

Evaluation of Total Employment Rate Aged 15-64 in EU15

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Abstract — Many papers have been written on the subject - total employment rate, and most of them stressed on excessive pressure emanating from economic recession, heavy competition, modern and skill biased technological changes as the main principal causes of demands for jobs. Unarguably, evaluating total employment rate remain issues of considerable importance for economists, statisticians, the media and policy makers. However, understanding how the economy works requires a shift from economic modelling to economic analysis. We will consider the use of association model as an alternative to reduced form methods. Against the background of total employment rate, this study considers and estimate the most accurate association model of the Categorical Data Analysis for the total employment rate - employed persons aged 15-64 as a share of the total population of the same age group in the EU15 from 2008-2017. 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 with the best fit and acceptable. In conclusion we find out that the Column Effects Association Model (C) has the best fit because it covers almost 90% of the data - giving the best fit among all.

Index Terms — EU15, Association models, Log-linear and non-linear models, total employment rate and employed persons aged 15-64.

I. INTRODUCTION

Statistically, the employment rate for a given age group is measured as the number of employed people of a given age as a percentage of the total number of people in that same age group. Employed people are defined as those aged 15 and over who report that they have worked in gainful employment for at least one hour in the previous week or who had a job but were absent from work during the reference week while having a formal job attachment.

Employment rates are shown for three age groups: people aged 15 to 24 (those just entering the labour market following education); people aged 25 to 54 (those in their prime working lives); people aged 55 to 64 (those passing the peak of their career and approaching retirement). This

indicator is seasonally adjusted, and it is measured as a percentage in same age group. To determine the percentage in the labour force we divide the number of people in the labour force by the total adult (working-age) population and multiply by 100 to obtain the percentage. Retirees are counted in the real unemployment rate. The other group that isn't included in the labour force comprises students, homemakers, retired people, and those under 16 who are working, and they are counted in the population.

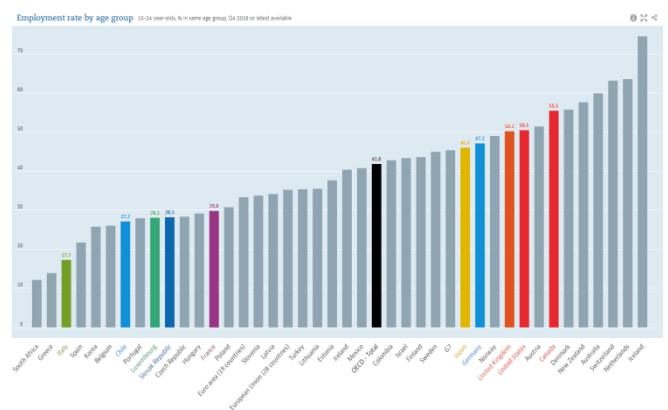


Fig.1. Employment rates are shown for three age groups: people aged 15 to 24 [1].

The EU17 consists of Belgium, Germany, Estonia, Ireland, Greece, Spain, France, Italy, Cyprus, Luxembourg, Malta, the Netherlands, Austria, Portugal, Slovenia, Slovakia and Finland, while the EU28 includes Belgium, Bulgaria, the Czech Republic, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Croatia, Malta, the Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland, Sweden and the United Kingdom.

A. Economic Performance

According to estimates by Swiss institutions, the EU maintains 30% of the world's net wealth (estimated at \$223 trillion in 2015). 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) [2].

Economic performance varies from state to state. The

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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 summarized 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 [3].

II. STATISTICAL DATA AND PROCESSING OF THE RESULTS

The data used for this study was obtained from the Organization for Economic Co-operation and Development (OECD), and the Eurostat, calculated on an annual basis. The introduction and processing of observations (data) consists of the total employment rate - employed persons aged 15-64 as a share of the total population of the same age group in the EU15 from 2008 - 2017.

