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A Model for Tourism: The Total Number of Trips by Main Mode of Transport Used in 13 EU Countries

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Tourism is an important and fast-evolving economic activity with social, cultural and environmental implications, involving large numbers of small and medium-sized businesses. Its contribution to growth and employment varies widely from one region of the EU to another. In rural regions that are usually remote from the economic centers of their countries, tourism is often one of the main sources of income for the population and a prominent factor in securing an adequate level of employment. In this study, we consider and estimate the most accurate association model of the Categorical Data Analysis (CDAS) for tourism: the total number of trips (absolute value/unit) by main mode of transport used in 13 EU countries. The data used in this study were obtained from the Eurostat and estimated on actual base year from 2004 - 2012. Since the main focus is to have a better understanding of tourism - holidays in 13 EU countries, the analysis of association (ANOAS) table is given in order to ascertain the percentage of the data which is covered by each model. We find and estimate the association model with the best fit and in conclusion we find out that the Row-Column Effects Association Model (RC) of the (M = 8) has the best fit among all.

Introduction

The statistical definition of tourism is broader than the common everyday definition. It comprises not only private trips but also business trips. This is primarily because it views tourism from an economic perspective. Private visitors and business visitors have broadly similar consumption patterns. They both make significant demands on transport, accommodation and restaurant services. To providers of these services, it is of secondary interest whether their customers are private tourists or on business [13]. The crucial role that tourism plays in generating growth and jobs, its growing importance and its impact on other policy areas ranging from regional policy, diversification of rural economies, maritime policy, employment, sustainability and competitiveness to social policy and inclusion (‘tourism for all’) are widely acknowledged all over the European Union. Thus, tourism is reflected in EU policy as well as in national policies. The Lisbon Treaty acknowledges the importance of tourism, outlining a specific competence for the European Union in this field.

The statistically important factor is the usual place of residence of the visitors, not their nationality. Foreign visitors, particularly from far-away countries, usually spend more per day than visitors from the same country during their trips and thus generate greater demand for the local economy. Their expenditure also contributes to the balance of payments of the country visited. They therefore help to offset foreign trade deficits.

According to the UN World Tourism Organization, Europe is the most frequently visited region in the world. In 2008, five of the top 10 countries for visitors in the world were European Union Member States. The wealth of its cultures, the variety of its landscapes and the exceptional quality of its tourist infrastructure are likely to be part of the explanation. Enlargement hugely enriched the EU's tourism potential by enhancing cultural diversity and providing interesting new destinations to discover [13]. An analysis of the structure of and trends in tourism in Europe's regions confirms the compensatory role which this sector of the economy plays in many countries. It is particularly significant in regions remote from the economic centers of their country. There tourism services are often a prominent factor in securing employment and are one of the main sources of income for the population. This applies especially to Europe's island states and regions, to many coastal regions, particularly in southern Europe, and to the whole of the Alpine region.

A report conducted by the World Tourism Organisation (WTO), during the Global Tourism Forum 2011, in Andorra, has shown that Switzerland emerged as the number one most attractive European country for travel and tourism, followed by Germany, and Austria, in third place. Holland, Luxemburg, Denmark and Finland took seventh, eight, ninth and tenth place, while Portugal bagged the 13th place respectively [11]. The main beneficiaries of the upswing in tourism over the period 2004–08 were regions from Poland, Lithuania, Bulgaria, Greece and the United Kingdom. Nine Member States were on the list of the top 20 tourist regions visited by foreign tourists: Spain, France, the United Kingdom, Italy, Austria, Greece, Cyprus, Portugal and the Czech Republic [10].

Below are the data showing the total number of trips by main mode of transport used in 13 EU countries.

The data were obtained from the Eurostat and estimated on actual base year from 2004 – 2012.

