Quantitative Solutions for the Substantiation of Decisions on the Food Market

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Abstract

The present paper intends, by using the spectral analysis, to measure and analyze the intensity of systematic variations of the time series referring to one of the most sensitive and important statistical macro-economic indicators, which has a significant impact upon all the economic and social policy decisions – the average monthly rate of consumer prices for food commodities.

Keywords: *Fourier series, seasonality, consumer prices, food commodities*

JEL classification: Q11, Q14

Introduction

The use of the spectral analysis in the analysis of the time series is of great interest for scientists. The first studies that date back from the mid '60s focused on the seasonal adjustment procedures and on the general spectral structure of the economic data. From the very beginning, it was considered that the spectral methods are significant in the determination and interpretation of the relation between the economic variables. Thus, after the first years, this method was used on an increasingly large scale, being useful in the investigation of the international business cycles, in the analysis of co movements between time series, as well as in the estimation of trends and cyclical oscillations. An extremely significant contribution to the analysis of temporal series was brought by the remarkable study made by Box Jenkins at mid '70s. A significant development, mainly for the macro-econometric studies, was given by the improvement of the social accounting systems, on the basis of which this author designed a useful and flexible methodology for carrying out certain important functions, such as prediction or forecasting. In the year 1972, Nold developed a bibliography of spectral methods applications in the economy that covered a great part of the most active period, recording 101 studies written by 68 different authors,

although certain references are only marginally relevant. While the progress in the computer science increased the availability of information, it made it possible for the econometricians to operate with larger systems, which could reveal the complexity of economic behaviour and decision-making, as well as to address the problems that seemed impossible to solve before, such as non-linearity, changing structure and stochastic properties. Under this changing background of research facilities, the econometric studies shifted from the analysis of periods to Vector Autoregressive Models (VAR), cointegration analyses and consistent model systems (with rational expectations).

When all the properties of these different methods are considered, the theoretical aspects of the "frequency domain" representations continue to remain of great importance.

1. Analysis of the seasonality of consumer prices for food commodities

1.1 Model structure specification

The theoretical model that has been used is similar to that presented by E. Pecican (Spectral Analysis and Decomposition of Time Series, Journal of Statistics, 10/1973) and Granger and Engle (Applications of Spectral Analysis in Econometrics, Handbook of Statistics, vol. 3, 1983). Thus, according to the spectral analysis, a diachronic phenomenon in time can be considered an aggregate of periodical variations with different frequencies and amplitude. The presence of a multiple number of different cadence oscillations, the vibration of which takes place on a synchronic basis, imposes the expression of the complex periodical wave by a trigonometric polynomial. Such a wave can be obtained by the aggregation of distinct frequency oscillations in a harmonic relation. The sequence of data that reveals a fluctuating evolution under a stationary background is represented by the finite sum of sine and cosine functions, under the form:

$$y_t = \frac{a_0}{2} + \sum_{f=1}^{p} (a_f \cos \frac{2\pi}{T} f \cdot t + b_f \sin \frac{2\pi}{T} f \cdot t) + u_t, (t = 1,2,...,T),$$

where:

a_0, a_f, b_f – parameters,

T – number of time units (t) in the considered time period,

f – apriorically established frequency.

The parameter sizes, by each frequency component f, can be estimated for a sample of n y_t values, by using the least squares method. In the same way, the $\frac{1}{2\pi}\int_0^{2\pi}\left[f_{(t)} - y_{n(t)}\right]^2 dt$ integral is taken into consideration, which reaches a minimum value when a_f, b_f are Euler-Fourier coefficients of the f(t) function, which can be calculated by means of the following relations:

$$\hat{a}_f = \frac{2}{T}\sum_{t=1}^{T} y_t \cdot \cos\frac{2\pi}{T} f \cdot t \,;\, \hat{b}_f = \frac{2}{T}\sum_{t=1}^{T} y_t \cdot \sin\frac{2\pi}{T} f \cdot t \,;\, \hat{a}_0 = \frac{\sum y_t}{T}.$$