TABLE 1: SHOWING TOTAL EMPLOYMENT RATE - EMPLOYED PERSONS AGED 15-64 AS A SHARE OF THE TOTAL POPULATION OF THE SAME AGE GROUP IN EU15 [4]

Time\Geo	Belgium	Denmark	Germany	Greece	Spain	France	Ireland	Italy
2008	55.7	72.3	64.7	54.2	46.1	59.1	53.0	51.4
2009	56.1	73.4	64.6	54.7	46.9	59.5	54.4	51.0
2010	56.2	73.8	64.1	55.0	47.9	59.5	55.4	51.2
2011	56.8	74.9	63.7	55.1	49.4	59.6	57.6	51.3
2012	57.4	75.1	63.9	55.5	51.2	60.2	60.6	52.0
2013	59.3	76.0	65.2	55.3	53.7	60.9	63.3	52.7
2014	60.5	76.3	65.6	55.7	56.2	62.1	65.2	53.7
2015	59.9	76.2	65.8	55.4	57.7	62.8	65.8	54.8
2016	59.9	75.9	65.4	56.1	58.4	63.0	65.6	55.5
2017	59.6	75.1	65.1	57.8	59.7	63.2	65.4	56.1

Time\Geo	Luxembourg	Netherlands	Austria	Portugal	Finland	Sweden	United Kingdom
2008	59.9	64.0	68.5	64.1	60.3	70.2	67.9
2009	58.7	64.7	68.8	63.7	61.6	70.9	68.5
2010	59.2	66.3	67.8	64.1	62.4	70.3	69.0
2011	59.9	68.5	67.8	65.7	63.3	69.5	69.9
2012	60.5	70.2	67.9	66.8	64.6	70.3	70.5
2013	61.7	71.7	68.6	67.4	66.4	71.7	71.0
2014	62.7	72.9	68.5	68.4	67.2	73.0	71.5
2015	63.1	74.1	68.5	69.0	68.1	74.0	71.7
2016	63.4	74.4	68.7	68.8	68.1	73.6	71.7
2017	62.7	73.5	69.0	68.1	67.7	72.9	71.8

With the help of the Categorical Data Analysis program (CDAS), we were able to ascertain the results of our data for the total employment rate - employed persons aged 15-64 as a share of the total population of the same age group in the EU15 from 2006-2015. Below are the values (prices) of all

models to be estimated. The statistics used to compare the correlation (association) of the various models are X^2 (Pearson) Chi-Square and the Likelihood-Ratio Chi - Square G^2 -probability ratio [5]. In continuation, the program gives us the following results in Table 2 below.

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	5.90022	5.91215	126	0.00883	0.00000000
U	5.89269	5.90487	125	0.00886	0.00002232
R	5.88189	5.89438	117	0.00881	0.00001202
C	0.80160	0.80136	112	0.00351	0.00012508
R+C	0.79111	0.79098	104	0.00350	0.00013441
RC	0.58943	0.58914	104	0.00306	0.00098946

A. Association Model

In the categorical data analysis system, we apply the methodology by considering six of the most 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:

$$\log(F_{ij}) = \lambda + \lambda_{A(i)} + \lambda_{B(j)},$$

where log denotes the natural logarithm, F_{ij} the expected frequencies under the independence model, $\lambda_{A(i)}$ are the rows main effects and $\lambda_{B(j)}$ are the columns main effects [6].

2) The Uniform association model, which is symbolized by (U) in log-linear form is:

$$\log(F_{ij}) = \lambda + \lambda_{A(i)} + \lambda_{B(j)} + \varphi\chi_i\gamma_j$$

where φ is a single parameter for interaction and χ_i, γ_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

$$\log(F_{ij}) = \lambda + \lambda_{A(i)} + \lambda_{B(j)} + \varphi\mu_i\gamma_j \quad [7]$$

Where γ_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:

$$\log(F_{ij}) = \lambda + \lambda_{A(i)} + \lambda_{B(j)} + \varphi\nu_j\chi_i$$

where χ_i are fixed scores for the row variable ($i = 1, \dots, I$) and ν_j are unknown scores for the column variable ($j = 1, \dots, J$).

