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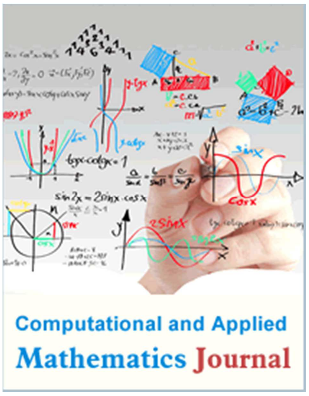

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Association Model for Gross Human Apparent Consumption of Main Food Items, Fish and Seafood (Tons Live Weight) in EU22

Joel C. Nwaubani[1]**, Antonia Gkouma**[2]**, Evangelia Vussa**[3]

[1]Faculty of Social Sciences, Department of Applied Informatics, University of Macedonia Thessaloniki, Thessaloniki, Greece
[2]A' General Clinic, 251 General Airforce Hospital Athens, Athens, Greece
[3]Group Cater Agency, a Subsidiary Group of Groupoma Thessaloniki, Thessaloniki, Greece

Email address
joelino@uom.gr (J. C. Nwaubani)

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Abstract
Global reports have shown that there are major shifts in dietary patterns, even in the consumption behaviour of basic staples towards more diversified diets. Accompanying these changes in food consumption at global and regional level is characterized with health consequences. Population in countries undergoing rapid transition is experiencing nutritional transition. The diverse nature of this transition may be the result of differences in socio-demographic factors and other consumer characteristics. Among other factors including urbanization and food industry marketing, the policies of trade liberalisation over the past two decades have implications for health by virtue of being a factor in facilitating the 'nutrition transition' that is associated with rising rates of obesity and chronic diseases such as cardiovascular disease and cancer. In this study, we consider and estimate the most accurate association model of the Categorical Data Analysis (CDAS) for the gross human apparent consumption of main food items, fish and seafood (tons live weight) in 22 EU countries. The data used in this study are obtained from the Eurostat and estimated on actual base year from 2003-2012. The analysis of association (ANOAS) table is given in order to ascertain the percentage of the data covered by each model. We estimate the model with the best fit and in conclusion we find out that the Row-Column Effects Association Model (from the multivariate model M=9) has the best fit among all.

1. Introduction

Fish and seafood are amongst the most important consumption of main food items, satisfying the basic physiological needs of hunger and thirst and forming one of the most recurrent expenditure items for the majority of EU households. There is great diversity across the EU as regards to main food products and these often form a part of local, regional and national, cultural identity. At the same time, however, there are examples of convergence in consumption patterns, perhaps reflecting greater consumer awareness and more international distribution networks. Additionally, there are health issues related to food that are not directly linked to the inherent safety of the food, but to the level and balance of food consumption. Among other factors including urbanization and food industry marketing, the policies of trade liberalization over the past two decades have implications for health by virtue of being a factor in facilitating the 'nutrition transition' that is associated with rising rates of obesity and chronic diseases.

Similar information for meat products shows that the highest annual apparent consumption among these products was recorded for pork products, averaging over 40 kg per capita – a level that was higher than the combined total of poultry, cattle, sheep and goats. Spain, Austria, Germany, Denmark and Belgium were reported the highest per capita apparent consumption of pig meat – all recording to averages in excess of 50 kg. Moreover, Spain, Ireland and the United Kingdom all recorded annual apparent consumption of poultry meat averaging around 30 kg per capita. The United Kingdom, Lithuania and Greece recorded per capita averages below 30 kg, while the Czech Republic recorded by far the lowest apparent consumption of poultry meat, with only 2.3 kg per capita (Eurostat /JP, 2010).

