A Model for Comparing Government Expenditure on Civil Servants-Gross Wages And Salaries in the EU24

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Abstract— Following government responses to the economic crisis, aimed at restabilising financial markets, maintaining employment and mitigating the effects of unemployment, public budgets have come increasingly under strain. The debt crisis that struck some EU members and is far from having been surmounted, has prompted governments to embark on a policy of strict budgetary austerity. Recent developments in the European Union reflects the reformation needs of most EU governments, in form of wage and employment moderation and, in some cases, even cuts in public sector wages and employment. All over Europe the public sectors have been the main target of governments' reformation policies. Public sector employers have bypassed established collective bargaining procedures and wages and jobs have been cut or frozen, most frequently by unilateral state decision. Against the background of governments' reformation strategies, this study compare and estimate the most accurate association model of the Categorical Data Analysis (CDAS) for government expenditure on civil servants- gross wages and salaries in 24 countries of the European Union from 2002 - 2011. The analysis of association (ANOAS) table is given in order to ascertain the percentage of the data which is covered by each model. We estimate the association model to find the model that has the best fit, but none proved accepted. Consequently, we proceeded to the multivariate model to find the model with the best fit and in conclusion we find out that the multivariate Row-Column Effects Association Model (RC) of the ($M = 9$) has the best fit because it covers 100% of the data - giving it the best fit among all.

Index Terms— Association models, Log-linear and non-linear models, government expenditure, gross wages and salaries, civil servants in EU24.

I. INTRODUCTION

The dimension and the state of the economic crisis that struck Europe in July 2008 have gradually changed. The US financial markets was struck first and later progressed rapidly to Europe. Consequently, the second phase of the crisis saw many European countries' real output decreasing rapidly as many companies were forced to exit the market. The labour market generally suffered a great loss during the crisis which is being felt up to date. The bailing out of failed banks, the stabilisation of the financial sector and increasing unemployment, reduction in wages, salaries, pensions and overall effect of rising interest rates, put public budgets under severe strain.

The political situation and negotiations has been changing gradually since the crisis began. At the onset of the crisis, there was far-reaching consensus between organised labour, the government and employers on the necessity of maintaining employment and avoiding lay-offs. The role of the state in providing support for the maintenance of

employment and the protection of workers through various policy instruments such as part-time and temporal work for the unemployed.

Some European countries like Cyprus, Hungary and Romania; and high-deficit countries, such as Greece, Spain, Italy, Portugal and Ireland secured emergency loans from the IMF and the EU as from 2008. As a result of this, pressures were mounted on them to reduce government spending, increase in taxes and layoff some workers. Subsequently, the fiscal and monetary crisis in some European countries has forced their governments into high-debt and to re-establish trust in the financial sustainability of their budgets. Unarguably, the International Monetary Fund (IMF) has been the pioneer on the enforcement of austerity measures in many countries facing financial crises around the globe.

A. Historical background

The European Union (EU) is a confederation of twenty-eight nations. It was established in 1992 by the Treaty of the European Union (Maastricht Treaty) and it is the de facto successor to the European Communities (ECSC, EEC, EURATOM) of the six member states established in 1951, 1957 and 1965 respectively. Since then, new enlargements have increased the number of its member States and its competencies have been extended. It is an open process of European integration and it is one of the largest economic and political entities in the world (Eurostat Online support, 2008). Luxembourg City, together with Brussels and Strasbourg, is one of the three official capitals of the European Union and the seat of the European Court of Justice - the highest judicial authority in the EU. The European Union is a single market with a common commercial, agricultural, fisheries and regional policy to help the poorer regions. It introduced a single currency, the Euro, adopted by 15 Member States.

