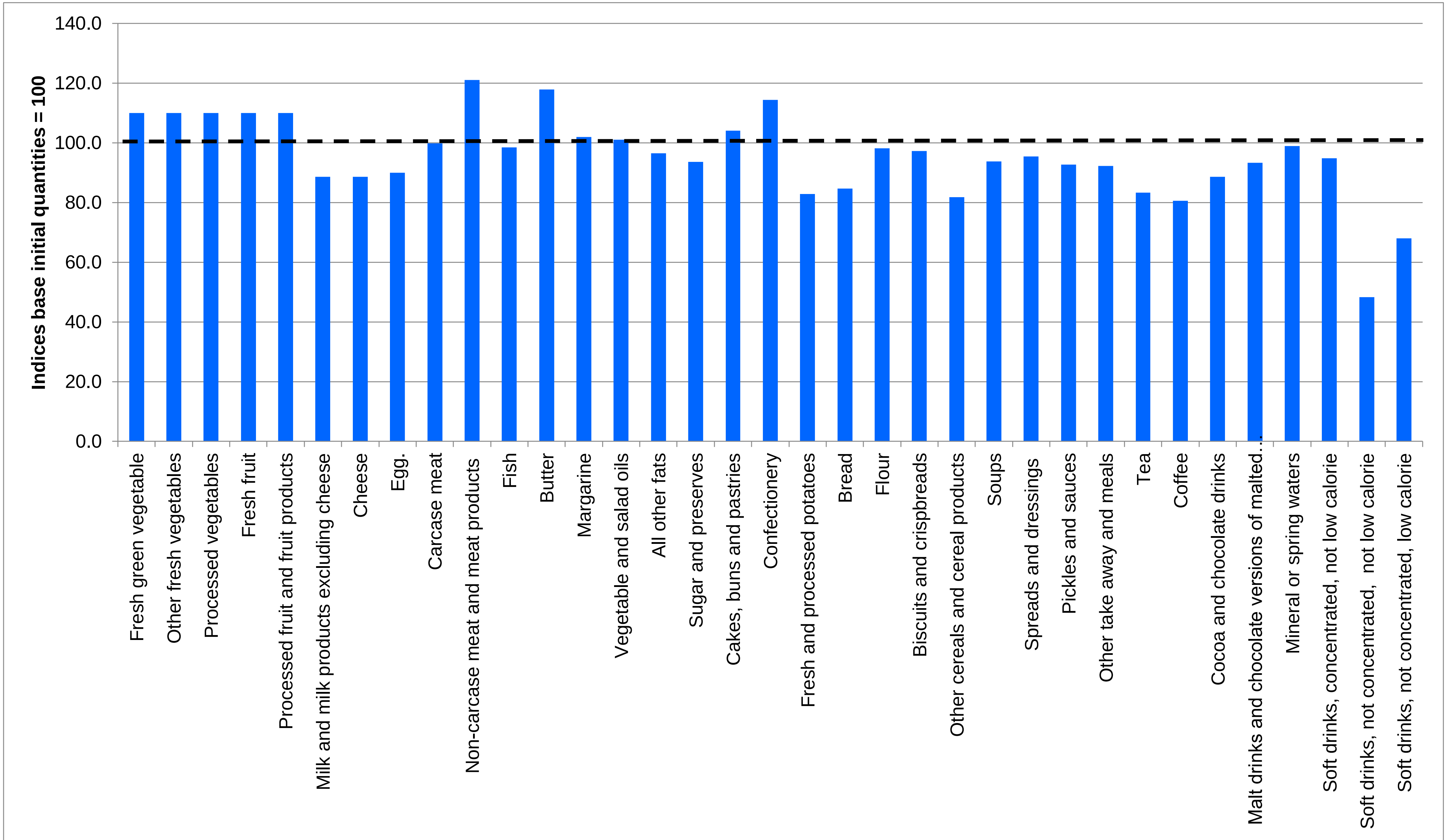

Figure 4. Estimated diet after increasing fruits and vegetables by 10 per cent for the average person.