Consumption of dairy products and eggs on average per capita apparent consumption of milk, cheese and butter in the EU was just over 100 kg, of which more than 80% was accounted for by drinking milk. Finland, Ireland and Sweden recorded the highest average apparent consumption of drinking milk, all in excess of 130 kg per capita. The lowest figure was in Latvia (32 kg), equivalent to just one fifth h of the level in Finland. Apparent consumption of cheese was highest in Luxembourg, followed by Greece, both with an average per capita consumption above 25 kg. Slovakia and Hungary had the lowest apparent consumption of cheese, just over 6 kg per capita. Luxembourg, France, Finland and Germany recorded the highest levels of apparent consumption of butter, all in excess of 6 kg per capita. Several southern Member States recorded low apparent butter consumption, with Spain, Malta and Greece all averaging 1 kg per capita or less. Hungary was lowest in this ranking with an average of 0.8 kg (Kris-Etherton, Penny M., William S., *et al.* 2002).

While fish catches worldwide are on the increase, fish stocks are being depleted owing to over-fishing. The main fishes consumed are white fish, oily fish and seafood invertebrates. Fishes are an important source of good quality protein and are low in fat (except for the oily fish which provide a very good source of long-chain polyunsaturated fatty acids). Fishes may also be a major source of iodine accumulated from their environment. Compared with many European countries, consumption of fish in the UK is low at 22 g per capita per day (Roberts *et al.* 2001).

Past trends in fish consumption shows that little or no increases were seen in the consumption (grams per capita per day) of marine or pelagic fishes. The main changes in consumption patterns may be seen for seafood and freshwater fishes, both of which have increased appreciably since the early 1960s. Industrial countries when compared with developing countries have also seen higher increases in freshwater fish consumption in Oceania and Asia, especially China, with an increase from approximately 11 g per capita per day in 2003 to approximately 71.9 g per capita per day in 2012. In terms of future trends, modest increases in pelagic fish consumption are predicted. The pelagic fishes are rich in long-chain omega-3 fatty acids of benefit to cardiovascular health. Many food-based dietary guidelines recommend increased intake of this particular food group which need to be balanced against concerns for sustainability of marine stocks (Scorletti, E; Byrne, CD 2013).

Table 1. *Gross human apparent consumption of main food items, fish and seafood (tons live weight)*

geo / time	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Czech Republic	64700	64726	82548	82693	101850	104256	96983	99799	109118	107054
Denmark	116614	116401	123249	123691	121913	123420	119327	113682	123798	123642
Germany	1019939	983763	1045019	1044351	992058	1046663	1098354	1028559	973870	1010264
Estonia	71106	50337	33511	34536	28189	22162	24433	27731	23378	27721
Ireland	60517	64077	65807	65639	60864	52983	53391	48772	53123	68004
Greece	220814	233491	263763	236684	257678	271287	246636	249822	240556	252568
Spain	1470748	1530421	1647092	1600760	1646021	1644668	1853748	1760188	1765806	1840119
France	1651891	1615875	1628382	1626173	1651631	1637497	1765266	1768554	1735436	1779898
Italy	1244532	1219687	1227106	1233120	1235118	1224515	1268186	1279160	1301074	1414976
Cyprus	15899	13656	15374	17460	16171	16468	18787	18589	19459	20010
Latvia	83475	79724	88230	72886	61343	32771	29166	31021	31441	22682
Lithuania	100612	89165	67826	59453	115548	81239	78216	105844	128513	189963
Hungary	35978	33549	36903	34301	32195	37404	40039	38291	42438	43625
Malta	8468	6513	8559	10042	10105	11320	11439	12040	11747	15323
Netherlands	199405	207158	208077	254831	261514	232956	329907	312402	353854	380686
Austria	79491	76709	94004	75221	92166	90813	91176	92502	82006	94565
Poland	339241	345668	392307	416600	377137	470141	421089	360018	370297	382733
Portugal	570435	585017	575309	573439	620742	573133	616958	610258	546294	567053
Slovenia	8274	10950	11754	14228	14049	13039	13538	13723	13005	14844
Finland	165051	163239	167975	166859	166189	162309	162150	156946	155460	158448
Sweden	228345	235999	241565	229430	223651	227499	223308	219851	224157	245732
United Kingdom	1103940	1101958	1104832	1124388	1181261	1238813	1155586	1164897	1158477	1249195

Source: Eurostat Food statistics

With the help of the Categorical Data Analysis program (CDAS), we were able to ascertain the results of our data for the gross human apparent consumption of main food items, fish and seafood (tons live weight) in the EU22.

