Finding the Appropriate Model to Evaluate the Price Indices of Domestic Agricultural Production in EU24

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Abstract — The structure of the European Union producer price indices, nominal total agricultural production varies from one country to another. The EU agricultural price indices involve the index of producer prices of agricultural products and the index of purchase prices of the means of agricultural production. The purpose of agricultural price indices is to unveil trends in the prices of individual agricultural products and purchase prices of the means of agricultural production. Moreover, the objective of the applying statistics on agricultural prices is to make comparisons between member states and also for economic analyses. Absolute agricultural prices are needed for many model calculations and for the ascertainment of price elasticity. The means through which these objectives could be achieved are believed to be when the absolute prices are compared between the member states, and also, when the products for which the prices from the respective member state are to be recorded for economic relevance. These objectives are not always compatible and sometimes require some compromise. In this study, we evaluate the price indices of domestic agricultural production as a whole in the EU24, using the most accurate association model of the Categorical Data Analysis. Figures from the Eurostat office calculated on annual base year from 2005-2017 were used to analyse this study. Since the main focus is to have a better understanding of producer price indices, nominal total domestic agricultural production, the analysis of association table (ANOAS) 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-Effects Association Model (R) has the best fit because it covers 93% of the data, thereby giving the best fit among all.

Index Terms — Association Model, Log-Linear and Non-Linear Models, Agricultural Price Indices, Domestic Agricultural Production, EU24.

I. INTRODUCTION

One of the EU sources of economy is agriculture which is banded with a bilateral principle. The national indices of agricultural prices of member states may vary from the EU

agricultural price indices as a result of their formula, base and field of observation. Price changes and price trends are fundamental for the measurement of absolute agricultural prices and agricultural price indices. Updates on the prices of products and the means of production are basically necessary to allow individual goals in the European Union agricultural principle to be decided, the indispensable measures to be taken and the effects of the principle to be observed.

To enable indices of groups of products or an overall index to be compiled from the various elementary indices of prices, weighting scheme is involved and the weighting problem is compounded in the case of an international index covering several countries. Thus, in principle, price indices can relate either to the production of agricultural products and the consumption of the means of production or to sales and purchases, but whichever combination is chosen the weights must be consistent with them. Agricultural products can be divided into two groups depending on their final use. These are: products sold outside the agricultural sector (for direct utilisation/utilisation after processing) or for export, and products to be sold within the agricultural sector as means of production, such as animal feeding stuffs, seeds or rearing animals.

The national authorities of the EU member states (National Statistical Offices and/or Ministries of Agriculture) are responsible for collecting absolute prices and calculating corresponding average prices for their country, as well as for calculating price indices and periodically updating the weights. The EU Working Group on agricultural accounts and prices normally meets once in a year in Luxembourg and are responsible for every question relating to agricultural price indices and absolute agricultural price statistics are discussed. Member States are required by the Eurostat to provide estimates of the output and input indices for the current year as a whole, 45 days before the end of the reference year. The selling prices of agricultural products and purchase prices of the means of production have a decisive influence on farmers' incomes. Therefore, it is useful to have indicators showing how agricultural revenue and expenditure are influenced by their price component [1].

A. Agricultural Price Index and Statistics

There are a wide range of methods by which estimates of a price or of an index may be generated from its current and past values and knowledge of the factors which may affect its future values. The EU Agricultural Price Indices are calculated for each Member State on the basis of the Laspeyres formula. The fixed weighting structure is

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representative of the base year. The use of Laspeyres indices is acceptable for practical reasons, as long as the period between two rebasements is not too long. The EU Agricultural Price Indices base level (output and input) are re-established for every 5 years [2].

$$I^t = \frac{\sum_{i=1}^k p_i^t q_i^0}{\sum_{i=1}^k p_i^0 q_i^0} \times 100 = \sum_{i=1}^k \frac{p_i^t}{p_i^0} \times \frac{p_i^0 q_i^0}{\sum_{i=1}^k p_i^0 q_i^0} \times 100 \quad (1)$$

where I - index (output or input).

p - prices of products (or means of production)

q - quantities sold of products (or quantities purchased of means of production)

i - product i (or means of production), ($i = 1, 2, \dots, k$).

t - observation period.

0 - base period.

Regardless of how we take the calculation, in practice there are in most cases several price quotations for a given product i . It is then necessary to calculate separately, on the basis of the available prices, a representative price relative for the product concerned. The Laspeyres formula can rarely be applied at this level, given that the weighting of the individual price series is not always known.

Replacing $\frac{p_i^t}{p_i^0}$ by R_i^t in the formula set out in equation (1), we derive the following formula:

$$I^t = \sum_{i=1}^k R_i^t \times \frac{p_i^0 q_i^0}{\sum_{i=1}^k p_i^0 q_i^0} \times 100 \quad (2)$$

with R_i^t being the elementary price index for the individual product i (or means of production i) in observation period t (i.e. the index of each product or means of production or the smallest grouping of them for which an index weight is used). In this formula the index is expressed in the form of the weighted average of the elementary indices with fixed base weights. The weights used are values (of sales or purchases) and not quantities. This formula allows one to adapt the calculation of the elementary indices to the different practical circumstances.

There are several possibilities for the calculation of the elementary price indices. The choice of the appropriate method depends essentially on the data available and on the degree of homogeneity of the products or means of production for which prices are recorded. As these circumstances might differ from one Member State to the other, a given elementary price index can be calculated using different methods.

B. Quarterly versus Annual Indices and Treatment of Complementary Payments

Agricultural price indices are calculated on a quarterly and an annual basis. Two options are involved for the calculation of the elementary quarterly indices. These are:

1. In cases where Member States collect API data on a

monthly basis for their national purposes: starting from monthly indices, the quarterly indices are calculated as a weighted average of the monthly indices using the monthly weights.

2. Starting from quarterly prices. This option means that the Member State collects API data quarterly.

Whichever option is chosen for the calculation of the quarterly price indices, the prices should reflect the average price of all sales and purchases in the quarter.

Ideally the elementary price of a product should be the weighted mean of the elementary prices of the varieties of the product. Usually the weights are the quantities sold (or purchased in the case of input products). In any case the calculation of the elementary prices will depend on the availability of appropriate data for the weighting coefficients [1].

