eXclusive e-JOURNAL
ISSN 1339-4509
ECONOMY & SOCIETY & ENVIRONMENT

Analysis of evolution and interdependence of FAO food indices

Ing. Jaroslav Korečko, PhD., Ing. Ivana Ondrijová

Faculty of management - Department of Finance and Accounting -University of Prešov in Prešov; Konštantínova 16, 080 01 Prešov, Slovakia; jaroslav.korecko@unipo.sk, ivana.ondrijova@smail.unipo.sk

Abstract
International Organization FAO publishes in its activities the FAO Food Price Index (FFPI) which aims to help in monitoring developments in the global agricultural commodity markets. It consists of the average of five commodity group price indices, Meat Price Index, Dairy Price Index, Cereals Price Index, Oil and Fat Price Index, Sugar Price Index. The aim of the paper is to identify statistically significant effect of selected variables operate on meat index through a linear regression model.

Key words Food Price Index, FAO, Econometric model

1. INTRODUCTION

Food and Agriculture Organization of United Nations (FAO), an intergovernmental organization, has 194 Member Nations, two associate members and one member organization, the European Union. Its employees come from various cultural backgrounds and are experts in the multiple fields of activity FAO engages in. FAO's staff capacity allows it to support improved governance inter alia, generate, develop and adapt existing tools and guidelines and provide targeted governance support as a resource to country and regional level FAO offices. Headquartered in Rome, Italy, FAO is present in over 130 countries.

The main mission of FAO

- Help eliminate hunger, food insecurity and malnutrition
- Make agriculture, forestry and fisheries more productive and sustainable
- Reduce rural poverty
- Increase the resilience of livelihoods to disasters

Five main areas of FAO's activities

- Putting information within reach and supporting the transition to sustainable agriculture.
- Strengthening political will and sharing policy expertise.
- Bolstering public-private collaboration to improve smallholder agriculture.
- Bringing knowledge to the field.
- Supporting countries prevent and mitigate risks.
  (FAO, 2014)

2. MATERIAL AND METHODS

The FAO Food Price Index (FFPI)

The FAO Food Price Index (FFPI) was introduced in 1996 as a public good to help in monitoring developments in the global agricultural commodity markets. The only major modification made to it – until now – was in 2009, when its base period was updated to 2002–2004.

The index includes the following 5 groups of 23 commodities (The Monthly Bulletin of Statistics, 2014):

- **Meat Price Index**: Consists of 3 poultry meat product quotations (the average weighted by assumed fixed trade weights), 4 bovine meat product quotations (average weighted by assumed fixed trade weights), 2 pig meat product quotations (average weighted by assumed fixed trade weights), 1 ovine meat product quotation (average weighted by assumed fixed trade weights): the 4 meat group average prices are weighted by world average export trade shares for 2002-2004.
- **Dairy Price Index**: Consists of butter, skimmed milk powder, whole milk powder, cheese, casein price quotations; the average is weighted by world average export trade shares for 2002-2004.
- **Cereals Price Index**: This index is compiled using the grains and rice price indices weighted by their average trade share for 2002-2004. The Grains Price Index consists of International Grains Council (IGC) wheat price index; itself average of 9 different wheat price quotations, and 1 maize export quotation; after expressing the maize price into its index form and converting the base of the IGC index to 2002-2004. The Rice Price Index consists of 3 components containing average prices of 16 rice quotations: the components are Indica, Japonica and Aromatic rice varieties and the weights for combining the three components are assumed (fixed) trade shares of the three varieties.
- **Oil and Fat Price Index**: Consists of an average of 11 different oils (including animal and fish oils) weighted with average export trade shares of each oil product for 2002-2004.
- **Sugar Price Index**: Index form of the International Sugar Agreement prices with 2002-2004 as base.

This construction includes the use of 73 price series.

The objective of using an econometric model is to quantify the effect of selected explanatory variables on the explained variable. The aim is to find and develop the best linear model showing the dependencies between selected variables. The data in the model are annual data from 1990 to 2014 obtained from the FAO database. The basic design model reflects the impact of all these explanatory variables on the explained variable - **Mpi**.
The model was made in freely available comprehensive statistical and graphical programming language *R* (version 2.13.1.). For creation a linear model and its testing were loaded packages **Akima**, **fBasics**, **lmtest**, **car** and the following data:

- *Mpi* (Meat price index) – **Explained variable**

- *Dpi* (Dairy price index)
- *Cpi* (Cereals price index)
- *Opi* (Oils price index)
- *Spi* (Sugar price index)

} **Explanatory variables**

Normality of residues testing – Jarque-Bera Test

Normality of the distribution of casual failures is the basis for statistical inference of the model (model parameters and testing the model as a whole, interval estimation of parameters etc.). The test measures the difference between selected skewness and kurtosis of residues and skewness and kurtosis of normal distribution.