The "f" frequency oscillation is quantified by means of an indicator specific to the spectral analysis – (A) amplitude:

$$A_f = \sqrt{\hat{a}_f^{\,2} + \hat{b}_f^{\,2}}$$

The measurement of the seasonal effect in the additive variant is determined as follows:

$$s_j \sum_{j=1}^{H/2} (a_f \cos\frac{2\pi}{H} f \cdot j + b_f \sin\frac{2\pi}{H} f \cdot j),$$

where:

$$a_f = \frac{2}{H} \cdot \sum_{j=1}^{H} s_j \cdot \cos\frac{2\pi}{H} f \cdot j;\; b_f = \frac{2}{H}\sum_{j=1}^{H} s_j \cdot \sin\frac{2\pi}{H} f \cdot j.$$

1.2 Results and discussions

In order to reveal the seasonal variation trend in the case of consumer prices for food commodities, we used the evolution of the average monthly rate in the period 2003-2009.

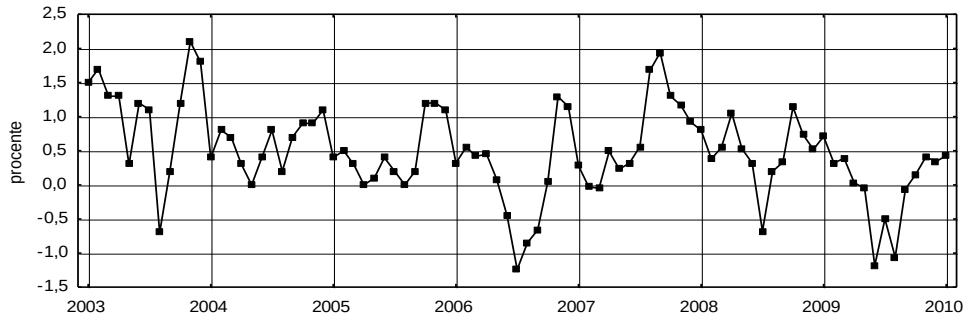


Figure 1: Average monthly rate for food commodities
Source: Prices Statistical Bulletin No. 1/2010, National Institute of Statistics

During the analyzed period, the prices of consumption for food has recorded a monthly average rate of 0.489 percent due to the administrative measures and awareness because of the diminution of the growth of the external currency income, of developing a powerful competitive environment in the retail sector, with an effect over the competition in the productive sector (this was stimulated in addition by the pressure of the imports), the substantial sterilization of the excess of liquidities on the internal market with the help of market operations, the accelerated implementation of the regulating laws of the crediting activities of the non-banking institutions. The absolute amplitude of the variation reached 3.34 percent, the decreasing adjustment between the extreme values of the

series could be associated to the increased competition along the whole production and marketing circuit under the pressure of complementary imports, of the competitive environment created on the retail market by the large-sized commercial operators, of the conjectural influences. The variation coefficient value (38.77 percent) indicates that the series is not homogenous, being a little bit asymmetric (Skewness = -0.17). The flattening coefficient indicates a leptokurtic distribution (Kurtosis=3.27>3).

For the analysis of the average monthly rate of the consumer prices for food commodities we first checked the data series stationarity hypothesis by means of the Dickey – Fuller Test (Unit Root Test), which implies testing the following hypotheses:

H_0: the series has a unitary root and it is stationary

H_1: the series is non-stationary

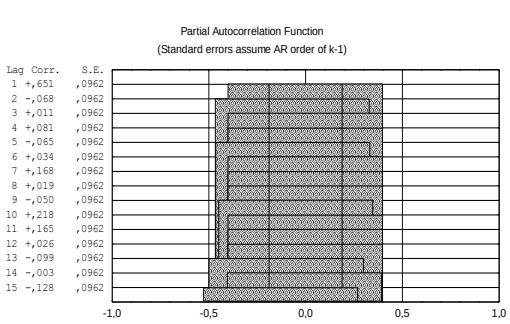
Starting from the temporal series model $Y_t - Y_{t-1} = (\varpi - 1) \cdot Y_{t-1} + \varepsilon_t / \varpi > 1$, the series is not stationary; $\varpi > 1$ the series is explosive; $\varpi < 1$ is stationary / the $\varpi - 1$ coefficient is tested by checking up the hypotheses: $\begin{cases} H_0 : \varpi = 1 \\ H_1 : \varpi < 1 \end{cases}$ By rejecting the null hypothesis we can consider the stationarity of the analyzed process, as in the table below.

