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Summary

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Demand for food in Finland has changed dramatically in recent decades and is continuously evolving as the result of multiple influences, including the relative prices of food items, economic growth, short-term variations in purchasing power, demographic changes, food scares, and other changes in preferences linked to nutrition, animal welfare, and environmental issues. Yet, little is known about the relative importance of those factors in shaping food demand, which appears problematic for both public policy makers and the private stakeholders of the food chain. For instance, it is becoming clear that transition to a low-carbon economy will require adjusments in consumption patterns, given the limited possibilities of mitigation through modification of production patterns and technology, but much debate remains about how to make that change happen. Similarly, the aging population and the growing number of single-person households have implications for the evolution of Finnish food consumption that remain, as yet, poorly understood by the stakeholders of the food chain.

Thus, we present a fresh analysis of Finnish food consumption based on the econometric estimation of a complete system of demand for food. The data originates from the 2012 Finnish Household Budget Survey, which contains over 3550 observations and gives a detailed account of household food consumption over a two-week period for more than 200 food categories. Those are aggregated into 19 product categories, hence ensuring the empirical tractability of the behavioural model, which is then linked to technical coefficients describing the nutritional properties and climate impact of each food aggregate. The demand system uses the recently developed Exact Affine Stone Index (EASI) functional form, which offers great flexibility in relating consumption to income and can therefore accommodate the highly non-linear Engel curves typically found in micro-level data. Estimation tackles two issues caused by the nature of the data, namely censored demand due to the high number of zero-consumption observations attributable to the short period of data collection, and the adjustment of unit values to measure prices.

The results are presented in terms of elasticities summarizing the responses of food and nutrient demands as well as greenhouse gas emissions to changes in economic and socio-demographic variables. In future work, those elasticities will support the analysis of policies aimed at increasing the sustainability of food consumption patterns in Finland. In particular, the estimated models can be utilised to simulate the effects of fiscal measures (e.g., a carbon tax) as well as dietary recommendations on diet quality, health, the climate, and economic welfare.

Keywords: food; demand; diet; elasticity; EASI

Finnish Summary

Elintarvikkeiden kysyntä on muuttunut Suomessa dramaattisesti viime vuosikymmeninä, ja se kehittyy jatkuvasti useiden tekijöiden vaikutuksesta. Näitä tekijöitä ovat mm. eri elintarvikkeiden suhteelliset hinnat, talouskasvu ja ostovoiman kehitys, väestörakenteen muutokset, elintarvikekohut sekä kuluttajien muuttuva suhtautuminen ravitsemukseen, eläinten hyvinvointiin ja ympäristöasioihin. Silti varsin vähän tiedetään siitä, kuinka tärkeitä nämä tekijät suhteellisesti ottaen ovat elintarvikekysynnän muovaamisessa. Tämä on ongelmallista sekä päätöksentekijöille että alan sidosryhmille. On esimerkiksi käymässä selväksi, että vähähiiliseen talouteen siirtyminen tulee vaatimaan muutoksia kulutustottumuksissa, kun huomioidaan tuotantoteknologian rajalliset mahdollisuudet. On kuitenkin edelleen epäselvää, kuinka tällainen muutos saadaan aikaan. Myös väestön vanheneminen ja yhden hengen kotitalouksien määrän kasvu muuttavat elintarvikkeiden kulutusta tavalla, jota elintarvikeketjun sidosryhmät eivät toistaiseksi kunnolla ymmärrä.

Tässä tutkimuksessa esitetään sen vuoksi ekonometriseen estimointiin perustuva analyysi suomalaisen elintarvikekulutuksesta ja siihen vaikuttavista tekijöistä. Tietoaineisto on peräisin Tilastokeskuksen vuoden 2012 kulutustutkimuksesta, joka sisältää yli 3 550 havaintoa ja antaa yksityiskohtaisen kuvauksen kotitalouksien elintarvikekulutuksesta kahden viikon ajalta yli 200 elintarvikkeesta. Elintarvikkeet on aggregoitu 19 eri tuoteryhmään, mikä varmistaa estimoidun kysyntämallin empiirisen jäljitettävyyden. Malliin on liitetty teknisiä kertoimia, jotka kuvaavat kunkin tuoteryhmän ravintoarvoa ja ilmastovaikutusta. Kysyntäjärjestelmä hyödyntää äskettäin kehitettyä Exact Affine Stone Index funktiomallia (EASI), jolla kulutus voidaan suhteuttaa hyvin joustavasti tulotason kehitykseen siten, että analyysiin saadaan mukaan myös mikrotason aineistoissa tyypillisesti esiintyvät erittäin epälineaariset Engelin käyrät. Tämä ratkaisee kaksi tietoaineiston luonteesta johtuvaa ongelmaa, joita ovat ns. piiloon jäävä kysyntä, joka johtuu lyhyen aineistonkeräysjakson synnyttämistä runsaista nollahavainnoista, sekä yksikköarvojen korjaukset hintojen mittaukseen.

Tulokset esitetään joustoina, jotka kertovat taloudellisissa ja sosiodemografisissa tekijöissä tapahtuvien muutosten vaikutukset elintarvike- ja ravintoainekysyntään sekä kasvihuonekaasupäästöihin. Estimoituja joustoja voidaan hyödyntää jatkossa arvioitaessa esimerkiksi ruoan kulutustottumusten kestävyyden lisäämiseen tähtäävien poliittisten toimenpiteiden vaikuttavuutta. Estimoiduilla kysyntämalleilla voidaan simuloida esimerkiksi veropoliittisten toimenpiteiden (esim. hiilivero) sekä ruokavaliosuositusten vaikutusta ruokavalion laatuun, terveyteen, ilmastoon ja taloudelliseen hyvinvointiin.

Asiasanat: elintarvikkeet, kysyntä, ruokavalio,

Contents

1. Introduction

Demand for food in Finland has changed dramatically in recent decades and is continuously evolving as the result of multiple influences, including economic forces (e.g., prices, income), demographic changes, and other changes in preferences linked to nutrition, animal welfare, food scares and the environment. Yet, little is known about the relative importance of those factors in shaping food demand, which appears problematic for both public policy makers and the private stakeholders of the food chain. Hence, it is becoming clear that transition to a low-carbon economy will require a decrease in consumption of animal products, but much debate remains about how to achieve that goal. Similarly, the aging population has implications for the evolution of Finnish food consumption that remain, as yet, poorly understood by the stakeholders of the food chain.

This limited understanding of Finnish food consumption and its determinants stems from the paucity, relative obsoleteness, and methodological limitations of the studies that have investigated the subject to date. Laurila (1994) first applied the modern techniques of demand analysis to investigate food consumption in Finland but the time span of the underlying data (1961-1991) limits the relevance of that work to the analysis of current issues. Irz (2010) updated the previous analysis using more recent country-level aggregate data (1975-2006) on consumption from the Finnish national accounts. However, by nature of the underlying data, those two studies are uninformative about the variability in consumption patterns within the Finnish population, and how that variability may be explained by observable socio-demographic variables such as education, age, or place of residence. Härkänen et al. (2014) were the first to estimate demand for food from Finnish micro-level data with the objective of simulating the impact of a sugar tax on consumption and public health in Finland, but the high level of product aggregation implied by the division of food expenditure into only six groups, and the specific focus on sugar products, limit the relevance of that study to the analysis of the health, economic and environmental effects of diets. For instance, the grouping of beef and chicken under the heading “meat” creates problems when assessing the effect of consumption changes on greenhouse gas (GHG) emissions, given the very different carbon footprints of those two items (Irz & Kurppa 2013). Similarly, the health effects of increased consumption of low-fat and high-fat dairy products are likely to be different, so that grouping those items together complicates the assessment of health impacts. Thus, the investigation of the sustainability of food consumption patterns in Finland requires a fresh analysis using recent micro-level data.

This report addresses this research gap and represents an output of the Era-Net SUSFOOD SUSDIET project on sustainable diets in Europe (https://www6.inra.fr/sustainablediets)[1]. The objective of the demand analysis is primarily to permit the simulations of policies in other parts of the project, including a carbon tax applied differentially to foods on the basis of their climate impact as well as the promotion of various dietary recommendations (e.g., daily consumption of five portions of fruits and vegetables). However, the estimated elasticities having broad relevance to the analysis of Finnish food markets, it was also deemed worth reporting them in this report, which is organised as follows. The next section presents the methodological framework, including the demand system that we estimate and how we have addressed the common but serious difficulties created by the short-term and micro-level nature of the consumption data. The following section presents the results, and the paper ends with a few general conclusions.

[1] Funding from the Ministry of Agriculture and Forestry, MAKERA fund, is gratefully acknowledged.

2. Methodology

2.1. The economic theory of consumer choice

The economic theory of consumer choice provides the conceptual underpinning of the analysis. Accordingly, consumers are assumed to choose the goods that they consume and their quantities so as to maximize their well-being, or utility, subject to a budget constraint. Minimal assumptions on preferences over bundles of goods are imposed to ensure the rationality of choices. For instance, transitivity requires that if bundle A is strictly preferred to bundle B, and bundle B to bundle C, then bundle A is also strictly preferred to bundle C. The budget constraint arises because, for given levels of income and prices, only certain combinations of goods (i.e., consumption bundles) can be afforded.

The main purpose of the analysis of demand is then to characterise consumer preferences from observed consumption choices or, in other words, to let the data "reveal" preferences. This differentiates the approach from the group of "stated preferences" methods that are also widely used to investigate consumer behaviour. Both groups of methods have their strengths and weaknesses, but in cases where markets exist, revealed preference methods are usually considered superior because they do not suffer from the hypothetical biases that plague stated preference methods (Murphy et al., 2005).

The theory helps guide the empirical inquiry, for instance by establishing criteria to compare specifications, reduce the number of parameters to estimate, and ensure the theoretical consistency of the simulations derived from the model (e.g., adjustments of consumption to a tax remain compatible with the budget constraint). In practice, three groups of restrictions follow from the axioms imposed on consumer preferences (Deaton & Muellbauer 1980): 1) Adding-up, which ensures that the total value of demand exhausts the available budget; 2) Homogeneity, which imposes the absence of money illusion (i.e., the fact that the same proportional increase in all prices and total budget does not modify choices); and 3) Symmetry, which is less intuitive and relates to the derivatives of the compensated demand functions. The fourth theoretical property of negativity or concavity is usually not imposed but only checked ex-post.

2.2. Functional form: The approximate exact affine Stone index (EASI) demand system

The first step in the parametric estimation of demand relationships is the choice of a functional form for the demand system, in order to allow imposition of the theoretical restrictions while preserving flexibility (i.e., limit the restrictions on the system implicit in the functional form). Several competing systems have been proposed, as reviewed by Barnett and Serlettis (2008) with Deaton and Muelbauer's Almost Ideal Demand System, or AIDS (Deaton & Muellbauer 1980), remaining the most popular (Irz 2010).

The AIDS model, however, presents two limiting features. First, it only allows income to influence demand in a linear or log-linear form, when it is now well established that Engel curves are often highly non-linear and vary widely in shapes across goods (Banks et al. 1997; Lewbel 1991). Second, the AIDS model does not allow for preference heterogeneity, which unfortunately is recognized as a fundamental feature of consumer microdata (Crawford & Pendakur 2013), as indicated by the relative poor fit of statistical models estimated from such data.

As a way of addressing both issues, Lewbel and Pendakur (2009) proposed the Exact Affin Stone Index (EASI) demand system. The system's Engel curves can be polynomials or splines of any order in real expenditures and are therefore highly flexible. Further, the EASI error terms equal random utility parameters, and the model therefore accounts for unobserved preference heterogeneity in a theoretically consistent manner.

However, estimation of the model is complicated by endogeneity and non-linearity issues, which means that iterative GMM or three-stage least squares procedures are called for. For large demand systems with censored data as specified in this study, it is likely that the computational problems created by those procedures are insurmountable, and estimation of the full EASI model was therefore deemed too challenging. Thus, we only estimate a simplified – or approximate - version of the EASI model. Support for this simplification comes from Lewbel & Pendakur (2009), who provide evidence that both linearity and endogeneity are only relatively small issues in practice. In particular, those authors find that the linearized version of the model estimated by OLS performs almost as well as fully-efficient endogeneity-corrected nonlinear estimation (Pendakur 2009).

Derivation of the EASI demand system starts from a dual representation of preferences in the form of a minimum cost function:

$$\ln C(p,u,z,\boldsymbol{\varepsilon}) = u + \sum_{j=1}^{J} m^j(u,z)\ln p^j + 1/2\sum_{j=1}^{J}\sum_{k=1}^{J} a^{jk}\ln p^j \ln p^k + \sum_{j=1}^{J}\boldsymbol{\varepsilon}^j \ln p^j \qquad (1)$$

where $\boldsymbol{p}$ is the J-vector of good prices; u denotes utility; $\boldsymbol{z}$ is a vector of observed socio-economic characteristics (e.g., education); **ε** is a J-vector of unobserved preference heterogeneity parameters; and $m_j(.)$ denotes an unrestricted function. Note that the specification of parameters a^{jk} as constants rather than functions of socio-demographic variables restricts the influence of those variables on price responsiveness. By application of Shephard's lemma, we obtain the Hicksian cost share equations:

$$\omega^j(p,u,z,\varepsilon) = m^j(u,z) + \sum_{k=1}^{J} a^{jk}\ln p^k + \varepsilon^j \qquad (2)$$

A few manipulations generate the implicit utility or real income y:

$$y = u = \ln(x) - \sum_{j=1}^{J}\omega^j \ln p^j + 1/2\sum_{j=1}^{J}\sum_{k=1}^{J} a^{jk} l\,\mathrm{n}\, p^j \ln p^k \qquad (3)$$

That manipulation represents the key step of the approach, as it permits to replace the unobservable utility level u by y, which is solely a function of observables and parameters. The implicit Marshallian budget shares then follow by substituting y, as expressed in equation (3), for u in the Hicksian budget shares (2).

$$w^j(p,y,z,\varepsilon) = m^j(y,z) + \sum_{k=1}^{J} a^{jk}\ln p^k + \varepsilon^j \qquad (4)$$

The advantages of the EASI model are evident in that expression. First, the functions $m^j(y; \boldsymbol{z})$ are completely unrestricted in their dependence on implicit utility y and observable demographic characteristics $\boldsymbol{z}$. Thus, the model can accommodate homothetic preferences (i.e., independence of $\boldsymbol{w}$ from y), linear Engel curves as in the AIDS, quadratic Engel curves as in the quadratic-AIDS model (Q-AIDS), or much more complex geometries of Engel curves. Second, the unobserved preference heterogeneity parameters $\boldsymbol{\varepsilon}$ show up as error terms' in the estimated equations and as cost shifters in the cost function, and are thus an integral part of the theoretical model.

We simplify the model further by assuming that the functions $m^j(.)$ are additively separable in y and $\boldsymbol{z}$, linear in $\boldsymbol{z}$ and polynomial of degree R in y:

$$m^j(y,z) = \sum_{r=1}^{R} b_r^j (y)^r + \sum_{t=0}^{T} g_t^j z_t \qquad (5)$$

The Marshallian budget share equations become:

$$w^j = \underbrace{\sum_{r=1}^{R} b_r^j (y)^r + \sum_{t=0}^{T} g_t^j z_t}_{m^j(y,z)} + \sum_{k=1}^{J} a^{jk} \ln p^k + \varepsilon^j,\ j = 1,...,J \tag{6}$$

Let's note that a constant is introduced as the first ***z*** variable, so that there are only *T* real socio-demographic characteristics in the model. More importantly, real income y is itself a function of the parameters a^{jk} and the cost shares ***w*** through equation (3). This implies first that model (6) is non-linear in parameters, which complicates estimation. This first issue is addressed by approximating implicit utility (3) by the value of expenditure deflated by a Stone price index:

$$y \approx \ln(x) - \sum_{j=1}^{J} w^j \ln p^j \tag{7}$$

However, that simplification does not address the endogeneity issue, since the right hand-side of equation (7) remains a function of vector ***w***. To circumvent that problem, we replace those observation-specific shares with sample averages, denoted with a bar:

$$\hat{y} = \ln(x) - \sum_{j=1}^{J} \overline{w}^j \ln p^j \tag{8}$$

2.3. Imposing theoretical restrictions

The system of equations (6), using (8) to approximate *y*, defines the unrestricted demand system, to which we impose the properties derived from microeconomic theory. One advantage of the EASI specification is that those theoretical constraints are linear in parameters. First, homogeneity implies *J* constraints: $\sum_{k=1}^{J} a^{jk} = 0,\ j = 1,...,J$. Thus, in each share equation, the price coefficients sum to zero. This property can be imposed on the coefficients of the unconstrained model or, alternatively, all prices can be expressed relative to the price of an arbitrarily chosen numeraire good. The second theoretical property, symmetry, implies: $a^{jk} = a^{kj}$ for all j, k. Hence, with *J* share equations (i.e., goods), there are *J*(J-1)/2* such restrictions (i.e., the number of non-diagonal elements of a *J*J* matrix divided by 2). Finally, adding-up implies that the sum of the *J* coefficients associated with the constant of each share equation (denoted $\boldsymbol{z_0}$) is equal to unity $\sum_{j=1}^{J} g_0^j = 1$; and the sum of the *J* coefficients associated with any other variable (i.e., price, socio-demographic, or expenditure) is equal to zero: $\sum_{j=1}^{J} a^{jk} = 0,\ k = 1,...,J$; $\sum_{j=1}^{J} b_r^j = 0,\ r = 1,...,R$; $\sum_{j=1}^{J} g_t^j = 0,\ \mathrm{t} = 1,...,T$.