4) The model that allows both row and column effects in additive form is called the R+C model [8]. The log-frequency version of the above model is:

$$\log(F_{ij}) = \lambda + \lambda_{A(i)} + \lambda_{B(j)} + \sum_{k=1}^{I-1} \beta_k \gamma_j Z_{A(k)} + \sum_{k=1}^{J-1} \nu_k \chi_i Z_{B(k)},$$

where χ_i, γ_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.

5) 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 [9]. 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 that has the best fit among the 6 models which we are examining, i.e., total employment rate - employed persons aged 15-64 as a share of the total population of the same age group in the EU15

from 2008-2017. 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 analyze the six association model describe above, with the help of the categorical data analysis statistical program [10]. 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:

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

Where:

f_{ij} are the observed frequencies,

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)	0.00883
2.Uniform Association Model (U)	0.00886
3. Row-Effects Association Model (R)	0.00881
4. Column-Effects Association Model (C)	0.00351
5.Row+Columns Effects Association Mode (R+C)	0.00350
6. Row Column Effects Association Model (R*C)	0.00306

In Table 3 above, it seems at first sight that the Row Column Effects of the Association Model (R*C) adjusted better to the percentage of the total employment rate - employed persons aged 15-64 as a share of the total population of the same age group in the EU15 from 2006–2015 for the years under study (having the lowest index of dissimilarity) with $D=0.00306$.

Since we have models with similar lower ratio, we justify the model with the best fit to match both counties 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 [11].

The formula for this calculation is:

$$BIC = G^2 - (D.F.) \log(n) \quad (2)$$

Notations:

G^2 = the likelihood-ratio chi-square statistics.

d.f. = degrees of freedom of the models.

n = the size of the sample (9538.9).

$\log(n) = \log(93199028) = 9.16313$.

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 4th, 5th and 6th models subsequently.

Subsequently, the calculation is as follows:

$$4^{\text{th}} \text{ model: } BIC = G^2 - (d.f) \log (n) = 0.80136 - (112 * 9.16313) = -1025.4692$$

$$5^{\text{th}} \text{ model: } BIC = G^2 - (d.f) \log (n) = 0.79098 - (104 * 9.16313) = -952.17454$$

$$6^{\text{th}} \text{ model: } BIC = G^2 - (d.f) \log (n) = 0.58914 - (104 * 9.16313) = -952.37638$$

As we can see from the above calculations, the 4th model (Column-Effects Association Model (C) finally accounts for the best fit from the results since it has the smallest index of BIC.

B. Analysis of Association Model

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 $G^2=5.91215$ with 126 degrees of freedom. The 95% reference point chi-square distribution is 153.382. It has acceptable fit because the X^2 distribution is much greater than the likelihood-ratio chi-square statistic G^2 .

Subsequently, the Uniform association model has $G^2=5.90487$ with 125 degrees of freedom. The 95% reference point chi-square distribution is 152.274. As it could be noticed, this statistic is accepted and has a satisfactory fit since the X^2 distribution is much larger than the likelihood-ratio chi-square statistic G^2 .

Moreover, the statistic G^2 for the Row model (R) is dramatically increased for 5.89438 with 117 degrees of freedom. The 95% reference point chi-square distribution is 143.483. The row model is also accepted because the X^2 distribution is much greater than the likelihood-ratio chi-square statistic G^2 .

The Column model (C) has $G^2=0.80136$ with 112 degrees of freedom. The 95% reference point chi-square distribution is 137.914 which show even a much better fit as we can observe that the X^2 distribution is very much bigger 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 $G^2=0.79098$ with 104 degrees of freedom. The 95% reference point chi-square distribution is 128.98 and has also an acceptable fit since the X^2 distribution is greater 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 0.58914 with 104 degrees of freedom. The 95% reference point chi-square distribution is 128.98. Furthermore, the statistics is dramatically increased just as the previous model and they have identical degrees of freedom. Also, this model has an acceptable fit because the X^2 distribution is very much larger than the likelihood-ratio chi-square statistic G^2 .