Table 1. *Data showing the total number of trips (in millions) by main mode of transport used in 13 EU countries.*

geo time	2004	2005	2006	2007	2008	2009	2010	2011	2012
Belgium	1706.18	1706.18	1474.02	1887.73	1643.60	1585.56	1692.65	2078.34	2340.67
Denmark	1527.00	1474.90	1562.10	1626.70	1513.70	1509.50	1687.10	1724.26	2132.75
Germany	2180.00	2730.00	3030.00	3349.00	3197.00	2788.00	2866.00	2932.00	2994.09
Greece	4568.85	3912.08	3855.60	4197.58	4557.02	3773.70	3830.28	7814.97	7948.17
Spain	2272.63	2881.20	2326.47	3545.69	3209.88	3285.45	3527.61	4205.74	6424.32
France	8949.34	8923.82	8681.00	9387.00	8793.00	8615.00	8640.00	9760.00	10444.98
Italy	5505.02	5462.46	6118.20	5990.82	6064.30	5786.19	6435945	7051.97	7649.65
Luxembourg	1480.00	1840.00	1880.00	2280.00	2140.00	2450.00	2280.00	2560.00	2810.00
Netherlands	3310.00	3310.00	3359.00	3545.00	3680.00	3599.00	3982000	4331.00	4592.00
Austria	1434.81	1434.81	1618.03	1864.86	1535.67	1500.19	2275364	2349.79	2123.33
Portugal	4987.88	508.779	5837.09	5811.92	6013.69	6718.50	5386.46	8968.99	8732.70
Finland	9990.00	9680.00	1108.00	1255.00	1308.00	1221.00	1233.00	1505.00	1549.00
UnitedKingdom	1910.00	2100.00	2330.00	3190.00	3460.00	3350.00	3370.00	3320.00	3320.00

Source: Eurostat/JP: Tourism statistics at regional level

Methodology

Examination of All the Association Models

We consider six of the most commonly used association models of the Categorical Data Analysis. These are:

1. The Null Association or Independence Model which holds that there is no relationship between the variables and it is also symbolized with (O). The log-linear model is: Log $(F_{ij}) = \lambda+\lambda_{A(i)}+\lambda_{B(j)}$, where log denotes to the natural logarithm, F_{ij} are the expected frequencies under the Independence Model, $\lambda_{A(i)}$ are the rows main effects and $\lambda_{B(j)}$ are the columns main effects [2, '3].

2. The Uniform Association Model, which is symbolized with (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 $\chi_{i,}$ y_j are the scores for the row and column variables (i = 1,…, I, j = 1,…, J) respectively.

3. The Row-Effects Association Model (R) where linear interaction holds: log $(F_{ij}) =\lambda+ \lambda_{A(i)}+ \lambda_{B(j)}+ \varphi\mu_I y_j$, 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).

4. The Column-Effects Association Model (C) is the same as the Row-Effects Association Model with a change in subscripts: $\text{Log}(F_{ij}) = \lambda+\lambda_{A(i)}+\lambda_{B(j)}+\varphi\nu_j x_I$, 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).

5. The model whereby we have both row and column effects in additive form is called the Row+Column Effects Association

Model (R+C) or {Model 1, Goodman [6, 8]}. The log-frequency version of the above model is: log(Fij) = λ+λA(i)+ λB(j)+ $\sum_{1}^{I-1} \beta_{\kappa} y_j Z_{A(\kappa)}$ $\sum_{1}^{J-1} \gamma_{\kappa} x_i Z_{B(\kappa)}$, where χi, yj are the scores as defined earlier, and $Z_{A(i)}$, $Z_{B(j)}$ denotes to indicators of variable indices (or dummy variables) for the levels of row and column effects respectively.

6. The model, instead of additive row and column effects on the local odds ratios has multiplicative effects called the Row Column Effects Association Model (RC) or {Model II, [7]}. 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 those estimated from the data.

Explanation of the Results

The results of the total number of trips (in millions) by main mode of transport used in 13 EU countries are seen below:

Table 2. *Showing the results of the total number of trips by main mode of transport used in 13 EU countries.*

Models	(Likelihood) X^2	(Likelihood) G^2	Degrees of Freedom	Index of Dissimilarity	Final Iteration	Maximum Deviation
O	9118.36170	8901.94052	96	0.04222	3	0.00000000
U	7299.26409	7001.81921	95	0.03533	6	0.00030787
R	5193.27525	5170.96683	84	0.03261	7	0.00034554
C	5624.80225	5431.70723	88	0.02801	6	0.00028511
R+C	3626.37092	3626.12169	7	0.02597	7	0.00048455
RC	4449.21525	4304.59330	77	0.02507	924	0.00099371

We aim at finding the model (out of the six) that best fit from the other models which we are examining, i.e., the total number of trips by main mode of transport used in 13 EU countries for the period of 2000-2008. For this reason, we are going to examine first the Index of Dissimilarity (L2), which shows that, the lesser the number, the more our model will give the best fit to match the total number of trips by main mode of transport used in 13 EU countries compared with other models under consideration.