Altogether, the model features *JxJ* price coefficients, *Jx(T+1)* socio-demographic coefficients (including the constant terms), and *JxR* income coefficients, for a total of *Jx(J+T+R+1).* There are *J* homogeneity constraints, *Jx(J-1)/2* symmetry constraints, and *R+J+T+1* adding-up constraints, but it is easy to show that, for the price coefficients, imposing symmetry together with any of the other two constraints implies that the third constraint is automatically satisfied. Thus, there are only *J(J+1)/2+R+T+1* independent constraints, and *(J-1)(R+T+1+J/2)* independent coefficients to estimate.

2.4. Elasticities of the approximate EASI model

2.4.1. Semi-elasticities of budget shares

Lewbel & Pendakur (2009) only provide the semi-elasticities of the budget shares for the full EASI model with interactions, so we need first to derive the expressions of the semi-elasticities for the approximate model. The second issue is to derive the elasticities of quantities (rather than semi-elasticities of budget shares).

The Hicksian share equations are given by (2) and (5), and the derivatives of those equations with respect to exogenous prices, real income, and sociodemographic variables give the Hicksian semi-elasticities:

$$\frac{\partial \boldsymbol{\omega}^i}{\partial \ln p^j} = a^{ij} \;\; \forall i, \; \forall j \tag{9}$$

$$\frac{\partial \boldsymbol{\omega}^j (p, y, z, \boldsymbol{\varepsilon})}{\partial y} = \sum_{r=1}^{R} b_r^j r y^{r-1} \tag{10}$$

$$\frac{\partial \boldsymbol{\omega}^i}{\partial z_t} = g_t^i \;\; \forall i, \; \forall t \geq 1 \tag{11}$$

The approximate model defined in terms of the Marshallian budget shares, as specified above, is:

$$w^j = \sum_{r=1}^{R} b_r^j (\hat{y})^r + \sum_{t=0}^{T} g_t^j z_t + \sum_{k=1}^{J} a^{jk} \ln p^k + \varepsilon^j, \; j = 1,...,J$$

$$\hat{y} = \ln(x) - \sum_{k=1}^{J} \overline{w}^k \ln p^k \tag{12-13}$$

This results in the following Marshallian semi-elasticities:

$$\frac{\partial w^j (p, \hat{y}, z, \boldsymbol{\varepsilon})}{\partial \ln x} = \left(\sum_{r=1}^{R} b_r^j r \left(\hat{y} \right)^{r-1} \right) \frac{\partial \hat{y}}{\partial \ln x} = \left(\sum_{r=1}^{R} b_r^j r \left(\hat{y} \right)^{r-1} \right) \tag{14}$$

$$\frac{\partial w^i}{\partial \ln p^j} = a^{ij} - \bar{w}^j \left(\sum_{r=1}^{R} b_r^j r \left(\hat{y} \right)^{r-1} \right) \;\; \forall i, \forall j \tag{15}$$

$$\frac{\partial w^i}{\partial z_t} = g_t^i \;\; \forall i, \; \forall t \geq 1 \tag{16}$$

The Hicksian semi-elasticities with respect to prices (9) and real income (10) can also be inferred by removing the interaction terms from the corresponding expressions for the full EASI model (i.e., equations (12) and (13) in Lewbel & Pendakur 2009). The expenditure semi-elasticity (14), however, differs from that of the full model because the approximation used to calculate real income (i.e., equation (8)) does not allow the budget shares $\overline{w}^k$ to depend on total expenditure *x*. If, following Zhen et al. (2013), one restores that dependence by calculating real expenditure as nominal expenditure deflated by the Stone price index, i.e. $-\sum_{j=1}^{J} w^j lnp^j$, the expenditure semi-elasticity of budget share *j* becomes:

$$\frac{\partial w^j (p, y(x), z, \boldsymbol{\varepsilon})}{\partial \ln x} = \left(\sum_{r=1}^{R} b_r^j r \left(y \right)^{r-1} \right) \left(1 - \sum_{k=1}^{J} \frac{\partial w^k}{\partial \ln x} \ln p^k \right) \tag{17}$$

This linear system of *J* equations is then solved using matrix algebra, leading to:

$$\frac{\partial w}{\partial \ln x} = \left(I_J + BP'\right)^{-1} B \tag{18}$$

where ***B*** is the *Jx1* vector whose *j*-th element is $\sum_{r=1}^{R} b_r^j r y^{r-1}$, and ***P*** is the *J*-vector of log prices.

2.4.2. Elasticities of demand

The relationship between the semi-elasticities of budget shares and the elasticities of quantities can be derived in general terms. Starting with Hicksian demands, we have $\boldsymbol{\omega}^i(p,u=y) = p^i q^i(p,u)/x(p,u)$ from which it follows that: $q^i(p,u,z) = \boldsymbol{\omega}^i(p,u=y,z).x(p,u,z)/p^i$. Thus,

$$\frac{\partial \ln q^i}{\partial \ln p^j} = \frac{\partial \ln \boldsymbol{\omega}^i}{\partial \ln p^j} + \frac{\partial \ln x(p,u,z)}{\partial \ln p_j} - \boldsymbol{\delta}_{ij} \tag{19}$$

where $\delta_{ij} = 1$ if $i=j$ and *0* otherwise. Using (9) and the expression for approximate real income (13), we obtain the Hicksian price elasticities:

$$\frac{\partial \ln q^i}{\partial \ln p^j} = \frac{a^{ij}}{w^i} + \overline{w}^j - \boldsymbol{\delta}_{ij} \tag{20}$$

In a Marshallian framework, demand for good *i* is $q^i = q^i(p,x)$, where total expenditure *x* is assumed exogenous. Each Marshallian budget share is: $w^i(p,x) = p^i q^i(p,x)/x$, from which it follows that $q^i(p,x) = w^i(p,x).x/p^i$. Log-differentiating this expression gives the Marshallian expenditure elasticities:

$$\frac{\partial \ln q^i}{\partial \ln x} = \frac{\partial \ln w^i}{\partial \ln x} + 1 = \frac{1}{w^i}.\frac{\partial w^i}{\partial \ln x} + 1 \tag{21}$$

Plugging back the expression of the expenditure semi-elasticity of Marshallian shares (14) gives the complete formula as a function of the estimated parameters:

$$\frac{\partial \ln q^i}{\partial \ln x} = \left(\sum_{r=1}^{R} b_r^i r \left(\hat{y}\right)^{r-1}\right)\frac{1}{w^i} + 1 \tag{22}$$

The Marshallian price elasticities of quantities are then most easily obtained by application of the Slutsky equation, using equations (20) and (22):

$$\frac{\partial \ln q^i}{\partial \ln p^j} = \frac{a^{ij}}{w^i} + \overline{w}^j - \boldsymbol{\delta}_{ij} - w^j\left[\left(\sum_{r=1}^{R} b_r^i r \left(\hat{y}\right)^{r-1}\right)\frac{1}{w^i} + 1\right] \tag{23}$$

Estimated at the sample mean, this becomes:

$$\frac{\partial \ln q^i}{\partial \ln p^j} = \frac{a^{ij}}{\overline{\overline{w^i}}} - \boldsymbol{\delta}_{ij} - \frac{\overline{w^j}}{\overline{\overline{w^i}}}\left(\sum_{r=1}^{R} b_r^i r \left(\overline{\hat{y}}\right)^{r-1}\right) \tag{24}$$

For the socio-demographic variables we have in a Marshallian context:

$$\frac{\partial \ln q^i}{\partial \ln z^j} = \frac{\partial \ln w^i}{\partial \ln z^j} = \frac{1}{w^i}.\frac{\partial w^i}{\partial \ln z^j} = \frac{z^j}{w^i}.\frac{\partial w^i}{\partial z^j} \tag{25}$$

Or for a dummy variable:

$$\frac{\partial \ln q^i}{\partial D^j} = \frac{\partial \ln w^i}{\partial D^j} = \frac{1}{w^i}.\frac{\partial w^i}{\partial D^j} \tag{26}$$

2.4.3. Elasticities and multi-stage budgeting

The model specified previously is applied to analyse consumers' allocation of resources to different product groups, assuming constancy of the total food budget. In reality, however, the food budget represents itself a choice variable whose optimal level may respond to exogenous changes in the economic environment. In order to capture those responses, the conditional elasticities (i.e., depending on the level of the food budget) are transformed into unconditional ones, following the results established by Carpentier and Guyomard (2001), who extended the seminal analysis of Edgerton (1997). Using the subscript *F* to denote the aggregate of all foods consumed at home, and the subscript *i* to denote any specific food group included in that aggregate, the unconditional expenditure elasticity of demand for food group *i*, denoted η_i is:

$$\eta_i = \eta_{(F)i}\eta_F \tag{27}$$

where $\eta_{(F)i}$ denotes the expenditure elasticity of food group *i* conditional on the food-at-home budget, and η_F denotes the expenditure elasticity of demand for food-at-home. The unconditional Hicksian elasticity of demand for food group *i* relative to the price of food group *j* is:

$$\tilde{\Sigma}_{ij} = \varepsilon_{ij} + w_{(F)j}\tilde{\Sigma}_{FF}\,\eta_{(F)i}\eta_{(F)j} \tag{28}$$

where ε_{ij} denotes the conditional Hicksian elasticity of demand for good *i* with respect to the price of good *j*, $w_{(F)j}$ denotes the share of good *j* in the at-home food budget, and $\tilde{\Sigma}_{FF}$ denotes the own-price elasticity of demand for food-at-home. The corresponding expression for the unconditional Marshallian elasticity of demand for food group *i* relative to the price of food group *j* is:

$$\Sigma_{ij} = \varepsilon_{ij} + w_{(F)j}\left(\frac{1}{\eta_{(F)j}} + \Sigma_{FF}\right)\eta_{(F)i}\eta_{(F)j} + w_{(F)j}w_F\eta_F\eta_{(F)i}(\eta_{(F)j} - 1) \tag{29}$$

Thus, the unconditional price and expenditure elasticities can be inferred from the conditional elasticities plus three sets of parameters: the own-price and expenditure elasticities of demand for food at home, as well as the expenditure share of food consumed at home. The first two parameters are drawn from a previously published time-series analysis of Finnish food consumption (Irz 2010).

3. The empirical model

3.1. Data

The empirical analysis uses data from the Finnish Household Budget Survey (HBS), which is carried at irregular intervals in the country. Data from the four last rounds were collected in years 1998, 2001, 2006 and 2012, and, in agreement with other partners of the SUSDIET project, the decision was made to base the demand analysis on the most recent survey (i.e., year 2012). The survey gives a detailed description of each respondent household's use of money, demographic and social structure, sources of revenue, and purchase of foods for consumption at home (henceforth denoted FAH for "Food-at-home" and by opposition to FAFH for "Food-away-from-home"). The FAH data, which is available in terms of both expenditure and physical quantities, was recorded by each household in a diary over a two-week period and backed up by actual sales receipts. The data on education and income are derived from registers and should therefore be of good quality. The 2012 survey includes 3551 household observations, with a detailed description of food and drink consumption according to the Classification of Individual Consumption by Purpose (COICOP). In particular, the physical quantities of 259 foods and drinks are recorded.

Estimation of demand systems is, however, subject to the curse of dimensionality and, consequently, becomes difficult as the number of goods exceeds 20-30. To see that, we note that for 20 goods, 10 socio-demographic variables, and an expenditure polynomial of degree 5, the approximate EASI model already contains 20*21/2+5+10+1=720 parameters, 226 of which can be inferred from the theoretical restrictions. Thus, the HBS product categories were aggregated further into 19 groups, adapting the classification developed in collaboration with SUSDIET work package 1. That classification keeps the model empirically tractable while making it meaningful to assess the environmental and health properties of the diets described in terms of this reduced number of product groups. From the 20 groups of the SUSDIET classification, alcoholic beverages were excluded because consumption on that product group is only recorded in terms of expenditure (i.e., there are no physical quantities from which to derive unit values).

A few observations with zero food expenditure or anomalous unit values were dropped from the original data set, resulting in a final sample of 3495 households. Table 1 presents descriptive statistics for the food consumption variables. The average Finnish household spent €5366 on FAH in 2012, or just over €100 a week, and the allocation of that total food budget to the different product groups is represented graphically in Figure 1. This shows that about two third of the food budget was allocated to the purchase of meat (18%), dairy/cheese (16%), fruits and vegetables (15%) as well as cereal products and starchy foods (16%). The other categories account for small shares of the food budget, although we note the relative importance of sugar products in terms of expenditure (9%). The physical quantities need to be analysed with caution due to the difficulty of aggregating heterogeneous products, or the old problem of "adding apples to oranges". However, as a form of check of the data, we compare those averages to those published in the Finnish food balance sheets (FBS) year 2012.[2] That comparison is difficult because the product categories do not match, as is evident for instance in relation to meat products. The HBS seems to greatly underestimate pork consumption (i.e., 10kg pc as opposed to 36kg in the HBS), but this is probably due to the fact that a large quantity of the primary commodity "pork", as registered in the FBS, is consumed as "processed meat" or in composite dishes, which are two categories that are represented in the HBS but not the FBS. Overall, the orders of magnitude of the quantities consumed are either comparable or explainable in terms of differences in product categories.

[2] Available at: http://stat.luke.fi/ravintotase under " Elintarvikkeiden kulutus henkeä kohti 1990-2014". Accessed 12.11.2015.

Table 1: Descriptive statistics of the food consumption data

Food Group	Nominal expenditure (€/hh)			Physical quantity (kg) Per household			Per capita		% zero values	UV (€/kg)	Exp. Share
	Mean	Median	SD	Mean	Median	SD	Mean	HBS		Mean	Mean
Grain	761	636	580	204	173	154	86	79	2 %	3.7	14 %
Ruminant meat	209	112	315	23	14	32	10	20	33 %	9.1	4 %
Pork	240	155	293	26	15	35	11	36	24 %	9.2	4 %
Poultry	269	187	293	50	36	54	21	19	12 %	5.4	5 %
Processed meat	268	196	274	38	27	39	16	NA	15 %	7.1	5 %
Composite dishes	216	125	268	36	21	47	15	NA	24 %	5.9	4 %
Fish	229	122	345	24	13	35	10	16	28 %	9.5	4 %
Dairy	475	387	455	369	287	367	155	181	3 %	1.3	9 %
Cheese	370	297	324	38	30	34	16	23	11 %	9.8	7 %
Animal fat	162	113	192	30	21	36	13	11	20 %	5.4	3 %
Plant-based fat	60	38	87	15	10	21	6	5	46 %	4.1	1.1 %
Fruits	453	343	420	243	192	204	102	75	3 %	1.9	8 %
Vegetables	361	280	328	143	111	128	60	57	4 %	2.5	7 %
Starchy foods	121	74	151	92	57	124	39	52	15 %	1.3	2.3 %
Snacks	36	0	70	4	0	8	2	NA	67 %	8.4	0.7 %
Residual group	369	111	1048	54	15	156	23	NA	19 %	6.8	7 %
Sugar	458	325	478	68	48	82	29	30	6 %	6.7	9 %
Tea & coffee	191	139	210	50	23	79	21	NA	24 %	3.8	4 %
Soft drinks	118	44	197	81	31	131	34	44	43 %	1.5	2.2 %
All food & drinks	5366	4853	3189	1589	1436	955			0 %	3.4	100 %

Table 1 also presents the average unit values of the 19 product groups obtained by dividing mean expenditure by mean physical quantity. Unsurprisingly, those unit values vary widely across groups, with variations often simply related to water content, which explains the relatively low values for dairy (including fluid milk), fruits, vegetables and soft drinks. The relatively large unit values of red meat, fish and snacks also conform to expectations. A more important characteristic of the data visible in Table 1 is that many households did not report any consumption of some of the product groups (see column labelled “% zero values”). On average, one in five households did not consume a given product category, but zero consumption is also very unevenly distributed across categories. Thus, two third of households did not purchase any snacks, and almost half did not buy plant-based fat or soft drinks. By contrast, all but a few percent of households purchased grain products, dairy products, fruits or vegetables. For most food categories, at least 5% of households in the data set did not record any purchase, and those zero values create important econometric issues to which we now turn.

