Canterbury Business School

Working Paper Series

An Exploratory Analysis of European Food Consumption Patterns

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CBS
UNIVERSITY OF KENT

Working Paper No. 37 rev2
February 2004

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ABSTRACT. This paper explores the heterogeneity of food consumption patterns in Europe. Estimates of the income elasticity of calorie demand are contrasted with those based on animal products. The dietary intake and the consumption of the main foods are analysed. The purpose is to outline the main dimensions of food consumption and identify the clusters of countries with homogeneous dietary patterns. The paper concludes with a discussion of the concept of hard core clusters.

KEY WORDS: income elasticity of calorie demand, dietary patterns, hard core clusters.

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1. Introduction

The topic of food consumption has been approached from an integrated perspective only in the two decades. Previously it had been comprised of a collection of fragmented studies eg (Ritson, Gofton and McKenzie, 1986). At a national level studies have focused on determinants of changes in food consumption (Senauer, Asp and Kivey, 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 (see Marshall, 1995; Tangermann, 1995; Gofton, 1995). Structural changes in food consumption in Western European countries have been outlined (Young, Burton, and Dorsett, 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, Gil and Gracia, 1997). As countries reached a saturation point in the calorific intake, the role of these factors diminished at the expense of consumer preferences. These preferences were thought to explain the international divergence persisting in food consumption patterns.

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.

Insert table 1 about here

Another topic of growing interest have been the heterogeneity in 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 Organisation of Economic Cooperation and Development - OECD countries (Blandford, 1984) or Europe (Elsner and Hartman, 1997).

Elsner and Hartmann (1997) provided evidence of convergence in food consumption between European Union (EU) and Central and Eastern European Countries (CEECs). Using a weighted relative deviation index, they reported a decline (convergence) in the case of sugar, wheat, potatoes and fruits, but divergence for beef and poultry. There was evidence of convergence in consumption structures in the case of most CEECs including Estonia, Latvia, Bulgaria. However divergence has been detected for Romania and Lithuania and results were inconclusive in other cases. For example, although calorific intakes in Hungary and Poland converged towards the EU standards, this did not hold in respect of the structure of protein consumption.

However there were also reported cases of divergence. An increasing divergence between the EU on the one hand and Romania and Slovakia on the other hand was reported in terms of calorific, respectively protein intake.

Gil, Gracia and Perez Y Perez (1995) reported no strong evidence of convergence in the calorie intake, but an increasing speed of convergence in the proportion of calories derived from main food groups. Blandford (1986) focused upon calorie intake as a basis to derive clusters of countries with homogeneous dietary patterns.

More recently, the theory of co-integration has been employed to test for long-run equilibrium relationships between the elasticity of calorific demand in the EU member states (Angulo et al, 1997). Little evidence of convergence was found.

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. Hermann and Roder (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.

2. Research objectives

The aim of the paper is to explore the diversity of food consumption patterns in Europe.
In this context, this 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 cluster are through time.

Specifically the objectives of the paper are as follows: i) to underline the main dimensions of the patterns food consumption (the configuration of products that allow the classification of countries); 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 EU states (see Gil et al, 1995) but also the CEECs candidate to EU membership.

The paper is structured as follows. Section 3 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. Section 5 begins with the reporting of estimates of calorie income elasticities in Europe and discusses the main dimensions of dietary patterns (Section 5.1), respectively the food consumption patterns (Section 5.2), as outlined by the cluster analysis using the input of factor analysis. These are followed by a discussion of the validity of the cluster solution (section 5.3). In the last section the conclusions and limitations of the paper are outlined (section 6). 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 (Norušis, 1985 in

Sandu, 1992). In this paper it refers to the countries that belong in 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.

3. 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 11 associated countries that are expected to join the EU by 2007 (Bulgaria, Hungary, Latvia, Lithuania, Estonia, Czech Republic, Slovakia, Slovenia, Poland, Romania). The data are based on the contribution of main food groups to the average per capita calorie per capita supply and the consumption of food items in the observed countries in the last year available (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 later can be significant in the developed countries, but also in CEECs. It has been suggested (Tangermann, 1991; 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).

The data from Food and Agriculture Organisation of the United Nations (FAO) balance sheets should be treated with caution, as the subsistence food production and the removal of effect of removing food subsidies may not be accurately reflected in this data set (Elsner and Hartmann, 1997).

In this context it is thought that using a variety of indicators to analyse the consumption patterns will improve the classification and overcome some of the above limitations. The contribution to the energy supply was observed for the following products: cereals (ENCER), sugar (ENSUG), vegetable oil (ENVEGOIL), roots and tubers (ENROOT), pulses and nuts (ENPULS), meat and offal (ENMEAT), milk (ENMILK), other vegetable products (ENOTHVEG) consisting of fruits, vegetables, oilcrops, alcoholic beverages except wine, spice and stimulants and other animal products (ENOTHANI) consisting of animal fats, eggs, honey, fish and seafood. The data used in the paper are derived from FAO food balance sheets by dividing the per capita daily calorie supply from each food group the total daily energy supply.

The use of measures expressed in percentage terms ensures the standardisation (equal weighting of each item) and have been reported in the literature; see the use of per capita protein consumption of food stuffs (Weber cited in Manly, 1994). The study follows the approach of Weber and Manly (1994) in the use of measures expressed in percentage terms. This ensures that the items were given equal weight in the analysis.