By virtue of the index of dissimilarity of the models, the model R+C and RC has the best fit. 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.

C. Analysis of Association Table (ANOAS)

The ANOAS table in table 4 below was given by [12]. In Table 4 below, 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: ANOAS

Models	Likelihood- G^2	Degrees of Freedom	Index of Dissimilarity
O	5.91215	126	0.00883
U	5.90487	125	0.00886
R	5.89438	117	0.00881
C	0.80136	112	0.00351
R+C	0.79098	104	0.00350
RC	0.58914	104	0.00306

The analysis of association table (ANOAS) 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-RC are the column effects model which gives the effects of the column RC and the residuals of the models.

TABLE 5: ANOAS MODEL UNIFORMITY

Effects Models	G^2 values	D.F.	Percentage
1. General (O-U)	0.00728	1	0.12%
2. Rows(U-C)	5.10351	13	86.42%
3. Column-effects which gives the Row-effects (C-RC)	0.21222	8	3.58%
4. Residual (RC)	0.58917	104	9.96%
Total (O)	5.91215	126	≈100.00%

From the ANOAS table we created, the uniform association model (U) as shown in table 5 above, covers only 0.12% of the total baseline chi-squared X^2 distribution, the Row model (R) accounts for a large percentage of 86.42%, the Column-effects which gives the Row-effects (C-RC) covers a small percentage of 3.58% of the baseline chi-squared value. Finally, the row column effects (Residuals) are weaker because the RC model accounts for only 9.96% of the baseline chi-squared value.

We could therefore observe that at the rate of 9.96%, the variation which is attributed to the null-independence has been measured from the model of RC. This rate is quite unsatisfactory and we can say that the corresponding percentage of the total employment rate - employed persons aged 15-64 as a share of the total population of the same age group in Belgium, Denmark, Germany, Ireland, Greece, Spain, France, Italy, Luxembourg, Netherlands, Austria, Portugal, Finland, Sweden and United Kingdom, as seen from the data taken from the Eurostat, depended slightly negative on the association of both the countries and also from the years under our study (2008-2017).

We could as well say that the percentage of $(5.91215 - 0.58914) / 5.91215 = 0.90\%$ 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 and acceptable due to better 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 larger for the model (RC).

III. EVALUATION OF THE MODELS

TABLE 6. EVALUATION OF THE BEST MODEL - COLUMN-EFFECTS MODEL (C)

