Exploring disparities and similarities in European food consumption patterns

Dan A. PETROVICI
Christopher RITSON
Mitchell NESS

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Dan A. PETROVICI *, Christopher RITSON **, Mitchell NESS **

Disparités et similarités des schémas de consommation alimentaire en Europe

Résumé – Nous étudions dans cet article l'hétérogénéité des schémas de consommation alimentaire en Europe. Est analysée, en particulier, la consommation des catégories alimentaires les plus importantes et leur contribution aux apports caloriques et nutritionnels. Des groupes sont constitués, basés sur les élasticités de la demande de calories et de protéines. Les élasticités-revenu des produits animaux sont supérieures à celles de la demande calorique totale. Nous observons le même résultat pour la demande de protéines. L'objectif est d'identifier les principales dimensions de la consommation alimentaire à l'aide d'une analyse factorielle, afin de constituer des groupes de pays homogènes. Nous dégageons des classes stables, quel que soit l'algorithme de classification utilisé ou quels que soient les indicateurs des schémas de consommation alimentaire. Nous obtenons un nombre limité de groupes stables. L'article se termine par une discussion sur l'homogénéité de ces groupes.

Mots-clés : schémas de consommation alimentaire, Europe, analyse factorielle, classification

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Summary *– This paper investigates the heterogeneity of food consumption patterns in Europe. The analysis relies on a wide set of indicators, namely the structure of calorie, protein and fat consumption as well as the consumption of main foodstuffs. Clusters based on estimated income elasticity of calorie and protein demand are also reported. Income elasticities of animal products tend to exceed those corresponding to the total calorie demand. The same pattern holds true for the elasticity of demand for proteins. Main dimensions of consumption are identified based on factor analysis and used subsequently for the purpose of clustering countries. The hard core clusters are those that remain stable regardless of the algorithm used in classification or the indicators as a proxy of food consumption patterns. A limited number of hard core clusters of countries emerged. The paper concludes with a discussion of clusters with homogeneous patterns of consumption.*

Key-words : *food consumption patterns, Europe, factor analysis, cluster analysis, hard-core clusters*

* *Kent Business School, University of Kent, Parkwood Road, Canterbury, CT2 7PE, United Kingdom.*
e-mail : D.A.Petrovici@kent.ac.uk

** *School of Agriculture, Food and Rural Development, Newcastle University, Agriculture building, Newcastle upon Tyne, NE1 7RU, United Kingdom.*
e-mail : Christopher.Ritson@newcastle.ac.uk
Mitchell.Ness@newcastle.ac.uk

THE topic of food consumption has been approached from an integrated perspective only recently. Previously it had comprised a collection of fragmented studies, *e.g.* Ritson *et al.* (1986). At a national level, studies have focused on determinants of changes in food consumption (Senauer *et al.*, 1991), and based on long time series data (Ritson and Hutchins, 1991). Other studies have investigated disparities between target groups (*e.g.* social classes, Tomlinson and Warde, 1993).

One distinction, which has emerged, has been that between the economic and the non-economic factors (*e.g.* cultural) as significant determinants in shaping the food patterns (Marshall, 1995; Tangermann, 1986). Structural changes in food consumption in Western European countries have been outlined (Young *et al.*, 1998). Ritson and Hutchins (1995) have identified the food products in the UK, which were becoming 'more' and 'less' popular, against the assumption of a constant economic environment.

Food consumption patterns in 1960 to 1980s were largely influenced by economic factors such as consumer disposable income, and food prices (Angulo *et al.*, 1997). Consumer preferences were thought to explain the international divergence persisting in food consumption patterns (Herrmann and Röeder, 1995). Despite homogenisation trends in corporate strategies in Europe, differences in preferences and habits underpin food consumption differences (Gracia and Albisu, 2001).

The hypotheses, that food preferences are invariant across countries (Stigler and Becker, 1977) is still controversial (Pollak and Wales, 1987; Selvanathan and Selvanathan, 1993). Factors such as health concerns (Ritson and Hutchins, 1995), media information (*e.g.* negative TV press; Verbeke and Ward, 2001) can influence consumer preferences.

As outlined in the literature (Blandford, 1986), affluent countries tend to derive a large proportion of calories from animal products at the expense of vegetable products. Although significant disparities are noticeable in calorie intake between European countries (table 1), these are not as high as indicated by income disparities.

Another topic of growing interest has been the heterogeneity in the patterns of food consumption patterns using cross-sectional data (Traill, 1998) and from a dynamic perspective, the international convergence in food consumption patterns. Research has focused on the OECD countries (Blandford, 1984) or Europe (Elsner and Hartmann, 1997). Evidence of increased homogeneity in patterns of consumption of food (Traill, 1998) and alcoholic beverages (Smith *et al.*, 1999) was reported. Blandford (1986) focused upon calorie intake as a basis to derive clusters of countries with homogeneous dietary patterns.

Table 1. **The calorific intake in Europe, 2000**

	Total calories	Animal calories (%)		Total calories	Animal calories (%)
Austria	3 794	32.8	Lithuania	3 293	23.6
Belgium-Lux.	3 695	30.6	Malta	3 543	25.8
Bulgaria	2 544	28.2	Netherlands	3 336	34.8
Cyprus	3 283	29.5	Poland	3 401	26.2
Czech Rep.	3 283	29.5	Norway	3 338	32.8
Denmark	3 443	38.4	Portugal	3 757	28.7
Estonia	2 946	26.1	Romania	3 329	20.2
Finland	3 169	36.4	Slovakia	2 789	22.7
France	3 597	37.7	Slovenia	3 149	29.9
Germany	3 505	29.6	Spain	3 387	27.5
Greece	3 738	22.6	Sweden	3 100	32.9
Hungary	3 552	31.0	Switzerland	3 435	33.0
Ireland	3 701	31.3	UK	3 312	30.1
Latvia	2 720	26.6	Italy	3 663	25.5
			Standard deviation	*237.7*	*160.4*

Source : derived from data available from *www.fao.org* (2004)

Studies concerned with the diversity of food consumption patterns across countries have examined similarities and differences in statistical indicators aimed at disentangling facets of food consumption using cross-sectional data sets (Traill, 1998). The studies concerned with the convergence in food consumption patterns tracked the similarity of such patterns over time and relied on time series data (Gil *et al.*, 1995) or pooled time series and cross-country data (Pollak and Wales, 1987). Aiming to quantify the degree of convergence in diets between countries such studies introduced and discussed criteria for convergence or divergence such as the export similarity index (Wöhlken and Fillip, 1988) or the aggregate similarity index (Elsner and Hartmann, 1997). There was no clear agreement regarding the hypothesis of convergence in food consumption patterns across countries. Herrmann and Röeder (1995) pointed out that, although convergence variables account for a large share of inter-country variation in food demand, convergence as well as divergence tendencies can be observed.

Previous research has generally used a single set of indicators, such as food intake or the structure of food consumption, to measure consumption variability. These studies showed an overall trend of convergence in dietary structures, yet divergence was reported with regards to consumption of specific foodstuffs. Herrmann and Röeder (1995) found convergence in the *per capita* protein and fat demand, but many cases of divergence in consumption of individual foods. Moreover, they reported overall convergence in *per capita* food consumption, but less uniform than for nutrients.

This paper draws on data on food consumption and dietary intake patterns and aims to explore the diversity of food consumption patterns in Europe. In this context, the paper addresses to what extent there are clusters of countries with similar dietary patterns regardless of the set of indicators selected to describe these patterns; and how consistent these clusters are across classification methods.