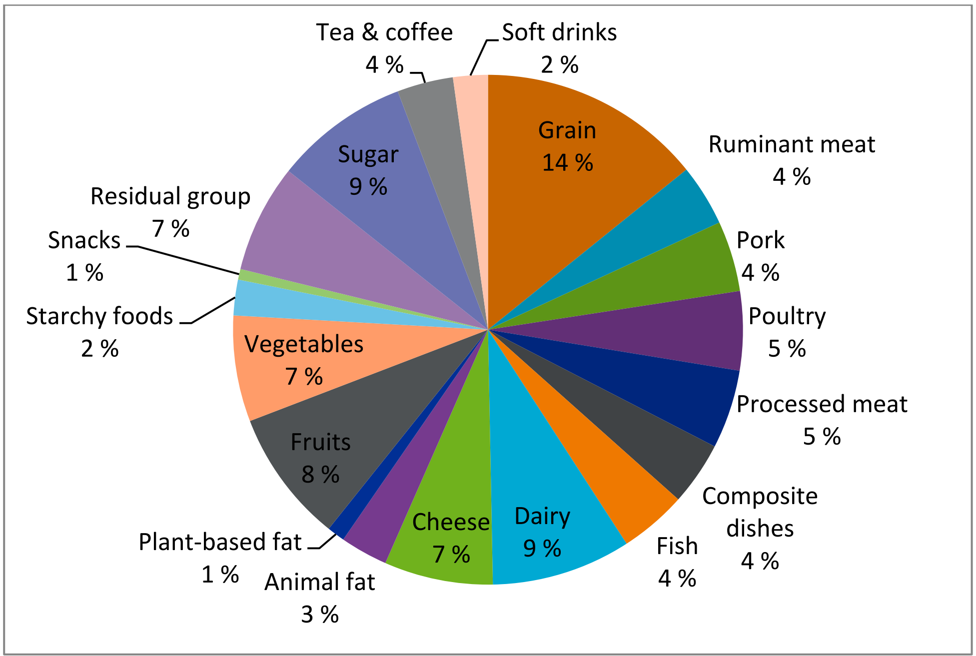

Figure 1. Expenditure Shares

3.2. Estimation of a demand system with censored consumption data

The high prevalence of zero consumption observations in microeconomic data sets used to estimate demand systems is actually very common (Coelho et al. 2010). The fundamental problem that this creates results from the fact that an observation of zero consumption may not indicate that the household does not and will never consume the food concerned, since other possibilities are equally plausible. Zero consumption may be attributable to the infrequency of purchase of some food items since the data is recorded over a relatively short period of time (i.e., two weeks here). In fact, Table 1 suggests that infrequency of purchase is a key feature of the Finnish HBS, since the proportion of zero consumption observations can often be related to the perishability of the product group. Thus, for highly perishable products such as bread (in the grain group), milk (in the dairy group), or fruits, only a tiny proportion of households report zero consumption. The situation is the opposite for easily storable commodities, such as vegetable oil (in the plant-based fat group) or soft drinks.

In addition to infrequency of purchase, an observation of zero consumption can also reflect a corner solution to the utility maximization problem: given its current income and prevailing prices, the household does not purchase the food item. However, under different economic circumstances, the household may opt to consume the good (Maddala 1983).

Zero consumption explained by infrequency of purchase or corner solutions implies that the dependent variable, consumption, is censored, which creates an econometric problem particularly difficult to address in the case of multi-variate models, such as demand systems (Coelho et al. 2010). Ignoring censoring by treating zero values as any other value of the consumption variable produces estimates of demand models, and elasticities, which are known to be both biased and inconsistent. The most complete treatment of this issue considers the simultaneous estimation of the decision to consume each good (i.e., a binary problem) and the decision regarding the amount of the good that should be purchased. However, when a system of multiple equations is considered, direct estimation involves the resolution of multiple integrals in the likelihood functions, which proves computationally intensive and is very likely to be intractable for a system of demand equations as large as ours.

Thus, more tractable multi-stage estimation procedures of censored demand models have been developed. Heien and Wesseils (1990, henceforth HS) used the general Heckman procedure to propose an estimation in two simple steps. In the first step, a probit equation is estimated to model the binary decision to consume a food item and, in a second step, the demand equations are augmented by the inverse Mills ratios extracted from the first-step regressions. Shonkwiler and Yen (1999) (henceforth SY), however, demonstrated the inconsistency of the HS estimator before offering a consistent alternative. That procedure is still widely used in empirical demand analysis (e.g., Gustavsen & Rickertsen 2014) and we adopt it as it represents a good compromise between theoretical soundness and empirical tractability.

In a first step, as in the HS framework, the probabilities of consuming positive quantities of any given food item are estimated by probit models. To allow for the possibility that the probability of consuming a given food item may be correlated with the probability of consuming another food item, a multivariate probit model would be ideally estimated. However, with 19 equations, this proves computationally challenging, and we therefore make the simplifying assumption that the decisions to purchase positive amounts are independent from one another in product space. This allows for the estimation of simpler equation-by-equation probit models. Denoting the vector of determinants of participation (i.e., positive consumption) by *v* for equation *j*, and by $\Phi(.)$ and $\phi(.)$ the normal cumulative distribution and probability density functions, the estimable equations (6) become:

$$w^j = \Phi(v'\lambda^j)\left[\sum_{r=1}^{R} b_r^j (y)^r + \sum_{t=1}^{T} g_t^j z_t + \sum_{k=1}^{J} a^{jk} \ln p^k\right] + \tau^j \phi(v'.\lambda^j) + \varepsilon^j \qquad (30)$$

The terms related to the first-stage probit equations are introduced to correct the bias in the coefficients of the EASI model brought about by censoring. Thus, those corrected coefficients can be used as such in the expressions of the elasticities previously described.

3.3. Prices and unit values

At least since the seminal contribution of Theil (1952), it has been known that heterogeneous commodity aggregates cannot be treated as homogenous goods in demand models. In particular, as shown by Deaton (1988), unit values, defined as the ratio of expenditure to physical quantity for a product aggregate, do not measure prices accurately since they also reflect endogenous quality choices. For example, higher income may induce households to expand their consumption of a heterogeneous commodity, such as the aggregate “meat”, by different means: either by consuming larger physical quantities of meat, or by switching to higher-price meat products (e.g., from ground beef to filet steaks). Consequently, the use of endogenous unit values in place of exogenous prices when estimating demand models results in biased elasticities (Irz 2010, Deaton 1988, Crawford et al. 2003, McKelvey 2011). The level of the approximation that is made when considering that unit values measure prices depends of the level of product aggregation and inherent heterogeneity of the products gathered into a single aggregate. Thus, in the present study in which the entire diet is partitioned into only 19 product groups, the problem is likely to be severe and needs to be addressed before proceeding to the estimation of the demand system. We also note that in addition to this quality adjustment issue, the use of unadjusted unit values as prices creates other problems related to sample selection (as only purchasing households are observed) and measurement errors (Gibson & Kim 2013).

Fortunately, the literature on the subject offers several options to correct unit values to make it possible to use them as price variables, as reviewed partially in Aepli (2014). Cox and Wohlgenant (1986) paved the way by showing how regressions of unit values on variables thought to influence quality choices (e.g., household size, education) can be used to “clean” unit values of their quality component. Their method, which is very close to that subsequently proposed by Park and Capps (1997), remains widely used in microeconometric analysis of household consumption (Gustavsen & Rickertsen 2014, Kuchler et al. 2005). Based on the theoretical model of quantity versus quality choice of Houthakker (1952), a unit value equation is specified as relating the unit value to: 1- Forces with a strong influence on supply conditions (hence prices), which are of particular importance in order to identify demand relationships. Typically, regional, seasonal and, where appropriate, yearly dummies are included, or the unit value equation are expressed in terms of deviation from regional/seasonal/annual means; and 2- Variables thought to influence quality choices, such as household size, or income. More recent developments of the approach also include the physical amount of the category aggregate to accommodate the possibility that the same goods purchased in larger quantities entail lower unit values (Capacci & Mazzocchi 2011). In a second stage, adjusted prices are calculated by removing from unit values the estimated effect of all the variables in the second group (i.e., influencing quality choices) or, equivalently, by adding the household-specific residual to the estimated effect of the first group of variables. Given that residuals are not available for non-consuming households, they are simply assumed to be zero so as to allow estimation of demand relationships over the whole sample.

This approach has been criticised, however, on conceptual and empirical grounds. One issue arises from the possibility that the adjusted prices may be negative, which is in fact a common finding in empirical work. While negative prices may suggest that, after accounting for quality differences, one would have to pay a particular household to consume the good in question (Park & Capps 1997), a large number of negative price observations seems suspect and undesirable. A quick fix to that problem involves estimating the unit value equations in logarithmic form, but this does not address the underlying difficulty of interpreting negative prices. More fundamentally, Cox and Wholgenant's method constructs household-specific prices that vary even within a given region during a given period of time, which is incompatible with the common view of how markets operate (Aepli 2014). Thus, other authors have proposed alternatives that start with the clustering of households across hypothesized markets defined by geography and time, and use within-cluster variations in unit values to net out the quality effects from price variations. This literature originated with the work of Deaton (1988) and has since expanded to produce several variants (e.g., Capacci & Mazzocchi 2012, Majumder et al. 2012, Aepli & Finger 2013).

The empirical analysis presented below used the Park and Capps (1997) approach to correct unit values.

3.4. Selection of the socio-economic variables

The socio-economic characteristics of the households enter the analysis at three different levels: first, as determinants of the participation equations in the probit models; second, as determinants of quality choices in the unit value equations; and third, as non-economic determinants of consumption in the EASI model. The theoretical literature provides little guidance on how to choose those variables, and we therefore selected variables commonly used in the empirical literature and available from the Finnish HBS. The selection of variables was also agreed with other SUSDIET partners in order to ensure the cross-country consistency of the empirical approach.

The upper part of Table 2 presents the main summary statistics for the variables that were used in all three types of estimated equations (i.e., unit values, market participation and demand). Thus, the age of the household head ranges from 18 to 95, with an average of 52 years. The educational level of the household head was divided into three categories: basic education, corresponding to primary and lower secondary education; a medium level, corresponding to upper secondary and post-secondary non-tertiary education; and tertiary education[3]. About 23% of household heads belonged to the lowest educational categories, with the rest divided almost equally between the medium- and higher levels. The average household is made up of 2.38 persons and a quarter of all households have kids under the age of 16. The socio-professional status of the household head was divided

[3] The detailed categories of the HBS and their English equivalents are described here: http://www.stat.fi/tk/tt/luokitukset/popup/iscedaste.html (accessed 16.11.2015).

into four categories: the first category corresponds to relatively lower-skilled (blue-collar) workers; soscat2 corresponds to entrepreneurs and white-collar professionals; the third category (soscat3) corresponds to pensioners; and soscat4 is a residual category including farm entrepreneurs, students, the long-term unemployed and other categories of non-professional workers. About 36% of household heads belong to the blue-collar category, 25% are white-collars; 30% belong to the pensioners category, with the residual category accounting for the remaining 9%. Finally, households are divided into income quartiles, where income is expressed per consumption unit as defined by the OECD (the household head gets a weight of one, each additional household member gets a weight of 0.5 if over the age of 13 and 0.3 up to the age of 13). The corresponding income thresholds are equal to €20662, €27737, and €35951 per consumption unit.

Table 2: Summary statistics of the socio-demographic variables used in the analysis

Variable	Mean	SD	Median	Min	Max	Obs.
Age	52.89	16.81	53.00	18.0	95.0	3495
Education (ref. Low)						
Medium	0.38	0.49	0.00	0.0	1.0	3495
High	0.39	0.49	0.00	0.0	1.0	3495
HH size	2.38	1.27	2.00	1.0	12.0	3495
Kids <=16	0.25	0.43	0.00	0.0	1.0	3495
Socio-prof. (ref. Blue collar)						
White collars	0.25	0.44	0.00	0.0	1.0	3495
Pensioners	0.30	0.46	0.00	0.0	1.0	3495
Other	0.09	0.29	0.00	0.0	1.0	3495
Income (Ref. Quartile 1)						
Quartile 2	0.25	0.43	0.00	0.0	1.0	3495
Quartile 3	0.25	0.43	0.00	0.0	1.0	3495
Quartile 4	0.25	0.43	0.00	0.0	1.0	3495
Region (ref. Achipelago)						
Helsinki	0.26	0.44	0.00	0.0	1.0	3495
South	0.21	0.41	0.00	0.0	1.0	3495
West	0.25	0.43	0.00	0.0	1.0	3495
North and East	0.24	0.43	0.00	0.0	1.0	3495
Annual quarter (ref. Q1)						
Q2	0.27	0.44	0.00	0.0	1.0	3495
Q3	0.22	0.41	0.00	0.0	1.0	3495
Q4	0.23	0.42	0.00	0.0	1.0	3495

The unit value equations include additional variables thought to influence supply conditions. Those variables, presented in the lower part of Table 2, include regional dummies corresponding to the NUTS2 division of Finland in five regions: Helsinki, Southern, Western and East/North, which are denoted with dummy variables "regdum" 1 to 4, plus the archipelago region, which is taken as the reference. The sample households are spread fairly evenly across regions, each accounting for more than 20% of observations, with the exception of the Archipelago region which only accounts for 4% of the sample households. The seasonal dummies correspond roughly to annual quarters and their mean values indicate that the survey data was collected reasonably evenly throughout year 2012. Finally, for each product category, the unit value equations also integrate the physical quantities of the aggregate to adjust for the possibility that larger quantities may be purchased at a lower cost per unit, as in Capacci & Mazzocchi (2011).

The probit equations were estimated by regressing, for each product category, a dummy variable indicating positive consumption on the same set of socio-demographic variables as used in the unit value equations.

4. Results

4.1. Step 1: Probit and unit value equations

Table 3 presents the results of the probit equations identifying the determinants and correlates of positive consumption of each of the 19 food aggregates. Those regressions serve mainly as an intermediate step to ensure that the demand elasticities are not biased by the presence of zero values in the household data, but a few results are worth commenting.

Positive consumption is strongly dependent on several socio-economic characteristics of the household in ways that often conform to intuition. Thus, older households, as identified by the age of the reference person, are less likely to consume any soft drinks, snacks and sugar products, but more likely to consume positive quantities of fish, dairy products, animal fat and starchy foods. The second group of products includes more traditional components of the Finnish diet than the first one. Household size is strongly associated with a higher probability of consuming almost any of the 19 categories, which can be explained by the necessity to shop more frequently in larger households, for reasons such as limited storage space (e.g., in refrigerators). The presence of kids under the age of 16 in the household decreases the probability of consuming positive quantities of fish as well as tea/coffee, but raises the probability of consuming positive amounts of snacks.

Among the variables describing the socio-economic conditions of the households, income has the largest influence on the probability of non-zero consumption, although there are differences across product groups. Thus, income has little influence on the probability of consuming grain products, dairy, plant-based fats and snacks but better-off people are more likely to consume positive amounts of all four types of meat products, fish, cheese, animal fat, fruits and vegetables, starchy foods, tea/coffee and soft drinks. Education is less systematically related to non-zero consumption than income, although there is evidence that the households belonging to the highest educational category are more likely to consume positive amounts of fruits and vegetables, which represents a common finding (Irala-Estevez et al. 2000). Socio-professional categories seem to have little impact on the probability of non-zero consumption, except for the "other" category, in which case that probability is significantly less than for blue collar workers. The result is difficult to interpret as the "other" category is heterogeneous and gathers, among others, farmers, students and the unemployed. Finally the results provide evidence of regional differences in consumption patterns. Thus, as compared to households in the Archipelago region, households elsewhere are less likely to consume fish but more likely to consume positive amounts of grain products, composite dishes, dairy and soft drinks. There is little evidence of seasonal effects in the probability of non-zero consumption.

Table 4 then presents the estimation results for the unit value equations of the 19 categories of food products. To address the potential endogeneity of the physical quantity variables q_i, the estimation used a two-stage least-squares (2SLS) procedure, using total physical quantity as instrument, in line with the approach followed by Capacci & Mazzocchi (2011). The results in Table 4 give evidence of quality and quantity effects in consumer choices. Household income is probably the socio-economic variable over which the strongest priors exist and we find that, in line with expectation, better-off households (i.e., those belonging to the fourth income quartile) tend to choose goods of higher quality for many categories, including meat from ruminants, cheese, processed meat, and vegetables, with fish products standing out as an exception. The better-educated also tend to choose higher-quality products, with the exception of the soft drinks and animal fat categories. Age, socio-professional status, region and season all affect quality choices in a statistically significant manner for at least some product groups. Finally, quantity effects are present and consistent with the idea that purchase of larger quantities tend to decrease unit values, although here again fish stands as a notable exception.