Years	Countries	Data	Values of 0 Model (f_{ij})	Values of RC (C) Model (F_{ij}^2)
ROW	COLUMN	DATA	OBSERVED	EXPECTED
1	1	55.7000	55.5502	55.7558
1	2	72.3000	71.5637	73.4485
1	3	64.7000	61.9231	64.2882
1	4	54.2000	53.0660	54.3107
1	5	46.1000	50.3716	45.6233
1	6	59.1000	58.2733	58.8010
1	7	53.0000	57.9293	53.6982
1	8	51.4000	50.6105	50.4038
1	9	59.9000	58.4548	58.9619
1	10	64.0000	66.9106	64.6531
1	11	68.5000	65.3628	68.2951
1	12	64.1000	63.6429	63.9286
1	13	60.3000	62.0760	60.9800
1	14	70.2000	68.4489	69.8087
1	15	67.9000	67.2163	68.4432
2	1	56.1000	55.9220	56.0934
2	2	73.4000	72.0426	73.5327
2	3	64.6000	62.3376	64.1989
2	4	54.7000	53.4212	54.4067
2	5	46.9000	50.7088	46.9201
2	6	59.5000	58.6633	59.0883
2	7	54.4000	58.3170	54.9553
2	8	51.0000	50.9492	50.7951
2	9	58.7000	58.8460	59.2549
2	10	64.7000	67.3584	65.5827
2	11	68.8000	65.8002	68.1036
2	12	63.7000	64.0689	64.3047
2	13	61.6000	62.4915	61.6368
2	14	70.9000	68.9070	69.9860
2	15	68.5000	67.6662	68.6410
3	1	56.2000	56.2085	56.3415
3	2	73.8000	72.4117	73.4975
3	3	64.1000	62.6569	64.0057
3	4	55.0000	53.6949	54.4143
3	5	47.9000	50.9685	48.1754
3	6	59.5000	58.9638	59.2806
3	7	55.4000	58.6158	56.1505
3	8	51.2000	51.2102	51.1065
3	9	59.2000	59.1475	59.4527
3	10	66.3000	67.7035	66.4177
3	11	67.8000	66.1373	67.8024
3	12	64.1000	64.3971	64.5780
3	13	62.4000	62.8116	62.1996
3	14	70.3000	69.2600	70.0500
3	15	69.0000	68.0128	68.7276
4	1	56.8000	56.8667	56.9580
4	2	74.9000	73.2597	73.9393
4	3	63.7000	63.3907	64.2273
4	4	55.1000	54.3237	54.7753
4	5	49.4000	51.5654	49.7854
4	6	59.6000	59.6543	59.8596
4	7	57.6000	59.3022	57.7442
4	8	51.3000	51.8100	51.7535
4	9	59.9000	59.8402	60.0383
4	10	68.5000	68.4964	67.7000
4	11	67.8000	66.9118	67.9407
4	12	65.7000	65.1513	65.2735
4	13	63.3000	63.5472	63.1749
4	14	69.5000	70.0711	70.5691
4	15	69.9000	68.8093	69.2610
5	1	57.4000	57.7018	57.7467
5	2	75.1000	74.3354	74.5974
5	3	63.9000	64.3215	64.6349
5	4	55.5000	55.1214	55.2971

5	5	51.2000	52.3226	51.5970
5	6	60.2000	60.5303	60.6180
5	7	60.6000	60.1730	59.5537
5	8	52.0000	52.5707	52.5593
5	9	60.5000	60.7189	60.8040
5	10	70.2000	69.5021	69.2053
5	11	67.9000	67.8944	68.2749
5	12	66.8000	66.1079	66.1660
5	13	64.6000	64.4803	64.3499
5	14	70.3000	71.1000	71.2964
5	15	70.5000	69.8197	69.9992
6	1	59.3000	58.8111	58.8046
6	2	76.0000	75.7645	75.5933
6	3	65.2000	65.5581	65.3319
6	4	55.3000	56.1811	56.0700
6	5	53.7000	53.3285	53.7105
6	6	60.9000	61.6940	61.6567
6	7	63.3000	61.3298	61.6908
6	8	52.7000	53.5814	53.6131
6	9	61.7000	61.8862	61.8510
6	10	71.7000	70.8383	71.0561
6	11	68.6000	69.1996	68.9133
6	12	67.4000	67.3788	67.3666
6	13	66.4000	65.7199	65.8359
6	14	71.7000	72.4669	72.3489
6	15	71.0000	71.1620	71.0572
7	1	60.5000	59.7009	59.6374
7	2	76.3000	76.9109	76.2899
7	3	65.6000	66.5500	65.7670
7	4	55.7000	57.0311	56.6217
7	5	56.2000	54.1354	55.6822
7	6	62.1000	62.6275	62.4573
7	7	65.2000	62.2578	63.6438
7	8	53.7000	54.3921	54.4648
7	9	62.7000	62.8226	62.6592
7	10	72.9000	71.9102	72.6586
7	11	68.5000	70.2467	69.2738
7	12	68.4000	68.3983	68.3090
7	13	67.2000	66.7143	67.0812
7	14	73.0000	73.5634	73.1172
7	15	71.5000	72.2388	71.8368
8	1	59.9000	60.1520	60.0267
8	2	76.2000	77.4920	76.4132
8	3	65.8000	67.0528	65.7064
8	4	55.4000	57.4620	56.7483
8	5	57.7000	54.5444	57.2918
8	6	62.8000	63.1006	62.7918
8	7	65.8000	62.7281	65.1643
8	8	54.8000	54.8031	54.9134
8	9	63.1000	63.2972	63.0001
8	10	74.1000	72.4534	73.7379
8	11	68.5000	70.7774	69.1119
8	12	69.0000	68.9151	68.7430
8	13	68.1000	67.2183	67.8356
8	14	74.0000	74.1192	73.3374
8	15	71.7000	72.7845	72.0781
9	1	59.9000	60.2861	60.0951
9	2	75.9000	77.6647	76.1271
9	3	65.4000	67.2023	65.2946
9	4	56.7000	57.5901	56.5708
9	5	58.4000	54.6660	58.6323
9	6	63.0000	63.2413	62.7903
9	7	65.6000	62.8680	66.3639
9	8	55.5000	54.9252	55.0694
9	9	63.4000	63.4383	63.0038
9	10	74.4000	72.6149	74.4327
9	11	68.7000	70.9352	68.5814
9	12	68.8000	69.0687	68.8096
9	13	68.1000	67.3682	68.2312
9	14	73.6000	74.2844	73.1645
9	15	71.7000	72.9468	71.9332
10	1	59.6000	60.2007	59.9408
10	2	75.1000	77.5548	75.5611
10	3	65.1000	67.1071	64.6450
10	4	57.8000	57.5086	56.1850
10	5	59.7000	54.5886	59.7820