Specifically the objectives of the paper are as follows: i) to identify underlying dimensions of patterns of dietary intake; ii) to identify groups/clusters of European countries that have highly similar food consumption and nutrient intake patterns; iii) to discuss the concept of "hard-core clusters". The present study contrasts to the previous research in two respects: i) it is based on a wide set of indicators aimed at evaluating food consumption in the analysis; ii) it uses the family of classification methods in clustering not only the European Union (EU) States (Gil *et al.*, 1995), but also the Central and Eastern European Countries (CEECs) that joined the EU in May 2004 or are expected to become members by 2007.

Clustering on the basis of a series of income elasticities and different food consumption variables provides a basis for validation (the likelihood of spurious solutions can be reduced if the same countries are grouped using different classification methods). Furthermore, a wider set of variables can produce a more complete picture of food consumption.

The paper is structured as follows. The next section describes the data used to analyse food consumption patterns. This is followed by a methodological section containing the application of factor and cluster analysis to a data set related to both *per capita* food consumption and the structure of nutrient intake in Europe. Then, we present the reporting of estimates of income elasticities of demand in Europe and discuss the classifications based on dietary patterns, food consumption patterns, and income elasticity of demand as outlined by the cluster analysis using the input of factor analysis.

These are followed by a discussion of cluster solution and profiling based on additional variables. In the last section, the conclusions and limitations of the paper are outlined. Special attention is paid to the clusters obtained and the concept of hard-core clusters is explored. The hard-core clusters are those that remain stable regardless of the classification method and have increased credibility - they correspond to the "natural grouping of objects" (Noruˇis, 1985). In this paper, it refers to the countries that belong to the same group regardless of the algorithm used in classification or the indicators as a proxy of food consumption patterns. In other words, these countries display strong homogeneity in food consumption patterns.

Data

This study is based on secondary data on food consumption and dietary patterns in Europe with respect to the breakdown of calorific, protein, and fat consumption. It includes the 15 EU member States, EFTA countries (Norway, Switzerland), and the associated countries that have already joined the EU in May 2004 (Hungary, Latvia, Lithuania, Estonia, Czech Republic, Slovakia, Slovenia, Poland, Malta and Cyprus) or are expected to join the EU by 2007 (Bulgaria, Romania). The data are based on the contribution of main food groups to the average *per capita* calorie, protein and fat supply as well as the consumption of food items in the observed countries in the year 2000.

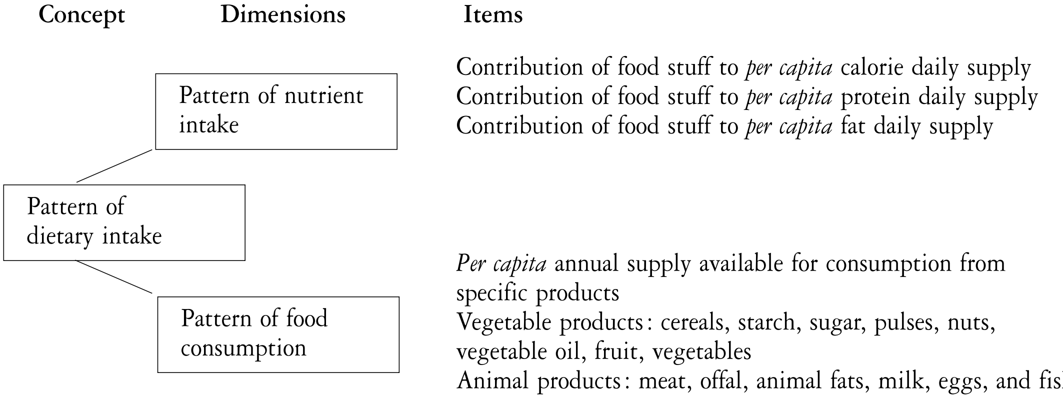
The calorific intake data facilitate aggregation of food products. However, it overlooks conversion factors that vary between countries. The same calorific intake can be obtained through distinctive animal, and vegetable product ratios. Calorie equivalents emphasise the importance of foods which are high in calorie content (meat) and put less emphasis on those which are low in calories (fruit and vegetables) (Blandford, 1984). It should be noted that food balance sheets are concerned with the quantity of food available for consumption (allowing for wastage) and may overstate actual food intake (Senauer *et al.*, 1991). They reflect food available at retail level. It allows for wastage at farm gate and retail level, but not for that in the household. The latter can be significant in the developed countries, but also in CEECs. It has been suggested (Henson and Sekula, 1994) that wastage was high in CEECs due to price subsidies that induced distortions in consumer behaviour (*e.g.* bread used to feed pigs).

It is thought that using a variety of indicators to analyse the consumption patterns can improve the classification and overcome some of the above limitations. The contribution to the energy supply was observed for the following products: wheat (ENWHEAT), rice (ENRICE), potatoes (ENPOT), sugar and sweeteners (ENSUG), pulses (ENPULS), nuts (ENUTS), vegetable oil (ENVEGOIL), vegetables (ENVEG), fruit (ENFRUIT), stimulants such as coffee and cocoa (ENSTIMUL), beef and veal (ENBEEF), pig (ENPIG), poultry (ENPOULTRY), offal (ENOFFAL), animal fat (ENANFAT), milk (ENMILK), fish and seafood (ENFISH) and eggs (ENEGGS).

Data on the nutrient intake and food consumption were available from Food and Agriculture Organisation of the United Nations (FAO). Notwithstanding the criticism of FAO food balance sheets (Grigg, 1993), it was thought that this source represented a valuable database for the aim of classifying countries according to the structure of their nutrient intake. Data on the structure of nutrient intake were analysed in conjunction with the data on *per capita* food consumption. Thus a wide set of sample characteristics was selected to describe a multidimensional phenomenon such as the patterns of food consumption (figure 1).

The structure of calorie intake was used in previous classifications (Blandford, 1984). However this may hide variation in food consumption. Results reported by Herrmann and Röeder (1995), and Elsner and Hartmann (1997) suggested higher convergence when patterns of calorie intake, relative to consumption of specific food products, are used. It was thought that pooling data on nutrient intake with data on consumption of specific food products (18 altogether) would reduce the risk of generating artificially homogeneous clusters.

Figure 1. **Interrelationships between main concepts and empirical measures**



Thus the contribution of food products to *per capita* average protein supply was also observed as follows: wheat (PWHEAT), rice (PRICE), starchy products (PSTARCH), pulses (PPULS), nuts (PNUTS), vegetable oil (PVEGOIL), vegetables (PVEG), stimulants (PSTIM), beef and veal (PBEEF), mutton and lamb (PLAMB), pig (PPIG), poultry (PPOULTRY), offal (POFFAL), animal fat (PANFAT), milk (PMILK), eggs (PEGGS), fish and seafood (PFISH) and olives (POLIVES). The commodities that did not have a significant contribution (less than 3 grams per day) to protein consumption have been excluded from analysis, namely sugar and fruit. Some commodities that did not contribute significantly to energy consumption and accordingly had not appeared so far have been added: namely mutton and lamb (PLAMB) and olives (POLIVES).

The contribution of food products to *per capita* average fat supply was also observed as follows: wheat (FWHEAT), pulses (FPULS), nuts (FNUTS), vegetable oil (FVEGOIL), stimulants (FSTIM), beef and veal (FBEEF), mutton and lamb (FLAMB), pig (FPIG), poultry (FPOULTRY), offal (FOFFAL), animal fat (FANFAT), milk (FMILK), eggs (FEGGS), fish and seafood (FFISH) and olives (FOLIVES). The commodities that did not have a significant contribution to fat consumption have been excluded from analysis, namely rice, starchy products, sugar, vegetables and fruit.