4.2. Step 2: EASI model and demand elasticities

The EASI model was estimated using an iterative seemingly unrelated regression (ISUR) procedure, with the maximum number of iterations set at 500. The initial specification entailed a polynomial of degree five in real income, and we performed a Wald test of the null hypothesis that all 19 coefficients associated with the fifth-order term were not significantly different from zero. That hypothesis was rejected at any reasonable level of confidence, and we therefore selected the degree-five polynomial specification as the preferred one. Further tests revealed that the probability density function terms in equation (30) was also highly statistically significant, a result pointing to the importance of correcting for censoring in the demand equations.

The estimated coefficients are not directly interpretable and therefore not worth reporting. Instead, Table 5 presents the Hicksian elasticities measuring the response of demand to prices while holding utility constant (i.e., compensating the consumer any price change). A necessary condition for utility maximisation (i.e., rationality) is that the diagonal elements of the matrix, which correspond to the own-price elasticities, should be non-positive. All 19 own price-elasticities are negative, although four elasticities are not significantly different from zero. For three of those four elasticities, corresponding to the product groups “animal fat”, “snacks” and “soft drinks”, the non-significance arises from very large standard errors, which reflect the inability of the model to estimate the price coefficients with any precision. In turn, this can be due to the small expenditure shares for those product categories (Table 1), and the fact that those shares enter the denominators of the expressions of the Hickisan elasticities (20). Altogether, the estimates are broadly consistent with the theory-driven view that prices influence demand, and that consumers respond to a change in the price of a good by substituting away from its consumption (when compensation for the price change occurs).

Figure 2 presents the own-price elasticities graphically and shows that responsiveness to own price varies greatly across product groups. As expected, demand for food aggregates tends to be inelastic (i.e., the absolute value of the own-price elasticities is smaller than one), although this is not the case for cheese, and the graph shows that the absolute values of the elasticities cover the whole interval from zero to one. The most price responsive products include cheese, plant-based fat, and all meats except the “Poultry and other meats” aggregate. The least price elastic groups include starchy foods, snacks, soft drinks, animal fats, as well as grain and sugar products.

Table 5 also shows that there are significant relationships of substitution and complementarity among the 19 groups that form the Finnish diet. From a total of 342 cross-price elasticities, 119 or 35% are statistically significant at the 10% level, and 73 or 21% are significant at the 5% level. Relationships of substitutability tend to dominate but the table also contains many negative and relatively large (in absolute values) cross-price elasticities. For instance, grain products and sugar products are Hicksian complements.

Table 6 presents the Marshallian price and expenditure elasticities of demand. Through the Slutsky relationship, the own-price elasticities become slightly more negative than their Hicksian counterparts but the results are qualitatively similar to those presented above for Hicksian demands. In particular, all own-price elasticities are negative, but four of those corresponding to the “animal fat”, “starchy foods”, “snacks” and “soft drinks” categories are not statistically significant. It is worth noting the low absolute values of the own-price elasticities for many of the groups falling under the heading “junk foods”, i.e. “snacks”, “sugar”, “soft drinks”. This raises doubts about the effectiveness of a sugar or junk-food tax in achieving dietary change, which contrasts with a recent analysis of the health and welfare effects of a sugar tax in Finland (Härkänen et al. 2014).

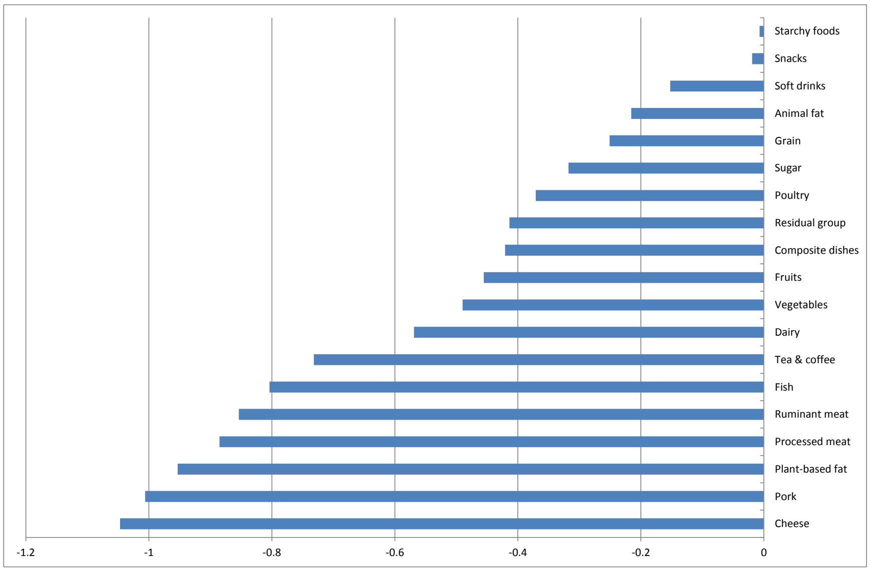

Figure 2: Hicksian own- price elasticities

Table 6 also presents the expenditure elasticities, which are all positive and strongly statistically significant. The graphical representation of those elasticities in Figure 3 shows that about half of the food groups are expenditure elastic, which seems high, but one needs to keep in mind that expenditure is measured here by the food budget rather than the total budget available for consumption. Thus, the absolute values of those elasticities are less informative than their relative magnitudes. The particularly low expenditure elasticity of demand for dairy products (except cheese) has been noticed elsewhere (Irz & Kuosmanen 2013). However, it is difficult to identify clear patterns on the basis of expenditure elasticities between products of animal or plant origins, or between processed and non-processed products, or healthy vs non-healthy foods.

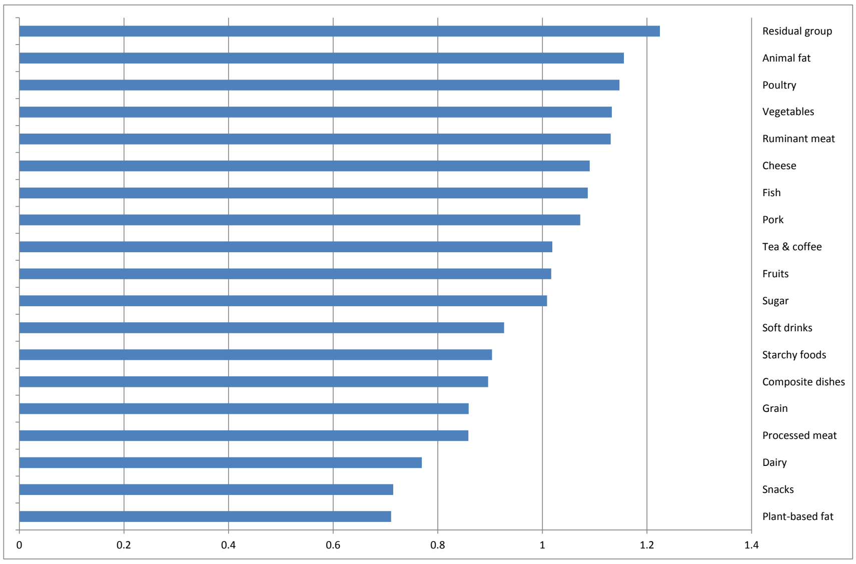

Figure 3: Marshallian expenditure elasticities

Tables 7 and 8 then present the unconditional Hicskian and Marshallian elasticity estimates, which are obtained by relaxing the restrictive assumption of a constant food budget. The price elasticities are not very different from their conditional equivalents, but all the unconditional expenditure elasticities are much smaller than their conditional counterparts. That finding was expected, as it reflects Engel's law, which states that food's budget share (i.e., its relative importance in terms of expenditure) is inversely related to the household's budget, and has been established as an extremely robust empirical regularity (Hamilton 2001). The analysis therefore shows that all food categories are normal goods (i.e., their expenditure elasticities are smaller than unity) and that, as households become more prosperous, the relative importance of all those food categories in consumption decreases.

Table 9 presents the elasticities of demand with respect to the socio-demographic variables. Many elasticities are statistically significant, showing that for any given food category, demand is heterogeneous within the population but that a systematic link exists to observable socio-demographic characteristics. Symmetrically, for any of the socio-demographic variables introduced into the model, the results show that that variable has a statistically significant influence on demand for at least some of the food groups.

4.3. Extension: responses of GHG emissions and demand for nutrients to economic signals

The elasticities of demand for foods are then linked to technical coefficients describing the nutritional and environmental characteristics of those foods, following a method first proposed by Huang (1996). Those technical coefficients are described in Table 10 and were provided by work package 1 of the SUSDIET project. Calculations of the GHG coefficients are explained in detail in Hartikainen & Pulkkinen (2016). The method produces price and expenditure elasticities of demand for nutrients and GHG emissions reported in Table 11. For instance, the first number of the table (top left) indicates that a 10% increase in the price of grain products induces a 0.5% increase in GHG emissions from food consumption. The result is explained by substitutions: although the price increase would reduce consumption of grains, as shown by the negative own-price elasticity of grain products in Table 7, consumers would replace the lost calories with other foods, in particular meat from ruminants, fish, processed meat and composed dishes (see cross-price elasticities in Table 7), and the total net effect would be to increase GHG emissions. Thus, the first row of Table 11 establishes that GHG emissions from food consumption respond most strongly to the prices of animal products, including beef/lamb/veal, processed meat and cheese but also to the prices of “composed dishes” and tea/coffee/cocoa/drinking water, which was less expected. Reductions in the prices of grain products, vegetables, fish but also sugar products and plant-based fats would result, ceteris paribus, in a reduction in GHG emissions, but the magnitudes of the effects would be small. Finally, the last number of the first row reveals that GHG emissions respond strongly to total consumption expenditure, since a 10% increase in budget results in a 7% increase in emissions.

In a similar way, the second row identifies the foods which, if taxed, would reduce energy intake the most, taking into account the substitutions driven by consumer preferences. Those foods include grain products, plant-based fat and composite dishes, but the elasticities are small in absolute value. By contrast, the last column indicates that intake of calories grows strongly with total consumption expenditure. Altogether, the results suggest that the issue of excessive caloric intake in Finland may be more driven by growing prosperity than changing relative prices between healthy and unhealthy foods.

The remaining sections of Table 11 present the responses of demand for macro-nutrients, vitamins and minerals to prices and expenditure. The last column indicates that the expenditure elasticities for nutrients vary relatively little, from a minimum of 0.62 for vitamin D to a maximum of 0.74 for beta-carotene. Among macronutrients, it is worth noting that the expenditure elasticity of demand for free sugar is highest, but altogether the estimates imply that, as consumers’ budgets expand, the relative quality of the Finnish diet does not change much.

The price elasticities of demand for nutrients are quite small but there are noteworthy exceptions that can be easily interpreted. For example, demand for calcium responds strongly to the prices of milk/dairy products and cheese and demand for vitamin C is very sensitive to the price of fruits. As far as macronutrients of particular relevance to dietary health are concerned, demand for saturated fat responds strongly to the prices of cheese and plant-based fats, while demand for fibres is sensitive to the prices of grain products and fruits.

5. Conclusion

By estimating an EASI demand system from household-level data, the research reported in this document has produced a comprehensive investigation of the economic and socio-demographic drivers of demand for foods and nutrients, as well as diet-related GHG emissions, in Finland. Although the elasticities summarizing the results may be interpreted on their own to generate valuable insights, the main purpose of the exercise is to provide parameters to simulate policies aimed at improving the sustainability of the Finnish diet. Indeed, the elasticities are in use within the SUSDIET project to assess ex-ante the effects of a carbon tax applied to foods on consumers' welfare, diet quality and GHG. Another part of the project is investigating the sustainability effects of dietary recommendations and also uses the reported elasticities, which measure the difficulty for consumers to substitute foods for one another and therefore their fundamental food preferences.

The research could be extended in several directions in the future in order to address specific issues and build richer behavioural models. The neoclassical theory of choice assumes that preferences are either linked to observable socio-demographics or randomly distributed within the population, which some regard as an oversimplification (Caplan 2003) that should be addressed by bringing insights from preference-based explanations of human behaviour into the model. Another unresolved issue relates to quality adjustments on the quantity side (McKelvey 2011) – for instance consumers may respond to a change in price by reducing their consumption through quality downgrading, but this phenomenon is not captured by the reported elasticities. Finally, the imminent release of the next round of the household budget survey gives an opportunity to test whether Finns' preferences for food have fundamentally changed in recent years as a result of public discussions over the sustainability of food consumption patterns, for instance in relation to consumption of meat and animal products.

Table 3: Estimated probit equation of positive consumption (Standard errors in parentheses; *p<0.1; **p<0.05; ***p<0.01)