The elementary quarterly index of the price of a product is obtained by relating the quarterly price to the reference price, i.e. to the average price of the elementary product in the base year. The aggregated quarterly indices (for a group of products or for all products) are obtained by calculating the weighted average of the elementary indices of the group or of all products.

In some countries, only an annual price (and therefore an annual index) is available for certain products. An example of this is sugar beet, for which the annual index (or the index of the crop year) is used in the quarter(s) where the sales take place.

The annual indices can be obtained in two ways: (i) either as a simple or weighted arithmetic mean of the corresponding quarterly indices or (ii) on the basis of an annual mean price, possibly stemming from other data sources. Eurostat advocates the first method, which is used in most cases (weighted arithmetic mean for the output indices, simple arithmetic mean – as a rule – for the input indices).

Although, inconsistencies will arise if the components of annual, quarterly and base prices are not the same, however, in some Member States, producers receive a preliminary payment for certain products when selling the product and a complementary payment afterwards (possibly at the end or after the marketing year). Such complementary payments are part of the price and are not subsidies. Complementary (or final) payments should be included both in the annual and in the quarterly price indices. If at the time of calculating a given quarterly or annual index the amount of the complementary payment is not yet known, an estimate of this payment should be made. Once information on the complementary payment is available, the indices concerned should be revised.

C. EU Calculation of Price Indices

There are three ways used for the calculation of EU agricultural price indices for the European Union as a whole. This includes:

- Estimation of the API for the euro area with the national weight.
- Conversion of the weights of the non-Euro Member States into Euro.
- Calculation of the API for the EU with the Euro weights.

D. Treatment of Seasonal Discontinuity of Output Price Series

When there are no transactions and therefore no prices for certain products in some quarters, the quarterly weight is zero and the related product should not be considered in the calculation of the quarterly aggregated index. This method reflects the actual market situation better and computation with fictitious prices of non-existing products can be avoided. On the other hand, the weighting scheme is different from quarter to quarter and as a result of this, quarterly price indices are only comparable between the corresponding quarters of different years.

E. Treatment of Missing Observations

Member States often fail to collect the intended number of representative prices, i.e., when there is weight, but the corresponding price data is not available), which leads to “missing observations”. The procedures which are mainly followed by countries are:

- (i) repetition of the last recorded price. In the case of a high rate of inflation, it may be appropriate to adjust the last recorded price.
- (ii) repetition of the last recorded price by applying the normal seasonal pattern to it.
- (iii) imputation of price changes on the basis of prices recorded on other markets for the same product.

F. Seasonal Adjustment

Many quarterly series of agricultural prices or price indices show a marked seasonal pattern. However no seasonally adjusted indices are calculated. Discussion is limited to comparisons with the corresponding period (quarter) of the previous year. Annual rates of change are thus calculated, and their interpretation is limited to an evaluation of the development of prices compared to their previous year's level.

G. Choice of Representative Products and Considerations Related to Price Formation

For each index heading (i.e. product or means of production or the smallest grouping of them for which an index weight) is used, a representative product must be selected whose price is to be monitored. The choice of these representative products is in the ‘Member States’ responsibility. It must be noted that the selected products should have an important share in the sales or purchases of the country in question so that the corresponding price series represent what the farmer actually receives (selling price) or pays (purchase price).

Differences in prices which are related, for example, to changes in quality, variations in the tonnage delivered, changes in the list of survey points or changes to any other price determining characteristic, must be eliminated by the Member States from the data forwarded, so that, as far as possible, only “pure” price variations are taken into account. The requirement regarding changes in quality applies to both output and input price indices. For industrial products (input) these changes are relatively frequent and major, and often represent an improvement in quality.

In order to avoid changes in prices, which might be caused by differences in quality, variety, packaging or terms of delivery etc., the selected products or services must be

defined as to the quality, variety, weight, packaging and other characteristics which influence the prices.

Loosely defined specifications, or the use of unit values, may cause considerable “unit value bias”, i.e. distortions due to the fact that for instance quality or variety changes are treated as price changes. For example, if in the case of the output price indices the unit value is taken for an agricultural product, an improvement of the quality and a tendency towards production of more highly priced varieties, would result in an increase of the product's average price (unit value). In the case of the input price indices, if the quality of a means of production, for example of ternary fertilisers, is loosely defined (i.e. 1-1-2) and an important quality characteristic such as the concentration of N-P-K is omitted from the definition, and the price observed is the average price (unit value) of the same product with different ratio of N-P-K, then this average price may increase simply for the reason that the concentration of N-P-K was increased between the two periods.

H. Treatment of Quality Changes and Product Replacement

It is sometimes necessary to change one of the selected products or means of production whose price is being used in the index. When this is done and a replacement product or means of production is selected there may be an associated change in quality or other price determining characteristics. This problem may be dealt with in several ways though, in the following, only the most important practices will be outlined.

Concerning the output price indices, changes in the definitions of the collected prices do not happen frequently. The effects of changes in quality on price may be readily quantified and the observed price of the item adjusted to allow for the change in quality. Also changes in other price determining characteristics (for instance in packaging, place of delivery, terms of payment etc.) in most cases can be valued and taken into account in a satisfactory way.

Changes in the definitions are more frequent in the case of the input price indices and concern chiefly the quality of the input. Frequent quality changes can occur particularly for compound feeding stuffs, fertilisers and, above all, agricultural tools and machinery. In the case where a defined input becomes unavailable, either generally or in a particular district, then a new product is chosen to replace the old one. If, however, an existing input is replaced by another of differing quality, then the problem is to assess how much of the price difference is attributable to differences in quality between the substitute and the replaced input. On this basis the price of the new product is adjusted to be in accordance with the quality level of the replaced product.

If, however, the change in quality is so great or difficult to quantify that no such adjustment can be made, then the old product is replaced by the new one. If both products existed in parallel during the period before substitution, then the price of the new product is recorded both for the period of substitution and the preceding period. The substitute product is linked into the index and a fictitious reference price is imputed for it on the basis of the rise in the elementary index of the replaced item from the base period.

$$p_i^{(0)} = \frac{p_i^{(t-1)}}{i_i^{(t-1)}} \times 100 \quad (3)$$

where: $p_i^{(0)}$ imputed base price of the substitute product (or means of production) i.

$p_i^{(t-1)}$: price of substitute product i in the preceding period.

$i_i^{(t-1)}$: elementary index in the preceding period.

