FORECASTING SEASONAL TIME SERIES WITH CALOT MODEL

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Abstract

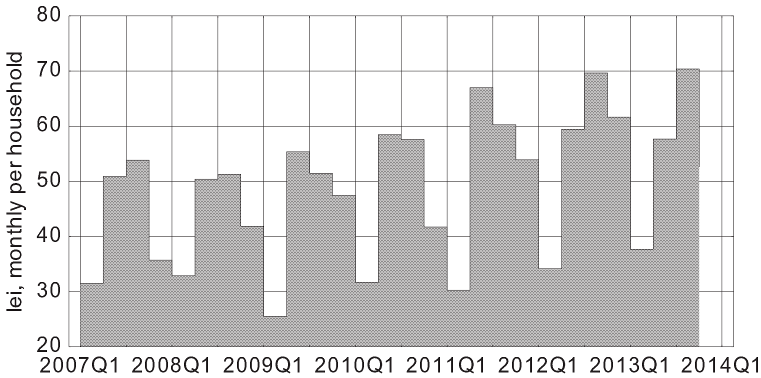
Activities with a variation trend depending on the change of seasons are frequent in agriculture. For such phenomena it is not enough just to analyze the annual change trend, the cyclical fluctuations which occur from one quarter to another or from one month to another must also be taken into account. In this context, the present paper proposes that by using statistical and econometric techniques to reveal regularities in the evolution of the agricultural monthly average income per household, the extrapolation of the investigated variable being based on it.

Keywords *Calot model; autocorrelation function; income from agriculture; seasonal time series; forecasting*

INTRODUCTION

The agricultural income, in real terms, was of RON 49.01 monthly average per household in the period 2007Q1-2013Q4, providing 2.93 percent of the total income, of which the income from sales of agro-food products, animals and poultry accounted for 2.11 percent, and the income from the agricultural works for 0.82 percent. The highest income in agriculture, monthly average per household, were made by the households of farmers (RON 316.88) and the lowest, by the households of employees (RON 11.59), the report between them being 27: 1. Their share in the total income of the households of farmers was 23.9 percent versus 0.52 percent in the households of employees. The agricultural income of rural households were 11.8 times higher than those of urban households and represented 7.18 percent of the total income of rural households and 0.46 percent of the urban households. The analysis of the average level of the agricultural income per deciles in 2013 shows a gap of 5.3: 1 between the

the average income per household in the first decile and the average income per household in the last decile.



Source: Own calculation based on the data from the statistical publication "Population Income and Consumption" National Institute of Statistics (2007 - 2013) the data are comparable, being expressed in the average prices of 2005
Figure 1 The quarterly evolution of the agricultural income between 2007 and 2013

The absolute amplitude of the variation, calculated for the monthly average agricultural income of a household in the period 2007Q1-2013Q4 (AIH), amounted to RON 44.88. The coefficient of variation (25.91 percent) reflects the absence of heterogeneity, the calculated mean being representative of the investigated series. The analysed distribution is slightly asymmetrical (Skewness = - 0.19). The flattening coefficient indicates a platykurtic distribution (Kurtosis =1.99)

Table 1. Descriptive indicators

Series: AIH Sample: 2007Q1 2013Q4 Observations: 28	
Mean	49.01393
Median	51.37000
Maximum	70.39000
Minimum	25.51000
Std. Dev.	12.69817
Skewness	-0.193226
Kurtosis	1.993830
Jarque-Bera	1.355343
Probability	0.507798

In order to verify whether the considered data series was affected by seasonality, we determined the autocorrelation function and partial autocorrelation function with the help of Statistica software – the ARIMA model.