	Grain	Ruminant meat	Pork	Poultry	Processed meat	Composite dishes	Fish	Dairy	Cheese	Animal fat	Plant-based fat	Fruits	Vegetables	Starchy foods	Snacks	Residual group	Sugar	Tea & coffee	Soft drink
Age	0.005	-0.001	0.013***	0.002	0.014***	-0.002	0.012***	0.010***	-0.001	0.006***	0.012***	0.015***	0.003	0.015***	-0.018***	-0.005**	-0.010***	0.003	-0.017***
	(0.004)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.002)	(0.002)	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
Educ. (ref. low)																			
Medium	0.255*	0.181***	0.112	0.104	0.08	0.222***	0.141**	0.074	0.07	0.1	0.047	0.307**	0.196*	0.126*	0.078	0.013	0.047	-0.022	0.066
	(0.134)	(0.064)	(0.069)	(0.078)	(0.078)	(0.066)	(0.065)	(0.121)	(0.078)	(0.071)	(0.062)	(0.124)	(0.107)	(0.077)	(0.071)	(0.071)	(0.095)	(0.066)	(0.063)
High	0.332**	0.107	-0.01	0.139*	-0.033	0.135*	0.139**	0.072	0.273***	0.01	0.105	0.312**	0.428***	0.044	0.148**	0.061	0.172*	0.016	-0.01
	(0.149)	(0.067)	(0.072)	(0.083)	(0.081)	(0.069)	(0.069)	(0.127)	(0.087)	(0.074)	(0.065)	(0.136)	(0.126)	(0.080)	(0.074)	(0.076)	(0.104)	(0.070)	(0.066)
Household size	0.037	0.282***	0.258***	0.305***	0.306***	0.124***	0.229***	0.224***	0.250***	0.352***	0.230***	0.111*	0.272***	0.357***	0.223***	0.436***	0.365***	0.228***	0.194***
	(0.065)	(0.031)	(0.033)	(0.043)	(0.040)	(0.032)	(0.031)	(0.067)	(0.045)	(0.037)	(0.028)	(0.066)	(0.064)	(0.041)	(0.029)	(0.040)	(0.062)	(0.032)	(0.030)
Kids under age of 16	0.107	0.076	-0.116	-0.176	-0.094	0.14	-0.301***	0.065	-0.107	-0.095	-0.079	0.093	-0.129	-0.164	0.226***	-0.208*	-0.045	-0.189**	0.107
	(0.198)	(0.088)	(0.092)	(0.115)	(0.108)	(0.093)	(0.088)	(0.183)	(0.126)	(0.099)	(0.080)	(0.189)	(0.175)	(0.108)	(0.081)	(0.107)	(0.176)	(0.091)	(0.085)
Socio-prof. Cat (ref. blue col.)																			
White collars	-0.196	-0.067	-0.167**	0.103	-0.211***	-0.11	0.072	-0.224*	-0.131	-0.043	-0.135**	0.055	0.013	-0.011	-0.129**	-0.087	-0.18	-0.003	-0.043
	(0.156)	(0.066)	(0.070)	(0.086)	(0.080)	(0.070)	(0.068)	(0.129)	(0.096)	(0.074)	(0.062)	(0.143)	(0.132)	(0.080)	(0.065)	(0.078)	(0.120)	(0.070)	(0.065)
Pensioners	-0.065	0.064	-0.158*	0.057	-0.183*	-0.207**	-0.084	-0.229	-0.174	0.14	-0.023	-0.132	0.246	-0.074	-0.383***	0.121	-0.083	-0.143*	-0.103
	(0.190)	(0.080)	(0.087)	(0.100)	(0.099)	(0.084)	(0.084)	(0.157)	(0.106)	(0.089)	(0.077)	(0.171)	(0.152)	(0.097)	(0.088)	(0.090)	(0.127)	(0.084)	(0.078)
Others	-0.441***	-0.087	-0.249***	0.085	-0.252**	-0.249***	-0.221**	-0.281*	-0.220**	-0.065	-0.144*	0.188	-0.015	-0.01	-0.326***	0.012	-0.355***	-0.173*	-0.133
	(0.162)	(0.087)	(0.090)	(0.106)	(0.099)	(0.091)	(0.086)	(0.151)	(0.107)	(0.093)	(0.084)	(0.167)	(0.137)	(0.100)	(0.089)	(0.099)	(0.134)	(0.088)	(0.086)
Income quartile (ref. Q1)																			
Q2	0.153	0.205***	0.273***	0.281***	0.255***	0.009	0.170**	0.043	0.245***	0.246***	0.091	0.356***	0.337***	0.251***	0.028	0.127*	0.086	0.046	0.161**
	(0.143)	(0.066)	(0.069)	(0.080)	(0.079)	(0.070)	(0.067)	(0.125)	(0.080)	(0.072)	(0.064)	(0.129)	(0.110)	(0.077)	(0.073)	(0.073)	(0.100)	(0.068)	(0.066)
Q3	0.177	0.285***	0.416***	0.341***	0.313***	0.002	0.183***	0.1	0.484***	0.235***	0.044	0.435***	0.711***	0.376***	0.053	0.349***	0.190*	0.136*	0.134*
	(0.155)	(0.069)	(0.074)	(0.085)	(0.083)	(0.073)	(0.070)	(0.134)	(0.090)	(0.076)	(0.066)	(0.141)	(0.140)	(0.083)	(0.075)	(0.079)	(0.112)	(0.072)	(0.069)
Q4	0.225	0.336***	0.441***	0.316***	0.346***	-0.042	0.293***	0.081	0.568***	0.430***	0.028	0.366**	0.546***	0.249***	0.043	0.312***	0.201	0.249***	0.134*
	(0.172)	(0.076)	(0.081)	(0.095)	(0.092)	(0.080)	(0.078)	(0.147)	(0.104)	(0.085)	(0.072)	(0.157)	(0.144)	(0.090)	(0.080)	(0.087)	(0.125)	(0.080)	(0.075)
Regions (ref. Archipelago)																			
Helsinki	0.513**	-0.143	-0.346**	-0.141	-0.026	0.411***	-0.422***	0.411**	0.181	-0.186	-0.081	-0.05	-0.16	-0.089	-0.198	-0.371**	-0.008	0.038	0.382***
	(0.223)	(0.126)	(0.143)	(0.164)	(0.149)	(0.122)	(0.143)	(0.190)	(0.159)	(0.144)	(0.119)	(0.271)	(0.250)	(0.156)	(0.130)	(0.160)	(0.194)	(0.127)	(0.123)
South	0.470**	-0.006	-0.141	-0.082	0.13	0.406***	-0.363**	0.560***	0.234	-0.036	-0.156	-0.043	0.187	0.042	-0.149	-0.271*	0.033	0.151	0.455***
	(0.227)	(0.129)	(0.146)	(0.166)	(0.153)	(0.124)	(0.145)	(0.199)	(0.162)	(0.147)	(0.121)	(0.274)	(0.260)	(0.159)	(0.133)	(0.162)	(0.197)	(0.130)	(0.126)
West	0.484**	-0.046	-0.107	-0.09	0.255*	0.433***	-0.408***	0.508***	0.24	0.005	-0.209*	0.068	0.068	0.012	-0.153	-0.271*	0.243	0.11	0.450***
	(0.223)	(0.127)	(0.144)	(0.165)	(0.152)	(0.123)	(0.143)	(0.194)	(0.160)	(0.146)	(0.120)	(0.275)	(0.255)	(0.158)	(0.131)	(0.161)	(0.199)	(0.128)	(0.124)
East and North	0.423*	-0.016	-0.05	0.091	0.223	0.337***	-0.238*	0.637***	0.179	-0.012	-0.12	0.064	0.059	-0.049	-0.224*	-0.213	0.066	0.211	0.399***
	(0.221)	(0.128)	(0.145)	(0.167)	(0.153)	(0.123)	(0.144)	(0.200)	(0.160)	(0.147)	(0.120)	(0.275)	(0.255)	(0.158)	(0.132)	(0.161)	(0.196)	(0.129)	(0.125)
Yearly quarter (ref. Q4)																			
Q1	-0.121	0.055	0.012	0.003	0.047	-0.054	0.105*	0.367***	0.084	-0.087	-0.097*	-0.065	0.190*	-0.087	0.115*	0.055	0.028	-0.091	-0.088
	(0.141)	(0.061)	(0.065)	(0.078)	(0.074)	(0.065)	(0.062)	(0.127)	(0.081)	(0.068)	(0.058)	(0.129)	(0.114)	(0.074)	(0.064)	(0.069)	(0.093)	(0.064)	(0.060)
Q2	-0.108	-0.079	0.129*	-0.160**	0.018	-0.053	0.186***	0.03	-0.086	-0.118*	-0.012	-0.022	0.197	-0.042	0.068	0.08	0.269**	-0.078	0.129**
	(0.150)	(0.064)	(0.070)	(0.079)	(0.078)	(0.068)	(0.067)	(0.116)	(0.082)	(0.071)	(0.062)	(0.139)	(0.122)	(0.078)	(0.068)	(0.073)	(0.107)	(0.067)	(0.064)
Q3	-0.135	-0.034	-0.035	-0.017	0.051	-0.149**	0.058	0.052	0.076	-0.031	-0.083	-0.172	-0.011	-0.115	0.124*	0.048	0.190*	0.016	-0.200***
	(0.145)	(0.063)	(0.067)	(0.080)	(0.076)	(0.066)	(0.064)	(0.113)	(0.084)	(0.071)	(0.060)	(0.126)	(0.109)	(0.075)	(0.067)	(0.071)	(0.101)	(0.067)	(0.062)
Constant	1.111***	-0.441**	-0.578***	0.152	-0.569***	0.183	-0.426**	0.306	0.265	-0.423**	-0.946***	0.514	0.356	-0.639***	0.006	0.262	1.127***	-0.073	0.202
	(0.343)	(0.180)	(0.196)	(0.226)	(0.211)	(0.183)	(0.192)	(0.298)	(0.226)	(0.200)	(0.173)	(0.361)	(0.329)	(0.215)	(0.186)	(0.214)	(0.282)	(0.184)	(0.178)

Table 4: Estimated unit value equations (Standard errors in parentheses; *p<0.1; **p<0.05; ***p<0.01)

	Grain	Ruminant meat	Pork	Poultry	Processed meat	Composite dishes	Fish	Dairy	Cheese	Animal fat	Plant-based fat	Fruits	Vegetables	Starchy foods	Snacks	Residual group	Sugar	Tea & coffee	Soft drink
Age	-0.002	0.0005	-0.002	-0.007*	-0.017***	-0.002	0.019*	-0.002***	0.022***	0.003***	0.004	0.001	-0.005**	-0.015***	-0.0002	0.016**	-0.041***	0.001	-0.004**
	(0.002)	(0.006)	(0.003)	(0.004)	(0.005)	(0.003)	(0.010)	(0.001)	(0.003)	(0.001)	(0.005)	(0.001)	(0.002)	(0.003)	(0.000)	(0.008)	(0.006)	(0.020)	(0.002)
Educ. (ref. low)																			
Medium	0.092*	0.011	0.235***	0.135	-0.032	-0.07	0.537*	0.011	-0.006	-0.027	0.141	0.041	0.095	0.056	-0.020*	0.075	0.295	-0.03	-0.192***
	(0.054)	(0.191)	(0.077)	(0.117)	(0.140)	(0.088)	(0.275)	(0.022)	(0.091)	(0.024)	(0.128)	(0.040)	(0.067)	(0.085)	(0.011)	(0.262)	(0.180)	(0.620)	(0.070)
High	0.07	0.326*	0.329***	0.399***	0.244	-0.087	0.966***	0.067***	0.02	-0.066***	0.194	-0.011	0.063	0.290***	-0.009	0.123	0.528***	0.25	-0.218***
	(0.056)	(0.197)	(0.081)	(0.122)	(0.150)	(0.092)	(0.284)	(0.023)	(0.094)	(0.025)	(0.134)	(0.042)	(0.070)	(0.090)	(0.011)	(0.248)	(0.188)	(0.637)	(0.073)
Household size	0.048*	-0.131	0.101***	-0.068	-0.157**	0.087**	-0.237**	-0.041***	-0.047	0.005	-0.167**	-0.042**	-0.02	-0.033	0.005	-0.117	0.123	-0.394	0.005
	(0.029)	(0.098)	(0.038)	(0.062)	(0.076)	(0.040)	(0.120)	(0.012)	(0.044)	(0.012)	(0.075)	(0.019)	(0.031)	(0.040)	(0.005)	(0.225)	(0.098)	(0.256)	(0.030)
Kids under age of 16	-0.126*	-0.138	-0.082	0.028	-0.137	-0.091	0.19	-0.002	0.022	-0.006	-0.032	-0.041	0.053	0.049	-0.025**	-0.187	0.434*	0.627	-0.041
	(0.068)	(0.217)	(0.097)	(0.145)	(0.179)	(0.105)	(0.339)	(0.028)	(0.110)	(0.030)	(0.169)	(0.050)	(0.084)	(0.106)	(0.010)	(0.299)	(0.224)	(0.740)	(0.077)
Socio-prof. Cat (ref. blue col.)																			
White collars	0.026	0.452**	0.003	0.123	0.196	-0.189**	0.619**	-0.018	0.204**	-0.01	0.173	0.013	-0.059	0.005	-0.006	-0.114	-0.115	0.637	0.022
	(0.054)	(0.179)	(0.076)	(0.115)	(0.142)	(0.084)	(0.269)	(0.022)	(0.087)	(0.024)	(0.132)	(0.040)	(0.066)	(0.084)	(0.009)	(0.231)	(0.178)	(0.600)	(0.064)
Pensioners	-0.101	0.143	-0.036	0.006	0.106	-0.086	-0.778**	-0.061**	0.03	-0.026	-0.244	0.055	-0.137*	-0.203*	-0.007	-0.139	-0.598***	0.96	0.116
	(0.067)	(0.235)	(0.096)	(0.146)	(0.182)	(0.108)	(0.336)	(0.028)	(0.111)	(0.030)	(0.165)	(0.050)	(0.083)	(0.106)	(0.015)	(0.309)	(0.225)	(0.777)	(0.088)
Others	-0.155**	-1.007***	-0.285***	-0.042	-0.051	-0.068	-0.859**	-0.121***	0.213*	0.015	-0.165	-0.032	-0.247***	-0.206*	-0.003	-0.109	-0.276	0.368	-0.071
	(0.073)	(0.267)	(0.109)	(0.157)	(0.197)	(0.115)	(0.391)	(0.030)	(0.122)	(0.033)	(0.189)	(0.053)	(0.090)	(0.118)	(0.013)	(0.316)	(0.241)	(0.833)	(0.086)
Income quartile (ref. Q1)																			
Q2	-0.002	-0.072	0.047	-0.107	-0.045	-0.004	-0.566*	0.005	0.186**	-0.025	0.144	-0.063	0.032	-0.087	0.016	0.139	-0.088	-0.278	-0.078
	(0.055)	(0.199)	(0.082)	(0.121)	(0.148)	(0.089)	(0.295)	(0.023)	(0.094)	(0.025)	(0.137)	(0.041)	(0.069)	(0.089)	(0.010)	(0.252)	(0.187)	(0.640)	(0.071)
Q3	0.031	0.217	0.1	-0.036	0.002	0.005	-0.833***	0.016	0.176*	-0.038	-0.112	-0.059	0.082	-0.014	0.016	0.167	0.065	-1.300*	-0.067
	(0.058)	(0.207)	(0.085)	(0.129)	(0.155)	(0.091)	(0.304)	(0.024)	(0.099)	(0.027)	(0.153)	(0.043)	(0.072)	(0.093)	(0.011)	(0.266)	(0.194)	(0.666)	(0.073)
Q4	0.103	0.685***	0.181**	0.18	0.383**	0.229**	-1.339***	0.067***	0.331***	-0.028	0.327**	-0.016	0.202**	-0.004	0.0001	0.363	-0.046	-0.742	-0.066
	(0.064)	(0.239)	(0.092)	(0.143)	(0.171)	(0.101)	(0.379)	(0.026)	(0.114)	(0.029)	(0.158)	(0.048)	(0.080)	(0.101)	(0.012)	(0.392)	(0.212)	(0.721)	(0.082)
Regions (ref. Archipelago)																			
Helsinki	0.216**	-0.537	0.112	0.520**	-0.293	-0.370**	1.654***	0.054	-0.395**	0.164***	0.183	-0.016	0.333***	0.184	-0.008	-0.404	0.905***	-3.680***	0.091
	(0.104)	(0.343)	(0.144)	(0.220)	(0.270)	(0.183)	(0.489)	(0.043)	(0.171)	(0.047)	(0.244)	(0.076)	(0.126)	(0.160)	(0.018)	(0.500)	(0.343)	(1.201)	(0.149)
South	0.198*	-0.823**	0.084	0.116	-0.239	-0.373**	0.732	-0.012	-0.356**	0.196***	0.13	-0.076	0.14	-0.103	0.009	-0.297	0.51	-4.498***	0.031
	(0.105)	(0.347)	(0.143)	(0.223)	(0.273)	(0.182)	(0.499)	(0.044)	(0.174)	(0.047)	(0.243)	(0.077)	(0.128)	(0.161)	(0.018)	(0.562)	(0.349)	(1.213)	(0.149)
West	0.142	-1.190***	0.039	0.271	-0.632**	-0.396**	0.787	-0.037	-0.632***	0.227***	-0.011	-0.062	0.232*	-0.15	0.024	-0.514	0.758**	-4.288***	0.105
	(0.104)	(0.343)	(0.142)	(0.221)	(0.270)	(0.181)	(0.501)	(0.043)	(0.172)	(0.046)	(0.248)	(0.077)	(0.127)	(0.160)	(0.018)	(0.507)	(0.344)	(1.191)	(0.147)
East and North	0.048	-1.489***	0.098	-0.015	-0.238	-0.374**	-0.702	-0.014	-0.686***	0.225***	-0.062	-0.047	0.011	-0.371**	0.021	-0.715	0.612*	-4.642***	0.044
	(0.105)	(0.345)	(0.142)	(0.221)	(0.271)	(0.181)	(0.489)	(0.044)	(0.173)	(0.046)	(0.240)	(0.077)	(0.127)	(0.160)	(0.018)	(0.511)	(0.346)	(1.192)	(0.148)
Yearly quarter (ref. Q4)																			
Q1	0.046	0.199	-0.057	0.116	-0.111	0.067	0.183	-0.001	-0.255***	-0.011	0.003	-0.045	0.025	-0.171**	0.01	-0.293	-0.268	-0.06	-0.106*
	(0.051)	(0.171)	(0.079)	(0.109)	(0.133)	(0.082)	(0.271)	(0.021)	(0.083)	(0.023)	(0.124)	(0.038)	(0.062)	(0.080)	(0.009)	(0.239)	(0.170)	(0.571)	(0.063)
Q2	0.084	-0.056	-0.031	-0.024	-0.203	0.175**	0.473*	0.047**	-0.037	0.059**	0.083	0.190***	-0.353***	-0.224***	0.001	-0.293	-0.334*	-0.678	-0.049
	(0.053)	(0.184)	(0.078)	(0.116)	(0.144)	(0.084)	(0.271)	(0.022)	(0.089)	(0.024)	(0.127)	(0.039)	(0.067)	(0.086)	(0.010)	(0.303)	(0.181)	(0.628)	(0.067)
Q3	0.028	-0.123	0.111	0.052	0.224	0.069	0.066	0.014	-0.025	0.059**	0.101	0.327***	-0.415***	-0.164**	0.001	-0.597***	-0.305*	-0.809	-0.195***
	(0.052)	(0.180)	(0.080)	(0.113)	(0.139)	(0.084)	(0.275)	(0.022)	(0.086)	(0.023)	(0.128)	(0.039)	(0.066)	(0.083)	(0.009)	(0.230)	(0.176)	(0.592)	(0.067)
Physical quantity q	-0.002***	0.005	-0.009***	0.001	-0.002	-0.004	0.035***	-0.0001***	-0.001	0.001	0.013	0.0003*	-0.001**	-0.002***	0.000	-0.008	-0.022***	-0.046***	-0.001*
	(0.000)	(0.008)	(0.003)	(0.003)	(0.005)	(0.003)	(0.011)	(0.000)	(0.003)	(0.001)	(0.011)	(0.000)	(0.000)	(0.001)	(0.002)	(0.009)	(0.003)	(0.009)	(0.001)
Constant	4.213***	9.687***	9.527***	5.603***	9.225***	6.649***	8.033***	1.643***	9.349***	5.041***	3.761***	1.868***	3.027***	3.158***	8.384***	9.174***	10.983***	16.677***	2.138***
	(0.150)	(0.517)	(0.226)	(0.325)	(0.405)	(0.255)	(0.775)	(0.063)	(0.251)	(0.068)	(0.389)	(0.110)	(0.184)	(0.242)	(0.036)	(0.725)	(0.499)	(1.732)	(0.197)

Table 5: Conditional Hicksian price elasticities of demand (Standard errors in parentheses; *p<0.1; **p<0.05; ***p<0.01; diagonal elements in bold).