The final indicator represented average *per capita* consumption of the following products: wheat (WHEAT), rice (RICE), starchy products (STARCH), sugar (SUG), pulses (PULS), nuts (NUTS), sunflower oil (SUNFLOW), rape seeds oil (RAPE), other vegetable oil (OTHEROIL), vegetables (VEG), citrus fruit (CITRUS), other fruit (OTHFR), stimulants (STIMUL), beef and veal (BEEF), mutton and lamb (LAMB), pig (PIG), poultry (POULTRY), offal (OFFAL), animal fat (ANFAT), milk (MILK), eggs (EGGS), fish and seafood (FISH), olives (OLIVES), other cereal products (OTHCER) and other meat products (OTHMEAT). In the analysis, the variables were standardised as z scores. For example, the observed values (*e.g. per capita* consumption of fruit expressed in kilograms) were replaced by the differences between the observed values of that country and the mean accross all countries, divided by the standard deviation accross all countries. This transformation ensures that the items were given equal weight and is suitable when indicators with different measurement scales are included in the analysis.

Countries with strong similarities on one dimension of food consumption may display dissimilarities in other dimensions and thus cannot be regarded as strongly homogeneous. Similarities in all the dimensions evaluated in terms of different classification methods may lead to what has been called “hard-core” clusters. A key feature of hard-core clusters is the stability of their members irrespective of the classification method.

Methodology and assumptions

The data were analysed using statistical package for the social sciences (SPSS) (Noruˇis, 1999). Factor analysis (FA) examines variables that are assumed to be metric and interdependent and aims to identify the factors or underlying dimensions (latent variables) behind these variables. These factors explain the inter-relationships (covariance or correlation) amongst an original set of variables with a minimum loss of information (or maximum variance explained).

In the study, the variables are given by the contribution of food groups to energy intake that is assumed to be interdependent. FA is employed to identify the underlying dimensions of food consumption patterns.

Factor scores (FS) are saved as variables. FS are generated from the estimated factor structure and were calculated as follows:

$$F_{jk} = \sum w_{ij} x_{ik},$$

where F_{jk} – FS for the object k with regards to the factor j; w_{ji} – coefficient of the FS corresponding to the relationship between variable i and the factor j; x_{ik} – normalised value of variable i for the object k.

The coefficients of the FS are similar to regression coefficients β in an equation where the dependent variables represent the factors and the independent variables are the observed variables.

FS are subsequently used in cluster analysis (CA) to establish clusters of countries. The countries were classified based on the homogeneity in the FS related to the dimensions of food consumption patterns.

The third stage of data modelling consists of the classification of countries according to indicators related to food consumption or their key dimensions as underlined by FA. It is recommended to apply FA with orthogonal rotation and use of the resultant uncorrelated factor scores for each observation as an input in clustering in order to address the issue of multicollinearity (Punj and Stewart, 1983; Ketchen and Shook, 1996). Another technique to address the problem of multicollinearity is to specify the Mahalanobis distance in classification. In this paper, the first approach was adopted.

CA is used to identify groups of states that display homogeneity in food consumption patterns, as described by the contribution of main food groups to the dietary intake. The groups are determined so that the within-group variance is minimised or the between-group variance is maximised (Ness, 1997).

The study critically reports the cluster solutions based upon a competitive set of hierarchical classification methods. Then a validation of the clusters is generated by employing an optimisation technique in the form of the K-Means procedure within SPSS. Unlike hierarchical methods, this non-hierarchical method generates the groups based on a pre-specified number. The objects are allocated based on the proximity to the cluster centres. The optimisation involves an iterative procedure following the criterion of minimisation of within group variance.

A measure which synthesised the balance between the aim of parsimony (reduction of number of clusters) and of interpretability (based on the homogeneity of the classes) is the coefficient of parsimony of classification (PC) (Sandu, 1992): PC = 1 – (number of classes/total number of objects to be classified). The advantage of using the PC coefficient for diagnosis is that it allows effective comparisons between cluster solutions.

Cluster profiles are then derived and established on the basis of average FS. Additional variables are included in the analysis in order to enhance the interpretability of the clusters.

In all subsequent analyses the following methodological assumptions were made: the latent root criterion (factors with an eigenvalue greater than one) was used to derive factors; only loadings above 0.60 were considered significant, given the relatively small sample size (n = 28) (Hair *et al.*, 1998); the interpretability of the factors was enhanced by the VARIMAX rotation.

The choice of the final classification solution in the case of each hierarchical method was based on the examination of the Gower diagram and the cut of the dendrogram at the merging points/ distances thought as unacceptable. A minimum value of PC of 0.6 was aimed in the hierarchical classification. This ensured a significant number of clusters, given an acceptable level of parsimony. Differences between country profiles accounted by the shape of profiles (pattern of contribution of products to the food consumption) are detected by the Euclidean distances. The methods that generated a cluster solution containing more than three entropy groups were not reported, as these solutions were considered unsatisfactory.

Empirical results

Preliminary results

In this preliminary section, the relationship between income and food consumption is explored based on the income elasticity of demand for calories and proteins. In line with the literature, two alternative functional forms have been used to estimate the relationship between income and nutrient intake[1].

[1] As a first step, though a Box-Cox model was estimated to test for the transformation of the functional form. The Likelihood Ratio (LR) test gave evidence in favour of a cubic transformation of the dependent variable. The results using this functional form were not different from the log-linear transformation used and supported by the literature.

Following Gil *et al.* (1995), a reciprocal functional form was assumed to describe the relationship between income and average daily calorie intake. The underlying assumption is that the total food consumption as well as consumption of animal products will reach a maximum level as income grows. Using data on the year 2000, four equations were estimated containing *per capita* daily calorie consumption (C); *per capita* daily calorie consumption derived from animal products (Ca); *per capita* daily protein consumption (P); and *per capita* daily protein consumption derived from animal products (Pa) as dependent variables; and the gross domestic product (GDP) in purchasing power parity terms as independent variable. The corresponding R-squared coefficients were: 0.364; 0.595; 0.345 and 0.595.

The second functional form specified was log-inverse. This also allows for a saturation point, as the calorie intake does not increase after a certain level of income.

As the goodness-of-fit measure of the log-inverse model cannot be compared to the reciprocal model, the approach recommended by Wooldridge (2000) was followed. After obtaining the fitted values log y in the models (1-4), the dependent variable y was regressed on $\hat{w}$ through the origin, where $\hat{w}_i$ = exp(log $\hat{y}_i$). The squared sample correlation between $\hat{y}_i$ and the actual y_i (r^2) in the sample is comparable to R-squared in the corresponding reciprocal function.

$$\text{Log } C_t = \alpha_1 + \beta_1 (1/GDP)\; r^2(\hat{C}_t, C_t) = 0.602 \qquad \text{Ramsey Reset test } F(3, 23) = 0.92 \qquad (1)$$

$$\text{Log } Ca_t = \alpha_2 + \beta_2 (1/GDP)\; r^2(\hat{Ca}_t, AC_t) = 0.778 \qquad \text{Ramsey Reset test } F(3, 23) = 1.56 \qquad (2)$$

$$\text{Log } P_t = \alpha_3 + \beta_3 (1/GDP)\; r^2(\hat{P}_t, P_t) = 0.587 \qquad \text{Ramsey Reset test } F(3, 23) = 1.80 \qquad (3)$$

$$\text{Log } Pa_t = \alpha_4 + \beta_4 (1/GDP)\; r^2(\hat{Pa}_t, Pa_t) = 0.777 \qquad \text{Ramsey Reset test } F(3, 23) = 2.04 \qquad (4)$$

where α_i intercept terms and β_i parameters associated with income (i = 1, …, 4).