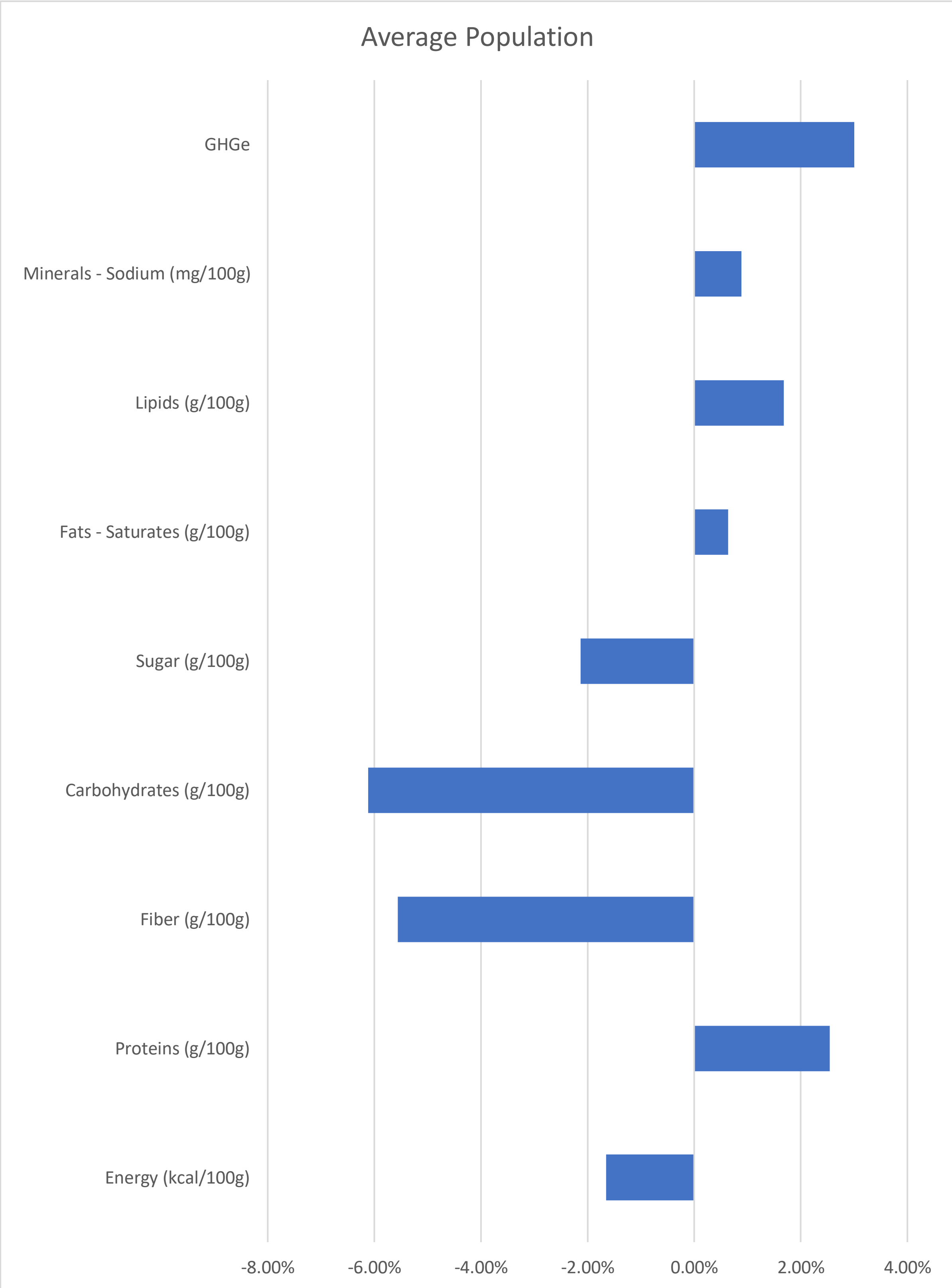

Figure 5 Average changes in Energy, macronutrients, and GHGe after increasing fruits and vegetables than 10 per cent.