If no reliable information on the actual price of the substitute product in the preceding period can be provided, then the price of the preceding period is estimated according to the price changes of similar products and a fictitious base price is calculated for the new product.

I. Concepts of Marketing Agricultural Products

Under the market price concept, the prices received from the sale for products and paid for the purchase of the means of production should be recorded without the deduction of taxes or levies and without the addition of subsidies. The treatment of taxes, levies and subsidies in the agricultural price statistics is the same as their treatment in the economic accounts for agriculture. As value added tax rates should be established so as not to affect income, Eurostat in principle records prices net of value added tax. It should be noted that this rule applies only to “deductible” value added tax. While value added tax paid when purchasing means of production is not refunded or compensated for all products and in all countries, non-deductible or non-compensable value added tax which is paid, is not deducted from recording prices.

The only exception to the principle of recording prices net of VAT concerns the value added tax on purchases of certain means of agricultural production for which there is no refund or compensation. Non-deductible or non-reimbursable VAT, which is paid in some EU countries for instance, on certain commodities like fuels in France, is not deducted from prices. It is the only one which is regarded as a component of purchase prices for the purpose of the EU Statistics on Agricultural Prices [1].

Furthermore, under the Economic Accounts for Agriculture, the production of wine and olive oil (exclusively using grapes and olives grown by the same holding) is considered as a characteristic agricultural activity. The production of wine or olive oil by units closely linked to agricultural holdings (e.g. agricultural cooperatives) is also treated as a characteristic agricultural activity. In contrast, the production of wine or olive oil by agro-food businesses is excluded.

II. PROCESSING OF DATA

The introduction and processing of observations (data) from table.1 below consists of producer price indices, nominal of the total domestic agricultural production as a whole for the period 2005-2017. The data used in this study were obtained from the Eurostat calculated on annual basis. The sub-indices were weighted by the values of sales in 2015 = 100.

TABLE 1: SHOWING TRENDS IN THE PRODUCER PRICE INDICES OF AGRICULTURAL PRODUCTION AS A WHOLE

Time/Geo	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Belgium	100	101,2	104,7	106,5	110,2	114,3	116,9	118,1	121,6	122,9	126,6	129,5	115,2
Czech Republic	100	104	103,3	102,5	103,9	107,6	112,4	116,4	121,3	128,7	136,4	143,4	110,3
Denmark	100	102,8	106,1	108,4	111,2	115,1	116,5	116,9	119,4	123,1	126,9	129,9	115,9
Germany	100	101	102,8	104,9	107	110,4	111,8	111,6	113	114	117,1	118,4	111,8
Estonia	100	104,4	116	121,1	121,5	134,7	156,6	167,7	181,2	200,2	223	244,2	145
Ireland	100	108,3	120,9	131,2	145,3	158,9	178,3	186	194	204,7	215,5	226,9	168,2
Greece	100	102,4	106,1	109,7	113,4	118,5	129,3	135,4	141,7	146,9	153,3	158,9	124,5
Spain	100	102,4	106,4	111,1	116,4	122,3	130,2	134,1	138,5	143,4	148,9	153,9	126,7
France	100	101,1	103,3	106,9	110,4	114,8	118,1	119,4	122,2	123,6	126,3	129,2	116,9
Italy	100	100,7	102,6	104,1	106,1	109,9	112,3	112,3	113,6	113,7	115,9	117,4	111,9
Cyprus	100	101,8	104,2	109,5	114,8	120,6	127,9	130,2	135,7	140,9	146,3	151,9	125,4
Latvia	100	103,9	112,6	117,9	121,8	130,2	149,7	160,5	174,5	192,9	215,9	235,2	140,6
Lithuania	100	105,1	114	122,5	120,7	125,7	143,3	158,1	169,7	182,5	196,2	209,9	134
Luxembourg	100	101,5	107,5	114,5	124,2	134,7	143,3	145,3	150,6	156,5	166,2	173,7	138
Hungary	100	101,3	106	111,1	115,8	121,8	132,2	137,7	144,4	150,5	156,4	160,2	126,7
Netherlands	100	103,4	107,8	112,1	117,3	121,9	124,4	124,8	127,2	129,2	132,9	136,8	124,3
Austria	100	102,6	104,5	108,2	111,8	115,6	117,5	118,8	121,7	124,2	128	131,3	116,5
Poland	100	106,2	113,8	119,4	124,8	130,1	133,4	138,5	145,9	151	159,8	167,3	131,5
Portugal	100	103,6	108	113,1	117,6	122,2	125,6	124,7	126,3	127	128,6	130,4	124,6
Slovenia	100	103,7	108,8	113	119,1	124	131,7	135,2	141,1	146,8	154,5	161	127,3
Slovakia	100	106,9	113,1	117,2	117,6	118,5	127,3	132,6	139,8	148,2	160,5	172,1	122,3
Finland	100	103,7	110	115,7	120,2	126,2	131,7	134	139	143,1	150,9	155,5	129,6
Sweden	100	101,3	103,7	107,5	112,4	117,2	120,9	122,9	128	131,7	137,5	142,1	118,5
United Kingdom	100	102,8	105,9	109,4	112,7	117	122,2	125,5	129,6	132	135,7	139,3	119,8

Source: Eurostat: Bureau of Economic Analysis/JP: Economic & Agricultural Production Research Institute.

With the help of the Categorical Data Analysis program, we were able to process the data in table.1 above for the Price Indices of the total Domestic Agricultural Production in the EU24. Below are the values (prices) of all models under estimation. The statistics used to compare the association (correlation) of the various models are X^2 (Pearson) Chi - Square and the Likelihood-Ratio Chi - Square G^2 -probability ratio [3]. In continuation, we have the following results b below:

A. Null Association-Independence Model (O)

Goodness-Of-Fit Information
Pearson chi-square = 191.84564
Likelihood-ratio chi-square = 191.56936
Degrees of freedom = 276
Index of dissimilarity=0.02477
Final iteration=3
Maximum deviation=0.00000000

B. Uniform Association Model (U)

Goodness-of-fit information
Pearson chi-square=190.46406
Likelihood-ratio chi-square=190.06999
Degrees of freedom=275
Index of dissimilarity=0.02473
Final iteration=4
Maximum deviation=0.00007288

C. Row-Effects Association Model(R)

Goodness-of-fit information
Pearson chi-square = 18.65966
Likelihood-ratio chi-square=18.66713
Degrees of freedom = 253
Index of dissimilarity = 0.00785
Final iteration = 6
Maximum deviation=0.00009947