Data on the nutrient intake were available from FAO and refer to 1990-1992 and 2002 (FAO, 1996, 2002). Data on food consumption were also available from food balance sheets. Notwithstanding the criticism 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 was 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).

Insert figure 1 about here

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 Roder (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 (14 altogether) would reduce the risk of generating artificially homogeneous clusters.

Countries with strong similarities on one dimension of food consumption may display dissimilarities in other dimensions and can not be regarded as strongly homogeneous. Similarities in all the dimensions evaluated in terms of different classification methods may lead to what was called hard core clusters. Hard core clusters are defined by the stability of members irrespective of the classification method.

4. Methodology

The data were analysed using SPSS (SPSS, 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. The algorithm of FA aimed to identify the underlying dimensions of food consumption patterns.

Thus the analysis involves two stages. An initial solution to establish the number of factors and at this stage statistical properties of the model are determined. The second stage rotates the solution to aid factor interpretation.

The validation of a factor model concentrates upon two indicators of performance, respectively, communality and cumulative variance. Communality indicates the proportion of variance of original variables explained by the factor solution. Cumulative variance reflects the proportion of total variance of all original variables explained by the set of derived factors.

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

$F_{jk} = \sum w_{ji} x_{ik}$, 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 b 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 was 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 multicolinearity (Punj and Stewart, 1983; Ketchen and Shook, 1996). Another technique to address the problem of multicolinearity is to specify Mahalanobis distance in classification. In this paper the first approach was adopted.

The aim of CA is to group objects (countries in our study) according to their characteristics as measured through a set of indicators. The objects enjoying the same cluster membership are homogeneous from the point of view of indicators used. Unlike other multivariate methods the set of variables used for classification (cluster variate) are not estimated empirically but predefined (Hair, Anderson, Tatham and Black, 1998). In the study the cluster variate consists of a set of complementary indicators describing the food consumption outlined in Figure 1 (see Section 2).

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. In other words (Ness, 1997, p.263) it is aimed homogeneity within the groups and heterogeneity between them.

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 (SPSS, 1999). Unlike hierarchical methods, this nonhierarchical 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) reported in the last row of the table 4. The coefficient is calculated according to the following formulae (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. A minimum value of PC of 0.6 was aimed in the hierarchical classification.

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 interpretation of clusters. This operation was regarded as a criterion validation (see Hair et al, 1998). All statistical tests are conducted at the 5 per cent significance level.

5. Empirical results

In this preliminary section the relationship between income and food consumption is explored based on the income calorie elasticity. It is assumed a reciprocal functional form to describe the relationship between income and average daily calorie intake. This allows for a saturation point, as the calorie intake does not increase after a certain level of income. The following functional forms were used to derive the estimates presented in Table 2:

$C_t = \alpha_1 + \alpha_2 (1/GDP) + e_t$

$AC_t = \beta_1 + \beta_2 (1/GDP) + e_t$

Where:

C: Per capita daily calorie consumption;

AC: Per capita daily calorie consumption derived from animal products;

GDP: the gross domestic product in purchasing power parity terms;

α_2, β_2 : Parameters associated with income;

α_1 β_2 : asymptotic coefficients corresponding to the maximum level of consumption.

As outlined in Table 2, the calorie income elasticity is very low in most EU states. Larger coefficients are noticeable in CEECs candidates to accession.

Insert table 2 about here

Income elasticities of animal products are larger than those corresponding to the total calorie demand. The declining trend in the magnitude of elasticities continued and even accelerated from 1990 to 2000 relative to previous decades (see Gil et al, 1995).

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.

5.1. Exploring the dietary intake

This section contains the empirical results of the application of FA to the data set on patterns of energy intake. Namely the contribution of food groups to the average per capita daily calorific supply in Europe. The aim of this exploratory technique is to reduce the dimensions of the inter-correlated metric variables. The matrices relating to the protein and fat intake were not positive definite. Therefore, only the contribution of food products to the calorie supply was analysed based on the factor analysis.

To confirm the existence of interdependency between variable the Bartlett test is used. The chi-square test resulted in the rejection of the null hypothesis related to the existence of an identity correlation matrix (i.e. the variables are not correlated) ($\chi^2 = 375.89$, $p < 0.05$). This suggests interdependency in the variables. The correlation matrix shows a large number of significant relationships. For instance, strong positive significant relationships ($p<0.05$) between the intake of vegetables and pulses/nuts; sugar and animal products; and negative relationship between cereal products and meat.

According to the latent root criterion six factors with an eigenvalue above one may be derived. The interpretability of the factors was enhanced by the VARIMAX method (Table 3).

Insert table 3 about here

It is noticeable that the first factor (F1) is positively associated with the energy from pulses and other vegetable products and inversely associated with cereal products; the second factor (F2) with the energy from other animal products and sugar. The contribution of milk to dietary intake is the key feature of the third factor (F3). Only loadings above 0.75 were considered significant, given the relatively small sample size (n=28) (see Hair et al, 1998).

There is a substantial proportion of variance of original variables explained by the complete set of derived factors, ranging from 56% in the case of other vegetable products to 91% in the case of energy from milk. Overall the factor solution explains a significant proportion of variation in the original data set (73%) indicating a good fit of the model to the data. Factor scores saved as regression variables corresponding to each observation in the sample.

The factors scores 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. These excluded Ward’s method (unacceptable PC: less than 0.6).