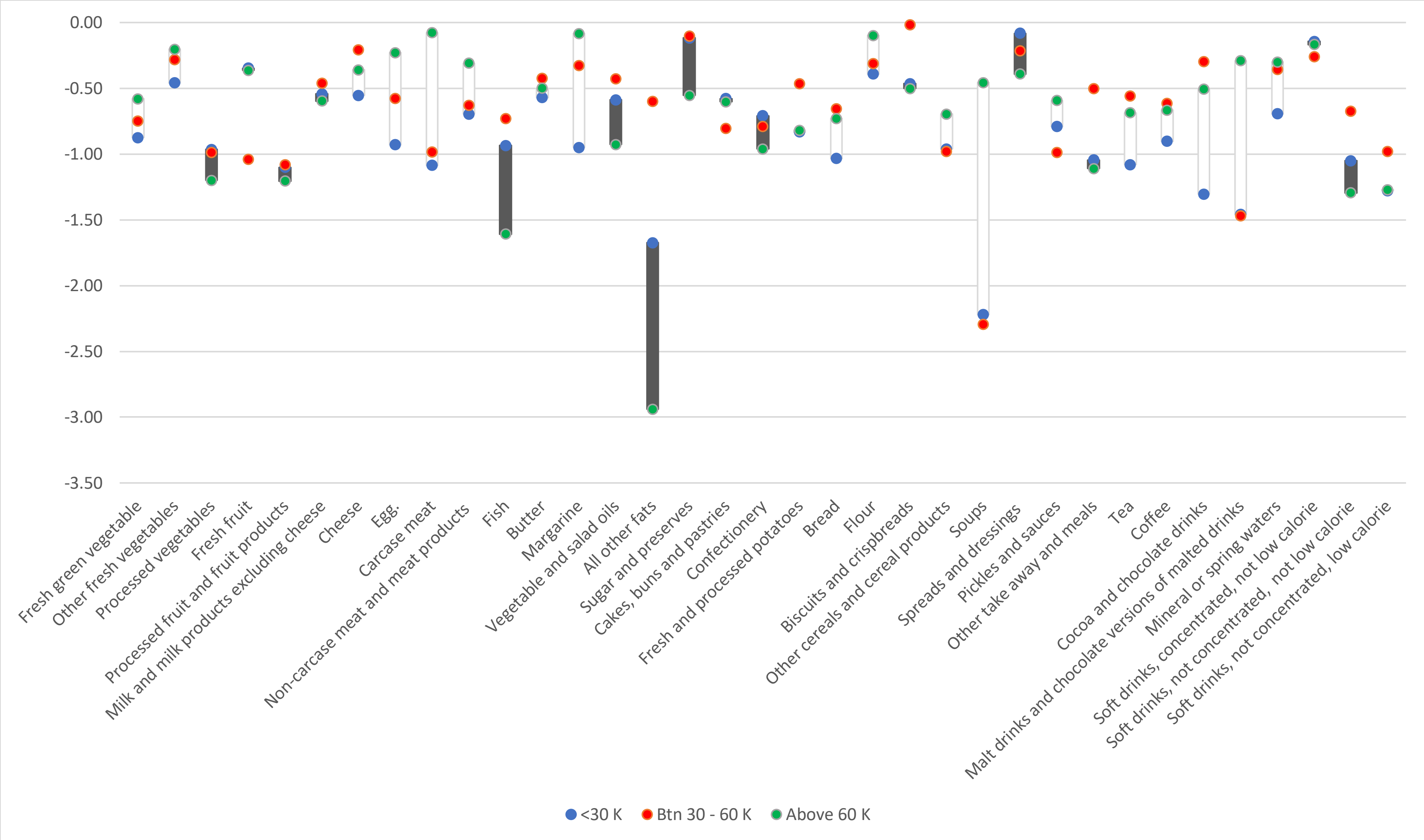

Figure 6. Variations in Unconditional compensated own price elasticities across income levels.