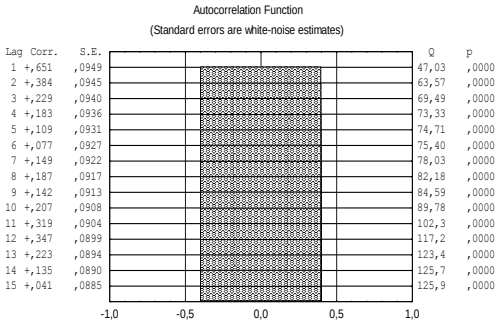
Unit root test for average monthly rate for food commodities

Table 1

			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-4.379089	0.0006
Test critical values:	1% level		-3.511262	
	5% level		-2.896779	
	10% level		-2.585626	
Dependent Variable: D(IPCMA)				
Variable	Coefficien	Std. Error	t-Statistic	Prob.
IPCMA(-1)	-0.369128	0.084293	-4.379089	0.0000
C	0.167253	0.070603	2.368919	0.0202
R-squared	0.191426	Mean dependent var		-0.013976
Adjusted R-squared	0.181444	S.D. dependent var		0.576004
S.E. of regression	0.521134	Akaike info criterion		1.558183
Sum squared resid	21.99804	Schwarz criterion		1.616468
Log likelihood	-62.66458	F-statistic		19.17642
Durbin-Watson stat	1.834950	Prob(F-statistic)		0.000035

In order to decide about the behaviour of the average monthly rate for food commodities we determined the auto-correlation and partial auto-correlation coefficients by means of the program Statistics – "Arima model".





The results show the stationarity of the series under study.

In order to estimate the parameters and calculate the indicators of the simple spectral analysis we calculated the monthly averages:

Month	**Jan.**	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
$\bar{y}_t$	0,63	0,6	0,52	0,52	0,17	0,14	0,03	-0,08	0,38	0,85	1,11	0,99

In order to determine the (A) amplitude we initially estimated the $\hat{a}_f, \hat{b}_f$ coefficients for each f frequency component:

$$\hat{a}_f = \frac{2}{T}\sum_{t=1}^{T} y_t \cdot \cos\frac{2\pi}{T} f \cdot t \qquad \hat{b}_f = \frac{2}{T}\sum_{t=1}^{T} y_t \cdot \sin\frac{2\pi}{T} f \cdot t \qquad A_f = \sqrt{\hat{a}_f{}^2 + \hat{b}_f{}^2}$$

$\hat{a}_1 = 0{,}4474$	$\hat{b}_1 = 0{,}04391$	$A_1 = 0{,}449548$
$\hat{a}_2 = 0{,}04464$	$\hat{b}_2 = -0{,}21053$	$A_2 = 0{,}215207$
$\hat{a}_3 = -0{,}02738$	$\hat{b}_3 = -0{,}08095$	$A_3 = 0{,}085459$
$\hat{a}_4 = 0{,}01798$	$\hat{b}_4 = 0{,}03155$	$A_4 = 0{,}036308$
$\hat{a}_5 = 0{,}00284$	$\hat{b}_5 = -0{,}0563$	$A_5 = 0{,}056369$
$\hat{a}_6 = 0{,}03072$	$\hat{b}_6 = 5{,}6E\text{-}16$	$A_6 = 0{,}030715$
$\hat{a}_7 = 0{,}00284$	$\hat{b}_7 = 0{,}0563$	$A_7 = 0{,}056369$

We obtained the following constants of seasonality:

$$s_j = \sum_{j=1}^{H/2} a_f \cos\frac{2\pi}{H} f \cdot j + b_f \sin\frac{2\pi}{H} f \cdot j$$

s_1 = 0,0949	s_7 = - 0,4396
s_2 = 0,1792	s_8 = - 0,5997
s_3 = -0,0451	s_9 = -0,0697
s_4 = 0,0907	s_{10} = 0,3274
s_5 = - 0,3602	s_{11} = 0,6355
s_6 = -0,3324	s_{12} = 0,519