Insert table 4 about here

There is great theoretical and empirical interest in the groupings that remained 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 (see Table 4): Malta, Poland and Latvia; Lithuania and Romania; Portugal and Slovakia; France, Switzerland and Netherlands;

Belgium-Luxembourg, Denmark, Germany and Hungary; Bulgaria, UK, and Slovenia; Ireland and Sweden; Mediterranean states (Spain, Greece and Italy); Central Europe (Austria and Czech Republic).

These groupings partly overlap with those generated by classification of countries based on their dietary patterns using 1990-1992 data on the contribution of food products to the calorie, protein and fat intake (see Petrovici, Ritson and Ness, 2001). The clusters based on the nutrient intake patterns reported in our previous work were as follows: Austria, Germany, Netherlands; Czechoslovakia and Hungary; The Balkans (Romania, Yugoslavia, Bulgaria and Albania); Ireland, UK and Poland; the Mediterranean states (Portugal, Spain, Greece and Italy) and Scandinavia (Norway and Sweden) (see Table 5).

Insert table 5 about here

Comparing the clusters based on 2000 data with those based on 1990-1992 data, it is noticeable that only the Bulgaria and Slovenia (as an ex-member of the fromer Yougoslavia) and the Mediterranean states (Spain, Greece and Italy) remain in the same cluster.

Although the groupings are slightly different from Henson and Loader (1981) (France does not belong to the Mediterranean cluster) or Gil et al (1995), yet there are many similarities.For example Greece and Italy on the one hand, and Norway and Sweden (apart from the average linkage) on the other hand, belong to the same cluster. The effects of including the CEECs into the analysis led to the Austria merging with Czech Republic. Germany and Netherlands are clustered with Austria, but not according to the same classification method. According to the average linkage and centroid methods Finland is also an entropy cluster. Nevertheless Portugal merges with Slovakia rather than Spain.

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 the parsimony coefficient of 0.6 was pursued. This ensured a significant number of clusters, given an acceptable level of parsimony. Overall the classification achieved a data reduction by over

74%. Differences between country profiles accounted by the shape of profiles (pattern of contribution of products to the intake) are detected by the Euclidean distances used to quantify differences between states.

The validity of classification may be further tested by using non-hierarchical classification methods such as K means procedure. The countries are now classified based on an optimisation method, namely the K means cluster procedure in SPSS (SPSS, 1999). The following cluster centres resulted based on a predefined number of eight groups (Table 6).

Insert table 6 about here

A strong similarity of clusters with those generated by the hierarchical techniques is noticeable. The composition of groupings is as follows: cluster 1 – Greece, Italy and Spain; cluster 2- Malta, Latvia and Estonia; cluster 3 - Slovenia, UK, Bulgaria and Czech Republic; cluster 4 – Germany and Portugal; cluster 5- Denmark, Belgium-Luxembourg and Norway; cluster 6 – Lithuania and Romania; cluster 7 - Finland; and cluster 8 - Switzerland, Netherlands and Sweden.

Mediterranean countries have above average scores on calories derived from pulses and other vegetable products, Denmark, Belgium, Luxembourg, Norway on the second factor correlated with sugar and animal products and Finland has the largest score on the factor correlated with milk.

The analysis of variance confirms that all FS have significant differences between cluster centers (Table 7).

Insert table 7 about here

The factors derived through FA are meaningful in classifying European states in terms of the structure of their calorific intake. A similar analytical strategy (FA followed by CA) is adopted in the following sections based on the data related to per capita food consumption.

5.2. Exploring food consumption in Europe

The variables that represented the average per capita consumption of foodstuffs were modeled based on both FA and CA. The observed set of variables were: vegetable products such as cereals, starch, sugar, fruit and vegetables and animal products such as eggs, fish, meat, milk, offal, and animal fats. In a first stage FA aimed at identifying the underling dimensions of food consumption. These factors were then used to classify the European states based on the similarity in the food consumption.

There was an adequate fit of the FA to the set of data on consumption of foodstuffs. The Bartlett test resulted in the rejection of the null hypothesis that the variables are not correlated ($\chi^2 = 259.1$, $p < 0.001$). Hence a desirable level of interdependency was found in the data.Furthermore, the Kaiser-Meyer-Olkin test (0.42) suggested a satisfactory fit of the model to the data.

The variables that represented the average per capita consumption of foodstuffs were normalised as Z scores so that the impact of variables with larger dispersion on similarity values in grouping was eliminated. Hence there was no risk of overstating variables that have a large measurement scale.

The correlation matrix between the observed variables shows positive relationships between the consumption of vegetable and pulses, nuts; fruit and vegetables; sugar and animal fat; meat and cheese; cream and animal fat; respectively negative between the consumption of sugar and cereals. Six factors (F1 – F6) were extracted according to the unit root criterion.

Following the factor rotation through VARIMAX method with Kaiser normalisation, it is noticeable (Table 8) that F1 is positively associated with the consumption of nuts and vegetables, F2 with consumption of cheese and sugar negatively associated with cereal products, F3 with consumption of cream and animal fat and to a less extent stimulants (eg coffee), F4 with offal and F5 with vegetable oil and eggs and F6 with fish. Yet, the forth factor is not clearly defined if a threshold of 0.75 is used in interpreting the loadings coefficients. In such case the highest loading (yet not less than 0.6) was used in the interpretation of the factors.