The European Union was also formally established when the Maastricht Treaty came into force on 1 November 1993. In 1995 Austria, Sweden and Finland entered the newly established Union. The next treaty was signed in Amsterdam in 1997. In 1999 the euro replaced the national currencies in 11 Member States, the so-called Eurozone. Greece joined the Euro in 2001. In 2004, ten new countries (eight of which were formerly communist countries) joined the European Union. In addition, Romania and Bulgaria joined the EU in 2007, while Croatia joined in 2013. Slovenia also joined the Eurozone in 2007. In 2008 Cyprus and Malta adopted the euro respectively.

B. European Union Member States

The European Union is described as "a family of

democratic European countries". On 23 July 1957 six founding members formed the European Coal and Steel Community, which was the first stage of today's EU. Twenty-one countries have since been introduced into successive waves of enlargement.

Year	Enlargement History	Total
1952/1958	Belgium Germany ¹ France Italy Luxemburg	6
1973 ²	Denmark ³ Ireland United Kingdom	9
1981	Greece	10
1986	Spain Portugal	12
1995 ²	Austria Finland Sweden	15
2004	Czech Republic Estonia Cyprus Latvia Lithuania Hungary Malta Poland Slovenia Slovakia	25
2007	Bulgaria Romania	27
2013	Croatia ⁴	28

Source: Office for Official Publications of the European Union, 2008
Notes:

¹ On 3 October 1990, East Germany joined with West Germany and its territory automatically became part of the EU.

² In 1973, as in 1995, Norway, despite the fact that it signed the respective Accession Treaties, did not endorse them because of the negative referendum of the Norwegian citizens.

³ Greenland, a self-governing territory under Danish sovereignty since 1979, left the European Communities in 1985 following a referendum

⁴ The population of Croatia in 2013 was 4,475,611 inhabitants and became the 28th member of the EU on July 1, 2013. In April 2009 it became a member of NATO

Fig. 1. European Union Member States

Any country willing to join the European Union must adhere to the economic and political terms, known as the Copenhagen Criteria (following the Copenhagen Summit in June 1993). This basically requires a secular, democratic government, the rule and respect of law and corresponding social and institutional freedoms. Under the EU Treaty, each Member State and the European Parliament must agree unanimously on any enlargement.

C. Candidate countries (En route to EU membership)

There are currently six candidate countries to join the EU.

These are:

- Albania
- Republic of North Macedonia
- Iceland
- Montenegro
- Serbia
- Turkey

In addition, the Balkan countries Bosnia and Herzegovina and Kosovo are recognized as potential candidates.

D. Demographics Data Population

The most populous country in the EU is Germany with 82,2 million inhabitants. The top five are: the United Kingdom with (66,57 million), France (64,1 million), Italy (59,29 million) and Spain (46,4). Greece ranks 10th with a population of 11,1 million according to the official census of 2011. The country with the smallest population in the EU is Malta with only 0.4 (432,089) million Residents followed by Luxemburg with 0.5 (590,321) million of which 50,9% are Luxembourgers while 49,1% are foreign citizens. Cyprus is followed after Luxembourg with 1.19 million. The largest city in the EU is London, with the population of the entire metropolitan complex according to 2011 census, 8,173,941. The metro population in 2018 estimated the population of London to be 8,787,892.

In continuation, Figure 2 below shows the 10 largest cities in the EU: (estimate 2013)

A/A	Town Planning Complex	Country	Population
1	Paris	France	12,2741,346
2	London	United Kingdom	8,787,892
3	Berlin	Germany	7,245,576
4	Madrid	Spain	6,514.620
5	Barcelona	Spain	6,4393,081
6	Essen - Bochum - Dortmund	Germany	5,126,013
7	Milan	Italy	4,851.565
8	Rome	Italy	4,039,813
9	Athens	Greece	3,750.124
10	Warsaw	Poland	1,781,740

Source: Official EU website, europa.eu.int

Fig. 2

E. Economic Performance

According to estimates by Swiss institutions, the EU maintains 30% of the world's net wealth (estimated at \$223 trillion in 2012). According to the annual list of the Fortune business magazine, about 161 out of 500 largest businesses in the world have their headquarters within the EU. The average per capita income shows very large deviations across the EU. The richest inhabitants based on the average annual per capita income are located in the center of London (78,000 € / inhabitant), Luxembourg (62,500 € / inhabitant) and Brussels (52,500 € / inhabitant) while the poorest in the northeastern provinces of Romania (6,900 € / inhabitant) and in the southern provinces of Bulgaria (6,900-7,200 € / inhabitant).