D. Column-Effects Association Model(C)

Goodness-of-fit information
Pearson chi-square=189.57769
Likelihood-ratio chi-square=189.44402
Degrees of freedom=264
Index of dissimilarity=0.02460
Final iteration = 4
Maximum deviation = 0.00000055

E. Row-Column Effects Association Model I (R+C)

Goodness-of-fit information
Pearson chi-square=18.23238
Likelihood-ratio chi-square =18.24477
Degrees of freedom=242
Index of dissimilarity=0.00788
Final iteration=6
Maximum deviation=0.00009843

F. Row-Column Effects Association Model Ii (Rc)

Goodness-of-fit information
Pearson chi-square=15.69197
Likelihood-ratio chi-square =15.70389
Degrees of freedom=242
Index of dissimilarity=0.00671
Final iteration=221
Maximum deviation=0.00098459

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 [4].

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

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

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

$$\log(F_{ij}) = \lambda + \lambda_{A(i)} + \lambda_{B(j)} + \phi \mu_i y_j [5]$$

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 [6]. The log-frequency version of the above model is:

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

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.

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 that has the best fit among the 6 models used in our study, i.e. producer price indices, nominal of the total domestic agricultural production as a whole for the period 2005-2017. 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 programme [7]. 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:

$$D = \sum_{ij} \left| f_{ij}/n - F_{ij}/n \right| / 2 \quad (4)$$

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:

TABLE2:INDEX OF DISSIMILARITY	
Models	Index of Dissimilarity (D)
(a) Null Association-Independence Model (O)	0.02477
(b) Uniform Association Model (U)	0.02473
(c) Row-Effects Association Model (R)	0.00785
(d) Column-Effects Association Model (C)	0.02460
(e) Row+Columns Effects Association Model (R+C)	0.00788
(f) Row Column Effects Association Model (R*C)	0.00671

At first sight from Table 2 above, it shows that the Row Column Effects of the Association Model (R*C) adjusted better to the percentage of producer price indices, nominal of the total domestic agricultural production as a whole for the years under our study (having the lowest index of dissimilarity) with $D=0.00671$.

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. The Bayesian Information Criterion (BIC) attempts to resolve this problem by introducing a penalty term for the number of parameters in the model and gives the best solution [8].

The formula for this calculation is:

$$BIC = G^2 - (D.F.) \log(n) \quad (5)$$

Notations:

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

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

n = the size of the sample (39535.2).

$\log(n) = \log(39535.2) = 10.5849467$.

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:

$$3^{\text{rd}} \text{ model: } BIC = G^2 - (D.F.) \log(n) = 18.66713 - (253 * 10.5849467) = -2659.32$$

$$5^{\text{th}} \text{ model: } BIC = G^2 - (D.F.) \log(n) = 18.24477 - (242 * 10.5849467) = -2543.31$$

$$6^{\text{th}} \text{ model: } BIC = G^2 - (D.F.) \log(n) = 15.69197 - (242 * 10.5849467) = -2545.87$$

As we can see from the above calculations, the 3rd model (Row-Effects Association Model (R)) 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 models are being tested 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.

First, we observe that the likelihood-ratio chi-square statistic for the Independence model (O) which is $G^2=191.56936$ with 276 degrees of freedom. The 95% reference point chi-square distribution is 316.309. This model has a satisfactory fit because the X^2 distribution is bigger than the likelihood-ratio chi-square statistic G^2 .

Secondly, the Uniform association model has $G^2=190.06999$ with 275 degrees of freedom. The 95% reference point chi-square distribution is 315.223. As it could be observed, this statistic is acceptable and has a satisfactory fit since the X^2 distribution is greater than the likelihood-ratio chi-square statistic G^2 .

Also, the statistic G^2 for the Row model (R) is reduced dramatically for 18.66713 with 253 degrees of freedom. The 95% reference point chi-square distribution is 291.549. The row model also has an accepted fit because the X^2 distribution is much greater than the likelihood-ratio chi-square statistic G^2 .

The Column model (C) has $G^2=189.44402$ with 264 degrees of freedom. The 95% reference point chi-square distribution is 303.398 which show even a better fit as we could observe that the X^2 distribution is 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 the Years in additive form, is $G^2=18.24477$ with 242 degrees of freedom. The 95% reference point chi-square distribution is 279.687 and has an acceptable fit since the X^2 distribution is much bigger 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 has 15.69197 with 242 degrees of freedom. The 95% reference point chi-square distribution is 279.687. Also, this statistic is tremendously augmented just as the previous model because they have identical degrees of freedom, thereby showing 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 has the best fit. However, we have to find out the degree or level of effects on each model. To verify this, we will construct the analysis of association (ANOAS) table.

B. Analysis of Association Table (ANOAS)

The ANOAS table was given by [9]. In Table 3 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 the models on the phenomenon being studied.

Models	Likelihood- G^2	Degrees of Freedom	Index of Dissimilarity
O	191.56936	276	0.02477
U	190.06999	275	0.02473
R	18.66713	253	0.00785
C	189.44402	264	0.02460
R+C	18.24477	242	0.00788
RC	15.70389	242	0.00671

The analysis of association Table (ANOAS) in Table 3 above has the following differences of our models: O-U is the overall or total effects of the models, U-R are the row effects model, R-RC are the row effects model which gives the effects of the column, and RC and the residuals of the models.

TABLE 4: DEGREE OR LEVEL OF EFFECTS ON EACH MODEL (UNIFORMITY)

Model Effects	G^2 Prices	D.F.	Percentage
1. General (O-U)	1.49937	1	0.77%
2. Rows (U-R)	171.40286	22	89.40%
3. Column-effects which gives the Row-effects (R-RC)	2.97516	11	1.54%
4. Residual (RC)	15.69197	242	8.19%
Total (O)	191.56936	276	100.00%

From the ANOAS table in Table 4 above, we created the uniform association model (U) as shown, covers only 0.77% of the total baseline chi-squared X^2 distribution. The Row model (R) accounts for a large percentage of 89.40%, the Column model (C) covers a small percentage of 1.54% of the baseline chi-squared value. Furthermore, the RC effects (Residuals) are weaker because it accounts for only 8.19% of the baseline chi-squared value. We can also say that a very small percentage (1.54%) is unsatisfactorily explained by the linear model on the column- effects, making it unreliable and unacceptable due to its poor fit as we could see above, i.e., the value of the Pearson chi-squared X^2 distribution point for 95% confidence intervals are very much lower for the RC model.