Table 2. *Data results for the gross human apparent consumption of main food items, fish and in EU22*

Models	Pearson Chi - Square X^2	Likelihood-Ratio Chi - Square G^2	Degrees of Freedom	Index of Dissimilarity	Maximum Deviation
O	592049.62220	576695.57416	189	0.02150	0.00000000
U	592034.02611	576694.44381	188	0.02151	0.00006583
R	220139.25157	218713.79542	168	0.01489	0.00043928
C	581965.73726	567077.52384	180	0.02051	0.00043531
R+C	210307.42654	209121.50467	160	0.01369	0.00043948
RC	210083.95801	208761.08502	160	0.01489	0.00099315

2. Association Model

In the categorical data analysis system, we apply the methodology by considering six of the most commonly used association model. These are:

a. The model of Independence or null association model which is also symbolized by (O), and holds that there is no relationship between the variables The log-linear model is: Log $(F_{ij}) = \lambda+\lambda_{A(i)}+\lambda_{B(j)}$, where log denotes the natural logarithm, F_{ij} the expected frequencies under the independence model, $\lambda_{A(i)}$ are the rows main effect and $\lambda B_{(j)}$ are the columns main effect (Diewert, W. Erwin. 1995)

b. The Uniform association model, which is symbolized by (U) in log-linear form is: $\log(F_{ij})=\lambda+\lambda_{A(i)}+ \lambda_{B(j)}+\varphi\chi_i y_j$, where φ ιs a single parameter for interaction and χ_i ,y_j are the scores for the row and column variables (i =1,…,I, j =1,…,J) respectively.

c. The row effects model (R) where linear-by-linear interaction holds that $\log (F_{ij}) = \lambda+\lambda_{A(i)}+\lambda_{B(j)}+\varphi\mu_I y_j$ (Goodman, L.A., 1979a), where y_j are fixed scores for the column variable (j = 1,…, J) and μ_I are unknown scores for the row variable (i =1,…,I).

d. The column effects model (C) is the same as the R model with a change in subscripts: Log $(F_{ij}) = \lambda+\lambda_{A(i)}+\lambda_{B(j)}+\varphi\nu_j x_I$, where x_I are fixed scores for the row variable (i =1,…,I) and ν_j are unknown scores for the column variable (j =1,…,J).

e. The model that allows both row and column effects in additive form is called the R+C model, (Goodman, L.A., 1979b). The log-frequency version of the above model is: $\log(F_{ij}) = \lambda+\lambda_{A(i)}+ \lambda_{B(j)}+ \sum_{\kappa=1}^{I-1}\beta_\kappa y_j Z_{A(\kappa)} + \sum_{\kappa=1}^{J-1}\gamma_\kappa x_i Z_{B(\kappa)}$, where χ_i ,y_j are the scores (as defined earlier), and $Z_{A(i)}$, $Z_{B(j)}$ denote to variables (dummy variables) for the row and column levels respectively.

f. The model, instead of additive row and column effects on the local odds ratios has multiplicative effects called the R*C model or model II, (Goodman, L.A., 1981a). The log-multiplicative model is: $\log (F_{ij}) = \lambda+\lambda_{A(i)}+\lambda_{B(j)}+\varphi\mu_I\nu_j$, where the row score parameters μ_I and column score parameters ν_j are not known, but are estimated in the data.

We aim at finding out the model (out of the six) that has the best fit among the other models which we are examining, i.e., the gross human apparent consumption of main food items, fish and seafood (tons live weight) in 22 EU countries from 2003-2012. For this reason, first, we are going to examine the Index of Dissimilarity (L2), which shows that, the lesser the number, the more our model will give the best fit to match the data under consideration.