	Grain	Rum. meat	Pork	Poultry	Proc. meat	Compos.dish	Fish	Dairy	Cheese	Animal fat	Plant-b. fat	Fruits	Veg.	Star. foods	Snacks	Residual	Sugar	Tea/coffee	Soft drinks
Grain	**-0.251*****	0.104***	0.054**	0.031	0.086***	0.088***	0.076***	-0.004	0.021	-0.064***	-0.023*	-0.006	-0.027*	0.003	0.027*	0.04**	-0.067***	0.043***	0.013
	(0.031)	(0.015)	(0.023)	(0.020)	(0.020)	(0.023)	(0.012)	(0.019)	(0.021)	(0.017)	(0.013)	(0.018)	(0.016)	(0.010)	(0.015)	(0.017)	(0.020)	(0.014)	(0.021)
Ruminant meat	0.271***	**-0.854*****	0.164***	-0.032	-0.002	0.001	-0.009	0.091***	0.106***	0.053**	0.039*	0.141***	0.07**	-0.016	0.02	0.053	0.043	0.032	-0.025
	(0.040)	(0.037)	(0.040)	(0.035)	(0.034)	(0.038)	(0.022)	(0.034)	(0.034)	(0.026)	(0.021)	(0.034)	(0.028)	(0.016)	(0.024)	(0.034)	(0.035)	(0.026)	(0.037)
Pork	0.144**	0.168***	**-1.006*****	0.058	-0.004	-0.017	0.047*	0.11*	0.234***	0.136**	0.097**	0.07	0.086*	-0.068**	-0.209***	0.05	0.076	0.093***	0.079
	(0.061)	(0.041)	(0.098)	(0.057)	(0.059)	(0.064)	(0.026)	(0.057)	(0.063)	(0.060)	(0.042)	(0.048)	(0.046)	(0.030)	(0.056)	(0.038)	(0.051)	(0.036)	(0.063)
Poultry	0.057	-0.023	0.04	**-0.371*****	0.032	0.003	-0.008	0.034	0.023	-0.026	0.063***	0.049	0.03	0.005	0.069***	0.077***	-0.002	0.045**	0.048
	(0.037)	(0.024)	(0.039)	(0.047)	(0.034)	(0.037)	(0.018)	(0.033)	(0.035)	(0.029)	(0.022)	(0.030)	(0.027)	(0.017)	(0.026)	(0.026)	(0.032)	(0.023)	(0.035)
Processed meat	0.228***	-0.002	-0.004	0.046	**-0.885*****	-0.012	0.043*	-0.018	0.267***	0.276***	-0.005	0.015	0.072*	-0.011	0.055	-0.001	0.062	0.038	-0.02
	(0.053)	(0.035)	(0.058)	(0.049)	(0.070)	(0.054)	(0.024)	(0.048)	(0.052)	(0.046)	(0.034)	(0.042)	(0.039)	(0.025)	(0.040)	(0.036)	(0.045)	(0.032)	(0.051)
Composite dishes	0.258***	0.002	-0.019	0.005	-0.013	**-0.421*****	0.181***	0.155***	-0.137**	-0.038	0.055	-0.047	0.066	-0.022	0.024	0.047	0.106*	-0.074*	0.016
	(0.066)	(0.043)	(0.070)	(0.060)	(0.060)	(0.094)	(0.031)	(0.058)	(0.062)	(0.053)	(0.040)	(0.053)	(0.048)	(0.030)	(0.046)	(0.046)	(0.056)	(0.040)	(0.062)
Fish	0.21***	-0.009	0.049*	-0.012	0.045*	0.171***	**-0.804*****	0.106***	0.073***	0.006	0.02	-0.03	0.051**	0.05***	0.009	0.06	0.091***	0.011	0.047*
	(0.032)	(0.024)	(0.027)	(0.027)	(0.025)	(0.030)	(0.031)	(0.025)	(0.025)	(0.017)	(0.014)	(0.027)	(0.021)	(0.012)	(0.017)	(0.037)	(0.029)	(0.022)	(0.026)
Dairy	-0.006	0.056***	0.066*	0.03	-0.011	0.085***	0.062***	**-0.569*****	0.089***	0.055**	0.009	0.075***	0.022	-0.057***	0.041*	-0.002	0.076***	0.041**	0.082***
	(0.031)	(0.021)	(0.034)	(0.029)	(0.029)	(0.032)	(0.014)	(0.040)	(0.031)	(0.027)	(0.020)	(0.025)	(0.023)	(0.015)	(0.025)	(0.021)	(0.026)	(0.019)	(0.030)
Cheese	0.041	0.08***	0.172***	0.024	0.199***	-0.092**	0.052***	0.109***	**-1.047*****	0.051	0.084***	0.046	0.234***	0.094***	0.008	0.034	0.046	0.059**	-0.051
	(0.041)	(0.026)	(0.046)	(0.037)	(0.038)	(0.042)	(0.018)	(0.037)	(0.058)	(0.039)	(0.027)	(0.032)	(0.030)	(0.019)	(0.035)	(0.026)	(0.034)	(0.023)	(0.041)
Animal fat	-0.269***	0.086**	0.212**	-0.06	0.438***	-0.055	0.009	0.143**	0.109	**-0.216**	-0.086	0.092*	0.073	-0.051	-0.118	0.055	-0.168***	0.061	-0.112
	(0.070)	(0.043)	(0.094)	(0.067)	(0.072)	(0.076)	(0.026)	(0.071)	(0.083)	(0.184)	(0.064)	(0.053)	(0.055)	(0.037)	(0.154)	(0.037)	(0.056)	(0.038)	(0.082)
Plant-based fat	-0.176*	0.116*	0.28**	0.268***	-0.014	0.146	0.056	0.044	0.332***	-0.158	**-0.953*****	0.148*	0.187**	-0.045	-0.083	-0.042	-0.232***	0.105*	0.163
	(0.100)	(0.064)	(0.122)	(0.095)	(0.099)	(0.106)	(0.040)	(0.099)	(0.108)	(0.119)	(0.107)	(0.077)	(0.078)	(0.051)	(0.111)	(0.057)	(0.082)	(0.057)	(0.109)
Fruits	-0.01	0.092***	0.044	0.045	0.01	-0.027	-0.019	0.079***	0.04	0.037*	0.032*	**-0.455*****	-0.019	0.047***	0.038*	0.091***	0.061**	0.043**	0.017
	(0.031)	(0.022)	(0.030)	(0.028)	(0.027)	(0.031)	(0.016)	(0.026)	(0.027)	(0.021)	(0.017)	(0.035)	(0.022)	(0.013)	(0.021)	(0.024)	(0.027)	(0.020)	(0.028)
Vegetables	-0.057*	0.056**	0.067*	0.035	0.057*	0.048	0.039**	0.029	0.25***	0.036	0.051**	-0.023	**-0.49*****	-0.015	-0.004	0.073***	-0.03	0.038*	-0.016
	(0.034)	(0.022)	(0.036)	(0.031)	(0.031)	(0.034)	(0.016)	(0.030)	(0.032)	(0.028)	(0.021)	(0.027)	(0.035)	(0.016)	(0.024)	(0.024)	(0.029)	(0.020)	(0.032)
Starchy foods	0.018	-0.037	-0.146**	0.014	-0.025	-0.044	0.106***	-0.206***	0.276***	-0.07	-0.033	0.16***	-0.043	**-0.007**	0.049	0.014	0.093*	0.023	0.001
	(0.058)	(0.037)	(0.065)	(0.054)	(0.055)	(0.060)	(0.026)	(0.054)	(0.057)	(0.051)	(0.038)	(0.046)	(0.044)	(0.040)	(0.041)	(0.037)	(0.049)	(0.035)	(0.056)
Snacks	0.235*	0.066	-0.681***	0.332***	0.183	0.073	0.03	0.224*	0.037	-0.247	-0.094	0.196*	-0.015	0.074	**-0.019**	-0.033	0.315***	-0.005	-0.525***
	(0.135)	(0.082)	(0.183)	(0.124)	(0.132)	(0.137)	(0.055)	(0.134)	(0.155)	(0.321)	(0.125)	(0.108)	(0.102)	(0.063)	(0.476)	(0.080)	(0.107)	(0.070)	(0.151)
Residual group	0.074**	0.037	0.035	0.078***	0	0.03	0.041	-0.002	0.032	0.024	-0.01	0.1***	0.064***	0.004	-0.007	**-0.414*****	0.068**	0	-0.01
	(0.032)	(0.024)	(0.026)	(0.027)	(0.025)	(0.029)	(0.025)	(0.024)	(0.024)	(0.017)	(0.014)	(0.027)	(0.021)	(0.012)	(0.017)	(0.063)	(0.029)	(0.023)	(0.027)
Sugar	-0.11***	0.027	0.046	-0.002	0.038	0.059*	0.054***	0.078***	0.038	-0.066***	-0.049***	0.059**	-0.024	0.026*	0.059***	0.06**	**-0.318*****	0.072***	0.095***
	(0.032)	(0.022)	(0.031)	(0.029)	(0.028)	(0.032)	(0.017)	(0.027)	(0.028)	(0.022)	(0.017)	(0.026)	(0.023)	(0.014)	(0.020)	(0.026)	(0.039)	(0.020)	(0.029)
Tea & coffee	0.143***	0.041	0.115***	0.082**	0.048	-0.085*	0.013	0.086**	0.101**	0.049	0.045*	0.085**	0.06*	0.014	-0.002	0.001	0.146***	**-0.732*****	-0.065
	(0.047)	(0.033)	(0.045)	(0.041)	(0.041)	(0.045)	(0.027)	(0.039)	(0.040)	(0.030)	(0.024)	(0.039)	(0.033)	(0.020)	(0.027)	(0.041)	(0.041)	(0.044)	(0.041)
Soft drinks	0.055	-0.042	0.128	0.114	-0.032	0.024	0.073*	0.219***	-0.111	-0.115	0.091	0.044	-0.032	0.001	-0.259***	-0.024	0.249***	-0.084	**-0.152**
	(0.089)	(0.060)	(0.101)	(0.081)	(0.084)	(0.092)	(0.041)	(0.082)	(0.090)	(0.084)	(0.061)	(0.072)	(0.066)	(0.042)	(0.075)	(0.062)	(0.076)	(0.052)	(0.124)

Table 6: Conditional Marshallian price and expenditure elasticities (Standard errors in parentheses; *p<0.1; **p<0.05; ***p<0.01; diagonal elements in bold).

	Grain	Rum. meat	Pork	Poultry	Proc. meat	Compos.dish	Fish	Dairy	Cheese	Animal fat	Plant-b. fat	Fruits	Veg.	Star. foods	Snacks	Residual	Sugar	Tea/coffee	Soft drinks	Expenditure
Grain	**-0.375*** **	0.056***	0.008	-0.037*	0.039*	0.046**	0.031***	-0.081***	-0.043**	-0.094***	-0.039***	-0.079***	-0.086***	-0.018*	0.013	-0.027	-0.143***	0.006	-0.016	0.859***
	(0.031)	(0.015)	(0.023)	(0.020)	(0.020)	(0.023)	(0.012)	(0.019)	(0.021)	(0.017)	(0.013)	(0.018)	(0.016)	(0.010)	(0.015)	(0.017)	(0.020)	(0.014)	(0.021)	(0.027)
Ruminant meat	0.108***	**-0.916*** **	0.103***	-0.122***	-0.064*	-0.054	-0.068***	-0.011	0.022	0.014	0.018	0.045	-0.008	-0.045***	0.001	-0.035	-0.057	-0.017	-0.063*	1.13***
	(0.040)	(0.037)	(0.040)	(0.035)	(0.034)	(0.038)	(0.022)	(0.034)	(0.034)	(0.026)	(0.021)	(0.034)	(0.028)	(0.016)	(0.024)	(0.034)	(0.035)	(0.026)	(0.037)	(0.056)
Pork	-0.01	0.109***	**-1.064*** **	-0.027	-0.063	-0.07	-0.009	0.014	0.156**	0.099	0.077*	-0.022	0.012	-0.094***	-0.226***	-0.033	-0.019	0.046	0.043	1.072***
	(0.061)	(0.041)	(0.098)	(0.057)	(0.059)	(0.064)	(0.026)	(0.057)	(0.063)	(0.060)	(0.042)	(0.048)	(0.046)	(0.030)	(0.056)	(0.038)	(0.051)	(0.036)	(0.063)	(0.060)
Poultry	-0.109***	-0.086***	-0.022	**-0.461*** **	-0.031	-0.054	-0.068***	-0.069**	-0.062*	-0.066**	0.042*	-0.049	-0.049*	-0.024	0.051*	-0.013	-0.103***	-0.005	0.01	1.147***
	(0.037)	(0.024)	(0.039)	(0.047)	(0.034)	(0.037)	(0.018)	(0.033)	(0.035)	(0.029)	(0.022)	(0.030)	(0.027)	(0.017)	(0.026)	(0.026)	(0.032)	(0.023)	(0.035)	(0.041)
Processed meat	0.104*	-0.049	-0.05	-0.022	**-0.932*** **	-0.054	-0.002	-0.095*	0.204***	0.246***	-0.021	-0.058	0.013	-0.033	0.041	-0.067*	-0.014	0.001	-0.048	0.858***
	(0.053)	(0.035)	(0.058)	(0.049)	(0.070)	(0.054)	(0.024)	(0.048)	(0.052)	(0.046)	(0.034)	(0.042)	(0.039)	(0.025)	(0.040)	(0.036)	(0.045)	(0.032)	(0.051)	(0.056)
Composite dishes	0.129*	-0.048	-0.067	-0.066	-0.062	**-0.465*** **	0.134***	0.074	-0.203***	-0.069	0.038	-0.124**	0.005	-0.044	0.01	-0.022	0.027	-0.113***	-0.014	0.896***
	(0.066)	(0.043)	(0.070)	(0.060)	(0.060)	(0.094)	(0.031)	(0.058)	(0.062)	(0.053)	(0.040)	(0.053)	(0.048)	(0.030)	(0.046)	(0.046)	(0.056)	(0.040)	(0.062)	(0.072)
Fish	0.054	-0.07***	-0.01	-0.098***	-0.015	0.117***	**-0.861*** **	0.008	-0.007	-0.031*	0	-0.123***	-0.024	0.023*	-0.009	-0.024	-0.004	-0.036	0.01	1.087***
	(0.032)	(0.024)	(0.027)	(0.027)	(0.025)	(0.030)	(0.031)	(0.025)	(0.025)	(0.017)	(0.014)	(0.027)	(0.021)	(0.012)	(0.017)	(0.037)	(0.029)	(0.022)	(0.026)	(0.069)
Dairy	-0.117***	0.013	0.024	-0.031	-0.053*	0.047	0.022	**-0.638*** **	0.033	0.028	-0.005	0.009	-0.031	-0.076***	0.028	-0.062***	0.008	0.008	0.056*	0.769***
	(0.031)	(0.021)	(0.034)	(0.029)	(0.029)	(0.032)	(0.014)	(0.040)	(0.031)	(0.027)	(0.020)	(0.025)	(0.023)	(0.015)	(0.025)	(0.021)	(0.026)	(0.019)	(0.030)	(0.032)
Cheese	-0.117***	0.019	0.113**	-0.062	0.139***	-0.146***	-0.005	0.011	**-1.127*** **	0.013	0.064**	-0.047	0.159***	0.066***	-0.01	-0.051*	-0.05	0.012	-0.087**	1.09***
	(0.041)	(0.026)	(0.046)	(0.037)	(0.038)	(0.042)	(0.018)	(0.037)	(0.058)	(0.039)	(0.027)	(0.032)	(0.030)	(0.019)	(0.035)	(0.026)	(0.034)	(0.023)	(0.041)	(0.040)
Animal fat	-0.435***	0.022	0.15	-0.151**	0.375***	-0.112	-0.051**	0.039	0.024	**-0.256**	-0.107*	-0.007	-0.007	-0.08**	-0.138	-0.035	-0.27***	0.011	-0.151*	1.156***
	(0.070)	(0.043)	(0.094)	(0.067)	(0.072)	(0.076)	(0.026)	(0.071)	(0.083)	(0.184)	(0.064)	(0.053)	(0.055)	(0.037)	(0.154)	(0.037)	(0.056)	(0.038)	(0.082)	(0.058)
Plant-based fat	-0.278***	0.077	0.242**	0.212**	-0.052	0.111	0.018	-0.02	0.28***	-0.183	**-0.966*** **	0.087	0.139*	-0.062	-0.095	-0.098*	-0.294***	0.075	0.139	0.711***
	(0.100)	(0.064)	(0.122)	(0.095)	(0.099)	(0.106)	(0.040)	(0.099)	(0.108)	(0.119)	(0.107)	(0.077)	(0.078)	(0.051)	(0.111)	(0.057)	(0.082)	(0.057)	(0.109)	(0.089)
Fruits	-0.157***	0.035	-0.011	-0.035	-0.046*	-0.078**	-0.072***	-0.013	-0.035	0.002	0.013	**-0.542*** **	-0.089***	0.021	0.021	0.012	-0.029	-0.001	-0.017	1.017***
	(0.031)	(0.022)	(0.030)	(0.028)	(0.027)	(0.031)	(0.016)	(0.026)	(0.027)	(0.021)	(0.017)	(0.035)	(0.022)	(0.013)	(0.021)	(0.024)	(0.027)	(0.020)	(0.028)	(0.039)
Vegetables	-0.22***	-0.006	0.006	-0.055*	-0.005	-0.008	-0.021	-0.073**	0.167***	-0.003	0.03	-0.12***	**-0.568*** **	-0.044***	-0.022	-0.015	-0.13***	-0.011	-0.053*	1.133***
	(0.034)	(0.022)	(0.036)	(0.031)	(0.031)	(0.034)	(0.016)	(0.030)	(0.032)	(0.028)	(0.021)	(0.027)	(0.035)	(0.016)	(0.024)	(0.024)	(0.029)	(0.020)	(0.032)	(0.037)
Starchy foods	-0.112*	-0.087**	-0.195***	-0.057	-0.074	-0.088	0.058**	-0.287***	0.209***	-0.101**	-0.05	0.083*	-0.105**	**-0.03**	0.034	-0.056	0.013	-0.016	-0.03	0.904***
	(0.058)	(0.037)	(0.065)	(0.054)	(0.055)	(0.060)	(0.026)	(0.054)	(0.057)	(0.051)	(0.038)	(0.046)	(0.044)	(0.040)	(0.041)	(0.037)	(0.049)	(0.035)	(0.056)	(0.059)
Snacks	0.132	0.027	-0.719***	0.276**	0.144	0.038	-0.008	0.16	-0.016	-0.272	-0.107	0.135	-0.064	0.056	**-0.031**	-0.089	0.252**	-0.036	-0.549***	0.715***
	(0.135)	(0.082)	(0.183)	(0.124)	(0.132)	(0.137)	(0.055)	(0.134)	(0.155)	(0.321)	(0.125)	(0.108)	(0.102)	(0.063)	(0.476)	(0.080)	(0.107)	(0.070)	(0.151)	(0.121)
Residual group	-0.103***	-0.03	-0.031	-0.019	-0.068***	-0.03	-0.024	-0.112***	-0.058**	-0.018	-0.033**	-0.005	-0.02	-0.026**	-0.027	**-0.509*** **	-0.04	-0.053**	-0.051*	1.225***
	(0.032)	(0.024)	(0.026)	(0.027)	(0.025)	(0.029)	(0.025)	(0.024)	(0.024)	(0.017)	(0.014)	(0.027)	(0.021)	(0.012)	(0.017)	(0.063)	(0.029)	(0.023)	(0.027)	(0.095)
Sugar	-0.255***	-0.029	-0.008	-0.081***	-0.017	0.009	0.001	-0.013	-0.036	-0.1***	-0.068***	-0.028	-0.093***	0.001	0.042**	-0.019	**-0.407*** **	0.028	0.061**	1.009***
	(0.032)	(0.022)	(0.031)	(0.029)	(0.028)	(0.032)	(0.017)	(0.027)	(0.028)	(0.022)	(0.017)	(0.026)	(0.023)	(0.014)	(0.020)	(0.026)	(0.039)	(0.020)	(0.029)	(0.041)
Tea & coffee	-0.005	-0.016	0.06	0.001	-0.008	-0.135***	-0.04	-0.005	0.026	0.014	0.026	-0.002	-0.01	-0.012	-0.019	-0.079*	0.056	**-0.776*** **	-0.099**	1.019***
	(0.047)	(0.033)	(0.045)	(0.041)	(0.041)	(0.045)	(0.027)	(0.039)	(0.040)	(0.030)	(0.024)	(0.039)	(0.033)	(0.020)	(0.027)	(0.041)	(0.041)	(0.044)	(0.041)	(0.067)
Soft drinks	-0.079	-0.093	0.078	0.041	-0.083	-0.022	0.024	0.136*	-0.179**	-0.147*	0.073	-0.035	-0.096	-0.023	-0.274***	-0.096	0.167**	-0.125**	**-0.183**	0.927***
	(0.089)	(0.060)	(0.101)	(0.081)	(0.084)	(0.092)	(0.041)	(0.082)	(0.090)	(0.084)	(0.061)	(0.072)	(0.066)	(0.042)	(0.075)	(0.062)	(0.076)	(0.052)	(0.124)	(0.097)