10	6	63.2000	63.1518	62.5563
10	7	65.4000	62.7790	67.3354
10	8	56.1000	54.8475	55.0213
10	9	62.7000	63.3485	62.7741
10	10	73.5000	72.5122	74.8557
10	11	69.0000	70.8347	67.8028
10	12	68.1000	68.9709	68.6211
10	13	67.7000	67.2728	68.3749
10	14	72.9000	74.1792	72.7217
10	15	71.8000	72.8435	71.5227

fij: Expected frequencies of the independence model.

2Fij: Expected frequencies of the model C.

From Table 6 above, it could be seen that the prices (value) of the Column-effects model (C) fully fitted to the data.

IV. LOGARITHMS OF THE COLUMN-EFFECTS ASSOCIATION MODEL (C)

TABLE 7: COLUMN-EFFECTS ASSOCIATION MODEL (C)

Belgium: $\hat{\tau}_1 = \ln(0.99883) = -0.001$
Denmark: $\hat{\tau}_2 = \ln(0.99396) = -0.006$
Germany: $\hat{\tau}_3 = \ln(0.99144) = -0.008$
Greece: $\hat{\tau}_4 = \ln(0.99457) = -0.005$
Spain: $\hat{\tau}_5 = \ln(1.02104) = 0.020$
France: $\hat{\tau}_6 = \ln(0.99767) = -0.002$
Ireland: $\hat{\tau}_7 = \ln(1.01606) = 0.016$
Italy: $\hat{\tau}_8 = \ln(1.00053) = 5.298$
Luxembourg: $\hat{\tau}_9 = \ln(0.99775) = -0.002$
Netherlands: $\hat{\tau}_{10} = \ln(1.00709) = 0.007$
Austria: $\hat{\tau}_{11} = \ln(0.99003) = -0.010$
Portugal: $\hat{\tau}_{12} = \ln(0.99866) = -0.001$
Finland: $\hat{\tau}_{13} = \ln(1.00351) = 0.003$
Sweden: $\hat{\tau}_{14} = \ln(0.99534) = -0.004$
United Kingdom: $\hat{\tau}_{15} = \ln(0.99569) = -0.004$

V. RESEARCH FINDINGS ON TOTAL EMPLOYMENT RATE - EMPLOYED PERSONS AGED 15-64

Evaluating these 15 countries which formed the EU15 from 1951 to 1995, i.e. Belgium, Germany, France, Italy, Luxemburg, Holland, Denmark, Ireland, United Kingdom, Greece, Spain, Portugal, Austria, Finland, Sweden, our findings shows that the employment rate of the population aged 15–64 rose by 7.2 percentage between 2006 and 2015. A steady growth was accompanied by in the share of temporary employees, which increased from 2.5 percent to 11.9 percent of total employment. On the other hand, the number of hours actually worked per week drastically decreased in the EU15.