The estimates presented in table 2 are based on the log-inverse function given the superior goodness-of-fit. The elasticities relied on White-Huber heteroskedasticity consistent robust estimators for the log-inverse function (Green, 1997, p. 505). The Ramsey-Reset test indicated that the model was well specified with no omitted variables (Ramsey, 1969).

The calorie income elasticity is very low in most EU States. The estimates of income elasticity for protein demand overweight those corresponding to calorie demand, albeit differences are rather modest. Income elasticities of animal products are larger than those corresponding to the total calorie and total protein demand. Larger coefficients are noticeable in CEECs, particularly those with lower levels of consumer income. This pattern suggests a greater potential of growth for products of animal origin in this economic area, which is consistent with lower levels of consumption in this region relative to Western counterparts. The highest estimates of the demand for animal products appear in the case of the two countries candidate for EU accession in January 2007.

Table 2. **Estimated income elasticities for calorie demand in Europe**

	Calorie intake	Animal calorie intake	Protein intake	Animal protein intake
Austria	0.02	0.06	0.03	0.06
Belgium-Lux.	0.02	0.06	0.03	0.06
Bulgaria	0.11	0.30	0.14	0.30
Cyprus	0.03	0.08	0.04	0.08
Czech Rep.	0.05	0.12	0.06	0.12
Denmark	0.02	0.06	0.03	0.06
Estonia	0.06	0.17	0.08	0.17
Finland	0.03	0.07	0.03	0.07
France	0.03	0.07	0.03	0.07
Germany	0.03	0.07	0.03	0.07
Greece	0.04	0.10	0.05	0.10
Hungary	0.05	0.14	0.07	0.14
Ireland	0.02	0.06	0.03	0.06
Italy	0.03	0.07	0.03	0.07
Latvia	0.09	0.24	0.11	0.24
Lithuania	0.09	0.24	0.11	0.24
Malta	0.04	0.10	0.05	0.10
Netherlands	0.03	0.07	0.03	0.07
Poland	0.07	0.19	0.09	0.10
Norway	0.02	0.06	0.03	0.06
Portugal	0.04	0.10	0.05	0.10
Romania	0.10	0.26	0.13	0.27
Slovakia	0.06	0.15	0.07	0.15
Slovenia	0.04	0.10	0.05	0.10
Spain	0.03	0.09	0.04	0.09
Sweden	0.03	0.07	0.03	0.07
Switzerland	0.02	0.06	0.03	0.06
UK	0.03	0.07	0.03	0.07

Note: all coefficients are estimated based on White-Huber robust consistent estimators and are significant at the 1% level.
Source: own calculations derived from data available at *http://www.geographyiq.com* (2004) and *www.fao.org* (2004)

The following two sections explore the homogeneity of patterns of food consumption in Europe. The aim is to identify underlying dimensions in food consumption patterns using factor analysis. These dimensions are subsequently used in identifying clusters of European countries with strong similarities in respect of such patterns.

Clusters based on patterns of calorie consumption

This section contains the empirical results of the application of FA to the data set on patterns of dietary intake, namely the contribution of food groups to the average *per capita* daily calorific, protein and fat supply in Europe. Only the products which had at least 1% contribution to the total average nutrient consumption were retained in factor analysis. Using the factor scores derived from FA, groups of countries are then identified based on CA.

The following table records the factor solution based on the data on patterns of calorie consumption.

Table 3. **Rotated factor matrix: patterns of calorie consumption**

Variable	Factor number							Communality
	1	2	3	4	5	6	7	
ENWHEAT	0.20	**-0.73**	-0.01	0.12	-0.22	-0.01	-0.01	.65
ENRICE	0.13	-0.01	**0.87**	0.01	0.01	0.20	0.01	.82
ENSTARCH	-0.41	-0.18	-0.01	-0.01	-0.12	0.01	0.67	.68
ENSUGAR	0.01	**0.63**	-0.43	0.43	-0.01	-0.10	0.11	.81
ENPULS	0.57	-0.20	0.48	-0.01	-0.10	0.28	0.34	.80
ENNUTS	**0.69**	0.27	0.29	0.01	0.14	-0.18	-0.21	.74
ENVEGOIL	**0.65**	0.11	0.25	-0.33	-0.16	-0.10	-0.01	.65
ENVEG	**0.77**	-0.24	0.19	0.01	-0.15	0.11	-0.01	.73
ENCITRUS	**0.71**	0.10	0.17	-0.01	0.34	0.01	0.14	.68
ENOTHFR	0.38	0.28	**0.69**	-0.01	0.01	-0.11	-0.24	.78
ENSTIM	-0.11	-0.01	-0.01	**0.83**	0.16	-0.01	0.26	.81
ENBEEF	0.01	-0.01	0.41	0.14	**0.74**	-0.01	0.01	.76
ENLAMB	**0.74**	-0.11	-0.23	-0.19	0.14	0.46	0.01	.89
ENPIG	0.01	**0.78**	0.13	-0.01	-0.01	-0.11	-0.19	.69
ENPOULTRY	0.24	0.14	0.28	0.13	0.27	**0.77**	-0.14	.87
ENOFFAL	-0.01	-0.16	0.01	-0.18	0.19	**0.80**	0.01	.74
ENANFAT	-0.20	**0.63**	0.01	0.44	-0.37	0.01	0.01	.78
ENMILK	0.01	0.21	-0.19	-0.01	**0.84**	0.01	-0.01	.80
ENEGGS	-0.01	0.12	0.01	**0.79**	-0.01	-0.11	-0.32	.77
ENFISH	0.29	0.18	0.01	0.01	0.36	-0.26	**0.71**	.84
ENOLIVES	**0.87**	-0.29	-0.01	-0.01	0.01	0.01	-0.01	.87
Eigenvalue	4.22	2.49	2.26	1.98	1.96	1.76	1.50	
Variance (%)	20.10	11.90	10.80	9.50	9.30	8.40	7.10	
Cumulative variance (%)	20.10	32.00	42.80	52.30	61.60	70.00	77.10	

Source: own calculations

The Bartlett test resulted in the rejection of the null hypothesis that the variables are not correlated [$\chi^2(153) = 203.7$, $p < 0.004$]. Hence a desirable level of interdependency was found in the data. Furthermore, the Kaiser-Meyer-Olkin test (0.28) suggested a satisfactory fit of the model to the data. Communalities indicated that over 65% of the variation in variables were explained by the factor solution.

Seven factors reflected the contribution of the following food products to the calorie supply, as follows: factor 1 (vegetable products) – ENNUTS, ENVEGOIL, ENVEG, ENFRUIT and ENLAMB; factor 2 – inversely associated with

ENWHEAT and positively with ENSUGAR, ENPIG and ENANFAT; factor 3 (vegetable products) – ENRICE and ENOTHFR; factor 4 – ENSTIM and ENEGGS; factor 5 (animal products) – ENBEEF and ENMILK; factor 6 – positively associated with ENPOULTRY and ENOFFAL; factor 7 – ENSTARCH and ENFISH.

Overall the factor solution explains a significant proportion of variation in the original data set (77%) indicating a good fit of the model to the data. In all analyses, factor scores were saved as regression variables corresponding to each observation in the sample.

The FS obtained through the FA were used to cluster the countries with respect to the heterogeneity of their food consumption patterns. Very often CA is associated with technique bias, namely the dependency of results on the choice of model specification (Everitt, 1993). Hence several hierarchical methods were competitively employed. The results for distinctive hierarchical classification methods are reported in table 4.