We analyse the six association model describe above, with the help of the categorical data analysis statistical programme (Clogg, C.C. 1990). We used the Pearson chi-squared (X^2) statistics, the likelihood-ratio chi-square (G^2) statistics and the index of dissimilarity which is equated by:

$$D = \sum_{ij} \left| f_{ij}/n - F_{ij}/n \right| / 2 \quad \text{…………Equation (1)}$$

Where:
f_{ij} are the observed frequencies and
F_{ij} are the expected frequencies (under the model)

Additionally, we have the following results as shown in the table below:

Table 3. *Index of Dissimilarity*

Model	Index Of Dissimilarity(D)
1. Null Association-Independence Model (O)	0.02150
2. Uniform Association Model (U)	0.02151
3. Row-Effects Association Model (R)	0.01489
4. Column-Effects Association Model (C)	0.02051
5. Row+Column Effects Association Model (R+C)	0.01369
6. Row Column Effects Association Model (R*C)	0.01437

At first sight it seems that the Row Column Effects of the Association Model (R+C) adjusted better to the percentage of gross human apparent consumption of main food items, fish and seafood in 22 EU countries for the years under study (having the lowest index of dissimilarity with D = 0.01369).

Since we have models with similar lower ratio, we justify the model with the best fit to match both countries and years by calculating the Index BIC (Bayes Information Criterion) which gives the best solution.

The formula for this calculation is:

$$BIC = G^2 - (D.F.) \log (n) \ldots\ldots\ldots\ldots\ldots\text{Equation (2)}$$

Notations:
G^2 = the likelihood-ratio chi-square statistics
d.f. = degrees of freedom of the models
n = the size of the sample (93199028)
Log (n) = Log (93199028) = 18.35025

When comparing a number of models, the model with the smallest index of BIC is assumed to be the best. So we choose the models that have similar and lowest INDEX OF DISSIMILARITY out of the six models. More precisely, we will consider the 3rd, 5th and 6th models respectively.

Subsequently, the calculation is as follows:

3rd model: $BIC = G^2 - (D.F.) \operatorname{Log} (n) = 218713.79542 - (168 * 18.35025) = 215630.9534$

5th model: $BIC = G^2 - (D.F.) \operatorname{Log} (n) = 209121.50467 - (160 * 18.35025) = 206185.4646$

6th model: $BIC = G^2 - (D.F.) \operatorname{Log} (n) = 208761.08502 - (160 * 18.35025) = 205825.045$

As we can see from the above calculations, the 6th model (Row Column-effects of the Association Model (RC)) finally accounts for the best fit from the results since it has the smallest index of BIC.

2.1. Examination of the Association Model

In continuation, the association model undergo through several examinations to test or ascertain accuracy, quality, or satisfactory fit of each model. Examination is done through the use of the likelihood-ratio chi-square (G^2) statistics and the Pearson chi-squared (X^2) distribution. In the case of the X^2 distribution, the Statgraph programme will be of good help.

Initially, we observe that the likelihood-ratio chi-square statistic for the Independence model (O) is G^2 = 576.695.57 with 189 degrees of freedom. The 95th percentile of the reference chi-square distribution is 222.406. It has unacceptable fit because the X^2 distribution is smaller than the likelihood-ratio chi-square statistic G^2.

Subsequently, the Uniform association model is G^2 = 576.694.44 with 188 degrees of freedom. The 95th percentile of the reference chi-square distribution is 221.316. As it could be noticed, this statistics is not accepted and does not have a satisfactory fit since the X^2 distribution is much smaller than the likelihood-ratio chi-square statistic G^2.

Moreover, the statistic G^2 for the Row model (R) is reduced dramatically for 218.71380 with 168 degrees of freedom. The 95th percentile of the reference chi-square distribution is 199.488. The row model is also not accepted because the X^2 distribution is smaller than the likelihood-ratio chi-square statistic G^2.

The Column model (C) has G^2 = 567.077.52 with 180 degrees of freedom. The 95th percentile of the reference chi-square distribution is 212.595 which show even the worst fit as we could observe that the X^2 distribution is very much smaller than the likelihood-ratio chi-square statistic G^2.

The statistics of the model R+C, that takes into account the effects for both Countries and Years in additive form, is G^2 = 209.121.51 with 160 degrees of freedom. The 95th percentile of the chi-square distribution is 190.853 has equally unacceptable fit since the X^2 distribution is smaller than the likelihood-ratio chi-square statistic G^2.