We analyse the six association models used in the data describe above with the help of the statistic package CDAS [4]. We used the Pearson chi-squared (X^2) statistic, the likelihood-ratio chi-square (G^2) statistic and, the index of dissimilarity $D = \sum_{ij} \left| f_{ij}/n - F_{ij}/n \right| / 2$ where f_{ij} are the observed frequencies and F_{ij} the expected frequencies (under the model) and we have the following results:

Table 3. *Index of Dissimilarity.*

Models	Index of Dissimilarity (D)
1. Null Association-Independence Model (O)	0.04222
2. Uniform Association Model (U)	0.03533
3. Row-Effects Association Model (R)	0.03261
4. Column-Effects Association Model (C)	0.02801
5. Row+Columns Effects Association Model (R+C)	0.02597
6. Row Column Effects Association Model (RC)	0.02507

At first sight it seems that the Row Column Effects Association Model (RC) adjusted better to the total number of trips by main mode of transport used in 13 EU countries in the years under study, as it is the one that has the lowest index of dissimilarity with D = 0.02507.

Authentically, we can prove this in another way through the calculation of Indicator BIC (Bayes Information Criterion) [1]. The formula for this calculation is:

$$BIC = G^2 - (d.f.) \, Log(n)$$

Symbols:

n = the size of the sample
d.f. = degrees of freedom of the models

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

When comparing a number of models, the model with the smallest index of BIC is regarded as the best. So we choose the models, those whose INDEX OF DISSIMILARITY are similar and the lowest out of the six models. However, since we have models with similar lower indexes, to justify the model which gives the best fit to match the countries and years, the application and the calculation of the Index BIC (Bayes information criterion) gives the solution [12].

More precisely, the 4th, 5th and 6th model, hence, we see:

For n = 798159.89 and

Log (n) = Log (798159.89) = 13.59006422

In continuation we calculate the index for:

4° Model: BIC = G^2 – (d.f.) Log(n) = 5431.70723– (88 * 13.59006422) = 4235.78157864

5° Model: BIC = G^2 – (d.f.) Log(n) = 3626.12169 – (77 * 13.59006422) = 2579.68674506

6° Model: BIC = G^2 – (d.f.) Log(n) = 4304.59330 – (77 * 13.59006422) = 3258.15835506

From these calculations we could now verify that the best model is the 5th, i.e. the row + column effects model (R+C).

Analysis of the Association Model

Afterwards, we check the models to see whether any of them is acceptable. Checking is being done with the likelihood-ratio chi-square statistic G^2 and with the use of X^2 distribution. In the case of X^2 distribution Statgraph program will be of good help.

Firstly, the likelihood-ratio chi-square statistic for the Null Association – Independence Model (O) is G^2 = 8901.94052 with 96 degrees of freedom (d.f.). The 95th percentile of the reference chi-square distribution is 120.017. So, the model of independence (O) is rejected because it has a bad fit since the X^2 distribution is much smaller than the likelihood-ratio chi-square statistic G^2.

In continuation the Uniform Association Model (U) is G^2 = 7001.81921 with 95 degrees of freedom (d.f.). The 95th percentile of the reference chi-square distribution is 118.894). 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.

The likelihood-ratio chi-square statistic G^2 for the Row-Effects Association Model (R) is reduced dramatically to 5170.96683 with 84 degrees of freedom (d.f.). The 95th percentile of the reference chi-square distribution is 106.556). Similarly, we observe that the model has a very bad fit because the X^2 distribution is much smaller than the likelihood-ratio chi-square statistic G^2.

The Column-Effects Association Model (C) has G^2 = 5431.70723 with 88 degrees of freedom (d.f.). (The 95th percentile of the reference chi-square distribution is 111.08) We therefore conclude also that this model show even the worst fit since the X^2 distribution is very much smaller than the likelihood-ratio chi-square statistic G^2.

Moreover, the statistics of the Row+Colum Effects Association Model (R+C), that takes into account the effects for both the total number of tourism in 26 EU countries and years in additive form, is G^2 = 3626.12169 with 77 degrees of freedom (d.f.). The 95th percentile of the chi-square distribution is 98.6146. Similarly this model has a bad fit, because the X^2 distribution is very much smaller than the likelihood-ratio chi-square statistic G^2.