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
<i>Millions of euro (από το 1.1.2002)/Millions of ECU (μέχρι 31.12.2011)</i>										
Belgium	82368	82707	84918	90301	95158	100363	103519	104938	108373	112504
Czech Rep	16437	16900	17731	17892	19483	22157	26126	26796	28471	32508
Denmark	71303	73356	77315	82162	85759	89590	92507	94459	96590	100208
Germany	834705	810200	825140	855530	884520	903200	909050	908800	914630	911980
Estonia	1385	1621	1807	1983	2123	2371	2609	2978	3342	3860
Ireland	24315	28744	30914	34466	39151	43443	46746	50302	55390	61459
Greece	24298	27338	28331	31144	32256	33975	36986	39276	44425	48006
Spain	188334	194525	207738	223389	247209	263166	278906	297319	314523	332417
France	465704	469788	489558	515775	547556	574242	598685	614255	635688	654702
Italy	285306	302365	310363	323727	339610	359589	375583	388389	402937	422323
Cyprus	2869	3111	3279	3501	3794	4049	4377	4793	5056	5401
Latvia	1368	1974	2131	2373	2798	3018	3103	3247	3644	4598
Lithuania	2017	2730	3296	3505	3826	4076	4624	5170	5833	6610
Luxembourg	6539	6753	7119	7879	8797	9631	10237	10609	11347	12119
Hungary	11994	13345	13830	14602	16630	20116	24206	26181	29139	30005
Malta	1211	1316	1406	1509	1670	1801	1839	1850	1865	1906
Netherlands	142532	146507	147225	159361	170718	182607	189544	193799	194634	196555
Austria	77272	76294	79242	82754	85880	87687	89414	91341	93418	96109
Poland	43188	49360	54963	55995	64157	74950	70845	63278	63805	75987
Slovenia	7604	8059	8536	8905	9584	10238	10800	11085	11693	12366
Slovakia	5200	6209	6504	6068	6898	7182	7873	8818	9819	10916
Finland	39707	41579	43786	46193	49443	52656	54411	56410	58675	61615
Sweden	85969	88130	90301	96697	107652	103945	108336	111362	114202	116389
UK	431593	540842	601031	655181	758606	789519	808826	762482	811280	843789

Source: Eurostat/US: Bureau of Economic Analysis/JP: Economic and Social Research Institute

TABLE I. showing Government expenditure on civil servants—gross wages and salaries

Economic performance varies from state to state. The Stability and Growth Agreement defines the fiscal criteria for maintaining stability and (economic) convergence. It will be implemented in all Member States, with specific rules applying to the Eurozone area, which stipulate that each Member states should not exceed the deficit of 3% of GDP and the government debt should not exceed 60% of GDP. However, many larger members have consistently run deficits significantly above 3%, and the Eurozone area as a whole has a debt ratio of over 60%. From a macroeconomic perspective, the difference between rich nations and developing nations may be summarised by saying that rich nations have at some point in their history experienced extended periods of rapid growth but that the poorer nations either have never experienced sustainable growth or have had periods of short growth, offset by periods of economic decline.