There is a significant proportion of variance (over 52%) of original variables explained by the complete set of derived factors, that reach 92% in the case of fruit. Overall, the complete set of derived factors explains a large proportion of variation in the data (78%) suggesting a good fit of the model to the data.

Insert table 8 about here

A synthesis of the clusters resulted from three classification methods is shown in Table 9. The centroid method was not reported as it generated an unacceptably high number of entropy groups (five out of twelve groups). The classification based on average linkage method is the most parsimonious.

Insert table 9 about here

The following countries display strong homogeneity of per capita food consumption patterns: Scandinavia (Norway, Finland, Sweden); Hungary, Slovakia and Slovenia; Denmark, Germany, France, and Belgium- Luxembourg; Austria, Netherlands, Switzerland and Czech Republic; the Balkans (Bulgaria and Romania); Mediterranean (Greece and Italy); Poland and the Baltic states (Lithuania, Estonia, Latvia). Ireland and Malta seem to have distinctive profiles in terms of their food consumption patterns and did not merge with any other state. There are certain clusters that are maintained compared to previous classifications based on calorie intake, namely Greece and Italy; Austria and Czech Republic; Belgium-Luxembourg, Denmark and Germany; Switzerland and Netherlands; Poland and Latvia.

5.2.1. K means cluster procedure

The solution for an eight-cluster classification is displayed below (Table 10). The analysis permits a characterisation of clusters based on FS. Scandinavians have above-average scores on animal fat and other animal products (fish); Switzerland, Austria, Czech Republic derive their calories from cheese and sugar; Mediterranean countries rely heavily on pulses, nuts and vegetables; Belgium-Luxembourg, Ireland have large scores associated with cheese, sugar and offal. The classification of Malta into an entropy group can be attributed to its relatively distinctive profile (high factor scores for offal, other animal products and particularly vegetable oil).

Insert table 10 about here

The descriptive analysis of variance indicates that there are significant differences between cluster centers (Table 11) on each of the factor scores.

Insert table 11 about here

The hard core clusters include the Mediterranean countries (Greece, Italy), Austria and Czech Republic; Belgium-Luxembourg, Denmark and Germany; Switzerland and Netherlands; Poland and Latvia. It is noticeable that these states tend to have similarities from the point of view of economic development (except Austria and Czech Republic) but also with respect to consumer preferences and food culture. A particular hard core cluster consists of the central European countries, as it merges an EU member states with a candidate to membership. This is not surprising as some convergence in food consumption patterns between some CEECs and the EU has been achieved (Elsner, Hartmann, 1997) is expected in the future (Ratinger, Šlaisova, 2001).

Comparing the cluster solution generated by the quick cluster procedure, two clusters have similar composition: Greece and Italy; Spain and Portugal. Belgium-Luxembourg is also joining Ireland. Although there are similarities with Gil et al (1995), there are also differences: Belgium-Luxembourg merged with Denmark and Germany rather than France, Ireland and UK.

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.

5.3. Validation of 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 characterize 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 (see Saporta, 1991), as these variables wee not used in the set of variables 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 economic, demographic indicators associated with the five clusters that operate a distinction between the CEECs advanced in transition (e.g. Hungary) and Balkan states that include CEECs the least advanced in economic transition.

Insert table 12 about here

Significant differences between the average values of the selected indicators are noticeable in terms of both economic and demographic variables. 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 lower Gross Domestic Product (GDP) per capita and endowment with durable goods, a higher contribution of agriculture to GDP. The Balkans 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. It is suggested the significance of economic variables in the similarity of patterns of nutrient intake.

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 factors of convergence there 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 west 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 north European diets (Traill, 1998).

It can be argued that in the analysis of New Europe (including CEEC candidate to the EU membership), given the large income and thus food budget share heterogeneity (Petrovici and Ritson, 2000), the role of economic factors is maintained. Furthermore the rising income inequality in the CEECs (see Milanovic, 1999) generated in certain countries an elite whose high income will determine food purchasing patterns to follow those noticeable in the middle class in the EU (see Henson and Traill, 1991).

Following the developments associated with the EU enlargement (globalisation of consumer preferences, improvement in real consumer incomes in CEECS, harmonisation of public policies) an increasing convergence of CEECS towards the EU standards is expected. The gap between consumption level in CEECs and the EU is expected to narrow reflecting an expected improvement in consumer welfare in the CEECs (see Hertel et al, 1997).

6. Conclusions and further research

Income elasticities of animal products tend to exceed those corresponding to the total calorie demand. The declining trend in the elasticities continued and even accelerated from 1990 to 2000 relative to previous decades.

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 confirm 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. Differences in the configuration of clusters were noticeable between the cluster solution generated by hierarchical and non-hierarchical methods.

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 (e.g. Hungary) have established nutritional goals (Mann, Truswell, 1998).

This study used indicators available at country level, but this could, of course, overlook variations at regional level. Further research on less aggregated food consumption may test further the hypothesis of increasing convergence in the European diet.

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.

It should be mentioned that the 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.

Hermann and Roder (1995) suggested an increased convergence in patterns of nutrient intake compared to consumption of specific food products. These findings can be extended to the case of CEECs, as some of them (e.g. Portugal and Slovakia, Austria and Czech Republic) merge sometimes with EU member states although there remain significant disparities in the consumption of food stuffs between these countries and the EU.