The seasonal deviations in the months January and February were above the trend line by 0.522 percent, by 0.131 percent respectively. The price increase (by rates ranging from 1.9 percent to 4.8 percent) in certain basic foodstuffs – bread, potatoes, milk and dairy products, sugar were attenuated by price decreases by up to 6.7 percent in the prices for citrus, eggs, under the background of demand contraction after the winter holidays. The effective introduction of the single European currency on January 1, 1992 has not had a significant impact upon the modification of the general level of prices; only the variation of certain costs in the sector of services can be attributed to the launching of this currency on the market. The variation of the prices for food commodities was below the trend line by 0.136 percent in the month of March. With the beginning of the Lent period and of the yearly production cycle in the livestock sector, the tariffs of certain products like beef and pork, meat preparations, fish, eggs and oil decreased due to demand contraction and the absence of pressures on the side of import prices. In April, the seasonal factor deviated the prices of food commodities by 0.439 percent above the long-term trend, under the background of the contrary evolutions found in certain groups with a high share: speeding the increase rate of tariffs for meat and meat preparations by 2.5 percent, due to a higher consumption in poultry and lamb; increase of fruit and canned fruit prices by 3.4 percent, mainly due to citrus and meridional fruits; potato price cut by 3.7 percent, as a result of demand orientation to other types of vegetables, as well as of producers' concerns for the liquidation of stocks in the perspective of the new harvest, price cuts in eggs by 6.8 percent – the transfer in the product costs of the increase of tariffs for utilities being hindered by the existence of surplus supply, under the background of demand contraction after the end of Easter holidays. In May and June, the seasonal factor was below the trend line by 0.266 percent and by 0.119 percent respectively, under the background of a lower food consumption. Price attenuation in certain products that are important for population's consumption, such as milk and dairy products, eggs, white beans and other pulses, edible oil, fresh fish were partially balanced with the price increases in meat, meat preparations and canned meat, which followed an increasing trend up to 3.1 percent, which can be explained by the increasingly strong orientation of consumption towards beef and poultry meat, as well as by the evolution of world prices. The seasonal deviations in July, August and September

had the following negative values: -0.941 percent, -0.67 percent and –0.228 percent respectively, under the background of the price cuts in fresh fruit and vegetables, determined both by the increase of supply on the peasant market and by the diminution of import tariffs; decrease in egg prices; positive evolution of fuel prices. Inflationary pressures were exercised by the tensions generated on the meat market, by the drastic diminution of the pig herds, by the financial difficulties of the breeders and by the increase in the world prices. The variation of the food commodities prices in October and November was by 0.221 percent and by 0.416 percent respectively over the long-term trend. The highest relative increases were found in certain categories that account for about 28 percent of the consumption basket and about 63 percent of the total group: milling and baking products (+2.1 percent), meat, meat preparations and canned meat (+1.4 percent); milk and dairy products (+ 2 percent), eggs (+5.3 percent). The main cause of this evolution is the grain harvest output, which influences both the price of the milling and baking products and the feed costs and hence the tariffs of foodstuffs of animal origin and the speculative increase of commercial margins. In December, the seasonal factor deviated the dynamics rate of consumer prices for food commodities by 0.631 percent above the trend line. In the conditions of this month with the period of winter holidays and holidays at the end of the year, the most significant price increases were noticed in eggs (+15.6 percent), potatoes (+12.3 percent), fresh vegetables and canned vegetables (10 percent). The meat supply increase, which originated both from the domestic and foreign markets, due to the favourable tariffs practiced by the meat producers from certain countries (who benefit from subsidies from the government) led to the increase of prices for this product only by 0.6 percent on the average.

Conclusions

The consumer price evolution for the food commodities must be investigated in the context of a robust GDP increase up to the middle of the year 2008, followed by a strong decline of the economic activity, under the background of the world financial environment deterioration. In the next period, it seems necessary to implement more restrictive economic policies and to tighten up the monetary conditions in a broad sense, by the contribution brought by the increase of the effects of the prudential and administrative measures implemented by Romania's National Bank. By measuring the intensity of seasonal variations presented by the investigated time series, the present paper reveals the main characteristics of the spectral analysis, as well as the way in which this can be used in practice.

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