A nation's economic performance depends on many factors, including its natural and human resources, its capital stock (buildings and machines), its technology and the economic choices made by its citizens, both individually and

collectively. Another extremely important factor affecting economic performance is the set of macroeconomic policies pursued by the government (Andrew Abel, Ben Bernanke and Robert McNabb 2005, p.10)

II. STATISTICAL DATA AND PROCESSING OF THE RESULTS

Many papers have been written on the subject government expenditure on civil servants -wages and salaries, and most of them stressed on increased trade and skill biased technological change as the two principal causes, while some concluded that the role played by trade is limited points to a dominant role for trade. Others estimated the factor content of trade and use these estimates via exogenous (literature based) labour demand elasticity to infer the wage change attributed to trade. They then compare this to observed wage changes. We will consider the use of association models as an alternative to reduced form methods. The data used for this study was obtained from the International Monetary Fund of Washington (IMF) and Eurostat calculated on an annual basis. The introduction and processing of observations (data) consists of the total number of comparisons of government expenditure for civil

servants - gross salaries and wages in the EU24 for the period 2002-2011.

TABLE 2. The results of the data

Models	X ² (Pearson) Chi - Square	Likelihood-Ratio Chi - Square G ²	Degrees of Freedom	Index of Dissimilarity	Maximum Deviation
O	164525.84940	165674.62855	207	0.02320	0.00000000
U	131750.43429	131331.13659	206	0.02202	0.00066949
R	43821.21214	44267.96919	184	0.01226	0.00077353
C	105794.96467	105422.90575	198	0.01818	0.00020928
R+C	19628.15965	19599.58970	176	0.00818	0.00010073
RC	34306.98658	34338.25149	176	0.01129	0.00099378

With the help of the Categorical Data Analysis program (CDAS), we were able to ascertain the results of our data for the comparison of government expenditure on civil servants – Gross wages and salaries in the EU24. Below are the values (prices) of all models to be estimated. The statistics used to compare the correlation (association) of the various models are X² (Pearson) Chi - Square and the Likelihood-Ratio Chi - Square G² - probability ratio (Fienberg, 1980). In continuation, the program gives us the following results:

III. ASSOCIATION MODEL

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

- (1) 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: $\text{Log}(F_{ij}) = \lambda + \lambda_{A(i)} + \lambda_{B(j)}$, 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)
- (2) The Uniform association model, which is symbolized by (U) in log-linear form is: $\text{log}(F_{ij}) = \lambda + \lambda_{A(i)} + \lambda_{B(j)} + \phi \chi_i y_j$, where ϕ is a single parameter for interaction and χ_i, y_j are the scores for the row and column variables ($i = 1, \dots, I$, $j = 1, \dots, J$) respectively.
- (3) The row effects model (R) where linear-by-linear interaction holds that $\text{log}(F_{ij}) = \lambda + \lambda_{A(i)} + \lambda_{B(j)} + \phi \mu_i y_j$ (Goodman, L.A., 1979a), where y_j are fixed scores for the column variable ($j = 1, \dots, J$) and μ_i are unknown scores for the row variable ($i = 1, \dots, I$).
- (4) The column effects model (C) is the same as the R model with a change in subscripts: $\text{Log}(F_{ij}) = \lambda + \lambda_{A(i)} + \lambda_{B(j)} + \phi v_j x_i$, where x_i are fixed scores for the row variable ($i = 1, \dots, I$) and v_j are unknown scores for the column variable ($j = 1, \dots, J$).
- (5) 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:

$$\log(F_{ij}) = \lambda + \lambda_{A(i)} + \lambda_{B(j)} + \sum_{k=1}^{I-1} \beta_k y_j Z_{A(k)} + \sum_{k=1}^{J-1} \gamma_k x_i Z_{B(k)}$$

defined earlier), and $Z_{A(i)}$, $Z_{B(j)}$ denote to variables (dummy variables) for the row and column levels respectively.