There was a tendency of the centroid method to generate less parsimonious cluster solutions compared to the average linkage methods. Nevertheless, no single method outperformed from the point of view of parsimony. As Milligan (1980) concluded, no method is superior, the performance of classification being dependent on the nature of data and the research aims.

Finally it is worth mentioning that comparisons of the cluster solution with other studies are limited by the differences/variability 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 CEECS candidate to the EU membership in the analysis enhanced the understanding of the diversity of food European consumption patterns. Given the expected convergence of food consumption patterns between current EU sates and the CEECs, future changes in the composition of clusters are expected.

References

Alderferer (M.S.), Blashfield, (R.K.), -1984- *Cluster Analysis*, Beverly Hills, Sage.

Angulo (A.), Gil (J.M.) and Gracia (A.), 1997- Convergence in calorie intake elasticities across EU countries: A cointegration approach, in: (R.J.) Loader, (S.J.) Henson and (W.B.) Traill (eds), *Globalisation and the Food Industry: Policy Implications*, Reading, Centre for Food Economics Research, pp.49-68.

Askegaard (S.), Madsen (T.K.), 1995- Homogeneity and Heterogeneousness in European Food Cultures: An Exploratory Analysis, in: (M.) Bergado (ed.) European Marketing Academy Conference Proceedings, Cergy-Pontiose, France, pp.25 - 47.

Blandford (D.), 1984- Changes in food consumption patterns in the OECD area, *European Review of Agricultural Economics*, 11(1), pp.43-65.

Connor (J.M.), 1994- North America as a precursor in Western European food purchasing patterns, *European Review of Agricultural Economics* 21(2),pp. 155-173.

Elsner (K.), Hartmann (M.), 1997- Convergence in food consumption patterns between Eastern Europe and Western Europe, in: (R.J.) Loader, (S.J.) Henson and (W.B.) Traill (Eds), *Globalisation and the Food Industry: Policy Implications*, Reading: Centre for Food Economics Research, pp.85-104.

Everitt (B.), 1993- *Cluster analysis*, 3rd ed. London, Arnold.

FAO (Food and Agriculture Organisation of the United Nations), 1996- *The Sixth World Food Survey*, Rome, FAO.

FAO, 2000- Food Balance Sheets, On-line database, Rome, FAO.

Gil, (J.M.), Gracia (A.), Perez y Perez (L.), 1995- Food consumption and economic development in the European Union. *European Review of Agricultural Economics* 22(3), pp. 385-399.

Grigg (D.), 1993- The European diet: Regional variations in food consumption in the 1980s, *Geoforum*, 24(3), pp.279-289.

Hair (F.Jr.), Anderson (R.E.), Tatham (R.L.), Black (W.C.), 1998- *Multivariate Analysis*, 5th ed. New Jersey, Prentice Hall International.

Helsing (E.), 1991- Nutritional policies in Europe, *Food policy*, Vol. 16, No. 5, pp. 371-382.

Henson (S.) and Loader, 1991- The implications of the single market for European food consumption and diets, in: (H.E.) Buchholz and (H.) Wendt (eds.), Food Marketing and Food Industries in the Single European Market. Proceeedings of the 25th EAAE Seminar, Braunschweig, pp. 267-282.

Henson (S.), Traill (W.B.), 1991- The nutritional implications of changing food systems in Eastern Europe, *Proceedings of the Nutrition Society* 50(1), pp. 703-718.

Hermann (R.), Roder (C.), 1995- Does food consumption converge internationally? Measurement, empirical tests and determinants, *European Review of Agricultural Economics* 22(3),pp. 400-414.

Hertel, (T.), Brockmeier, (M.), Swaminathan, (P.), 1997- Sectorial and economy-wide analysis of integrating Central and Eastern European countries into the EU: Implications of alternative strategies, *European Review of Agricultural Economics* 24(3-4), pp. 359-387.

Ketchen, (D.J.) and Shook, (C.L.), 1996- The application of cluster analysis in strategic management research: An analysis and critique, *Strategic Management Journal*, 17, pp. 441-458.

Manly, (B.F.J.), 1994- *Multivariate statistical methods: a primer*, London, Chapman and Hall.

Mann, (J.), Truswell (A.S.) (Eds), 1998- *Essentials of human nutrition*. New York, Oxford University Press.

Milanovic, (B.), 1999- Explaining the increase in inequality during the transition, *Economics of Transition*, 7: pp. 299-341.

Milligan, (G.), 1980- An examination of the effect of six types of error perturbation on fifteen clustering algorithms, *Psychometrika*, 45(3),pp. 325-342.

Ness, (M.) 1997, Multivariate analysis in marketing research, in: (C.) Ritson, (D.I.) Padberg, (L.M.) Albisu (ed.), *Agro-Food Marketing*, New York, CAB International, pp.253-278.

Norušis (M.J.), 1985- *SPSS Advanced Statistics Guide*, SPSS Inc., Mc Grow Hill.

Norušis (M.J.) 1997- *SPSS 8.0 guide to data analysis*, New York, Prentice Hall.

Petrovici (D.A.), Ritson (C.), 2000- Food consumption patterns in Romania, *British Food Journal*, 102(4),pp. 290-307.

Petrovici (D.A.), Ritson (C.), Ness (M.), 2001- Exploring disparities and similarities in European food consumption patterns, 71 EAAE Seminar on *The Food Consumer in the Early 21st Century*, 19-20 April, Zaragoza.