Table 7: Unconditional Marshallian price and expenditure elasticities

Quantity \ Price	Grain	Rum. meat	Pork	Poultry	Proc. meat	Comp. dish	Fish	Dairy	Cheese	Animal fat	Plant fat	Fruits	Veg.	Starch	Snacks	Residual	Sugar	Tea/ coffee	Soft drinks	Exp.
Grain	**-0.30**	0.06	0.03	0.00	0.07	0.07	0.05	-0.03	-0.01	-0.08	-0.03	-0.04	-0.05	-0.01	0.02	0.00	-0.10	0.02	0.00	**0.63**
Ruminant meat	0.21	**-0.91**	0.13	-0.08	-0.03	-0.03	-0.04	0.06	0.07	0.03	0.03	0.10	0.03	-0.03	0.01	0.01	0.00	0.01	-0.05	**0.83**
Pork	0.09	0.12	**-1.04**	0.02	-0.03	-0.04	0.02	0.08	0.20	0.12	0.08	0.03	0.05	-0.08	-0.22	0.01	0.04	0.07	0.06	**0.78**
Poultry	-0.01	-0.08	0.01	**-0.41**	0.01	-0.02	-0.04	0.00	-0.02	-0.05	0.05	0.01	-0.01	-0.01	0.06	0.03	-0.05	0.02	0.03	**0.84**
Processed meat	0.18	-0.04	-0.03	0.01	**-0.91**	-0.03	0.02	-0.04	0.24	0.26	-0.01	-0.02	0.04	-0.02	0.04	-0.04	0.03	0.02	-0.04	**0.63**
Composite dishes	0.21	-0.04	-0.04	-0.03	-0.03	**-0.44**	0.15	0.13	-0.17	-0.05	0.05	-0.08	0.04	-0.03	0.01	0.01	0.07	-0.09	0.00	**0.65**
Fish	0.15	-0.06	0.02	-0.05	0.02	0.14	**-0.84**	0.07	0.04	-0.01	0.01	-0.07	0.02	0.04	0.00	0.01	0.05	-0.01	0.03	**0.79**
Dairy	-0.05	0.02	0.04	0.00	-0.03	0.07	0.04	**-0.59**	0.06	0.04	0.00	0.05	0.00	-0.07	0.03	-0.03	0.05	0.02	0.07	**0.56**
Cheese	-0.02	0.03	0.14	-0.02	0.17	-0.12	0.02	0.07	**-1.08**	0.03	0.07	0.01	0.20	0.08	0.00	-0.01	0.00	0.03	-0.07	**0.80**
Animal fat	-0.33	0.03	0.18	-0.10	0.41	-0.08	-0.02	0.11	0.07	**-0.24**	-0.10	0.05	0.04	-0.06	-0.13	0.01	-0.21	0.04	-0.14	**0.84**
Plant-based fat	-0.21	0.08	0.26	0.24	-0.03	0.13	0.04	0.02	0.31	-0.17	**-0.96**	0.12	0.16	-0.05	-0.09	-0.07	-0.26	0.09	0.15	**0.52**
Fruits	-0.07	0.04	0.01	0.01	-0.01	-0.05	-0.05	0.05	0.00	0.02	0.02	**-0.49**	-0.05	0.04	0.03	0.05	0.02	0.02	0.00	**0.74**
Vegetables	-0.12	0.00	0.03	-0.01	0.03	0.02	0.01	-0.01	0.21	0.02	0.04	-0.06	**-0.53**	-0.03	-0.02	0.03	-0.07	0.01	-0.04	**0.83**
Starchy foods	-0.03	-0.08	-0.17	-0.02	-0.05	-0.07	0.08	-0.23	0.24	-0.09	-0.04	0.13	-0.07	**-0.02**	0.04	-0.02	0.06	0.00	-0.02	**0.66**
Snacks	0.20	0.03	-0.70	0.30	0.17	0.06	0.01	0.20	0.01	-0.26	-0.10	0.17	-0.04	0.07	**-0.03**	-0.06	0.29	-0.02	-0.54	**0.52**
Residual group	0.01	-0.02	0.00	0.03	-0.03	0.00	0.00	-0.04	-0.01	0.00	-0.02	0.06	0.03	-0.01	-0.02	**-0.46**	0.02	-0.03	-0.03	**0.89**
Sugar	-0.16	-0.02	0.02	-0.04	0.01	0.03	0.02	0.05	0.00	-0.08	-0.06	0.02	-0.06	0.02	0.05	0.02	**-0.36**	0.05	0.07	**0.74**
Tea & coffee	0.09	-0.01	0.09	0.04	0.02	-0.11	-0.02	0.05	0.07	0.03	0.03	0.05	0.03	0.00	-0.01	-0.04	0.11	**-0.75**	-0.09	**0.74**
Soft drinks	0.00	-0.09	0.10	0.08	-0.05	0.00	0.05	0.19	-0.14	-0.13	0.08	0.01	-0.06	-0.01	-0.27	-0.06	0.21	-0.11	**-0.17**	**0.68**

Table 8: Unconditional Hicksian price elasticities

Quantity \ Price	Grain	Rum. meat	Pork	Poultry	Proc. meat	Comp. dish	Fish	Dairy	Cheese	Animal fat	Plant fat	Fruits	Veg.	Starch	Snacks	Residual	Sugar	Tea/ coffee	Soft drinks
Grain	**-0.28**	0.10	0.04	0.01	0.07	0.08	0.06	-0.02	0.00	-0.07	-0.02	-0.03	-0.05	0.00	0.03	0.02	-0.09	0.03	0.01
Ruminant meat	0.23	**-0.86**	0.15	-0.06	-0.02	-0.01	-0.02	0.07	0.08	0.04	0.04	0.11	0.04	-0.02	0.02	0.02	0.01	0.02	-0.03
Pork	0.10	0.16	**-1.02**	0.03	-0.02	-0.03	0.03	0.09	0.21	0.12	0.09	0.04	0.06	-0.07	-0.21	0.02	0.05	0.08	0.07
Poultry	0.01	-0.03	0.02	**-0.40**	0.02	-0.01	-0.02	0.01	0.00	-0.04	0.06	0.02	0.00	0.00	0.07	0.05	-0.03	0.03	0.04
Processed meat	0.19	-0.01	-0.02	0.02	**-0.90**	-0.02	0.03	-0.04	0.25	0.27	-0.01	-0.01	0.05	-0.02	0.05	-0.02	0.04	0.03	-0.03
Composite dishes	0.22	0.00	-0.03	-0.02	-0.03	**-0.43**	0.17	0.14	-0.16	-0.05	0.05	-0.07	0.04	-0.03	0.02	0.02	0.08	-0.08	0.01
Fish	0.17	-0.01	0.03	-0.04	0.03	0.16	**-0.82**	0.08	0.05	-0.01	0.02	-0.06	0.02	0.04	0.01	0.03	0.06	0.00	0.04
Dairy	-0.04	0.05	0.05	0.01	-0.02	0.08	0.05	**-0.59**	0.07	0.05	0.01	0.05	0.00	-0.06	0.04	-0.02	0.06	0.03	0.08
Cheese	0.00	0.07	0.16	-0.01	0.18	-0.10	0.04	0.09	**-1.07**	0.04	0.08	0.02	0.21	0.09	0.01	0.01	0.02	0.05	-0.06
Animal fat	-0.31	0.08	0.19	-0.09	0.42	-0.07	-0.01	0.12	0.08	**-0.23**	-0.09	0.06	0.04	-0.06	-0.12	0.02	-0.20	0.05	-0.12
Plant-based fat	-0.20	0.11	0.27	0.25	-0.02	0.14	0.05	0.03	0.32	-0.17	**-0.95**	0.13	0.17	-0.05	-0.08	-0.06	-0.25	0.10	0.16
Fruits	-0.05	0.09	0.03	0.02	0.00	-0.04	-0.03	0.06	0.02	0.03	0.03	**-0.48**	-0.04	0.04	0.04	0.06	0.03	0.03	0.01
Vegetables	-0.10	0.05	0.05	0.00	0.04	0.03	0.02	0.01	0.22	0.02	0.05	-0.05	**-0.52**	-0.02	-0.01	0.04	-0.06	0.03	-0.02
Starchy foods	-0.02	-0.04	-0.16	-0.01	-0.04	-0.05	0.09	-0.22	0.25	-0.08	-0.04	0.14	-0.06	**-0.01**	0.05	-0.01	0.07	0.01	-0.01
Snacks	0.21	0.06	-0.69	0.31	0.17	0.06	0.02	0.21	0.02	-0.26	-0.10	0.18	-0.03	0.07	**-0.02**	-0.05	0.30	-0.01	-0.53
Residual group	0.03	0.03	0.02	0.04	-0.02	0.02	0.02	-0.03	0.00	0.01	-0.01	0.07	0.03	0.00	-0.01	**-0.45**	0.03	-0.01	-0.02
Sugar	-0.15	0.02	0.03	-0.03	0.02	0.05	0.04	0.06	0.01	-0.08	-0.05	0.03	-0.05	0.02	0.06	0.03	**-0.35**	0.06	0.09
Tea & coffee	0.10	0.04	0.10	0.05	0.03	-0.10	0.00	0.06	0.08	0.04	0.04	0.06	0.04	0.01	0.00	-0.03	0.12	**-0.74**	-0.07
Soft drinks	0.02	-0.05	0.11	0.09	-0.04	0.01	0.06	0.20	-0.13	-0.13	0.09	0.02	-0.05	-0.01	-0.26	-0.05	0.22	-0.10	**-0.16**

Table 9: Elasticities with respect to socio-demographic variables

			Education (ref. = Basic)		Child<=16	Socio-professional class (ref. Blue collars)			Income quartile (ref. = Q1)		
Food group	**Age**	**Household size**	Intermediate	Tertiary		Self-employed/ white collars	Pensioners	Other	Q2	Q3	Q4
Grain	-0.003***	-0.079***	-0.211***	-0.185***	-0.04	0.033	0.066**	0.198***	-0.253***	-0.23***	-0.318***
	(0.001)	(0.011)	(0.025)	(0.026)	(0.032)	(0.025)	(0.031)	(0.036)	(0.026)	(0.027)	(0.03)
Ruminant meat	0.007**	-0.651***	0.033	0.268***	0.206***	0.166***	0.306***	0.068	0.142**	0.313***	0.097
	(0.003)	(0.036)	(0.06)	(0.061)	(0.063)	(0.053)	(0.099)	(0.087)	(0.06)	(0.067)	(0.075)
Pork	0.002	-0.072**	0.1*	-0.007	-0.043	0.048	0.021	0.002	0.019	-0.076	-0.15*
	(0.002)	(0.032)	(0.055)	(0.057)	(0.067)	(0.056)	(0.07)	(0.081)	(0.067)	(0.076)	(0.08)
Poultry/other fresh meat	-0.003***	0.041**	0.035	-0.012	0.026	-0.004	-0.01	0.045	-0.041	0.023	-0.021
	(0.001)	(0.018)	(0.038)	(0.039)	(0.046)	(0.037)	(0.047)	(0.05)	(0.042)	(0.044)	(0.049)
Processed meat	0.028***	0.283***	0.111**	-0.19***	-0.095	-0.298***	-0.463***	-0.351***	0.48***	0.479***	0.473***
	(0.002)	(0.028)	(0.051)	(0.053)	(0.063)	(0.053)	(0.065)	(0.075)	(0.058)	(0.062)	(0.067)
Composite dishes	-0.015***	0.185***	0.687***	0.456***	0.296***	-0.228***	-0.684***	-0.68***	0.056	-0.099	-0.305***
	(0.002)	(0.029)	(0.075)	(0.074)	(0.08)	(0.065)	(0.09)	(0.094)	(0.068)	(0.07)	(0.078)
Fish	0.008***	-0.112***	0.136**	0.16**	0.269***	-0.049	0.087	-0.029	0.06	0.046	0.145*
	(0.003)	(0.033)	(0.065)	(0.067)	(0.081)	(0.062)	(0.08)	(0.097)	(0.071)	(0.075)	(0.083)
Dairy	-0.001	0.032**	-0.083***	-0.086***	0.115***	-0.021	0.132***	0.048	-0.14***	-0.133***	-0.173***
	(0.001)	(0.013)	(0.029)	(0.031)	(0.038)	(0.03)	(0.038)	(0.041)	(0.031)	(0.032)	(0.035)
Cheese	-0.005***	-0.049***	0.054	0.109***	-0.024	0.008	-0.114**	-0.058	0.009	0.036	0.169***
	(0.001)	(0.018)	(0.037)	(0.041)	(0.044)	(0.036)	(0.047)	(0.052)	(0.044)	(0.052)	(0.057)
Animal fat	0.003	-0.144***	-0.027	-0.097*	-0.002	0.135***	0.099	0.166**	-0.266***	-0.262***	-0.423***
	(0.002)	(0.038)	(0.053)	(0.054)	(0.062)	(0.051)	(0.067)	(0.074)	(0.064)	(0.067)	(0.082)
Plant-based fat	0.056***	0.732***	0.203**	0.387***	-0.247**	-0.46***	0.099	-0.556***	0.49***	0.329***	0.049
	(0.005)	(0.066)	(0.08)	(0.087)	(0.097)	(0.09)	(0.101)	(0.129)	(0.089)	(0.091)	(0.099)
Fruits	-0.006***	-0.16***	-0.163***	-0.125***	0.027	0.097***	0.09**	0.042	-0.279***	-0.321***	-0.331***
	(0.001)	(0.015)	(0.037)	(0.039)	(0.046)	(0.036)	(0.045)	(0.048)	(0.04)	(0.043)	(0.045)
Vegetables	0.001	-0.015	0.157***	0.258***	0.004	0.028	0.08*	0.009	0.066*	0.182***	0.204***
	(0.001)	(0.015)	(0.035)	(0.037)	(0.043)	(0.034)	(0.043)	(0.046)	(0.038)	(0.042)	(0.044)
Starchy foods	-0.006**	-0.138***	0.034	0.158***	0	-0.009	-0.022	-0.103	-0.11	-0.129*	-0.152**
	(0.003)	(0.039)	(0.054)	(0.055)	(0.065)	(0.052)	(0.068)	(0.074)	(0.067)	(0.078)	(0.075)
Snacks	0.027***	-0.44***	-0.189	-0.253*	-0.75***	0.148	1.945***	1.103***	0.038	0.07	-0.287**
	(0.006)	(0.06)	(0.121)	(0.13)	(0.126)	(0.095)	(0.256)	(0.16)	(0.107)	(0.114)	(0.127)
Residual group	0.005	0.226***	-0.208**	-0.174*	0.009	0.105	0.051	0.193*	0.335***	0.355***	0.948***
	(0.003)	(0.04)	(0.086)	(0.091)	(0.108)	(0.085)	(0.11)	(0.117)	(0.093)	(0.101)	(0.109)
Sugar	-0.013***	0.015	-0.065*	-0.015	0.056	-0.061	-0.024	0.009	-0.118***	-0.186***	-0.191***
	(0.001)	(0.017)	(0.038)	(0.039)	(0.046)	(0.037)	(0.047)	(0.05)	(0.039)	(0.041)	(0.045)
Tea & coffee	0.015***	0.491***	-0.015	0.008	-0.462***	0.087	-0.461***	-0.351***	0.219***	0.301***	0.595***
	(0.002)	(0.036)	(0.061)	(0.064)	(0.075)	(0.058)	(0.08)	(0.088)	(0.066)	(0.07)	(0.079)
Soft drinks	-0.042***	0.196***	0.06	-0.111	-0.258**	0.002	-0.225*	0.074	0.202**	-0.023	-0.333***
	(0.004)	(0.041)	(0.092)	(0.095)	(0.101)	(0.081)	(0.133)	(0.114)	(0.092)	(0.096)	(0.106)