Finally, we can also say that the percentage of $(191.56936 - 15.69197) / 191.56936 = 91.8\%$ of the data explained the rate of 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 producer price indices, nominal of the total domestic agricultural production as a whole for the period 2005-2017 in Belgium, Czech Republic,

Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Netherlands, Austria, Poland, Portugal, Slovenia, Slovakia, Finland, Sweden and United Kingdom, as seen from the data taken from the Eurostat, depended directly on the changes of the indices of the individual markets of each country and also from the years under our study (2005-2017).

IV. EVALUATION OF THE BEST MODEL

TABLE 5: EVALUATION OF THE BEST MODEL - ROW-EFFECTS ASSOCIATION MODEL (R)

Years	Countries	Data	Prices of model (0)	Prices of Model (Row)
1	1	100.0000	90.3114	100.1572
1	2	101.2000	93.1750	101.7968
1	3	104.7000	97.5401	104.9505
1	4	106.5000	101.5063	107.5304
1	5	110.2000	105.2203	109.7093
1	6	114.3000	110.3380	113.1984
1	7	115.2000	113.8488	114.8895
1	8	116.9000	117.1603	116.2602
1	9	118.1000	120.6673	117.7066
1	10	121.6000	125.6834	120.4781
1	11	122.9000	130.8650	123.2339
1	12	126.6000	137.6986	127.341
1	13	129.5000	143.6855	130.4481
2	1	100.0000	90.4632	95.2663
2	2	104.0000	93.3316	97.6177
2	3	103.3000	97.7040	101.465
2	4	102.5000	101.6768	104.8094
2	5	103.9000	105.3971	107.8077
2	6	107.6000	110.5234	112.1461
2	7	110.3000	114.0401	114.7523
2	8	112.4000	117.3571	117.0711
2	9	116.4000	120.8701	119.4969
2	10	121.3000	125.8946	123.3108
2	11	128.7000	131.0849	127.163
2	12	136.4000	137.9300	132.4757
2	13	143.4000	143.9269	101.3176
3	1	100.0000	90.5846	136.818
3	2	102.8000	93.4569	102.8371
3	3	106.1000	97.8351	105.8798
3	4	108.4000	101.8133	108.3359
3	5	111.2000	105.5386	110.3818
3	6	115.1000	110.6717	113.7385
3	7	115.9000	114.1932	115.2817
3	8	116.5000	117.5146	116.4995
3	9	116.9000	121.0323	117.7895
3	10	119.4000	126.0636	120.4
3	11	123.1000	131.2608	122.9877
3	12	126.9000	138.1151	126.9149
3	13	129.9000	144.1201	129.836

4	1	100.0000	86.4323	100.511	7	13	158.9000	158.4046	160.0114
4	2	101.0000	89.1730	101.3832	8	1	100.0000	99.2108	99.8169
4	3	102.8000	93.3505	103.7331	8	2	102.4000	102.3566	103.006
4	4	104.9000	97.1464	105.4787	8	3	106.4000	107.1518	107.825
4	5	107.0000	100.7009	106.8015	8	4	111.1000	111.5088	112.1689
4	6	110.4000	105.5987	109.3642	8	5	116.4000	115.5889	116.196
4	7	111.8000	108.9588	110.158	8	6	122.3000	121.2108	121.7293
4	8	111.8000	112.1280	110.6286	8	7	126.7000	125.0677	125.4416
4	9	111.6000	115.4844	111.1572	8	8	130.2000	128.7054	128.8839
4	10	113.0000	120.2850	112.9135	8	9	134.1000	132.5581	132.4875
4	11	114.0000	125.2441	114.6222	8	10	138.5000	138.0684	137.6857
4	12	117.1000	131.7841	117.5459	8	11	143.4000	143.7606	142.9939
4	13	118.4000	137.5139	119.5027	8	12	148.9000	151.2676	150.0245
5	1	100.0000	122.3578	94.6296	8	13	153.9000	157.8444	156.0408
5	2	104.4000	126.2376	101.5201	9	1	100.0000	90.5846	100.2242
5	3	116.0000	132.1515	110.478	9	2	101.1000	93.4569	101.9029
5	4	121.1000	137.5251	119.4801	9	3	103.3000	97.8351	105.0991
5	5	121.5000	142.5570	128.6711	9	4	106.9000	101.8133	107.7229
5	6	134.7000	149.4906	140.1366	9	5	110.4000	105.5386	109.9467
5	7	145.0000	154.2473	150.129	9	6	114.8000	110.6717	113.4858
5	8	156.6000	158.7338	160.3573	9	7	116.9000	114.1932	115.2242
5	9	167.7000	163.4853	171.3687	9	8	118.1000	117.5146	116.6424
5	10	181.2000	170.2813	185.1451	9	9	119.4000	121.0323	118.1376
5	11	200.2000	177.3015	199.8976	9	10	122.2000	126.0636	120.9644
5	12	223.0000	186.5600	218.0313	9	11	123.6000	131.2608	123.7776
5	13	244.2000	194.6713	235.7554	9	12	126.3000	138.1151	127.9506
6	1	100.0000	129.8003	107.8269	9	13	129.2000	144.1201	131.1215
6	2	108.3000	133.9160	114.4973	10	1	100.0000	86.2320	100.3367
6	3	120.9000	140.1897	123.328	10	2	100.7000	88.9663	101.1978
6	4	131.2000	145.8901	132.0154	10	3	102.6000	93.1342	103.5336
6	5	145.3000	151.2281	140.7191	10	4	104.1000	96.9212	105.2659
6	6	158.9000	158.5835	151.6933	10	5	106.1000	100.4675	106.576
6	7	168.2000	163.6295	160.8506	10	6	109.9000	105.3540	109.123
6	8	178.3000	168.3888	170.0551	10	7	111.9000	108.7062	109.9046
6	9	186.0000	173.4294	179.8769	10	8	112.3000	111.8681	110.3638
6	10	194.0000	180.6387	192.353	10	9	112.3000	115.2168	110.8807
6	11	204.7000	188.0860	205.5594	10	10	113.6000	120.0062	112.6219
6	12	215.5000	197.9076	221.9175	10	11	113.7000	124.9538	114.3154
6	13	226.9000	206.5122	237.5075	10	12	115.9000	131.4787	117.2202
7	1	100.0000	99.5629	121.423	10	13	117.4000	137.1951	119.1604
7	2	102.4000	102.7199	101.1364	11	1	100.0000	97.6871	98.8379
7	3	106.1000	107.5321	106.2869	11	2	101.8000	100.7846	101.9075
7	4	109.7000	111.9046	111.0064	11	3	104.2000	105.5062	106.5829
7	5	113.4000	115.9991	115.4468	11	4	109.5000	109.7963	110.781
7	6	118.5000	121.6410	97.6189	11	5	114.8000	113.8136	114.6591
7	7	124.5000	125.5115	125.6211	11	6	120.6000	119.3492	120.0154
7	8	129.3000	129.1621	129.5792	11	7	125.4000	123.1468	123.5686
7	9	135.4000	133.0285	133.7293	11	8	127.9000	126.7287	126.8498
7	10	141.7000	138.5584	139.5262	11	9	130.2000	130.5222	135.2786
7	11	146.9000	144.2708	145.4788	11	10	135.7000	135.9479	130.2838
7	12	153.3000	151.8044	153.2356	11	11	140.9000	141.5527	140.3726