Punj (G.), Stewart (D.W.), 1983- Cluster analysis in marketing research: Review and suggestions for application, *Journal of Marketing Research*, 20, pp. 134-148.

Ritson (C.), Gofton (L.), McKenzie (J.), (eds), 1986- *The Food Consumer*, Chichester, John Wiley & Sons.

Ritson (C.), Hutchins (R.), 1991- The consumption revolution, in: (J.) Slater (Ed.), *Fifty Years of the National Food Survey*, London, HMSO, pp. 35-46.

Ritson (C.), Hutchins (R.), 1995- Food choice and the demand for food, In: (D.W.) Marshall (Ed.), *Food Choice and the Consumer*, Glasgow, Chapman & Hall, pp. 43-77.

Sandu(D.), 1992- *Introducere in statistica sociala*, Bucharest, Bucharest University.

Saporta (G.), 1991- *Probabilités, Analyse de Donées et Statistique Mathématique*, Paris, Technique.

Senauer (B.), Asp, (E.) and Kivey (J.), 1991-. *Food trends and the changing consumer*, Minesota, Eagen Press.

Ratinger (T.), Šlaisova (J.), 2001- Market potential for food in Central and Eastern Europe, in: (S.) Brosig and (M.) Hartmann (Eds.) *Analysis of food consumption in Central and Eastern Europe: relevance and empirical methods*, Kiel, Wissenschaftsverlag Vauk, pp.173-191.

SPSS, 1999- *SPSS for Windows (Version 9*), Chicago, Il, SPSS Inc.

Szabo (M.), 1999- Changes in the Hungarian food consumption patterns during the nineties, in: (S.) Brosig and (M.) Hartmann (Eds.) *Analysis of food consumption in Central and Eastern Europe: relevance and empirical methods*, Kiel, Wissenschaftsverlag Vauk, pp.157-167.

Tangermann (S.), 1986- Economic factors influencing food choice, in: (C.) Ritson, (L.) Gofton, and (J.) McKenzie (Eds), *The Food Consumer*, Chichester,: John Willey & Sons, pp. 61-84.

Marshall (D.W.), (Ed.), 1995- *Food Choice and the Consumer*, Glasgow, Chapman & Hall.

Tomlinson (M.), Warde (A.), 1993- Social class and changes in eating habits, *British Food Journal*, 95(11), pp. 3-10.

Traill (W.B.), 1998- Structural changes in the European food industry: consequences for competitiveness, in: W.B. Traill and E. Pitts (Eds.), *Competitiveness in the food industry*, London, Black Academic & Professional, pp. 35-57.

World Bank, 1998- *World Development Indicators*, CD-ROM.

Young, T., Burton, M. and Dorsett, R., 1998- Consumer theory and food choice in economics, with an example, in A. Murcott (ed), *The nation's diet: the social science of food choice*, London, Longman, pp.81-94.

www.geographyiq.com (2004) world atlas: economic indicators, (accessed on January 2004)

Figure 1. Interrelationships between main concepts and empirical measures

Concept	Dimensions	Items
Pattern of dietary intake	Pattern of nutrient intake	Contribution of food stuff to per capita calorie daily supply Contribution of food stuff to per capita protein daily supply Contribution of food stuff to per capita fat daily supply
	Pattern of food consumption	Per capita annual supply available for consumption from specific products Vegetable products: cereals, starch, sugar, pulses, nuts, vegetable oil, fruit, vegetables Animal products: meat, offal, animal fats, milk, eggs, and fish

Table 1. The calorific intake in Europe

	Total calories	Animal calories (%)		Total calories	Animal calories (%)
Austria	3757	32.6	Lithuania	3040	23.2
Belgium-Lux.	3701	30.3	Malta	3543	25.8
Bulgaria	2467	28.0	Netherlands	3294	36.0
Czech Rep.	3104	27.0	Poland	3376	26.4
Denmark	3396	38.5	Norway	3414	33.9
Estonia	3376	26.0	Portugal	3316	31.9
Finland	3227	35.7	Romania	3274	20.6
France	3591	37.5	Slovakia	3133	25.2
Germany	3451	30.0	Slovenia	3168	29.4
Greece	3705	22.9	Spain	3352	27.4
Hungary	3458	32.2	Sweden	3109	33.1
Ireland	3613	31.1	Switzerland	3293	33.2
Italy	3661	25.5	UK	3334	30.1
Latvia	2855	24.1	*Standard deviation*	*275.3*	*185.4*

Source: www.fao.org

Table 2. Estimated income elasticity for calorie demand in Europe, 2000

	Calorie intake	Animal calorie intake		Calorie intake	Animal calorie intake
Austria	0.05	0.12	Lithuania	0.20	0.74
Belgium-Lux.	0.05	0.13	Malta	0.09	0.29
Bulgaria	0.29	0.89	Netherlands	0.05	0.13
Czech Rep.	0.11	0.35	Poland	0.15	0.50
Denmark	0.05	0.11	Norway	0.05	0.12
Estonia	0.13	0.43	Portugal	0.08	0.23
Finland	0.06	0.14	Romania	0.23	0.96
France	0.05	0.12	Slovakia	0.14	0.47
Germany	0.05	0.16	Slovenia	0.12	0.34
Greece	0.07	0.26	Spain	0.07	0.23
Hungary	0.11	0.31	Sweden	0.06	0.17
Ireland	0.06	0.16	Switzerland	0.05	0.12
Italy	0.05	0.18	UK	0.06	0.17
Latvia	0.21	0.77			