- (6). 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: $\log(F_{ij}) = \lambda + \lambda_{A(i)} + \lambda_{B(j)} + \phi \mu_i v_j$, where the row score parameters μ_i and column score parameters v_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., government expenditure on civil servants– gross wages and salaries in 24 countries of the EU from 2002 - 2011. 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 (X²) statistics, the likelihood-ratio chi-square (G²) statistics and the index of dissimilarity which is equated by:

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

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

Models	Index Of Dissimilarity(D)
1. Null Association-Independence Model (O)	0.02320
2. Uniform Association Model (U)	0.02202
3. Row-Effects Association Model (R)	0.01226
4. Column-Effects Association Model (C)	0.01818
5. Row+Column Effects Association Model (R+C)	0.00818
6. Row Column Effects Association Model (R*C)	0.01129

At first sight it seems that the Row Column Effects of the Association Model (R+C) adjusted better to the percentage of the Comparison of government expenditure on civil servants – Gross wages and salaries in the EU24 for the

years under study (having the lowest index of dissimilarity) with $D = 0.00818$.

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 (Bayesian information criterion). In statistics, the Bayesian information criterion (BIC) or Schwarz criterion is a criterion for model selection among a finite set of models; the model with the lowest BIC is preferred. It is based, in part, on the likelihood function. When fitting models, it is possible to increase the likelihood by adding parameters, but doing so may result in over-fitting. BIC attempt to resolve this problem by introducing a penalty term for the number of parameters in the model and gives the best solution (Schwarz, Gideon E. 1978).

The formula for this calculation is:

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

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: $BIC = G^2 - (D.F.) \log(n) = 44267.96919 - (184 * 17.3862) = 41068.9$

5th model: $BIC = G^2 - (D.F.) \log(n) = 19599.58970 - (176 * 17.3862) = 16539.6$

6th model: $BIC = G^2 - (D.F.) \log(n) = 34338.25149 - (176 * 17.3862) = 31278.3$

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.

A. Analysis of the Association Models

In continuation, the association model passes through several tests to ascertain the accuracy, quality, or satisfactory fit of each model. Tests are 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) which is $G^2 = 165674.62855$ with 207 degrees of freedom. The 95% reference point chi-square distribution is 241.982. 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 has $G^2 = 131331.13659$ with 206 degrees of freedom. The 95% reference point chi-square distribution is 240.896. 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 44267.96919 with 184 degrees of freedom. The 95% reference point chi-square distribution is 216.957. 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 $G^2 = 105422.90575$ with 198 degrees of freedom. The 95% reference point chi-square distribution is 232.201 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 $G^2 = 19599.58970$ with 176 degrees of freedom. The 95% reference point chi-square distribution is 208.23 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 34338.25149 with 176 degrees of freedom. The 95% reference point chi-square distribution is 208.23. 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 .

By virtue of the index of dissimilarity of the models, the model R+C has the best fit. However, upon clear test to ascertain the accuracy, quality, or satisfactory fit of the model, we find out that it has a very poor fitting, making it unacceptable (Haritou A, Nwaubani J. C., (2008, 2010).

However, we have to find out the degree or level of effects on each model. To verify this, we have to construct the Analysis of association (ANOAS) table.

B. Analysis of the 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. Relational Analysis

Models	Likelihood- G^2	Degrees of Freedom	Index of Dissimilarity
O	165674.62855	207	0.02320
U	131331.13659	206	0.02202
R	44267.96919	184	0.01226
C	105422.90575	198	0.01818
R+C	19599.58970	176	0.00818
RC	34338.25149	176	0.01129

The analysis of association table has the following differences of our models: O-U is the overall or total effects of the models, U-C are the column effects model, C-CR are the column effects model which gives the effects of the column, RC and the residuals of the models.

Table 5. The ANOAS showing differences between the models

Effects	Models	Df	G2	Percentage
General	O-U	1	34343.4916	20.73%
Rows	U-C	8	25908.2304	15.64%
Column-effect	C-RC	22	71084.6546	42.91%
Residual	RC	176	34338.2519	20.72%
Total	O	207	165674.6255	100.00%

From the ANOAS table we created, the uniform association model (U) as shown, covers 20.73% of the total baseline chi-squared X^2 distribution, the Column model (C) accounts for a small percentage of 15.64%, the Row model (R) covers a large percentage of 42.91%.