11	12	146.3000	148.9444	147.147	15	11	150.5000	146.3820	109.0226
11	13	151.9000	155.4202	152.9157	15	12	156.4000	154.0258	156.4826
12	1	100.0000	118.7215	93.5177	15	13	160.2000	160.7226	163.6399
12	2	103.9000	122.4860	100.0653	16	1	100.0000	94.8279	103.5268
12	3	112.6000	128.2242	108.6105	16	2	103.4000	97.8347	105.4837
12	4	117.9000	133.4381	117.1539	16	3	107.8000	102.4181	109.0226
12	5	121.8000	138.3205	125.8365	16	4	112.1000	106.5826	111.9809
12	6	130.2000	145.0480	136.6916	16	5	117.3000	110.4824	114.5346
12	7	140.6000	149.6633	146.0561	16	6	121.9000	115.8560	118.4717
12	8	149.7000	154.0165	155.5996	16	7	124.3000	119.5424	120.5411
12	9	160.5000	158.6268	165.8502	16	8	124.4000	123.0194	122.2831
12	10	174.5000	165.2208	178.7151	16	9	124.8000	126.7019	124.1129
12	11	192.9000	172.0325	192.4516	16	10	127.2000	131.9688	127.3517
12	12	215.9000	181.0157	209.3618	16	11	129.2000	137.4096	130.5893
12	13	235.2000	188.8860	225.7901	16	12	132.9000	144.5849	135.2778
13	1	100.0000	114.2293	96.6606	16	13	136.8000	150.8712	138.9238
13	2	105.1000	117.8514	102.3651	17	1	100.0000	91.1006	100.8607
13	3	114.0000	123.3725	109.9646	17	2	102.6000	93.9892	102.5395
13	4	122.5000	128.3890	117.3952	17	3	104.5000	98.3924	105.7447
13	5	120.7000	133.0867	124.7995	17	4	108.2000	102.3933	108.3734
13	6	125.7000	139.5597	134.1716	17	5	111.8000	106.1398	110.5993
13	7	134.0000	144.0004	141.8898	17	6	115.6000	111.3021	114.1476
13	8	143.3000	148.1888	149.6072	17	7	116.5000	114.8437	115.8841
13	9	158.1000	152.6247	157.8239	17	8	117.5000	118.1840	117.2984
13	10	169.7000	158.9692	168.318	17	9	118.8000	121.7218	118.7897
13	11	182.5000	165.5231	179.3921	17	10	121.7000	126.7817	121.6196
13	12	196.2000	174.1664	193.1488	17	11	124.2000	132.0085	124.4351
13	13	209.9000	181.7389	206.1637	17	12	128.0000	138.9018	128.617
14	1	100.0000	106.5987	100.7733	17	13	131.3000	144.9410	131.7908
14	2	101.5000	109.9787	104.9831	18	1	100.0000	104.5165	103.5245
14	3	107.5000	115.1310	110.9409	18	2	106.2000	107.8305	107.0882
14	4	114.5000	119.8125	116.5093	18	3	113.8000	112.8822	112.367
14	5	124.2000	124.1963	121.8414	18	4	119.4000	117.4722	117.1743
14	6	134.7000	130.2369	128.8588	18	5	124.8000	121.7704	121.6722
14	7	138.0000	134.3810	134.0529	18	6	130.1000	127.6930	127.7719
14	8	143.3000	138.2896	139.043	18	7	131.5000	131.7561	131.9842
14	9	145.3000	142.4292	144.2915	18	8	133.4000	135.5884	135.9313
14	10	150.6000	148.3498	151.3806	18	9	138.5000	139.6471	140.067
14	11	156.5000	154.4659	158.7137	18	10	145.9000	145.4521	145.9117
14	12	166.2000	162.5319	168.1027	18	11	151.0000	151.4487	151.9005
14	13	173.7000	169.5985	176.5088	18	12	159.8000	159.3572	159.7512
15	1	100.0000	101.0199	98.1049	18	13	167.3000	166.2857	166.5561
15	2	101.3000	104.2230	101.7879	19	1	100.0000	94.1966	105.04
15	3	106.0000	109.1056	107.1273	19	2	103.6000	97.1834	106.6665
15	4	111.1000	113.5421	112.047	19	3	108.0000	101.7362	109.8753
15	5	115.8000	117.6965	116.6987	19	4	113.1000	105.8730	112.4782
15	6	121.8000	123.4210	122.9184	19	5	117.6000	109.7468	114.6574
15	7	126.7000	127.3481	127.3533	19	6	122.2000	115.0847	118.2009
15	8	132.2000	131.0522	131.5572	19	7	124.6000	118.7465	119.8623
15	9	137.7000	134.9751	135.9683	19	8	125.6000	122.2004	121.1867
15	10	144.4000	140.5860	142.0688	19	9	124.7000	125.8584	122.5875