Note: All coefficients are estimated based on ordinary least squares and are significant at 1% level.

http://www.geographyiq.com, retrieved on January 2003 and www.fao.org

Table 3. Rotated factor matrix

Variable	Factor number			Communality
	1	2	3	
ENCER	-0.72	-0.58	-0.11	.885
ENSUG	0.10	**0.81**	0.21	.728
ENVEG	0.68	-0.29	-0.21	.607
ENROOT	-0.72	0.06	-0.19	.570
ENPULS	**0.80**	-0.28	-0.19	.761
ENMEAT	0.68	0.22	0.42	.700
ENMILK	-0.08	-0.02	**0.94**	.909
ENOTHANI	-0.01	**0.90**	-0.26	.875
ENOTHVEG	0.70	0.07	-0.25	.559
Eigenvalue	3.18	2.07	1.33	
Variance (%)	35.39	23.02	14.84	
Cumulative variance (%)	35.39	58.42	73.26	

Table 4. Classification of European states based on the structure of energy intake, 2000

Cluste	Average linkage (between groups)	Average linkage (within groups)	Complete linkage	Centroid method
1	Malta, Poland, Latvia	Malta, Poland, Latvia, Estonia	Malta, Poland, Latvia	Malta, Poland, Latvia
2	Lithuania, Romania, Estonia	Lithuania, Romania	Lithuania, Romania, Estonia	Lithuania, Romania, Estonia
3	Portugal, Slovakia	Spain, Greece, Italy	France, Switzerland, Netherlands	Belgium-Luxembourg, Hungary, Germany, Denmark
4	Belgium-Luxembourg, Hungary, Germany, Denmark	Bulgaria, UK, Slovenia	Ireland, Sweden, Norway	Portugal, Slovakia
5	Spain, Greece, Italy	France, Switzerland, Netherlands, Ireland, Sweden, Finland	Spain, Greece, Italy	Bulgaria, UK, Slovenia
6	Bulgaria, UK, Slovenia	Portugal, Slovakia	Bulgaria, UK, Slovenia	FranceSwitzerland, Netherlands, Ireland, Sweden, Austria, Czech Republic, Norway
7	France, Switzerland, Netherlands, Ireland, Sweden, Austria, Czech Republic, Norway	Belgium-Luxembourg, Hungary, Germany, Denmark	Portugal, Slovakia	Finland
8	Finland	Austria, Czech Republic, Norway	Finland, Austria, Czech Republic, Belgium Luxembourg, Hungary, Germany, Denmark	Spain, Greece, Italy
PC	0.69	0.69	0.69	0.69

Table 5. Classification of European states based on the structure of nutrient intake, 1990-1992

Cluste	Average linkage (between groups)	Average linkage (within groups)	Complete linkage	Ward method
1	Austria, Germany, France, Switzerland, Belgium-Luxembourg, Netherlands	Austria, Germany, France, Switzerland, Netherlands	Austria, Germany, Belgium-Luxembourg, Netherlands	Austria, Germany, Belgium-Luxembourg, Netherlands, Hungary, Czechoslavakia,
2	Czechoslavakia, Hungary	Czechoslavakia, Hungary, Belgium-Luxembourg	Czechoslavakia, Hungary	Romania, Yugoslavia, Bulgaria, Albania
3	Romania, Yugoslavia, Bulgaria, Albania	Romania, Yugoslavia, Bulgaria, Albania	Romania, Yugoslavia, Bulgaria, Albania	Ireland, UK, Poland
4	Ireland, UK, Poland	Ireland, UK, Poland, Finland	Ireland, UK, Poland	Portugal, Spain, Greece, Italy
5	Portugal, Spain, Greece, Italy	Portugal, Spain, Greece, Italy	Portugal, Spain, Greece, Italy	France, Switzerland, Denmark, Finland
6	Denmark, Finland	Denmark	France, Switzerland, Denmark, Finland	Norway, Sweden
7	Norway, Sweden	Norway, Sweden	Norway, Sweden	
PC	0.70	0.70	0.70	0.74

Source: Petrovici, Ritson and Ness (2001)

Table 6. Final Cluster Centres

	Cluster number							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
FS1	1.44	-1.54	0.38	0.28	-0.02	-1.56	-0.25	0.54
FS2	-1.44	0.06	-0.21	0.27	1.35	-1.69	0.06	0.61
FS3	-0.58	-0.27	0.32	-1.44	-0.54	0.01	2.38	1.25

Table 7. Analysis of Variance

	Cluster Mean Square	DF	Error Mean Square	DF	F ratio	Probability
FS1	3.29	7	.15	19	21.18	.000
FS2	3.04	7	.24	19	12.37	.000
FS3	3.06	7	.24	19	12.73	.000