Finally, the Row Column Effects Association Model in multiplicative form (RC), has G^2 = 4304.59330 with 77 degrees of freedom (d.f.). The 95th percentile of the reference chi-square distribution is 98.6146. Again the Statistics is dramatically reduced just as the previous model because they have the same d.f, but is shown to remain unacceptable fit since the X^2 distribution is very much smaller than the likelihood-ratio chi-square statistic G^2.

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

Creation of the Analysis of Association Table (ANOAS)

The ANOAS table was given by Goodman [9]. In this table the chi-squared are partitioned as sums of square in a two-factor analysis of variance using the likelihood. The ANOAS table partitions the X^2 so that it could be used as 2 factors analysis of variance using the percent of the G^2 (O) statistic for the basic (zero) independence model which measures the total deviation of the variables. In other words, we can find the percentage of baseline chi-squared X^2 distribution, which have effects on each of our models on the phenomenon being studied.

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

Table 4. *The ANOAS table.*

Effects	Model used	G^2	D.F	Percentage
1. General	O-U	1900.12131	1	21.35%
2. Rows	U-C	1570.11198	7	17.64%
3. Columns	C-RC	1127.11393	11	12.65%
4. Residual	RC	4304.59330	77	48.36%
Total	O	8901.94052	96	100.00%

As shown from the ANOAS table above, the uniform effects are very weak because the U model accounts for less than 21.35% of the baseline chi-squared value. The row effects are weak because the R model accounts for only the 17.64% of the baseline chi-squared X^2 distribution value. The column effects are very weak because the C model accounts for only 12.65% of the baseline chi-squared value. Finally, the residual model RC accounts for only 48.36%. Moreover, because our best model (R+C) show bad fit, it is supposed that we should proceed to examining the multivariate model.

The Multivariate Model

In the RC (M) association model, M represents the dimension fit to be, which is utilized by PROGRAM RCDIM. As shown below the multivariate model RC (M=8) is the acceptable model with the best fit.

The results are as follows:

Table 5. *Multivariate model.*

Models	RC(5)	RC(6)	RC(7)	RC(8)
X^2	120.12010	36.54936	12.79289	0.00000
G^2	120.28671	36.50028	12.79029	0.00018
d.f.	21	12	5	0
D	0.00273	0.00118	0.00069	0.00000

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

Examination of the Multivariate Model

The Model RC(7) with M=7, has likelihood-ratio chi-square statistic G^2 = 12.79029 with 5 degrees of freedom (d.f.). The 95th percentile of the reference chi-square distribution is 12.79289. We can observe here that the model has a satisfactory fit because the X^2 distribution is bigger than the likelihood-ratio chi-square statistic G^2.

Finally, the model RC (8) with M= 8, has likelihood-ratio chi-square statistic G^2 0.00018 with 0 degrees of freedom (d.f.). In this case the 95th percentile of the reference chi-square distribution is 100 after the likelihood-ratio chi-square statistic X^2 has 0.00000 effects with 0 degrees of freedom (d.f.). Here we could see that the multivariate model RC with M=8 has a perfect fit. We observe also that model M=8 covers {(8901.94052 – 0.00018) / 8901.94052} of = 100% of the total data.

Because the model with the smaller M, if it is satisfactory gives the better explanation of interaction of rows and columns, we will prefer model M= 8 that has perfect fit.

Estimation of the Multivariate Model

The expected frequencies under the independent and row effects models for the total number the total number of trips (absolute value/unit) by main mode of transport used in 13 EU countries of are given below:

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Note: The row effects model seems to give much better fit, particularly at the end of nominal scale.

Table 6. *Multivariate model.*

Countries (Row)	Years (Column)	Data	Expected values of Model (0) F_{ij}^{1}	Expected values of RC(M=8) F_{ij}^{2}
1	1	1706.18000	1367.02460	1706.18000
2	1	1527.00000	1251.91750	1527.00000
3	1	21800.0000	22111.8008	21800.0000
4	1	456.890000	377.139300	456.890000
5	1	2272.63000	2689.45250	2272.63000
6	1	8949.34000	6972.50380	8949.34000
7	1	5505.02000	4755.92430	5505.02000
8	1	148.000000	167.284200	148.000000
9	1	3310.00000	2859.43940	3310.00000
10	1	1434.81000	1368.88410	1434.81000
11	1	498.790000	488.153300	498.790000
12	1	999.000000	945.511800	999.000000
13	1	19100.0000	22352.6246	19100.0000

As seen from the table above, the values/prices of the model RC(M = 8) show how they fit better in the data.