Table 4. **Classification of European States based on the structure of energy intake**

Cluster	Complete linkage	Ward method
1	Austria, Switzerland, Netherlands, France	Austria, Germany, Switzerland
2	Bulgaria, Romania, Slovenia, Italy	Slovakia, Czech Republic, Hungary, Belgium-Luxembourg, UK, Poland, Spain
3	Greece, Cyprus	Bulgaria, Romania
4	Slovakia, Czech Republic, Germany, Denmark, Hungary	Estonia, Latvia, Lithuania, Norway, Sweden, Finland
5	Malta	Portugal, Slovenia, Italy
6	Belgium-Luxembourg, UK, Poland, Spain, Estonia, Latvia, Lithuania, Norway, Sweden, Finland	Denmark, Netherlands, France, Malta
7	Portugal	Greece, Cyprus
8	Ireland	Ireland
PC	0.71	0.71

Source: own calculations

There is great theoretical and empirical interest in the groupings that remain stable regardless of the classification method used. This may be viewed as a test of validity. As far as the calorie *per capita* daily supply is concerned, the most homogeneous countries (similar pattern of contribution of food groups) are: Austria and Switzerland; Bulgaria and Romania; Greece and Cyprus; Slovakia, Czech Republic and Hungary; Belgium-Luxembourg, UK, Poland, Spain; and three Baltic States merged with the three Scandinavian Countries. The analysis of variance confirms that the FS corresponding to factor 2, 3 and 4 have significant differences between cluster centres. For instance, Central European post-communist economies have higher scores on factor 2, while Mediterranean States on the first factor.

Contribution of food products to protein consumption

Table 5 records the output of FA. The Bartlett test [$\chi^2(153) = 274.5$, $p<0.001$] and Kaiser-Meyer-Olkin test (0.38) suggested a satisfactory fit of the model to the data. Over 67% of the variation in variables were explained by the factor solution. A seven-factors solution was again extracted as follows: factor 1 – PNUTS, PLAMB, and POLIVES; factor 2 – PRICE, PPULS and PPOULTRY; factor 3 – PBEEF and PMILK; factor 4 – PEGGS; factor 5 – PWHEAT and PPIG; factor 6 – PSTIM; factor 7 – POFFAL. All factor loadings are positive except wheat in factor 5.

Table 5. **Rotated factor matrix: patterns of protein consumption**

Variable	Factor number							Communality
	1	2	3	4	5	6	7	
PWHEAT	0.13	0.01	-0.01	0.16	**-0.82**	-0.32	-0.01	.84
PRICE	0.01	**0.81**	0.14	0.01	0.01	0.01	0.01	.70
PSTARCH	-0.57	0.01	-0.01	-0.49	0.01	-0.44	-0.01	.77
PPULS	0.34	**0.81**	-0.11	-0.17	-0.15	-0.11	-0.01	.86
PNUTS	**0.75**	0.13	0.33	0.16	0.22	-0.01	-0.16	.79
PVEGOIL	-0.45	-0.28	0.47	-0.12	0.46	-0.22	0.11	.79
PVEG	0.59	0.42	0.16	0.23	-0.25	-0.47	0.01	.89
PSTIM	-0.11	0.01	0.30	0.16	0.21	**0.83**	-0.14	.88
PBEEF	0.14	0.27	**0.82**	0.13	-0.11	0.21	-0.01	.85
PLAMB	**0.87**	0.12	-0.13	-0.29	-0.01	-0.01	0.18	.91
PPIG	0.01	0.24	0.01	0.48	**0.71**	0.01	-0.18	.84
PPOULTRY	0.27	**0.61**	-0.26	0.22	0.01	0.01	0.53	.85
POFFAL	0.01	0.12	0.01	-0.22	-0.01	-0.14	**0.82**	.77
PANFAT	-0.24	-0.19	0.15	0.01	0.13	0.50	0.54	.67
PMILK	0.01	-0.20	**0.81**	0.01	0.19	0.01	0.01	.77
PEGGS	-0.11	0.01	0.18	**0.78**	0.01	0.12	-0.18	.71
PFISH	0.01	0.41	0.49	-0.50	0.01	0.15	-0.34	.81
POLIVES	**0.89**	0.13	-0.01	-0.01	-0.14	-0.18	-0.01	.87
Eigenvalue	3.32	2.43	2.22	1.74	1.68	1.65	1.53	
Variance (%)	18.40	13.50	12.40	9.60	9.40	9.10	8.50	
Cumulative variance (%)	18.40	31.90	44.30	53.90	63.30	72.40	80.90	

Source: own calculations

The cluster solutions generated by the two algorithms, using the factor scores related to dimensions of protein consumption, can be found in table 6.

Table 6. **Classification of European States based on the structure of protein intake**

Cluster	Complete linkage	Ward method
1	Norway, Sweden, Finland	Norway, Sweden, Finland
2	Greece, Cyprus	Austria, Netherlands, Denmark
3	Belgium-Luxembourg, Ireland	Slovakia, UK, Czech Republic, Germany, Switzerland, Bulgaria
4	Portugal, Spain	Estonia, Latvia, Lithuania, Poland
5	France, Slovenia, Hungary	Belgium-Luxembourg
6	Slovakia, UK, Czech Republic, Germany, Switzerland, Bulgaria	Malta, Italy, Romania
7	Malta, Italy, Romania	France, Slovenia, Hungary, Ireland
8	Austria, Netherlands, Denmark	Portugal, Spain
9	Estonia, Latvia, Lithuania, Poland	Greece, Cyprus
PC	0.68	0.68

Source: own calculations

Based on this indicator, seven clusters of countries that remained stable across all classification methods can be outlined: Scandinavian States (Norway, Sweden and Finland); France, Hungary and Slovenia; Austria, Netherlands and Denmark; Slovakia, Czech Republic, UK, Germany, Switzerland and Bulgaria; the three Baltic States and Poland; Malta, Italy and Romania; Greece and Cyprus; Portugal and Spain. Significant differences between clusters were found for all FS except the third factor. The non-hierarchical method confirmed the above clusters with the exception of Denmark and Switzerland. The structure of protein consumption generated some differences in cluster composition relative to the energy intake.

Contribution of food products to fat consumption

Table 7 records the output of FA. The Bartlett test [$\chi^2(91) = 140.7, p < 0.001$] and Kaiser-Meyer-Olkin test (0.42) suggested a satisfactory fit of the model to the data. At least, 65% of the variation in each variable were explained by the factor solution.

A six factors solution was extracted as follows: factor 1 – FNUTS, FVEGOIL, and FOLIVES (sources of fat derived from vegetal products); factor 2 – FPIG and FANFAT (animal sources of fat with higher cholesterol content); factor 3 – FWHEAT and FSTIM; factor 4 – FPOULTRY and POFFAL; factor 5 – FMILK and FFISH (animal sources of fat with lower cholesterol content); factor 6 – FBEEF.