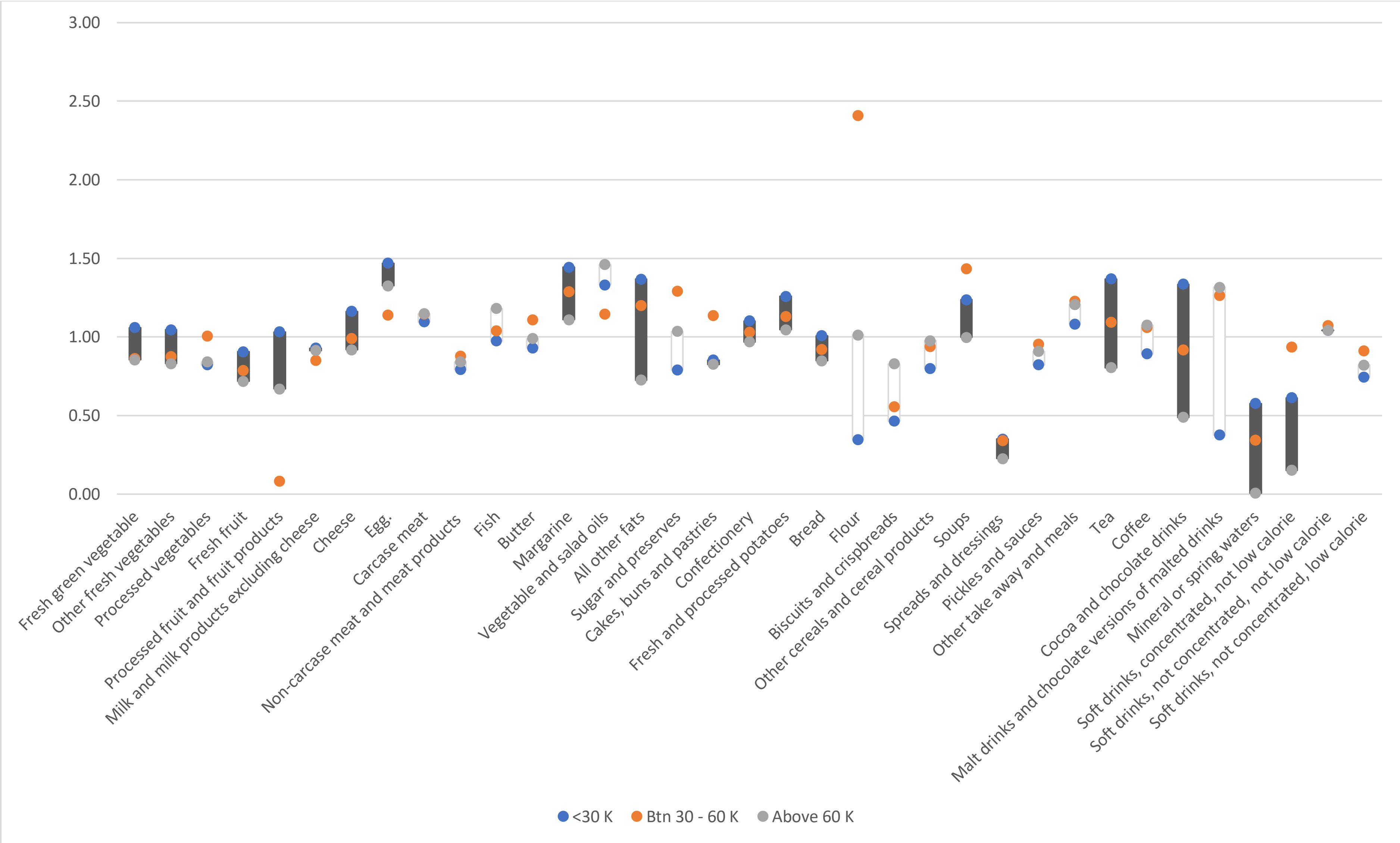

Figure 7. Unconditional expenditure elasticities for income groups

Table 5. Expected change in prices and difference when compared to average population

Food products	**Less than 30K**		**Between 30 - 50K**		**Above 50K**	
	Change in Price	Difference	Change in Price	Difference	Change in Price	Difference
Fresh green vegetable	-13.10	-0.60	-17.57	-5.07	-20.93	-8.43
Other fresh vegetables	-24.54	9.22	-44.86	-11.10	-68.94	-35.18
Processed vegetables	-12.02	-0.59	-13.88	-2.46	-9.16	2.26
Fresh fruit	-37.68	18.66	-10.27	46.08	-32.69	23.66
Processed fruit and fruit products	-10.13	-1.77	-9.40	-1.03	-8.51	-0.15