Finally, the model RC, that is log multiplicative but not log-linear, the G^2 Statistics is 208.761.09 with 160 degrees of freedom. The 95th percentile of the reference chi-square distribution is 190.853. Furthermore, the statistics is dramatically reduced just as the previous model because they have identical degrees of freedom, but is shown to remain unacceptable fit because the X^2 distribution is very much smaller than the likelihood-ratio chi-square statistic G^2 (Haritou A, Nwaubani J. C., (2008-2011).

By virtue of the index of dissimilarity of the models, the model R+C has the best fit. However, upon clear examination to test or ascertain accuracy, quality, or satisfactory fit of the model, we find out that it has a very poor fit which makes it unacceptable.

Also, we have to realise and in which degree or level of effects it has on each model. In order to verify this, we will have to construct the Analysis of association (ANOAS) table.

2.2. Analysis of Association Table (ANOAS)

The ANOAS table was given by (Goodman Goodman, L.A., 1981b). In this table, the X^2 is divided so that it can be used as two factor analysis of variance by making use of the G^2 (0) statistics for the base (zero) independence model which measures the total deviation of the variables. In other words, we can find the percentage of the baseline chi-squared X^2 distribution, which have effects on each of our models on the phenomenon being studied.

***Table 4.** Index of Dissimilarity*

Models	Likelihood-G^2	Degrees of Freedom	Index of Dissimilarity
O	576.695.57	189	0.02150
U	576.694.44	188	0.02151
R	218.713.80	168	0.01489
C	567.077.52	180	0.02051
R+C	209.121.51	160	0.01369
RC	208.761.09	160	0.01437

The analysis of association table has the following differences of our models: O-U is the total effects of the models, U-R are the Row effects model, R-RC are the column effects model that gives the effect of columns and RC are the residuals of the models.

Table 5. *The ANOAS showing differences between the models*

Models	Likelihood-Ratio Chi-Square G^2	Degrees of Freedom	Percentages (%)
1. General effect O-U	0.001.13	1	0.00%
2. Column-Effects U-R	357.980.64	20	38.70%
3. Row-Effects which gives the Column-Effects R-RC	9.952.71	20	38.73%
4. Residuals RC	208.761.09	160	22.57%
Total (O)	576695.57415	201	100.00%

As shown from the ANOAS table above, the uniform effects model (U) accounts for 0.00% of the baseline chi-squared X^2 distribution value, i.e. there were no effects at all. The row effects model (R) accounts for 38.70% of the baseline chi-squared value. The column effects model (C) accounts for 38.73% of the baseline chi-squared value. Finally, the row column effects model (RC) i.e. residuals accounts for only 22.57%.

We see therefore that at the rate of 22.57%, the variation which is attributed to the null-independence has been measured from the model of RC. This rate is quite satisfactory and we can say that the corresponding percentage of the gross human apparent consumption of main food items, fish and seafood (tons live weight) in Czech Republic, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Italy, Cyprus, Latvia, Lithuania, Hungary, Malta, Netherlands, Austria, Poland, Portugal, Slovenia, Finland, Sweden and United Kingdom, as seen from the data taken from the Eurostat, depended slightly positive on the association of both the countries and also from the years under our study (2003-2012).

We can as well say that the percentage of (576.695.57 – 208.761.09) / 576.695.57 = 63.8% of the data is explained by the row-column effects model (on the local odds ratios in a multiplicative way), giving it a satisfactory fit but not acceptable due to poor adjustment as was found earlier in our study, i.e. the value of the Pearson chi-squared X^2 distribution for 95% confidence intervals are much smaller for the model (RC).

Furthermore, because our best model (RC) under our study based on the index BIC show a bad fit upon clear examination to test or ascertain the accuracy, quality, or satisfactory fit of the model, thereby making it unacceptable, thus, we proceeded to examining the multivariate model to find the model with a satisfactory fit.