Table 7. **Rotated factor matrix: patterns of fat consumption**

Variable	Factor number						Communality
	1	2	3	4	5	6	
FWHEAT	0.12	-0.28	**0.71**	0.15	0.01	-0.33	.74
FNUTS	**0.81**	0.21	0.01	-0.01	0.17	-0.01	.73
FVEGOIL	**0.75**	-0.01	-0.42	-0.01	-0.23	0.13	.81
FSTIM	-0.15	0.01	**0.84**	-0.01	0.01	0.21	.79
FBEEF	-0.01	-0.13	0.01	0.01	0.19	**0.88**	.83
FLAMB	0.51	-0.35	-0.01	0.58	0.35	-0.10	.85
FPIG	0.16	**0.70**	-0.33	-0.01	0.41	-0.01	.80
FPOULTRY	0.01	0.31	0.15	**0.79**	-0.25	-0.19	.85
FOFFAL	-0.01	-0.26	-0.11	**0.82**	-0.01	0.22	.80
FANFAT	0.01	**0.81**	0.01	-0.01	-0.01	-0.15	.71
FMILK	0.20	0.01	0.01	0.19	**0.69**	0.42	.73
FEGGS	0.11	0.54	0.56	-0.16	-0.33	0.25	.81
FFISH	-0.01	0.01	0.11	-0.36	**0.71**	0.01	.65
FOLIVES	**0.79**	-0.40	0.20	0.19	0.12	-0.01	.88
Eigenvalue	2.26	2.03	1.90	1.89	1.59	1.30	
Variance (%)	16.2	14.5	13.6	13.5	11.4	9.3	
Cumulative variance (%)	16.2	30.7	44.3	57.8	68.2	78.5	

Source: own calculations

The cluster solutions generated by the two algorithms, using the factor scores related to dimensions of fat consumption, can be found in table 8.

Table 8. **Classification of European States based on the structure of fat intake**

Cluster	Complete linkage	Ward method
1	Latvia, Lithuania, Bulgaria, Romania, Estonia, Portugal, Poland, Sweden	Latvia, Lithuania, Bulgaria, Romania, Estonia, UK, Portugal, Poland, Sweden
2	Belgium-Luxembourg, Germany, Austria, Switzerland, Spain, UK	Norway, Finland
3	Norway, Finland	Ireland
4	Greece, Cyprus	Greece, Cyprus
5	Ireland	Malta
6	Netherlands, Italy	Netherlands, Italy
7	Czech Republic, Slovakia, Hungary, Slovenia	Czech Republic, Slovakia, Hungary, Slovenia
8	Denmark, France, Malta	Austria, Switzerland, France, Belgium-Luxembourg, Germany, Spain, Denmark
PC	0.71	0.71

Source: own calculations

Based on this indicator, seven clusters of countries that remained stable across all classification methods can be outlined: the three Baltic States, Romania, Portugal, Poland, Bulgaria, Sweden; Belgium-Luxembourg, Germany, Austria, Switzerland and Spain; Norway and Finland; Greece and Cyprus; Netherlands and

Italy; Central European cluster of post-socialist economies (Czech Republic, Slovenia, Hungary, Slovakia); Denmark and France. Apart from Spain and the Mediterranean cluster, all the others were confirmed by the K-means procedure.

Clusters based on patterns of food consumption

The factor analysis results are summarised in table 9. The Bartlett test [$\chi^2(300) = 515.7$, $p<0.001$] suggested a satisfactory fit of the model to the data, but Kaiser-Meyer-Olkin test was rather weak (0.26). At least 57% of the variation in each variable was explained by the factor solution.

According to the unit root criterion, a seven factors solution was extracted as follows: factor 1 – NUTS, other oils (except sunflower and rape seed), VEG, LAMB and OLIVES; factor 2 – directly associated with CITRUS, STIM, BEEF and MILK and inversely associated with SUNFLOIL; factor 3 – directly associated with OTHFR and PIG; factor 4 – EGGS and OTHMEAT; factor 5 – POULTRY; factor 6 – directly associated with RICE and inversely associated with SUGAR; factor 7 – STARCH.

Table 9. **The rotated factor matrix: *per capita* food consumption**

Variable	Factor number							Communality
	1	2	3	4	5	6	7	
WHEAT	0.42	-0.26	-0.45	0.25	0.01	0.24	0.01	.57
RICE	0.01	0.21	0.37	-0.01	0.36	**0.74**	0.01	.87
STARCH	-0.19	0.15	-0.14	0.27	-0.01	-0.01	**0.85**	.89
SUGAR	-0.13	0.25	0.23	0.42	-0.01	**-0.67**	0.2	.81
PULS	0.50	0.01	0.01	0.01	0.57	0.40	0.17	.78
NUTS	**0.70**	0.30	0.50	0.18	-0.01	0.18	-0.01	.91
SUNFLOIL	0.20	**-0.68**	-0.01	0.10	0.01	0.34	-0.26	.70
RAPESOIL	-0.43	0.12	0.01	-0.19	0.16	-0.52	-0.16	.56
OTHOIL	**0.77**	0.30	0.32	0.20	-0.01	0.12	0.17	.87
VEG	**0.86**	-0.13	0.01	0.15	0.16	0.26	-0.01	.88
CITRUS	0.37	**0.72**	-0.01	0.01	0.27	-0.01	-0.19	.77
OTHFR	0.26	0.17	**0.83**	-0.01	-0.01	0.25	-0.11	.86
STIM	-0.41	**0.68**	0.18	0.14	0.01	0.01	-0.34	.80
BEEF	0.19	**0.74**	0.12	0.24	-0.11	0.26	0.01	.73
LAMB	**0.72**	0.01	-0.11	-0.20	0.49	-0.16	-0.20	.87
PIG	-0.01	-0.01	**0.77**	0.28	0.11	-0.01	-0.01	.70
POULTRY	0.01	-0.14	0.22	0.16	**0.85**	0.13	-0.16	.86
OFFAL	0.01	-0.01	-0.13	-0.24	0.56	-0.01	0.11	.40
ANFAT	-0.50	0.20	0.43	0.27	0.10	-0.21	0.17	.68
MILK	0.01	**0.74**	0.15	0.01	-0.29	-0.13	-0.01	.67
EGGS	-0.20	0.01	0.01	**0.83**	-0.12	-0.01	-0.14	.77
FISH	0.24	0.53	-0.01	0.12	0.21	0.29	0.46	.70
OTHCER	-0.38	-0.01	-0.25	-0.57	-0.35	0.01	0.42	.84
OLIVES	**0.87**	0.01	0.01	-0.01	0.11	0.01	-0.17	.82
OTHMEAT	0.29	0.21	0.12	**0.76**	-0.01	0.01	-0.01	.73
Eigenvalue	4.81	3.36	2.45	2.44	2.19	2.08	1.66	
Variance (%)	19.20	13.50	9.80	9.80	8.70	8.40	6.60	
Cumulative variance (%)	19.20	32.70	42.50	52.30	61.00	69.40	76.00	

Source: own calculations

Overall, the complete set of derived factors explains a large proportion of variation in the data (76%). A synthesis of the cluster solutions is shown in table 10.

The following countries display strong homogeneity of *per capita* food consumption patterns:

Austria, Netherlands, Switzerland, Germany, Denmark, Belgium-Luxembourg; Mediterranean (Spain and Italy); Central Europe (Czech Republic, Hungary, Slovakia); Poland and the Baltic States (Lithuania, Estonia, Latvia); Scandinavia (Norway, Finland, Sweden); France and Malta; Ireland, UK and Cyprus; the Balkans (Bulgaria and Romania). Portugal and Slovenia seem to have distinctive profiles in terms of their food consumption patterns and did not merge with any other state. Apart from Belgium-Luxembourg, Mediterranean and the Central European cluster, the other were confirmed by the non-hierarchical method. Most of the factors (except the third) generated significant differences between clusters.