Table 10: Average dietary intakes and technical coefficients used to construct the elasticities of demand for nutrients

	Grains and grain-based products	Vegetables & products	Starchy roots, tubers	Fruit/ fruit products	Beef, veal and lamb	Pork	Poultry/ eggs/ other fresh meat	Processed and other cooked meats	Fish and other seafood	Milk/ dairy products	Cheese	Sugar/ confect./ prepared desserts	Soft drinks	Animal fats	Plant based fats	Tea,coffee, cocoa, and drinking water	Composite dishes	Snacks and other foods	Residual category
Intake (g/cap/day)	251	73	42	310	7	8	31	40	23	376	40	42	58	3	24	1416	321	2	15
GHGE (g/g)	1.2	1.2	0.9	0.8	42	10.2	8.5	5.6	4.6	1.5	8.3	3.2	0.3	9.5	1.8	0.3	3.8	0.9	1.7
Energy (kcal/100g)	195	28	170	42	179	228	189	209	187	50	223	281	23	670	543	2	117	427	186
Nutrients (g/100g, except cholesterol in mg/100g)																			
Fibers	4.5	1.5	2.2	0.9	0.1	0.1	0	0.2	0.3	0.1	0	1	0	0	0	0	1	4.1	0.7
Protein	5.5	0.9	4.7	0.3	23.4	24	22.9	15.3	18.7	3.2	19	3.4	0.4	1.6	0.5	0.1	6.1	7	1.6
Fats	3.7	0.6	8.6	0.2	9.1	13.7	10.5	15	11.4	1.4	15.5	8.5	0	74.6	60.9	0	5.9	21.7	15.5
Saturated Fat	1.2	0.1	1.2	0	2.9	4.4	2.5	5.6	2.6	1	10.2	4.9	0	48.2	21.1	0	2	3.9	1.9
MUFA	1.1	0.2	3.5	0.1	3.9	6.6	4.3	6.4	4	0.3	3.8	2.3	0	19.4	23.5	0	2.3	8.3	7.6
Carbohydrates	32.1	3.7	17.5	9.4	0.8	2.3	0.8	3.3	2.6	5.7	1.5	45.2	5.2	1	1	0.2	9.1	48.4	9.6
Sugar	4.5	3.4	1.2	8.9	0.2	0.3	0.3	0.6	0.6	5.6	1.5	39.2	5.1	1	0.4	0.2	1.9	2	7.2
Cholesterol (mg/100g)	8	0.2	0.5	0.1	61.1	62.9	127.1	48	75.7	5.4	41	9.5	0	155	47.8	0	27.5	2.4	15
PUFA	0.8	0.2	2.7	0	1.3	2.7	2.2	1.7	2.7	0	0.4	0.3	0	2.6	12.7	0	1	6.9	5.6
Free sugar	2.4	0.3	0.2	4.8	0.1	0	0.2	0.2	0.5	1.3	0.4	37.2	5	0	0	0.1	0.2	0.7	5.8
Vitamins (mg/100g)																			
vit_a	13.8	141.6	7.6	5.3	14.4	11.9	366.6	100	43.1	12.8	125.6	39.4	0	656	606.2	0.1	70.8	8.5	106.2
vit_ret	13.7	0.6	1.3	0	13.3	12.6	425.7	103.3	45.2	12	120.5	38.1	0	620.2	587.2	0.1	43.2	5.6	19.4
vit_b1	0.1	0.1	0.2	0	0.1	0.9	0.1	0.4	0.1	0	0	0	0	0	0	0	0.1	0.2	0.1
vit_b2	0.1	0.1	0.1	0	0.2	0.3	0.3	0.2	0.1	0.2	0.3	0.1	0	0.1	0	0	0.1	0.1	0.1
vit_b6	0.1	0.1	0.2	0.1	0.5	0.5	0.5	0.3	0.4	0	0.1	0	0.1	0	0	0	0.1	0.3	0.1
vit_b12	0.1	0	0	0	1.3	0.7	3	0.9	4.2	0.4	1.2	0.2	0.1	0	0	0	0.4	0	0.1
vit_b9	26.6	22.6	25.2	10	1.7	2.3	37.4	13.2	10.9	6	20	4.4	0.4	3.6	0.9	0.2	18	39.2	5.8
vit_c	0.7	22.7	5.9	18	0.1	0	0.5	0.2	0.2	1.4	0.3	2.5	0.4	0.1	0	0.1	5.7	1.2	4.5
vit_d	0.1	0	0	0	0.3	0.5	0.7	0.3	8.2	0.8	0.2	0.1	0	1.8	11.1	0	0.4	0	0.1
vit_e	0.7	0.5	2	0.2	1	1.2	1.2	0.4	2.3	0	0.3	0.4	0	2.1	8.2	0	0.7	3.4	4
vit_beta	10	1434	76.4	45.5	23.4	2	16	4.7	12.6	9.6	60.4	24.2	0.1	394.2	105.2	0	327.1	31.7	1013
Minerals (mg/100g)																			
min_fe	1.7	0.5	1.2	0.2	3.1	1	2	1.2	0.9	0.1	0.2	0.9	0	0.2	0.1	0	0.9	1.4	0.6
min_ca	30.6	23.7	21.8	14.6	12.4	11.2	18.8	17.3	102.9	123	545.6	113.4	2.3	38.2	11.3	4	42.8	28.2	36.2
min_mg	39.3	15	52.2	7.5	28	25	25.8	21.2	27.8	11.7	21.8	26.4	0.8	3.4	2.1	4.2	17.2	46.6	12.1
min_k	196.2	291.7	448.5	110.4	431	344	341.8	259.8	389.6	160.5	110.2	180.8	4.4	38.5	10.6	37.9	231.9	601.2	141.2
min_zn	1.2	0.3	0.7	0.1	4.2	2.2	2.2	1.7	1.2	0.4	2.5	0.5	0	0.1	0	0	0.9	0.9	0.3
min_na	299.9	66.8	101.2	5.5	433.6	429.2	398.8	816.3	567.8	44.6	416.4	85.4	7.5	568.5	442.8	1.4	271.4	529.6	788.8
min_p	132.2	37.1	104	11.7	242.3	198.5	204.6	158.6	248.6	89.7	381.4	84.4	5.2	36.1	9.5	3.8	88.2	136.5	43.2

Table 11: Elasticities of demand for nutrients and GHG emissions

	PRICES																			
	Grains and grain-based products	**Vegetables & products**	**Starchy roots, tubers**	**Fruit/ fruit products**	**Beef, veal and lamb**	**Pork**	**Poultry/ eggs/ other fresh meat**	**Processed / other cooked meats**	**Fish and other seafood**	**Milk/ dairy products**	**Cheese**	**Sugar/ confect./ prepared desserts**	**Soft drinks**	**Animal fats**	**Plant based fats**	**Tea,coffee, cocoa, and drinking water**	**Composite dishes**	**Snacks and other foods**	**Residual category**	**Expenditure**
GHGE	0.05	0.02	-0.01	-0.03	-0.07	0.01	-0.03	-0.04	0.02	-0.02	-0.08	0.02	-0.01	0.00	0.02	-0.08	-0.13	0.01	0.00	0.70
Energy	-0.06	0.00	-0.01	-0.04	0.00	0.01	0.00	-0.02	0.03	-0.03	-0.03	-0.04	0.01	-0.04	-0.06	-0.01	-0.06	0.01	-0.01	0.66
Nutrients																				
Fibers	-0.15	-0.06	-0.01	-0.10	0.03	0.00	0.00	0.03	0.05	-0.01	-0.01	-0.05	0.00	-0.05	-0.01	0.00	-0.04	0.02	0.01	0.66
Protein	0.01	0.02	-0.01	-0.02	-0.02	-0.01	-0.05	-0.05	0.01	-0.05	-0.10	0.01	0.00	0.00	0.02	-0.02	-0.10	0.01	0.00	0.68
Fats	-0.02	0.04	-0.02	0.01	0.00	0.03	0.01	-0.05	0.03	-0.01	-0.03	-0.05	0.02	-0.04	-0.16	0.01	-0.08	-0.01	-0.03	0.66
Saturated Fat	-0.04	0.06	-0.02	0.01	0.01	0.05	0.01	-0.03	0.04	-0.03	-0.09	-0.06	0.02	-0.04	-0.15	0.01	-0.07	-0.01	-0.02	0.66
MUFA	-0.01	0.05	-0.02	0.01	-0.01	0.02	0.02	-0.07	0.03	0.01	0.00	-0.05	0.02	-0.04	-0.18	0.00	-0.09	-0.01	-0.03	0.66
Carbohydrates	-0.12	-0.04	-0.01	-0.09	0.02	0.01	0.00	0.01	0.04	-0.05	-0.01	-0.05	0.01	-0.04	-0.01	-0.01	-0.04	0.02	0.00	0.66
Sugar	-0.08	-0.04	0.00	-0.14	0.01	0.02	0.00	0.00	0.01	-0.10	0.00	-0.05	0.02	-0.01	0.00	-0.01	-0.02	0.02	0.00	0.68
Cholesterol	0.05	0.03	-0.02	-0.02	-0.03	0.00	-0.07	-0.06	0.00	0.01	-0.09	0.00	0.01	-0.02	-0.02	-0.02	-0.14	0.01	0.00	0.70
PUFA	-0.03	0.03	-0.02	0.02	0.00	0.02	0.03	-0.05	0.02	0.02	0.06	-0.05	0.03	-0.06	-0.22	0.00	-0.07	-0.01	-0.04	0.66
Free sugar	-0.11	-0.04	0.01	-0.14	0.01	0.03	0.00	0.00	0.00	-0.02	-0.01	-0.10	0.02	-0.03	-0.01	0.00	0.00	0.01	0.01	0.71
Vitamins																				
vit_a	-0.01	-0.02	-0.02	-0.01	-0.01	0.05	-0.03	-0.03	0.04	0.01	-0.02	-0.05	0.02	-0.04	-0.14	0.00	-0.10	0.00	-0.01	0.69
vit_ret	-0.02	0.06	-0.02	0.01	-0.01	0.07	-0.04	-0.04	0.03	0.00	-0.03	-0.07	0.03	-0.05	-0.19	0.01	-0.07	0.00	-0.01	0.68
vit_b1	0.02	-0.03	-0.02	-0.03	-0.01	-0.09	-0.02	-0.14	0.05	0.02	0.03	0.01	-0.01	0.01	0.01	-0.01	-0.13	0.00	-0.01	0.68
vit_b2	-0.02	-0.01	-0.03	0.00	0.00	0.01	-0.03	-0.04	0.04	-0.22	-0.05	0.01	0.02	0.01	0.01	0.00	-0.05	0.02	-0.01	0.65
vit_b6	0.00	-0.03	0.00	-0.11	-0.03	-0.03	-0.04	-0.06	-0.02	0.03	-0.02	0.01	-0.01	-0.01	0.02	-0.01	-0.09	0.01	0.01	0.71
vit_b12	0.05	0.03	-0.02	-0.01	-0.04	0.01	-0.08	-0.05	-0.09	-0.10	-0.09	0.02	0.02	0.00	0.02	-0.01	-0.07	0.02	0.00	0.69
vit_b9	-0.05	-0.04	-0.01	-0.09	0.01	0.00	-0.03	0.00	0.04	-0.03	-0.04	-0.01	0.00	-0.03	0.01	-0.02	-0.09	0.02	0.01	0.68
vit_c	-0.03	-0.11	0.01	-0.28	0.01	0.00	0.00	-0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.02	-0.01	-0.10	0.02	0.03	0.73
vit_d	-0.02	0.05	-0.03	0.02	0.01	0.08	0.04	-0.02	-0.12	-0.15	0.08	-0.04	0.07	-0.04	-0.26	0.02	0.03	-0.01	-0.03	0.62
vit_e	-0.05	0.01	-0.02	-0.02	0.00	0.03	0.02	-0.01	0.01	0.02	0.04	-0.05	0.02	-0.07	-0.18	0.00	-0.06	-0.01	-0.04	0.67
vit_beta	0.03	-0.20	-0.02	-0.08	-0.02	0.00	-0.01	0.00	0.06	0.04	0.01	0.00	-0.02	-0.02	0.03	-0.03	-0.17	0.00	-0.01	0.74
Minerals																				
min_fe	-0.06	-0.03	-0.01	-0.05	-0.01	-0.01	-0.03	-0.02	0.04	0.00	-0.02	-0.03	0.00	-0.04	0.00	-0.01	-0.09	0.02	0.00	0.67
min_ca	-0.02	0.03	-0.02	-0.01	0.01	0.05	-0.01	0.02	0.02	-0.21	-0.20	0.01	0.01	0.01	0.02	-0.03	-0.05	0.02	-0.01	0.66
min_mg	-0.05	-0.02	-0.01	-0.03	0.00	0.01	-0.01	0.00	0.03	-0.06	-0.01	0.00	-0.01	-0.02	0.00	-0.12	-0.06	0.01	-0.01	0.68
min_k	0.00	-0.03	-0.02	-0.05	-0.01	0.00	-0.01	-0.02	0.02	-0.07	0.01	0.02	-0.01	-0.01	0.01	-0.12	-0.09	0.01	-0.01	0.68
min_zn	-0.02	0.00	-0.01	-0.03	-0.02	0.00	-0.04	-0.03	0.04	-0.05	-0.10	-0.01	0.00	-0.01	0.01	-0.01	-0.10	0.02	0.00	0.67
min_na	0.00	0.01	-0.02	-0.03	-0.01	0.00	-0.02	-0.08	0.03	0.00	-0.06	-0.01	0.00	-0.01	-0.02	-0.02	-0.11	0.01	-0.02	0.67
min_p	-0.03	0.01	-0.02	-0.02	-0.01	0.01	-0.03	-0.02	0.02	-0.10	-0.10	0.00	0.01	-0.01	0.01	-0.03	-0.07	0.02	-0.01	0.67

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