3. Multivariate Models

In the RC (M) association model, M represents the dimension fit to be, which is utilized by the row –column dimension (RCDIM PROGRAM). As shown below the multivariate model RC (M=9) is the acceptable model with the best fit.

The results are as follows:

Table 6. *Multivariate model*

Model	RC(8)	RC(9)
Pearson Chi-Square X^2	22.3707	0.000
Likelihood-Ratio Chi-Square G^2	1353.855	-0.003
Degrees of Freedom	13	0
Index of Dissimilarity	0.001	0.000

Model RC (8) multivariate row, column, M=8
Model RC (9) multivariate row, column, M=9

3.1. Examining of the Multivariate Model

As it is shown above, the multivariate model RC (8) with M = 8 has likelihood-ratio chi-square statistic G^2 = 1353.855 with 13 degrees of freedom. The 95th percentile of the reference chi-square distribution is chi-squared X^2 distribution are 22.3707. We could understand that this model has a bad fit because the X^2 distribution is much smaller than the likelihood-ratio chi-square statistic G^2.

Moreover, the model RC (9) with M = 9 has likelihood-ratio chi-square statistic G^2 = -0.003 with 0 degrees of freedom. The 95th percentile of the reference chi-square distribution is 0.000. Here we notice that the multivariate model RC with M = 9 has a perfect fit because $G^2 < X^2$. Since the $G^2 < 0$, therefore, the X^2 distribution is greater than the likelihood-ratio chi-square statistic G^2. We also observe that the model M=9 covers {(592049.62220 – (-) 0.003) / 592049.62220} = 99.999%, (almost 100% of the total data).

Because the model with the smallest M, if satisfactory gives the best explanation of the effects of rows and columns, therefore, we will prefer the model M=9 to having a perfect fit.

3.2. Estimation of the Multivariate Model

The practical implementation of multivariate statistics to a particular problem may involve several types of univariate and multivariate analysis in order to understand the relationships between variables and their relevance to the actual problem being studied. In addition, multivariate statistics is concerned with multivariate probability distributions, in terms of both: how these can be used to represent the distributions of observed data; and how they can be used as part of statistical inference, particularly where several different quantities are of interest to the same analysis.

The expected frequencies under the independent and row effects models for the gross human apparent consumption of main food items, fish and seafood (tons live weight) in 22 EU countries are given below:

Note: The multivariate model RC (M=9) seems to give much better fit, particularly at the end of nominal scale.

Table 7. *Estimation of the multivariate model*

Countries	Years	Data	Prices of O Model (fij[1])	Prices of RC(M=9) Model (Fij[2])
1	1	64700.0000	86858.6474	64700.0000
2	1	116614.0000	114617.0409	116614.0000
3	1	1019939.0000	973681.6666	1019939.0000
4	1	71106.0000	32615.3757	71106.0000
5	1	60517.0000	56387.2490	60517.0000
6	1	220814.0000	235111.1501	220814.0000
7	1	1470748.0000	1593160.3952	1470748.0000
8	1	1651891.0000	1602764.4705	1651891.0000
9	1	1244532.0000	1202265.5399	1244532.0000
10	1	15899.0000	16338.2020	15899.0000
11	1	83475.0000	50642.0287	83475.0000
12	1	100612.0000	96616.7194	100612.0000
13	1	35978.0000	35621.0695	35978.0000
14	1	8468.0000	10034.1255	8468.0000
15	1	199405.0000	260538.7739	199405.0000
16	1	79491.0000	82573.9249	79491.0000
17	1	339241.0000	368378.4359	339241.0000
18	1	570435.0000	555019.3871	570435.0000
19	1	8274.0000	12110.9906	8274.0000
20	1	165051.0000	154436.5187	165051.0000
21	1	228345.0000	218593.3802	228345.0000
22	1	1103940.0000	1101109.9082	1103940.0000

From the table above it is evident that the prices (value) of the model RC (M = 9) fully adapted to the data.