Finally, in order to realise the degree of association (correlation) which exists between the countries and years (row and columns models), we use θ (Theta) of the second model, the (uniform association U) in order to calculate the indicator of innate association – i.e. φ (phi).

THETA (FOR THE MODEL II) = 1.00443

We observe that the price of θ (Theta) is in the price of 1, which means that we have independence association (correlation) between the 13 EU countries.

The odds ratio is θ (Theta) = 1.00443. The parameter of interaction is φ (phi) = φlnθ = ln (1.00443) = 0.00442. The φ (phi) ½ = √0.00442 = 0.0665

Based on the result, we can see that the relationship between the 13 EU countries and the years are slightly positive. In other words, there is no change in the relationship over these years (the change is about 0.07%). This means that the correlation is zero independence.

Logarithm and Comparison of the 13 EU Countries

All the six association models show bad fit. The columns effects model (years) are weak because it covers only 12.65% of the data. The multivariate model RC (M= 8) gives the best fit.

The estimated effects for the total number of trips by main mode of transport used in 13 EU countries are:

Belgium: $\hat{\tau}_1$ = Log (0.377349) = -0.974585 Italy: $\hat{\tau}_7$ = Log (0.873182) = -0.135611

Denmark: $\hat{\tau}_2$ = Log(0.462013) = -0.772162 Luxembourg: $\hat{\tau}_8$ = -Log (2.485100) = -0.910313

Germany: $\hat{\tau}_3$ = Log (2.409193) = 0.879292 Netherlands: $\hat{\tau}_9$ = Log (0.363599) = -1.011704

Greece: $\hat{\tau}_4$ = - Log (1.699264) = -0.530195, Austria: $\hat{\tau}_{10}$ = - Log (0.384853) = 0.954894

Spain: $\hat{\tau}_5$ = Log (0.261676) = -1.340648 Portugal: $\hat{\tau}_{11}$ = - Log (1.419529) = -0.350325

France: $\hat{\tau}_6$ = Log (1.259433) = 0.230662 Finland: $\hat{\tau}_{12}$ = - Log (0.748218) = 0.290061

United Kingdom: $\hat{\tau}_{13}$ = Log (2.403235) = 0.876816

We now compare 13 EU countries with each other for the total number of trips by main mode of transport used. For instance, if we compare some mediterranean countries like Spain and Greece, we see that: $\hat{\tau}_5 - \hat{\tau}_4$ = -0.8105, exp(-0.8105) = 0.4. This means that Spain had 0.4 percent fewer trips per 100.000 tourists than Greece.

In the case of countries like France and Italy we find out that $\hat{\tau}_6 - \hat{\tau}_7$ = 0.366273, exp(0.366273) = 1.4. In otherwords, France had 1.4 percent more trips per 100.000 tourists than Italy.

The difference in the total number of trips between Germany and England are: $\hat{\tau}_3 - \hat{\tau}_{13}$ = 0.00248, exp(0.00248) = 1. It means that Germany had 1 percent more trips per 100.000 tourists than England.

Finally, comparing the Scandinavian countries like Denmark and Finland, we see that: $\hat{\tau}_2 - \hat{\tau}_{12}$ = -1.06, exp(-1.06) = 0.35, equivalent to both countries. In otherwords, Denmark had 0.35 percent lesser trips per 100.000 tourists than Finland.

Summary and Conclusion

In generally conclusion we could see that the multivariate model RC (M= 8) gives the best fit among all. However, to be more precise, the percentage of trips with the most common means of transport by 100.000 tourists was influenced by several factors. These could be as a result of:

- government spending on tourism (Political factors)
- the standard of living of each country (Social, health and weather factors)
- the geographical location of each country (Market and accessibility factors)
- Technology Factors and
- various other factors which are difficult to be identified or determined.

Moreover, we can easily see from the above data showing the total number of trips by main mode of transport used in 13 EU that over the years the rate of tourism increased due to improved economic conditions [5]. ■

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