H_0: $u_t \sim N(0, \sigma^2)$
H_1: $u_t \nsim N(0, \sigma^2)$

Heteroscedasticity testing – Breusch-Pagan Test

Heteroscedasticity is inconstancy of casual failures and residues variance. It is a violation of the assumption of dispersions constancy in linear econometric model. Heteroscedasticity causes that the parameter estimates of econometric model, obtained by the method of least squares, lose some optimal properties (undistortion).
Breusch-Pagan test compared to other tests for the presence of heteroscedasticity in the examined model covers a wider range of alternative hypotheses to the null hypothesis of homoskedasticity.

H_0: Heteroscedasticity is present in the model
H_1: Heteroscedasticity is not present in the model

Autocorrelation testing – Durbin-Watson Test

The second requirement is the zero covariance assumption of off-diagonal elements in the covariance matrix of casual components. Unless this condition is fulfilled there is autocorrelation of casual components in the model. The consequences of autocorrelation are similar to those of heteroscedasticity. Estimated variances and standard errors, using conventional formulas, are biased and the quality of inductive conclusions is losing momentum. For testing autocorrelation we used Durbin-Watson test.

H_0: Autocorrelation is present in the model
H_1: Autocorrelation is not present in the model

Multicollinearity testing – VIF (variance inflation factor)

Multicollinearity is interdependence of explanatory (independent) variables and reduces the accuracy of the estimate of regression coefficients, due to the large standard errors of least squares estimator. Simple diagnostics of collinearity is VIF.

3. RESULTS

The FAO Food Price Index is a measure of the monthly change in international prices of a basket of food commodities. It consists of the average of five commodity group price indices, weighted with the average export shares of each of the groups for 2002-2004.

Under the new approach, the index includes the following 23 commodities: wheat (10 price quotations monitored and reported by the IGC), maize (1 quotation) and rice (16 quotations) for cereals; butter, whole milk powder, skimmed milk powder (2 quotations for each) and cheese (1 quotation) for the dairy group; poultry (13 quotations), pig (6 quotations), bovine (7 quotations) and ovine (1 quotation) for the meat dairy group; sugar (1 quotation); the oils group consists of one oil price quotation for soybean, sunflower, rapeseed, groundnut, cotton seed, copra, palm kernel, palm, linseed and castor. This construction, thus, includes the use of 73 price series.

(FAO, 2014)

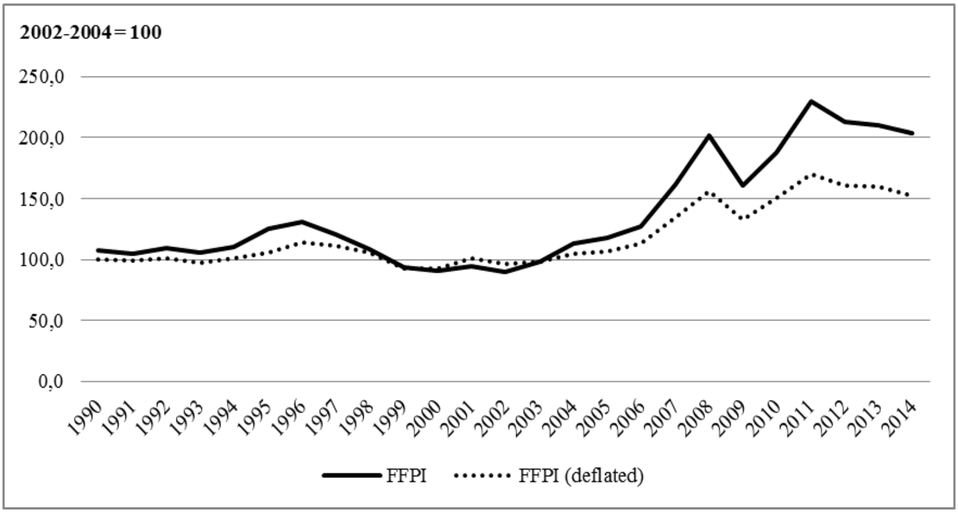

Figure 1 Development of indices over time
Source: Food and Agriculture Organization of the United Nations