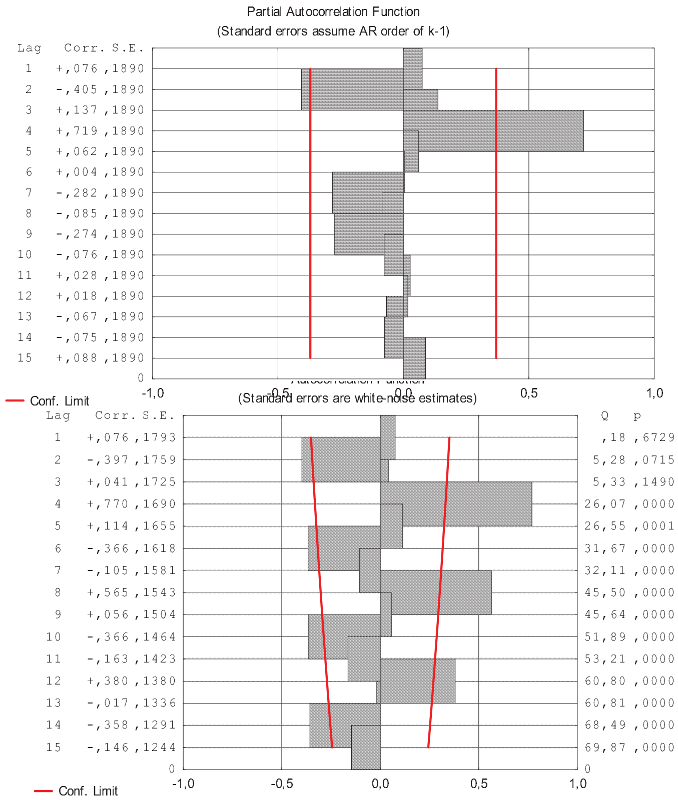


Figure 2. The Corel gram for AIH

The results obtained provide information on the non-stationarity of the analysed series and confirm the presence of seasonality.

THE ECONOMETRIC MODEL

A statistical model of simultaneous approach of the trend and seasonality was developed by the French professor Gerard Calot. This model can be applied if the time series meets the following conditions: the general trend is linear; the seasonality is stationary; the disturbance follows a normal distribution.

Starting from the linear form:

$$y_t = a_0 + a_1 t + u_t$$

seasonality is introduced into the model by dividing parameter a_0 in elements that refer to the origin ordinate of the trend (A) and s_j constants, $j=\overline{1,m}$, m being the number of periods in one cycle.

$$y_t=A+a_1t+s_j+u_t$$

Writing: $a_j = A + s_j$, is obtained:

$$y_t=a_j+a_1t+u_t$$

Knowing that: $\sum_{j=1}^{m} a_j = \sum_{j=1}^{m}(A+s_j) = mA$ and $\sum_{j=1}^{m} s_j = 0$ (principle of "minimizing the areas”), result:

$$A=\frac{1}{m}\sum_{j=1}^{m}a_j\ ;\ s_j=a_j-A=a_j-\frac{1}{m}\sum_{j=1}^{m}a_j$$

Since the variable "t" is an aggregate that allows running time per decades, months, quarters, semesters and years can be symbolized by j+im (where j =1,2,…, m sub-annual periods; i=0,1,2,…,(n-1) years).

$$y_{j+im}=a_j+a_1(j+im)+u_{j+im}$$

By using the method of least squares we estimate parameters a_j, a_1 on which we will determine the coefficients of seasonality, s_j, and the amount of term A, their calculation formulas are the following:

$$\hat{a}_1=\frac{1}{n(n^2-1)}\sum_{i=0}^{n-1}i(\bar{y}_i-\bar{y})\ ;$$

$$\hat{A}=\bar{y}-\frac{nm+1}{2}\hat{a}_1\ ;$$

$$\hat{s}_j=\overline{y_j}-\bar{y}-(j-\frac{m+1}{2})\hat{a}_1,$$

where:

$\overline{y_i}$ - the sub-period average (quarter, month) in the year i;

$\bar{y}$ - the sub-period average based on all the data;

$\overline{y_j}$ - the average of sub-period j regardless of the year.