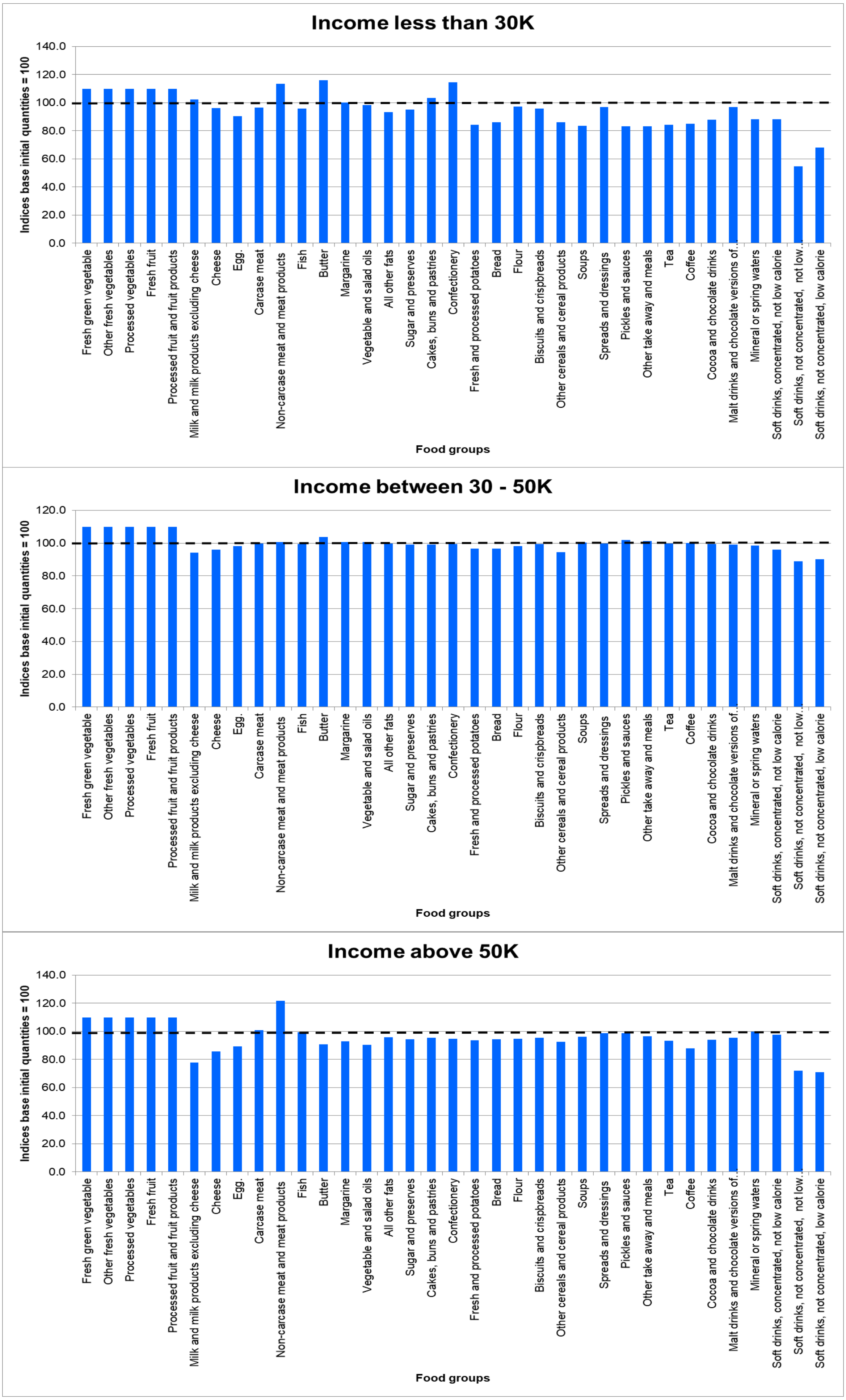

Figure 8 Changes in purchases across different income groups after increasing fruits and vegetables by 10 per cent