For instance, we compared Italy and Spain, we find out that $\hat{\tau}_8 - \hat{\tau}_5 = 5.278$, $\exp(5.278) = 1.96$. That is, Italy has 2 percent more workers aged 15-64 than Spain.

In the Scandinavian countries such as Sweden and Finland, the difference between them is $\hat{\tau}_{14} - \hat{\tau}_{13} = -0.007$, $\exp(-0.007) = 0.99$. This means that Finland has almost the same percentage of workers aged 15-64 with Sweden.

In the case Greece and Italy $\hat{\tau}_4 - \hat{\tau}_8 = -5.303$, $\exp(-5.303) = 0.005$, the difference in the percentage of workers aged 15-64 is very minimal, i.e., 0,005 fewer workers in Italy.

Even among the advanced countries of Europe there are variations in the number. More specifically between

Luxembourg and Sweden $\hat{\tau}_9 - \hat{\tau}_{14} = 0.002$, $\exp(0.002) = 1.00$, we find out that Luxembourg has equal percentage of workers aged 15-64 with Sweden.

Finally, comparing the number of workers aged 15-64 between the United Kingdom and Denmark, we see that $\hat{\tau}_{15} - \hat{\tau}_2 = 0.002$, $\exp(0.002) = 1.00$. It means that the United Kingdom also have equal percentage of workers aged 15-64 with Denmark.

VI. SUMMARY

The association model has a good fit and acceptable. However, the Column Effects Association Model (C) is much better and fully fitted to the data because it covers pretty well 100% of the data, thus, giving the best fit among all.

However, to be more precise, the total employment rate - employed persons aged 15-64 as a share of the total population of the same age group in the EU15 from 2008–2017 may have been influenced by various factors; these could be as a result of:

- A nation's natural and human resources, its capital stock (buildings and machines), its technology and the economic choices made by its citizens, both individually and collectively [13].
- Economic labour migration and social development
- The living standard of each country - the degree of utilization of the workforce, which is directly related to efficiency in the productivity of her citizens (the quantity of the goods and services that a worker can produce for each hour of work. A country may prosper if her citizens are productive and do not possess many anti-growth behaviours such as *corruption* and *bad work ethic* [14].
- A country's mortality rate; and
- Several other factors that is difficult to be determined in each country.

VII. CONCLUSION

We should mention that Θ , which is 0.99993, i.e. approximately equal to 1, disclose that we have independence between the variables. To determine the degree of association (correlation) between these countries and years, we use the θ of the second model, (the uniform association model which is represented by (U) for calculation. More specifically, the innate correlation index in log-linear form is equal to:

$$\log(F_{ij}) = \lambda + \lambda_{A(i)} + \lambda_{B(j)} + \phi X_i Y_j$$

where ϕ is a single parameter for interaction [15], [16].

The parameter of interaction

$$\phi = \log \theta = \log(0.99993)$$

$$\Phi = \ln(0.99993) = -7.00024$$

$$|\phi/2| = \sqrt{7.00024} = 2.6457966$$

$$\phi^{1/2} = \sqrt{7.00024} = 2.6457966$$

From our study on the association model for the total employment rate - employed persons aged 15-64, we could therefore, conclude that there is a negative correlation between countries and years in the total employment rate - employed persons aged 15-64 as a share of the total population of the same age group in the EU15 from 2008–2017. It will be interesting to know that experience-weighted measures can account for variation in work characteristics (e.g. working time) and job search behaviour (e.g. duration of unemployment) across countries and years. The definitions of employment are simple and augment the comparability across time and space.

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