Table 8. The rotated factor matrix

Variable	Factor number						Communality
	1	**2**	**3**	**4**	**5**	**6**	
Cereals	-0.11	0.70	-0.13	0.37	0.02	0.10	0.673
Starch	-0.48	0.00	-0.18	0.47	-0.13	0.54	0.806
Sugar	-0.15	**0.72**	0.23	-0.25	-0.41	0.00	0.838
Pulses	0.68	-0.18	-0.18	0.28	0.17	0.20	0.676
Nuts	**0.82**	0.11	-0.11	-0.25	0.12	0.15	0.792
Vegetable oils	0.07	-0.37	-0.15	0.08	**0.79**	0.26	0.867
Vegetables	**0.79**	-0.12	-0.25	0.16	-0.20	-0.06	0.785
Fruit	0.75	0.36	0.22	-0.25	-0.27	0.08	0.902
Stimulants	0.06	0.25	0.65	-0.48	-0.14	-0.09	0.752
Meat	0.66	0.55	0.23	0.06	0.31	0.04	0.907
Offal	0.13	0.07	0.15	**0.64**	-0.23	0.04	0.517
Animal fat	-0.17	0.41	**0.77**	0.03	0.15	0.03	0.836
Milk	0.13	0.18	0.17	**-0.65**	-0.09	0.27	0.599
Eggs	-0.04	0.24	-0.01	-0.28	**0.77**	-0.21	0.783
Fish	0.26	-0.07	0.01	-0.15	0.04	**0.85**	0.826
Cheese	0.09	**0.87**	0.14	0.22	0.08	-0.02	0.855
Cream	-0.09	0.03	**0.93**	0.06	-0.18	-0.01	0.925
Eigenvalue	4.33	3.32	1.82	1.46	1.29	1.07	
Variance (%)	25.52	19.56	10.75	8.63	7.62	6.34	
Cumulative variance (%)	25.52	45.08	55.83	64.46	72.08	78.42	

Table 9. Classification of European states based on per capita food consumption, 2000

Cluster	Average linkage (between groups)	Average linkage (within groups)	Ward's and Complete linkage
1	Norway, Finland, Sweden	Norway, Finland, Sweden	Norway, Finland, Sweden
2	Hungary, Slovakia, Denmark, Germany, France, Belgium-Luxembourg, Slovenia	Hungary, Slovakia, Denmark, Germany, France, Belgium-Luxembourg, Slovenia	Lithuania, Poland, Estonia, Latvia
3	Lithuania, Poland, Estonia, Latvia	Ireland	Hungary, Slovakia, Slovenia
4	Bulgaria, Romania	Greece, Italy, Spain	Bulgaria, Romania
5	Austria, Netherlands, Switzerland, Czech Republic	Austria, Netherlands, Switzerland, Czech Republic	Greece, Italy
6	Greece, Italy	Bulgaria, Romania, Lithuania, Poland, Estonia, Latvia, UK	Spain, UK, Portugal
7	Spain, UK, Portugal	Portugal	Denmark, Germany, France, Belgium-Luxembourg
8	Ireland	Malta	Ireland
9	Portugal		Austria, Netherlands, Switzerland, Czech Republic
10	Malta		Malta
PC	0.61	0.69	0.61

Table 10. Final cluster centres

	FS1	FS2	FS3	FS4	FS5	FS6
1) Norway, Finland, Estonia, Latvia, Sweden	-0.94	-0.63	0.56	-0.89	-0.65	0.66
2) Switzerland, Austria, Czech Republic, Netherlands	-0.07	1.25	-0.96	-1.02	0.28	-0.36
3) Denmark, France Germany, Hungary, Slovakia, Slovenia	0.09	0.32	1.16	0.26	0.48	-0.71
4) Greece, Italy	2.37	-1.06	-0.29	-0.14	-0.44	-0.27
5) Malta	-0.38	-2.01	-0.48	0.38	3.95	1.30
6) Spain, Portugal	1.31	0.36	-0.70	0.65	-0.11	1.66
7) Belgium-Luxembourg, Ireland	-0.03	1.18	0.66	1.65	-0.55	0.67
8) Romania, Bulgaria, Lithuania, Poland, UK	-0.49	-0.54	-0.96	0.46	-0.49	-0.61

Table 11. Analysis of Variance

	Cluster Mean Square	DF	Error Mean Square	DF	F ratio	Probability
FS1	2.94	7	0.28	19	10.46	.000
FS2	2.83	7	0.32	19	8.78	.000
FS3	2.90	7	0.29	19	9.72	.000
FS4	2.32	7	0.51	19	4.54	.004
FS5	3.11	7	0.22	19	14.11	.000
FS6	2.26	7	0.53	19	4.23	.006

Table 12. Profiling indicators of clusters emerging from per capita food consumption [1]

	GDP-head, 2002	GDP composition by sector, 2000		Number of TV sets	Population density
	(US $, PPP)	agriculture	services	(per 1000 people)	(people per sq km)
Scandinavian [2]	27800	2.7	66	529.1	16.3
CEECs advanced in transition [3]	14500	4	61.3	429.7	104.9
Denmark, Germany and France	27100	2.3	70	578	194.6
Austria, Netherlands, Switzerland and Czech Republic	25400	2.8	64	454.3	196.6
Balkan states [4]	6700	14.5	56.5	331	81.8
Mediterranean [5]	22000	5.5	69	382.2	136
Poland and the Baltic states [6]	9275	5.8	64.5	436.3	61.8

Source: www.geographyiq.com (accessed on January 2004)

Notes: 1 – average values; 2 - Scandinavia (Norway, Finland, Sweden); 3 - CEECs advanced in transition: Hungary, Slovakia and Slovenia; 4 - the Balkans (Bulgaria and Romania); 5 - Mediterranean (Greece and Italy); 6 - the Baltic states (Lithuania, Estonia, Latvia).