Table 10. **Classification of European States based on *per capita* food consumption**

Cluster	Average linkage (between groups)	Complete linkage	Ward method
1	Austria, Germany, Switzerland, Denmark, Belgium-Luxembourg, Netherlands	Austria, Germany, Switzerland, Denmark, Belgium-Luxembourg, Netherlands, Czech Republic, Slovakia, Hungary	Austria, Germany, Switzerland, Denmark, Netherlands, Belgium-Luxembourg
2	Spain, Italy	Norway, Sweden, Finland	Norway, Sweden, Finland
3	Czech Republic, Slovakia, Hungary	Ireland, UK, Cyprus	Latvia, Poland, Estonia, Lithuania
4	Latvia, Poland, Estonia, Lithuania	Portugal	Portugal, Slovenia
5	Norway, Sweden, Finland	Slovenia	Ireland, UK, Cyprus
6	France, Malta	Spain, Italy, Greece	Greece
7	Ireland, UK, Cyprus	Bulgaria, Romania	Spain, Italy, France, Malta
8	Bulgaria, Romania	Latvia, Poland, Estonia, Lithuania	Bulgaria, Romania, Czech Republic, Slovakia, Hungary
9	Greece	France, Malta	
10	Portugal		
11	Slovenia		
PC	0.61	0.68	0.71

Source: own calculations

There are only three clusters that are maintained compared to previous classifications based on calorie, protein and fat consumption, namely Slovakia and Czech Republic; Finland and Norway; Baltic States (Estonia, Lithuania and Latvia). In such cases, here is a strong similarity in terms of *per capita* food consumption, but also sources of nutrients and energy in the diet.

Clusters based on income elasticity of food demand

This section reports the cluster solutions using data on income elasticity of demand for calories and proteins (table 11). A set of four indicators was used in the classification, namely income elasticity of demand for C, AC, P and AP, as derived from the log-inverse functions.

The following clusters consistent across methods have emerged: first a very large and heterogeneous cluster formed by three Scandinavian States, South European countries (Cyprus, Spain, France and Italy), but also Central (Austria, Switzerland, Belgium-Luxembourg) and Northern European countries (UK, Netherlands, Germany, Denmark, Ireland); second Central European post-socialist countries (Hungary, Slovakia); third (Lithuania, Latvia, Romania and Bulgaria) and Mediterranean States (Portugal, Greece and Malta).

Except Norway, all the clusters were confirmed by the K-means procedure. Furthermore, the analysis of variance indicates that there are significant differences between cluster centers for all four estimates of elasticity.

Table 11. **Classification of European States based on estimates of the income elasticities of demand for calories and proteins**

Cluster	Average linkage (between groups)	Complete linkage	Ward method
1	UK, Italy, Finland, Netherlands, Sweden, France, Germany, Norway, Switzerland, Austria, Denmark, Ireland, Belgium-Luxembourg, Portugal Slovenia, Greece, Malta, Spain, Cyprus	UK, Italy, Finland, Netherlands, Sweden, France, Germany, Norway, Switzerland, Austria, Denmark, Ireland, Belgium-Luxembourg, Portugal, Slovenia, Greece, Malta, Spain, Cyprus, Czech Republic	UK, Italy, Finland, Netherlands, Sweden, France, Germany, Norway, Switzerland, Austria, Denmark, Ireland, Belgium-Luxembourg, Spain, Cyprus,
2	Latvia, Poland, Hungary, Slovakia, Czech Republic	Hungary, Slovakia, Estonia, Poland	Estonia, Poland
3	Lithuania, Latvia, Romania, Bulgaria	Lithuania, Latvia, Romania, Bulgaria	Hungary, Slovakia, Portugal, Slovenia, Greece, Malta, Czech Republic
4			Lithuania, Latvia, Romania, Bulgaria
PC	0.96	0.96	0.86

Source: own calculations

Discussion

As far as the patterns of calorie consumption are concerned, the groupings are slightly different from Henson and Loader (1991): France does not belong to the Mediterranean cluster. There are many similarities to the Gil *et al.* (1995) study: *e.g.* Belgium-Luxembourg merged with the UK; Norway merged with Sweden; Austria with Netherlands. Denmark emerges systematically as an entropy group. Yet, there are also differences from the study of Gil *et al.* (1995). Germany and Austria merged together based on their similarity of fat consumption rather than energy intake. Portugal and Spain merged together based on their similarity of protein consumption rather than energy intake. The Scandinavian Countries (Norway, Sweden) display strong similarity in terms of *per capita* food consumption rather than energy intake. Relative to Gil *et al.* (1995) study, our paper employs a more detailed number of products. Notwithstanding these limitations of comparability between studies, the results indicate that from 1970-1990 until 2000, some clusters remained stable, but other have changed as a result of changing consumption patterns in each country.

The inclusion of the new members of the EU into the analysis led to the Greece joining Cyprus rather than Italy and the Baltic States being clustered with Scandinavian Countries.

Post socialist countries from Central and Eastern Europe join occasionally countries from Western Europe. This is not surprising as some dietary patterns in some Eastern European countries became more similar to Western Europe (Elsner and Hartmann, 1997) and similarities are expected to increase in the future (Ratinger and Slaisova, 2001). However, only in the case of patterns of energy and nutrient intake, do such clusters remain stable across classification methods. The disparity in *per capita* food consumption between these two blocks can not create ground for common clusters. The macro-environment in Eastern Europe (low income, high inflation and food budget share, small urban elite ; Batra, 1997) is expected to be associated with consumption patterns distinctive from Western Europe.

Nevertheless, an increased similarity in marketing environments has been outlined (Leeflang and van Raaij, 1995). Several demographic and cultural trends found in Western Europe became more visible in Eastern Europe : ageing population, health concerns in dietary choice (Brosig and Ratinger, 1999 ; Petrovici *et al.*, 2004). An increased similarity in food consumption patterns in the enlarged Europe may occur if indeed Southern and Eastern European nations will catch up with the Northern European development, as some have suggested (*e.g.* Leeflang and van Raaij, 1995). Convergence at the level of macro-environmental variables can increase the probability of identifying homogeneous cross-national segments (Ganesh, 1998).

The cluster solution based on the estimates of income elasticity of demand is more parsimonious relative to those using indicators of food consumption. Such patterns indicate smaller disparities in elasticity.

A maximum number of eight clusters of countries emerge when each indicator is used in the classification procedure. The increase in the number of indicators used in classification leads to a reduction in the number of hard-core clusters. Only two such clusters emerge regardless of the classification method and across the four sets of indicators used in grouping the countries ; namely Baltic States (Latvia and Lithuania) and Scandinavian (Finland and Norway). Strong similarities in consumer food preferences as well as the economic environment (income) underline the strong similarity in food consumption patterns and demand response (reaction to income change). The next section illustrates this argument by profiling in terms of additional variables the most stable groupings as generated by at least two indicators describing food consumption.

Overall the analysis suggests that a broad set of variables should be observed when the aim is to determine homogeneous countries in respect of their food consumption patterns.

Validation of the cluster solution

The hard-core clusters emerged from the analysis of *per capita* food consumption are now described based on additional variables. These are thought to characterise the purchasing power of consumers (GDP *per capita*, number of television sets per 1,000 inhabitants) and demographic indicators (population density). This stage of analysis assists the researcher in the interpretation of clusters but can be also viewed as a validation based on external variables (Saporta, 1991), as these variables were not used to derive the clusters (Ketchen and Shook, 1996). The logic of the criterion validity is to test the variability of variables not included in the CA across groups.

Table 12 summarises the average values of the socio-economic indicators associated with the five clusters that emerged in the most frequent cluster solutions as derived from at least two sets of indicators regarding food consumption. One can notice a distinction between the CEECs advanced in transition (*e.g.* Hungary) and Balkan States that include the least advanced CEECs in economic transition.