19	10	126.3000	131.0902	125.3647
19	11	127.0000	136.4947	128.1206
19	12	128.6000	143.6223	132.2753
19	13	130.4000	149.8667	135.3848
20	1	100.0000	101.1473	100.3181
20	2	103.7000	104.3545	103.7507
20	3	108.8000	109.2433	108.8433
20	4	113.0000	113.6854	113.4772
20	5	119.1000	117.8451	117.8097
20	6	124.0000	123.5768	123.691
20	7	127.3000	127.5089	127.7434
20	8	131.7000	131.2176	131.5374
20	9	135.2000	135.1455	135.5124
20	10	141.1000	140.7634	141.1388
20	11	146.8000	146.5667	146.9024
20	12	154.5000	154.2202	154.464
20	13	161.0000	160.9254	161.0115
21	1	100.0000	101.7483	99.6071
21	2	106.9000	104.9746	103.2206
21	3	113.1000	109.8924	108.5028
21	4	117.2000	114.3609	113.3476
21	5	117.6000	118.5453	117.9095
21	6	118.5000	124.3110	124.0424
21	7	122.3000	128.2665	128.3614
21	8	127.3000	131.9972	132.4371
21	9	132.6000	135.9485	136.711
21	10	139.8000	141.5997	142.6708
21	11	148.2000	147.4375	148.7927
21	12	160.5000	155.1365	156.7632
21	13	172.1000	161.8816	163.7337
22	1	100.0000	100.7467	102.452
22	2	103.7000	103.9412	105.5513
22	3	110.0000	108.8106	110.3077
22	4	115.7000	113.2351	114.5629
22	5	120.2000	117.3783	118.4807
22	6	126.2000	123.0873	123.9185
22	7	129.6000	127.0038	127.4876
22	8	131.7000	130.6978	130.7706
22	9	134.0000	134.6102	134.2058
22	10	139.0000	140.2058	139.242
22	11	143.1000	145.9861	144.3723
22	12	150.9000	153.6093	151.2215
22	13	155.5000	160.2880	157.0271
23	1	100.0000	93.7109	98.6955
23	2	101.3000	96.6823	101.1301
23	3	103.7000	101.2117	105.1143
23	4	107.5000	105.3272	108.5775
23	5	112.4000	109.1810	111.682
23	6	117.2000	114.4913	116.1746
23	7	118.5000	118.1343	118.8728
23	8	120.9000	121.5704	121.2731

23	9	122.9000	125.2095	123.7841
23	10	128.0000	130.4144	127.7331
23	11	131.7000	135.7910	131.7216
23	12	137.5000	142.8818	137.2227
23	13	142.1000	149.0941	141.7186
24	1	100.0000	94.2087	100.3755
24	2	102.8000	97.1959	102.6654
24	3	105.9000	101.7493	106.5172
24	4	109.4000	105.8867	109.8275
24	5	112.7000	109.7610	112.7634
24	6	117.0000	115.0995	117.0874
24	7	119.8000	118.7618	119.5901
24	8	122.2000	122.2162	121.7842
24	9	125.5000	125.8746	124.081
24	10	129.6000	131.1071	127.8079
24	11	132.0000	136.5123	131.5602
24	12	135.7000	143.6408	136.8068
24	13	139.3000	149.8860	141.0334

¹f_{ij} Expected frequencies of the independence model.

²F_{ij} Expected frequencies of the model R.

From Table 5 above, it is clearly seen that the prices (value) of the Row-Effects Association Model (R) fully fitted to the data under our study.

V. LOGARITHMS FOR THE COLUMN-EFFECTS ASSOCIATION MODEL

The Row-Effects Association Model (R) is as follows:

Belgium: $\hat{\tau}_1 = -\ln(0.98314) = -0.01715$

Czech Republic: $\hat{\tau}_2 = -\ln(0.99118) = -0.00904$

Denmark: $\hat{\tau}_3 = -\ln(0.9818) = -0.01918$

Germany: $\hat{\tau}_4 = -\ln(0.97570) = -0.02429$

Estonia: $\hat{\tau}_5 = -\ln(1.03774) = 0.039221$

Ireland: $\hat{\tau}_6 = -\ln(1.02714) = 0.076961$

Greece: $\hat{\tau}_7 = -\ln(1.00216) = 0.001998$

Spain: $\hat{\tau}_8 = -\ln(0.99821) = -0.002$

France: $\hat{\tau}_9 = -\ln(0.98351) = -0.1715$

Italy: $\hat{\tau}_{10} = -\ln(0.97561) = -0.02429$

Cyprus: $\hat{\tau}_{11} = -\ln(0.99735) = -0.003$

Latvia: $\hat{\tau}_{12} = -\ln(1.03503) = 0.034401$

Lithuania: $\hat{\tau}_{13} = -\ln(2.251785) = -0.812$

Luxembourg: $\hat{\tau}_{14} = -\ln(1.00771) = 0.007968$

Hungary: $\hat{\tau}_{15} = -\ln(1.00362) = 0.004$

Netherlands: $\hat{\tau}_{16} = -\ln(0.98559) = -0.0141$

Austria: $\hat{\tau}_{17} = -\ln(0.98341) = -0.01715$

Poland: $\hat{\tau}_{18} = -\ln(1.0006) = 0.0006$

Portugal: $\hat{\tau}_{19} = -\ln(0.98228) = -0.01816$

Slovenia: $\hat{\tau}_{20} = -\ln(1.0004) = 0.0004$

Slovakia: $\hat{\tau}_{21} = -\ln(1.0024) = 0.002397$

Finland: $\hat{\tau}_{22} = -\ln(0.99657) = -0.003$

Sweden: $\hat{\tau}_{23} = -\ln(0.99117) = -0.00887$

UK: $\hat{\tau}_{24} = -\ln(0.98937) = -0.01069$

VI. RESEARCH FINDINGS & COMPARISON OF THE PRODUCER PRICE INDICES, NOMINAL OF THE TOTAL DOMESTIC AGRICULTURAL PRODUCTION AS A WHOLE

We try to compare some EU countries under our study to ascertain the variations within the producer price indices, nominal of the total domestic agricultural production as a whole for the period 2005-2017.

For instance, comparing Greece with Spain, we see that $\hat{\tau}_7 - \hat{\tau}_8 = 0.004$, $\exp(0.004) = 1.004$. It could be seen that Greece has 1,004 higher prices indices of domestic products than Spain.

In the case of Latvia and the Lithuania, we find that $\hat{\tau}_{12} - \hat{\tau}_{13} = 0.0010685$, $\exp(0.0010685) = 1.0010742$. This means that Latvia has 1.01 higher prices indices of domestic products than Lithuania.