1 f_{ij} Expected frequencies of the independence model

2 F_{ij} Expected frequencies of the multivariate model M = 9

4. Logarithms of the Row-Effects Association Model

The Row-effects are as follows:

1. Czech Republic: $\hat{\tau}_1$ =-log(0.545654)=0.605770

2. Denmark: $\hat{\tau}_2$ = -log(0.252066) = 1.378064

3. Germany: $\hat{\tau}_3$ = log(1.887291) = 0.635142

4. Estonia: $\hat{\tau}_4$ = -log(1.577221) = -0.455664

5. Ireland: $\hat{\tau}_5$ = -log(0.966929) = 0.033630

6. Greece: $\hat{\tau}_6$ = log(0.465164) = -0.765365

7. Spain: $\hat{\tau}_7$ = log(2.377654) = 0.866114

8. France: $\hat{\tau}_8$ = log(2.385559) = 0.869433

9. Italy: $\hat{\tau}_9$ = log(2.097814) = 0.740896

10. Cyprus: $\hat{\tau}_{10}$ = -log(2.206084) = -0.791219

[12]. Lithuania: $\hat{\tau}_{12}$ = -log(0.476351) = 0.741600

[13]. Hungary: $\hat{\tau}_{13}$ = -log(1.424707)= -0.353966

[14]. Malta : $\hat{\tau}_{14}$ = -log(2.711711) = -0.997580

[15]. Netherlands: $\hat{\tau}_{15}$ = log(0.543984) = -0.608835

[16]. Austria: $\hat{\tau}_{16}$ = -log(0.583086) = 0.539421

[17]. Poland: $\hat{\tau}_{17}$ = log(0.911386) = -0.092789

[18]. Portugal : $\hat{\tau}_{18}$ = log(1.325014) = 0.281423

[19]. Slovenia: $\hat{\tau}_{19}$ = -log(2.511492) = - 0.920877

[20]. Finland: $\hat{\tau}_{20}$ = log(0.046252) = - 3.073651

[21]. Sweden: $\hat{\tau}_{21}$ = log(0.393396) = -0.932938

11. Latvia: $\hat{\tau}_{11}$ = -log(1.188344)=-0.172561

[22]. UK: $\hat{\tau}_{22}$ = log(2.009926) = 0.698098

5. Comparison

We try to compare and contrast with some of the countries in the EU 22 to ascertain the gross human apparent consumption of main food items, fish and seafood.

For example, if we want to compare France and Cyprus, we realise that $\hat{\tau}_{8} - \hat{\tau}_{10}$ = 1.6607, exp (1.6607) = 5.2630. This means that the consumption of fish and seafood species in France is much higher by 5.2630 than that in Cyprus.

In the case of the Mediterranean countries like Italy and Spain, we see that $\hat{\tau}_{9} - \hat{\tau}_{7}$ = - 0.1252, exp (-0.1252) = 0.8823. In other words, the consumption of fish and seafood species in Italy is 0.8823 less than in Spain.

Comparing Scandinavian countries like Finland and Sweden, we have $\hat{\tau}_{20} - \hat{\tau}_{21}$ = -2.1407, exp (-2.1407) = 0.1176, a result which shows that the consumption of fish and seafood dishes is 0.1176 less in Finland than in Sweden.

Also, when comparing the consumption of fish and seafood species in Malta and Ireland, we see that $\hat{\tau}_{14} - \hat{\tau}_{5}$ = -1.0312, exp (-1.0312) = 0.3566, this shows that Malta consumes 0.3566 less fish and seafood species than Ireland.

In the case of Germany and the Netherlands, we see that $\hat{\tau}_{3} - \hat{\tau}_{15}$ = 1.2440, exp (1.2440) = 3.4695, which means that Germany has much more consumption of fish and seafood by 3.4695 compared with Holland.

Finally, for the United Kingdom and Greece have $\hat{\tau}_{22} - \hat{\tau}_{6}$ = 1.4635, exp (1.4635) = 4.3211. Here we see that the consumption of fish and seafood species in the UK is much greater with 4.3211 than that of Greece.