Table 12. **Profiling indicators of clusters emerging from *per capita* food consumption**[a]

	GDP-head	**GDP composition by sector, 2002**		**Number of TV sets**	**Population density**	**Food budget share**
	(US $, PPP)	**agriculture**	**services**	**(per 1000 persons)**	**(population per km^2)**	%
Scandinavia[b]	27,800	3	66	527	16	19
CEECs advanced in transition[c]	13,600	4	60	418	116	30
Austria, Netherlands, Denmark	27,867	3	69	713	204	17
Balkan States[d]	6,700	15	56	460	81	56
Mediterranean[e]	19,100	8	69	238	81	22
Poland and the Baltic States[f]	9,275	6	65	440	62	39
F-test (differences between group means)	66.3**	34.2**	4.4*	1.5	2.1	12.6**

Notes : – * $p < 0.05$; ** $p < 0.01$

– The breakdown of GDP by sector refers 2002 in the case of Austria, Denmark, France, Germany, Greece and Switzerland and 2001 for the rest of the countries. Most of the data related to TV sets refers top 1997. The food budget shares refer to 1996 and exclude Norway which was excluded from the European Commission report. Greece is reported separately as the statistics for Cyprus were not reported at the level of the whole country.

– [a]: average values ; [b]: Scandinavia (Norway, Finland, Sweden) ; [c]: CEECs advanced in transition : Hungary, Slovakia and Czech Republic ; [d]: the Balkans (Bulgaria and Romania) ; [e]: Mediterranean (Greece) ; [f] : the Baltic States (Lithuania, Estonia, Latvia)

Sources : US Department of State (2004) and European Commission (1998)

Significant differences between the average values of the selected indicators are noticeable in terms of most indicators, particularly those concerned with income. The last row of the table highlights these differences in terms of the F-test, as part of an analysis of variance. For example, Scandinavian Countries display the largest economic development and the lowest density of population and share of agriculture. In contrast to this cluster, CEECs advanced in transition tend to have a GDP *per capita* and endowment with durable goods, as well as a higher contribution of agriculture to GDP. The Balkan Countries are characterised by the lowest GDP *per capita*, a relatively low population density and a strong agrarian structure of the economy.

The influence of the geographical and economic factors on the configuration of the clusters is noticeable. This suggests the significance of economic variables explaining the similarity of patterns of nutrient intake, as highlighted by the significant differences between the means of income and also food budget shares.

This does not exclude the role played by consumer preferences shaped by local food cultures. Askegaard and Madsen (1995) highlighted the regional dishes/cuisine and also food habits: single dishes frequently associated with meat in Northern Europe as opposed to several small dishes in Southern Europe. The role of local ecological factors in shaping food consumption patterns is also acknowledged. For example, the high consumption of wine, fruit and vegetables in the South of Europe; the high consumption of sugar, potatoes and animal fat in the North (see also Grigg, 1993).

Amongst the determinants of convergence which have been discussed are the similarity in cultural values and demographic determinants of food demand (Connor, 1994), the amplification of the horizontal and vertical integration of European firms and the similarities in public policies (Gil *et al.*, 1995).

The Scandinavian Countries display above-average proportions for the consumption of animal products such as milk and fish. This cluster is expected to become more similar to the other Western European countries as consumers attempted to pursue a Mediterranean diet in the last decade. At the same time, in the Southern regions of Europe there has been an increase in the intake of animal products that resemble to the Northern European diets (Traill, 1998).

Furthermore the rising income inequality in the CEECs (Milanovic, 1999) generated in certain countries an elite whose food purchasing patterns may resemble those noticeable in the middle class in the EU (see also Henson and Traill, 1991). Following the developments associated with the EU enlargement, *e.g.* the globalisation of consumer preferences, improvement in real consumer incomes in CEECS and harmonisation of public policies, an increasing convergence of CEECS towards the EU standards is expected. The gap between the consumption levels in CEECs and the EU is expected to narrow, reflecting an expected improvement in consumer welfare in the CEECs (see Hertel *et al.*, 1997).

Conclusions and further research

Income elasticities of animal products tend to exceed those corresponding to the total calorie demand. The same pattern holds true for income elasticity of demand for proteins.

In general, there is a substantial similarity in the configuration of cluster across classification methods. There is, however, a different positioning of certain countries depending on the method. The identified clusters largely overlap with classifications reported elsewhere (Gil *et al.*, 1995).

In this study, the concept of validity is centred around the hard-core clusters. The definition of these clusters was extended by adding the condition of stability of clusters at changes in the set of indicators that measures the same generic concept of patterns of dietary intake. The use of metric data and the Euclidean distance enabled a large number of methods to be tested. Slight differences in the configuration of clusters were noticeable between the cluster solution generated by hierarchical and non-hierarchical methods. More significant differences in the composition of clusters were outlined as a result of the change of the indicator used in classification. There were only two hard-core clusters invariant to both the set of indicators and classification methods used, namely Finland and Norway ; Latvia and Lithuania. Surprisingly, even countries that belonged to the same political entity in the past (Czech Republic and Slovakia) did not belong to this group.

The results may be useful to both marketers and policy makers. For example, the similarity in food consumption patterns may encourage further economies of scale based on standardisation. The extent to which marketing practices may be adopted in the emerging markets deserves further attention, given the large size of these markets and their positive impact on trade flows following EU enlargement. For food policy makers, as nutrition intervention is based on data from current population diets, the similarity in consumption patterns may suggest that dietary goals from strongly similar countries may be used as a blueprint for other countries with less experience in this area. The Scandinavian Countries have acquired substantial expertise in this area (Helsing, 1991) and the most advanced transitional economies have established nutritional goals (Mann and Truswell, 1998).

The analysis showed the heterogeneity of patterns of nutrient intake in Europe. It was found that there are few hard-core clusters of countries if the definition of these clusters is extended. The main disparity between the EU and the CEECs candidates to accession is related to the proportion of animal products in the nutrient intake ; namely a lower proportion in CEECs which would be expected given the lower incomes *per capita*.

Cluster analysis has been subject to extensive criticism. Alderferer and Blashfield (1984) pointed out that, although its objective is structure-seeking, the algorithm is structure-imposing. Everitt (1993) stressed the risk that a CA may generate clusters even when applied to random data. The use of several classification methods has reduced this risk (the generation of clusters related to the algorithm) and increased the likelihood that the identified hard-core clusters correspond to a natural configuration based on strong similarities of food consumption patterns.

The average linkage methods generated significantly less parsimonious solutions with more entropy groups. Nevertheless, no single method outperformed from the point of view of parsimony. As Milligan (1980) pointed out, no method is superior, the performance of classification being dependent on the nature of data and the research aims.

Comparisons of the cluster solution with other studies are limited by the differences in the sample of countries observed. Furthermore time comparisons are constrained by the changing configuration in the European geo-political map (*e.g.*

the transformation in the former Yugoslavia and Czechoslovakia). It is argued that the inclusion of countries that recently acquired the EU membership or are expected to join in 2007 enhanced the understanding of the diversity of European food consumption patterns. Given the expected convergence of food consumption patterns between Western and Eastern Europe, future changes in the composition of clusters can be expected.

This study used indicators available at a country level, but this could, of course, overlook variations at the regional level. Further research on regional data may identify geographical areas with strong homogeneity in food consumption patterns. Data derived from FAO food balance sheet is subject to limitations outlined in the paper. Further research can explore clusters based on data on *per capita* food consumption derived from representative household surveys conducted in each country or explore the effect of additional variables such as prices. Additionally, time series data may be used to test for the changes in food consumption patterns.

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