Even among the advanced countries of Europe, we could observe the differences in the producer price indices. Specifically between United Kingdom and Austria $\hat{\tau}_{24} - \hat{\tau}_{17} = 0.0065$, $\exp(0.0065) = 1.0065$, we find out that the United Kingdom has 1.0065 times higher price indices of domestic products than Austria.

Also, comparing the differences in the producer price between Germany and the United Kingdom, we have: $\hat{\tau}_4 - \hat{\tau}_{24} = 0.0136$ and $\exp(0.0136) = 1.0137$, it means that Germany's prices indices of domestic products were higher with 1.0137 greater than the United Kingdom.

Furthermore, in the case of Belgium and Germany, Belgium: $\hat{\tau}_1 - \hat{\tau}_4 = 0.01$, and $\exp(0.01) = 1.0101$. We could observe that Belgium had a minimal difference with Germany in the producer price indices of the total agricultural products.

By comparing two Central European EU member states like, Czech Republic and Slovakia we have: $\hat{\tau}_2 - \hat{\tau}_{21} = -0.011437$, and $\exp(-0.011437) = 0.9886$, it means that Czech Republic had 0.9886 producer price indices slightly lower than that of Slovakia in relation to the of total agricultural production as a whole.

Finally, comparing two Scandinavian countries like Finland and Sweden, we see that: $\hat{\tau}_{22} - \hat{\tau}_{23} = 0.0$, $\exp(0.01187) = 0.9882$. In other words, Finland also had 0.9882 producer price indices slightly lower than Sweden as regards to the total agricultural production as a whole

VII. SUMMARY

The comparability of agricultural products and means of production for which price indices are recorded depends on a certain number of specific characteristics associated with the procedure for recording the prices and their statistical processing. Based on the fact that the structure of production varies from one country to another, it is left to the discretion of the member states which representative price indices should appear in the subgroup in their own case. By

comparisons on the EU agricultural price indices, the structures of the weights with respect to products and means of production reflect the value of the sales and purchases in each country during the base year. The weights therefore differ from one country to another and this obviously has an effect on trends in the aggregate indices.

Under the EAA, the production of wine and olive oil (exclusively using grapes and olives grown by the same holding) is considered as a characteristic agricultural activity. The production of wine or olive oil by units closely linked to agricultural holdings (e.g. agricultural cooperatives) is also treated as a characteristic agricultural activity. In contrast, the production of wine or olive oil by agro-food businesses is excluded.

Furthermore, the description of the price indices for commodities such as fuels does not provide all the indications desired on the subsidies existing in several countries, for example, the non-deductible or non-refundable VAT, which exist on fuels in France, is not deducted from prices. The granting of subsidies mostly depends on certain conditions which can change in the course of time and not all farmers of a country always benefit from them. For this reason, it is almost impossible to draw up general rules for handling these subsidies. All these characteristics could have an influence on the price level of a specific product or means of production. Thus, strict comparability between Member States would require that there should be fairness for all the prices collected in individual countries. Although, a general agreement has been achieved on the marketing stage, in reality, full harmonisation of all the price-determining characteristics (some of the marketing conditions, treatment of taxes, levies and subsidies) between Member States has not been feasible [10].

VIII. CONCLUSION

Agricultural prices are recorded at points which are as close as possible to those of the transactions which the farmer actually undertakes. This means that product prices are being recorded at the first marketing stage so as to best indicate the actual producer prices received by farmers. Similarly, the prices paid by farmers for their means of production are recorded at the last marketing stage, that at which the items arrive on the farm, so as to best indicate the purchase prices paid by farmers.

The field of observation for a price index covers all the goods and services for which it is desired to measure the price trends. However, there are several concepts which can be distinguished, and these concepts are characterised by a different coverage of agricultural products. Agricultural products are divided into two groups depending on their end use such as:

- ✓ products sold outside the agricultural sector (for direct utilisation or utilisation after processing) or for export.
- ✓ products to be sold within the agricultural sector as means of production, such as animal feeding stuffs, seeds, or rearing animals.

Based on the results of our research, we can see that all the six association models show satisfactory fit. However,

the prices indices of the row-effects association model (R) fully fitted best among all to our data. The producer price indices were directly dependent on the changes of the indices of the individual markets, i.e., the price index of domestic and foreign market producers.

Specifically, the price of prices indices of domestic products is affected by a number of factors. These could be as a result of:

- The standard of living of each country; every country can prosper if its citizens are productive and do not display behaviours that hinder development such as corruption and poor work ethic [11].
- Diversification of investments, public spending on agricultural development and taxation [12].
- The degree of utilisation of the workforce, which is directly related to efficiency in the production of goods and services [13].
- It is a well-known proposition in economics that monopoly price will be higher (and output lower) than price (and output) under competitive conditions. This enables a monopolist to earn higher - equivalent to the loss in consumers' surplus from not producing the competitive output at the competitive price [14].
- When a producer would persuade government (politicians, bureaucrats) to establish a monopoly in an industry by raising barriers to entry (requiring new entrants to obtain permission from the government to set up in that industry) then he would benefit since, as we have seen, producer's surplus is greater under monopoly than under competition [15].
- Government intervention (the efforts of public officials to react to such monopoly [16].
- Third party distortions caused by monopoly activity, for instance, in a country with exchange controls, commodities may only be imported with an import licence [17].
- Several other factors which are difficult to be determined in each country.

To evaluate 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. We should mention that Θ (Theta in Greek language), which is 0.99976, i.e. approximately equal to 1, unveil that we have independence between the variables. 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.

The parameter of interaction ϕ is:

$$\text{Log } \theta = \log (0.08906)$$

$$\phi = \log (0.99976) = -0.00024$$

$$|\phi^{1/2}| = \sqrt{0.00024} = 0.015491933$$

$$\Phi^{1/2} = -\sqrt{0.00026} = -0.015491933$$

The general conclusion based on our study is that there is

a correlation (association) in the price indices of domestic agricultural production in EU24. In the majority of member states, national indices of agricultural prices differ from the EU agricultural price indices. This could be as a result of their base, formula or field of observation, thus, we can conclude that the producer price indices on domestic products were depended directly on the changes of the indices of the individual markets, i.e., the Price Index (PPI) of domestic and foreign market producers, but without very much fluctuation.

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