We could therefore observe that at the rate of 20.72%, 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 government expenditure on civil servants—gross wages and salaries in 24 countries of the EU in Belgium, Czech Republic, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, Netherlands, Austria, Poland, Slovenia, Slovakia, 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 (1999 - 2008).

We can as well say that the percentage of $(165674.6255 - 34338.2519) / 165674.6255 = \%$ of the data is explained by the column effects model (on the local odds ratios in a multiplicative way), thus, 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 the 95% reference point 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 the accuracy, quality, or satisfactory fit of the model, thereby making it unacceptable, therefore, we proceeded to examining the multivariate model to find the model with a satisfactory fit.

IV. THE MULTIVARIATE MODEL

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 (Haritou A., Nwaubani J C. 2008).

The results are as follows:

TABLE 6. Multivariate model

Μοντέλο	RC(5)	RC(6)	RC(7)	RC(8)	RC(9)
X^2	494,44750	314,78786	151,5389 3	62,90583	0
G^2	495,02581	314,93595	151,6188 1	62,91899	-0.01004
d.f.	72	51	32	15	0
D	0.00100	0.00083	0.00046	0.00030	0

Model RC (5) multivariate row, column, M=5
Model RC (6) multivariate row, column, M=6
Model RC (7) multivariate row, column, M=7
Model RC (8) multivariate row, column, M=8
Model RC (9) multivariate row, column, M=9

A. Examination of the Multivariate Model

In the RC (M) association model, M represents the dimension to be fit, which is utilized by PROG RCDIM. As it is shown above the multivariate model RC (M = 4) is the acceptable model with the best fit.

The multivariate model RC (5) with M=5 has likelihood-ratio chi-square statistic $G^2 = 495,02581$ with 72 degrees of freedom (d.f.). Thus, we find out that the 95% reference point of the X^2 distribution is 92.9779. It has a bad fit. We could conclude therefore 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 multivariate model RC (6) with M=6 has likelihood-ratio chi-square statistic $G^2 = 314,93595$ with 51 degrees of freedom (d.f.). The 95th percentile of the reference chi-square distribution is 77.2766. Similarly, this model has a bad fit since the X^2 distribution.

The multivariate model RC (7) with M=7, has likelihood-ratio chi-square statistic $G^2 = 151,61881$ with 32 degrees of freedom (d.f.). Thus, we find out that the 95% reference point of the X^2 distribution is 46,2631. It has a moderate fit but not acceptable.

The multivariate model RC (8) with M=8, has likelihood-ratio chi-square statistic $G^2 = 62,91899$ with 15 degrees of freedom (d.f.). Thus, we find out that the 95% reference point of the X^2 distribution is 25.0002. Here we see how the multivariable RC model with M = 8 has a moderate fit. We equally observe that the model M=8 covers $\{(165674.62855 - 62.91899) / 165674.62855\} = 99.96\%$ of all observations.

Finally, the multivariate model RC (9) with M=9, has likelihood-ratio chi-square statistic $G^2 = -0.01004$ with 0 degrees of freedom (d.f.). In this case, the 95% reference point of the X^2 distribution is 100 after the likelihood-ratio chi-square statistic G^2 has a negative sign with 0 degrees of freedom (d.f.). In this case, the multivariate model RC with M=9 has a perfect fit and covers $\{(165674.62855 - (-0.01004)) / 165674.62855\} = 100\%$ of the total data observed.

When a model with a smaller M has is satisfactory fit, it is accepted because it gives a better explanation of the interaction between the rows and columns. Therefore, we'll prefer the multivariate model M=9 which has a perfect fit.

B. Evaluation of the Multivariate Model

The practical implementation of multivariate statistics to a particular problem 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 (Haritou A., Nwaubani J C. 2010).