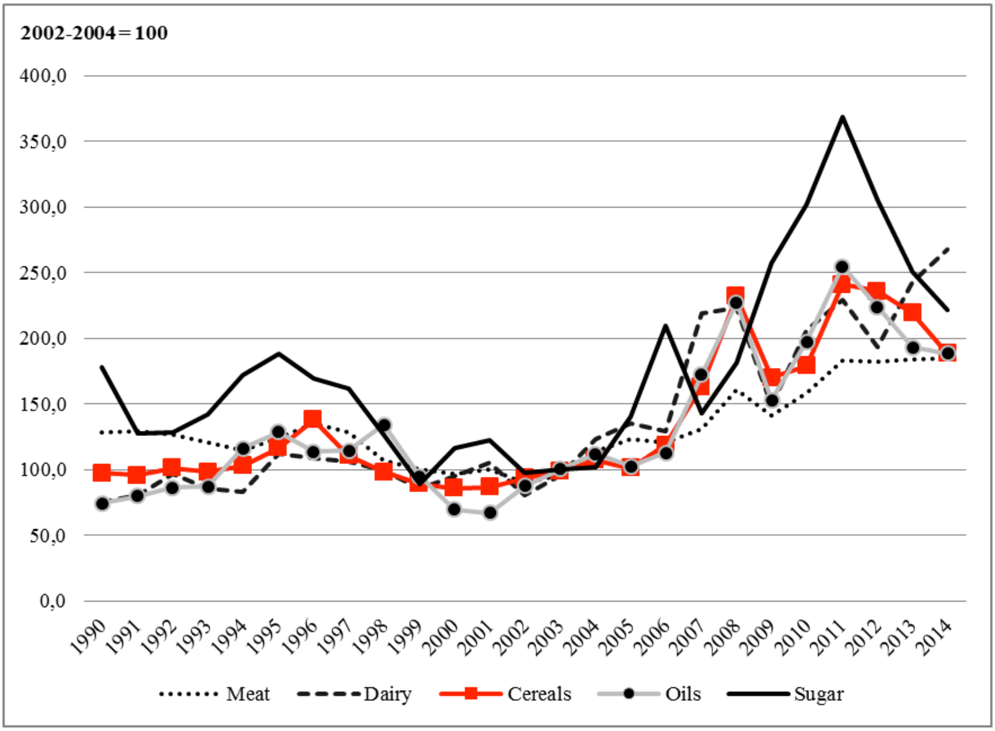

Figure 2 FAO Food Commodity Price Indices
Source: Food and Agriculture Organization of the United Nations

For creation a single-equation linear model we used following commands:

```
> model1=lm(Mpi~1+Dpi+Cpi+Opi+Spi,data=data1)

> summary(model1)
```

Estimated vectors of regression coefficients in the model generate impact of explanatory variables on the explained variable on significance level α. Realized test of statistical significance of variables determine which explanatory variables we considered as important determinants of **Mpi**. This fact illustrates the following Table 1:

Table 1 Model 1 – coefficients

```
Residuals:
   Min         1Q      Median    3Q      Max
-14.511    -10.336    2.430    5.768   18.021
Coefficients:
            Estimate  Std. Error t value  Pr(>|t|)
(Intercept) 59.50158    6.21534   9.573 6.55e-09 ***
Dpi          0.17019    0.08711   1.954   0.0649 .
Cpi          0.42082    0.17062   2.466   0.0228 *
Opi         -0.25741    0.14980  -1.718   0.1012
Spi          0.14527    0.05490   2.646   0.0155 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 10.8 on 20 degrees of freedom
Multiple R-squared: 0.8852,     Adjusted R-squared: 0.8622
F-statistic: 38.55 on 4 and 20 DF,  p-value: 3.917e-09
```

Source: own processing in R 2.13.1

Table 2 Model 1 – tests

Normality test	**jbTest(resid(model1))** Jarque - Bera Normality Test Test Results: PARAMETER: Sample Size: 25 STATISTIC: LM: 0.972 ALM: 1.01 P VALUE: LM p-value: 0.461 ALM p-value: 0.519 Asymptotic: 0.61
Heteroscedasticity test	**bptest(model1)** studentized Breusch-Pagan test data: model1 BP = 8.1936, df = 4, p-value = 0.08474

Autocorrelation test	**dwtest(model1)** Durbin-Watson test data: model1 DW = 0.6219, p-value = 4.735e-06
Multicollinearity test	**vif(model1)** Dpi Cpi Opi Spi 5.685721 16.353219 13.634986 3.299236

Source: own processing in R 2.13.1

The test result indicates presence of autocorrelation in the tested model (p-value <α). The factor of changes in variability indicates strong multicollinearity if (VIF > 10). We need to remove unwanted present characteristics from the tested model [model1]. Therefore, it is necessary to replace the original variables with differentiate variables and create new model [model2].

```
> model2=lm(diff(Mpi)~1+diff(Dpi)+diff(Cpi)+diff(Opi)+diff(Spi),data
  =data1)

> summary(model2)
```