ASSESSMENTS OF THE RESULTS PROVIDED BY THE ECONOMETRIC MODEL

After applying the Calot model for the data series on the monthly averages of the agricultural income per household, in the period 2007Q1 – 2013Q4, the aggregate of the systematic components (trend + seasonality) results as follows:

$$\hat{y}_{j+ih} = 46.124 + 0.199(j + ih) + \hat{s}_j$$

Quarter	I	II	III	IV
Seasonal deviations	-16.743	8.112	10.093	-1.462

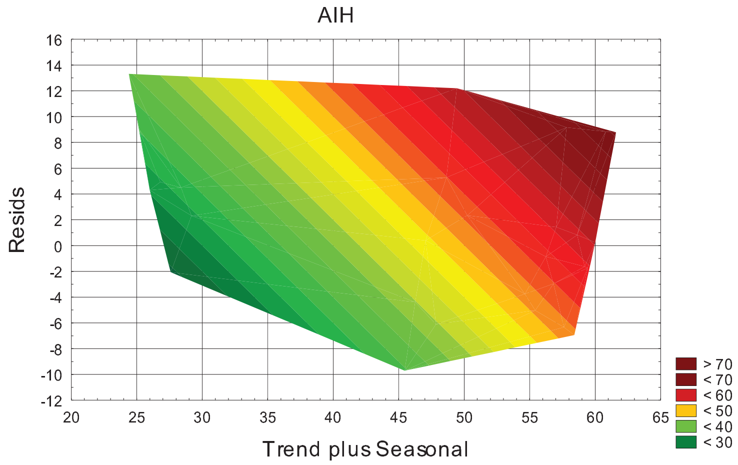


Figure 3. **Components of time series data**

Seasonal deviations in the first and fourth quarter were negative (under the trend line). The following contributed to this evolution: the decrease in the domestic supply in the animal product segment due to their high maintenance costs; the lack of adequate storage space for cereals, vegetables and fruits; the increasing trend in the demand for inferior products in times of economic downturn; the high competition of imports in the segment of agricultural products; the restrictions imposed by the EU accession. Seasonal deviations in the second and third quarters were positive (above trend line). The income from sales of agro-food products, animals and poultry contributed to the formation of the agricultural income of households by 68.07 percent.

The conjectural influences were also induced by: the difficult climatic conditions (2007, 2010, 2012), the very good results obtained in the vegetable production (2008, 2013), the massive reduction of bird flocks after outbreaks of highly pathogenic avian influenza virus type H5N1 (December 2007), the A type influenza virus specific to farmed pigs (2009), the increase in the volume of purchases of agricultural products from the commercial network made by the population, the increase of the number of slaughtered animals due to the high costs of fodder, the deterioration of the international financial climate (since the second half of 2007).

The model likelihood was checked up by using the variance analysis. The model is statistically valid, as long as the theoretical value for a significance level ά = 0.05 and 1, respectively 26 degrees of freedom, taken over from Fisher Snedecor distribution table is lower than the calculated F test value ($F_{ά,\ k,\ T-k-1} = 4.22 < F_{calc} = 116.82$). The correlation ratio is quite close to 1: R=0.87. The econometric model explains 75.69 percent of the total variance of the analysed phenomenon. For the first and second quarter of the year 2014, the point estimates of the expected levels for the investigated indicator are: $\hat{y}_{2014Q1} = 23.6$ lei and $\hat{y}_{2014Q2} = 60.21$ lei, respectively while the confidence intervals calculated for α=0.05 significance level are:[9.5929;37.6121],[46.1038;74.3233].

CONCLUSIONS

The subsistence economy, characteristic of the agricultural household, is evidenced by the low share of cash agricultural income, which represented, in the period 2007-2013, only 2.93 percent of the total income. The seasonal factor deflected the monthly averages of agricultural income per household in the first and fourth quarters by RON 16.743 and RON 1.462 below the trend line, and in the second and third quarters by RON 8.112, respectively RON 10.093 over the trend line. The degree of exposure of the national economy to climate variations or natural disasters affecting agricultural production is much higher than in developed countries. According to Vasile, Grabara (2014), supporting the development and putting into practice the agricultural strategies and policies at regional level accelerates the integration and strengthens the political dialogue with the regional organizations in the domain of agriculture, food safety and nutrition. Toderoiu (2013) mentioned that Romania's agri-food sector is in the process of restructuring and settlement of its structures on market principles. The purpose of the structural reform should be reflected in the increased competitiveness of the agri-food sector as a whole and in each of its components. In order to achieve the economic performance objectives it is necessary to evaluate the path travelled and outline the future development directions.

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