The expected frequencies under the independent and column effects model for government expenditure on civil servants – gross wages and salaries in 24 countries of the EU from 2002 - 2011 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. Evaluation of the multivariate model

Countries	Years	Data	Values of 0 Model (f_{ij}^1)	Values of RC (M=9) Model (F_{ij}^2)
ROW	COLUMN	DATA	OBSERVED	EXPECTED
1	1	82368	82368	77480.9769
2	2	16900	16900	18910.3692
3	3	77315	77315	76180.2079
4	4	855530	855530	818301.4219
5	5	2123	2123	2427.6426
6	6	43443	43443	43704.5520
7	7	36986	36986	37573.1559
8	8	297319	297319	277961.8137
9	9	635688	635688	629360.4117
10	10	422323	422323	410296.5218
11	1	2869	2869	229.6150
12	2	1974	1974	2379.9162
13	3	3296	3296	3678.8045
14	4	7879	7879	8505.6020
15	5	16630	16630	20168.8195
16	6	1801	1801	1724.5671
17	7	189544	189544	187139.0406
18	8	91341	91341	93770.7565
19	9	63805	63805	69712.8265
20	10	12366	12366	11556.6377
21	1	5200	5200	6060.0036
22	2	41579	41579	42493.3898
23	3	90301	90301	90276.4528
24	4	655181	655181	654355.6864

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

¹ f_{ij} Expected frequencies of the independence model

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

V. LOGARITHMS FOR THE COLUMN-EFFECTS ASSOCIATION MODEL

The column-effects of the (M=9) from the RCDIM (ROW TAU-S) are as follows:

$$\text{Belgium: } \tau_1 = \ln(0.939351) = -0.063$$

$$\text{Czech Republic: } \tau_2 = -\ln(0.540808) = 0.615$$

$$\text{Denmark: } \tau_3 = \ln(0.827495) = -0.189$$

$$\text{Germany: } \tau_4 = \ln(3.149744) = 1.147$$

$$\text{Estonia: } \tau_5 = -\ln(2.793523) = -1.027$$

$$\text{Ireland: } \tau_6 = \ln(0.061128) = -2.795$$

$$\text{Greece: } \tau_7 = -\ln(0.101699) = 2.286$$

$$\text{Spain: } \tau_8 = \ln(1.897627) = 0.641$$

$$\text{France: } \tau_9 = \ln(2.690371) = 0.990$$

$$\text{Italy: } \tau_{10} = \ln(2.22868679) = 0.801$$

$$\text{Cyprus: } \tau_{11} = -\ln(2.253178) = -0.812$$

$$\text{Latvia: } \tau_{12} = -\ln(2.636739) = -0.970$$

$$\text{Lithuania: } \tau_{13} = -\ln(2.251785) = -0.812$$

$$\text{Luxembourg: } \tau_{14} = -\ln(1.437827) = -0.363$$

$$\text{Hungary: } \tau_{15} = -\ln(0.682250) = 0.382$$

$$\text{Malta: } \tau_{16} = -\ln(3.143177) = -1.145$$

$$\text{Netherlands: } \tau_{17} = \ln(1.517678) = 0.417$$

$$\text{Austria: } \tau_{18} = \ln(0.826362) = -0.191$$

$$\text{Poland: } \tau_{19} = \ln(0.482536) = -0.729$$

$$\text{Slovenia: } \tau_{20} = -\ln(1.345220) = -0.297$$

$$\text{Slovakia: } \tau_{21} = -\ln(1.627615) = -0.487$$

$$\text{Finland: } \tau_{22} = \ln(0.286415) = -1.250$$

$$\text{Sweden: } \tau_{23} = \ln(0.997938) = -0.002$$

$$\text{United Kingdom: } \tau_{24} = \ln(2.907190) = 1.067$$

VI. RESEARCH FINDINGS & COMPARISON OF GOVERNMENT EXPENDITURE ON CIVIL SERVANTS

We try to compare and contrast with some of the countries in the EU 24 to ascertain the variation in

government expenditure on civil servants – gross wages and salaries from 2002 – 2011.