More specifically, the consumption of fish and seafood species are influenced by various factors (Fairbanks, Michael 2000). These could be as a result of:

- The living standard of each country
- Inflation
- The level of private consumption
- Unemployment, reduction in benefits, wages, salaries and pensions – when a situation such as this persists, the overall flow of money in each family remains unstable or uncertain.
- Several other factors which are difficult to be determined in each country

6. Research Findings

Health effects

• Cancer: A 2006 review concluded that there was no link between the consumption of fish to the risk of cancer. Again, there is tentative evidence that marine omega-3 polyunsaturated fatty acids reduce the risk of breast cancer but this is not conclusive.

• Inflammation: Some research suggests that the anti-inflammatory activity of long-chain omega-3 fatty acids may translate into clinical effects. For rheumatoid arthritis (RA), one systematic review found a consistent, but modest, evidence for the effect of marine n-3 PUFAs on symptoms such as "joint swelling and pain, duration of morning stiffness (Shetty P., 2002).

• Mental health: Contributes to the maintenance of normal brain function. The three types of omega-3 fatty acids that are important in human physiology are α-linolenic acid ALA (18:3, *n*-3), eicosapentaenoic acid (EPA) (20:5, *n*-3), and docosahexaenoic acid DHA (22:6, *n*-3). ALA (found in plant oils), EPA, and DHA (both commonly found in marine oils). Common sources of animal omega-3 EPA and DHA fatty acids include fish oils, egg oil, squid oils, krill oil, while some plant oils contain the omega 3 ALA fatty acid. There is some evidence that omega-3 fatty acids are related to mental health and there is preliminary evidence that EPA supplementation is helpful in cases of depression.

• Developmental disorders: Although not supported by current scientific evidence as a primary treatment for ADHD, autism spectrum disorders, and other developmental differences, omega-3 fatty acids have gained popularity for children with these conditions.

• Cognitive aging: Epidemiological studies suggest that consumption of omega-3 fatty acids can reduce the risk of dementia.

• Omega-3 fatty acids are important for normal metabolism

• Helps maintain normal vision**

• Supports normal function of the heart: Eating a diet high in fish that contain long chain omega-3 fatty acids does appear to decrease the risk of cardiovascular disease including myocardial infarction, sudden death or cardiac stroke. Evidently, omega-3 fatty acids reduce blood triglyceride levels and regular intake may reduce the risk of secondary and primary heart attack (Secher, NJ 2007).

7. Summary

Ageing, globalization and urbanization all represent new challenges to the achievement of a good nutrition status. The observed changes in dietary patterns brought about as a consequence of the rate and level of urbanization have significant effects on global food supply, markets and trade. This is particularly important in terms of the rise in over-nutrition (i.e. diet-related chronic disease) in many developing countries

The consequent health burden arising from the nutrition transition is enormous. Increased consumption of highly calorific and more energy-dense food with less activity leads to an increased incidence of obesity and diet-related diseases like diabetes, coronary heart disease (CHD) and certain types of cancer.

Fish and seafood, are high on average apparent consumption in Portugal and Lithuania (both over 50kg per capita), as well as in Spain and Malta. The lowest annual average apparent consumption of fish and seafood was recorded in Bulgaria (2.8kg per capita), with Hungary and Romania also recording averages below 5 kg per capita. Portugal was an exception as the share of household consumption expenditure on fish and seafood (3.2%) was higher than both of these categories, while in Spain the share of expenditure on fish and seafood (3.1%)

8. Conclusion

In order to realise the degree of association which exists between the gross human apparent consumption of main food items, fish and seafood in EU22 countries in these subsequent years, we use θ (Theta) to calculate the indicator of innate association – i.e. φ (phi).

Θ = 1.00001 (Derived from the uniform association model and is symbolised by (U) in log-linear form: $\log(F_{ij})=\lambda+\lambda_{A(i)}+\lambda_{B(j)}+\varphi\chi_i y_j$, where φ ιs a single parameter for interaction

$$\text{The parameter of interaction } \varphi = \log\theta = \log(1.00001) = 9.99995$$

And $|\varphi|$ ½ = and φ = 0.0000316

Therefore, we conclude that there is a slightly positive correlation between the EU22 and these subsequent years.

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