Table 3 Model 2 – ceofficients

```
Residuals:
  Min        1Q       Median      3Q       Max
-11.7284  -4.7067   0.5927   5.0794   11.7570

Coefficients:
Coefficients:
            Estimate Std. Error  t value Pr(>|t|)
(Intercept)  0.06294    1.57353   0.040 0.968511
diff(Dpi)    0.18526    0.06385   2.902 0.009145 **
diff(Cpi)    0.36475    0.09203   3.963 0.000833 ***
diff(Opi)   -0.14588    0.08867  -1.645 0.116393
diff(Spi)    0.07105    0.03960   1.794 0.088746 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 7.428 on 19 degrees of freedom
Multiple R-squared: 0.7099,     Adjusted R-squared: 0.6488
F-statistic: 11.62 on 4 and 19 DF,  p-value: 6.072e-05
```

Source: own processing in R 2.13.1

Based on the model test, we removed the exogenous variables, which, according to the obtained t-value showed as not significant.

```
> model2=lm(diff(Mpi)~1+diff(Dpi)+diff(Cpi),data=data1)

> summary(model2)
```

Table 4 Model 2 – coefficients (without insignificant variables)

```
Residuals:

  Min       1Q       Median     3Q      Max
-17.430   -5.085   1.487    5.607   12.577

Coefficients:

Coefficients:
            Estimate Std. Error  t value Pr(>|t|)
(Intercept)  0.40237    1.67773   0.240   0.8128
diff(Dpi)    0.11027    0.05808   1.898   0.0715 .
diff(Cpi)    0.28410    0.06760   4.203   0.0004 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 7.963 on 21 degrees of freedom
Multiple R-squared: 0.6315,     Adjusted R-squared: 0.5964
F-statistic: 17.99 on 2 and 21 DF,  p-value: 2.802e-05
```

Source: own processing in R 2.13.1

Gradually improved „model2“ appears to be optimal, values of variables (Pr (> | t |)) are sufficiently low. „Model2“ has a good explanatory power, it can be tested on significance level α = 0.05.

Table 5 Model 2 – test

Normality test	**jbTest(resid(model2))** Jarque - Bera Normality Test Test Results: PARAMETER: Sample Size: 24 STATISTIC: LM: 1.133 ALM: 1.273 P VALUE: LM p-value: 0.38 ALM p-value: 0.419 Asymptotic: 0.567
Heteroskedasticity test	**bptest(model2)** studentized Breusch-Pagan test data: model2 BP = 0.7111, df = 2, p-value = 0.7008
Autocorrelation test	**dwtest(model2)** Durbin-Watson test data: model2 DW = 1.5255, p-value = 0.1337
Multicollinearity test	**vif(model2)** diff(Dpi) diff(Cpi) 1.261427 1.261427

Source: own processing in R 2.13.1

4. CONCLUSION

Tested "Model2" based on test scores was no longer burdened by any of undesirable characteristics. Resulting effect of statistically significant explanatory variables (Dpi, Cpi) for explained variable (Mpi) can be interpreted as follows: if the Dairy Price Index increases by 1 unit than Meat Price Index increases by 0.11027 unit, if Cereal Price Index increases by 1 unit than Meat Price Index increases by 0.28410 unit. The impact of these indices on Meat Price Index is a natural result because both of them are logically closely linked with it.

References

1. The Monthly Bulletin of Statistics. 2014. United Nations Publications, Volume LXVIII No. 1, ISBN: 978-92-1-061388-5. [online] Dostupné na <https://unstats.un.org/unsd/mbs/data_files/MBS%20Jan%202014.pdf>
2. The Monthly Bulletin of Statistics Online. 2014. Technical notes: World food situation: FAO Food price index. [online] Dostupné na <https://unstats.un.org/unsd/mbs/app/mbsnotes.aspx?tid=55>
3. Food and Agriculture Organization of United Nations. 2014. World Food Situation: FAO Food Price Index. [online] Dostupné na <http://www.fao.org/worldfoodsituation/foodpricesindex/en/?_=1393604860591>
4. FAO. 2013. Food Outlook November 2013. Fao's food price index Revisited. [online] Dostupné na <http://www.fao.org/fileadmin/templates/worldfood/Reports_and_docs/Special_feature_FFPI_en.pdf>
5. FAO. 2014. FAO's Food Price Index Revisited. [online] Dostupné na <http://www.fao.org/fileadmin/templates/worldfood/Reports_and_docs/FO-Expanded-SF.pdf>