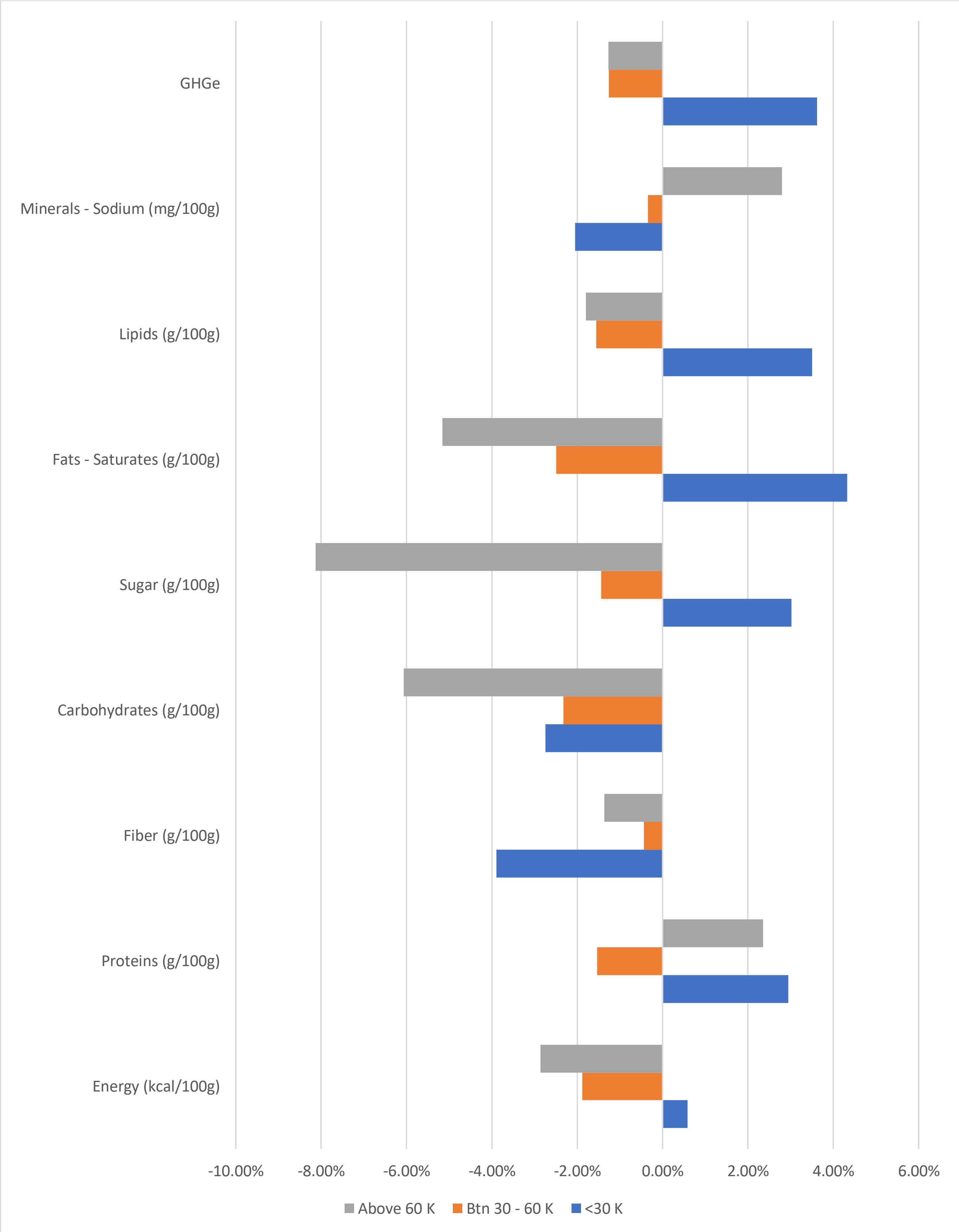

Figure 9 Changes in Energy, macronutrients, and GHGe after increasing fruits and vegetables by 10 per cent.