For example, we compared Greece and France and realised that $\tau_7 - \tau_9 = 1.296$, $\exp(1.296) = 3.65$. This means that the gross (salaries) wages, compensation of employees and all kinds of compensation in cash granted then or later, but have now been stable in Greece, was burdening the state budget proportionally by €3.65 million more than France.

In the case of Italy and the Netherlands, we find that $\tau^{24} - \tau^{17} = 0.384$, $\exp(0.384) = 2.421$. That is, Italy spends € 2.42 million more than the Netherlands.

The difference in government expenditure between Ireland and Luxembourg was also very high, where $\tau^6 - \tau^{14} = -2.43$ and $\exp(-2.43) = 3.70$ million. In other word, Ireland's compensation of employees was much higher than Luxembourg with €3.70 million.

In the case of Spain and Germany, we observe that $\tau^8 - \tau^4 = -0.506$ with $\exp(-0.506) = 2.03$, which shows that the costs and compensation of employees in Spain burdened the state budget by €2.03 million more than in Germany.

Greece's government expenditure in relation to England is $\tau^7 - \tau^{24} = 1.219$ and $\exp(1.219) = 3.38$, i.e. Greece was spending €3.38 million more than England.

In the case of the Mediterranean countries like Italy and Spain, we see that $\tau^8 - \tau^{10} = -0.641$, $\exp(-0.1252) = 0.77$. In other words, the state budget in Spain narrowly exceeds that of Italy by € 0.77million.

Finally, in the Scandinavian countries such as Finland and Sweden, the difference between them is $\tau^{22} - \tau^{23} = 0.001$ with $\exp(-1.248) = 0.056$, thus, the difference in government expenditure between Finland and Sweden was very small with only €0.06 million.

VII. SUMMARY

All the six association models show bad fit. Therefore we proceeded to the multivariate model in which the row column-effects RC multivariate model on ((M = 9) is better than all because it covers 100% of the data, thus, giving the best fit among all. However, to be more precise, the total number of government expenditures for civil servants - gross salaries and wages in the EU24 were influenced by various factors; these could be as a result of:

- Diversification of investments, government spending and taxation
- A nation's economic performance which depends on many factors, including its natural and human resources, its capital stock (buildings and machines), its technology and the economic choices made by its citizens, both individually and collectively.
- The set of macroeconomic policies pursued by each government member state
- The living standard of each country - the degree of utilization of the workforce, which is directly related to efficiency in the production of goods and services
- Several other factors which are difficult to be determined in each country (Fairbanks, Michael 2000).

VIII. CONCLUSIONS

We should mention that Θ , which is equal to 1.00140, i.e.1, which also reveals that we have independence between the variables. To determine the degree of correlation (association) between these countries and years, we use the θ of the second model, (the uniform association model which is symbolised by (U)) for calculation. More specifically, the innate correlation index in log-linear form is equal to: $\log(F_{ij}) = \lambda + \lambda_{A(i)} + \lambda_{B(j)} + \phi\chi_i\chi_j$, where ϕ is a single parameter for interaction

The parameter of interaction:

$$\begin{aligned}\phi &= \log \theta = \log(1.00140) \\ \phi &= \ln(1.00140) = 0.001399 \\ |\phi/2| &= \sqrt{0.001399} = 0.0374 \text{ and} \\ \phi/2 &= \sqrt{0.001399} = 0.0374\end{aligned}$$

Since there is a correlation based on our study on government expenditure, we could therefore, conclude that there is a slight increase in the total number of government expenditures for civil servants - gross salaries and wages in the EU24 for the subsequent years (2002-2011). It will be interesting to know that when the total government expenditure increases from year to year, one of the two must occur: either the economy produces more goods or services; or, goods and services are sold at higher prices.

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