

Appropriate tools of Marketing Information System for Citrus Crop in the Lattakia Region, R. A. SYRIA

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Anotace

Produkce citrusů představuje jediný zdroj obživy pro mnoho rodin v regionu Lattakia v Sýrii. Zemědělci, kteří citrusy pěstují, nemají dostatek informací o očekávaných cenách na trhu, přičemž tyto informace jsou nezbytné pro jejich rozhodování. Pro farmáře je nutné vzít v potaz rozdíl cen, dle místa a roční doby při arbitrážích citrusů tak, aby mohli omezit vliv překupníků. Cílem článku je verifikovat užití SARIMA modelů jakožto vhodného nástroje pro informační tržní systém a predikci cen na trhu Lattakia v Sýrii.

SARIMA modely byly testovány pro predikci velkoobchodních cen pro trh Lattakia. Data byla získána ze stávajícího tržního informačního systému pro region Lattakia. Na základě výsledků je možné konstatovat, že SARIMA model (2,1,0) (1,0,1)₁₂ je vhodný pro predikci cen a může být součástí tržního informačního systému. Data byla zpracována v softwaru Minitab.

Klíčová slova

Tržní informační systém, Lattakia, Sýrie, citrusy, rozhodovací proces, SARIMA model.

Abstract

Citrus production represents the only livelihood source for many families in Lattakia region. Citrus farmers are not informed about expected prices. This information is crucial to make business decisions. For the farmers is necessary to take into account the spatial and temporal arbitrage of citrus harvest and storage, which may improve citrus farmer's position in marketing chain and reduce the influence of intermediaries. The aim of the paper is to verify using of SARIMA models as a tool of Agricultural Marketing Information System for citrus price forecasting in Lattakia region, R. A. Syria.

The SARIMA model were tested for citrus wholesale prices prediction at Lattakia market in the paper. SARIMA model was applied on the empirical data, obtained from the actual Marketing Information System in the Lattakia Region. Results showed that SARIMA model (2,1,0) (1,0,1)₁₂ is suitable for seasonal prices prediction. This method is suitable to be part of AMIS. The data was processed in software Minitab.

Keywords

Marketing Information System, Lattakia, Syria, citrus fruits, decision-making, SARIMA model.

Introduction

Syria is a Mediterranean country, where agriculture plays a key role in enhancing the national economy through its multiple contributions to the economic and social development process of the country. Citrus is an important crop in the Syrian Arab Republic, it is consumed both as fresh fruit and citrus juice. Citrus production provides an important source of income for more than 35, 000 Syrian farm families located

in the coastal governorships of Lattakia and Tartous (CBS, 2014).

It is very important to find the way how to provide the services to the farmers. Csótó (2010) says: „information technology is regarded as mediating channels and a vehicle for new services“. Shepherd (1997) describes the contribution as follow: „A Market Information Service is seen as providing “transparency,” i.e. a full awareness of all parties of prevailing market prices and other

relevant information. This, in turn, can contribute to “arbitrage,” i.e. the act of buying at a lower price and selling at a higher price. In theory, when a marketing system functions efficiently prices at different markets are influenced by arbitrage activities of traders, i.e. “spatial arbitrage.” takes place. Traders take advantage of price differences until these differences decrease to the level of transaction costs. “Temporal arbitrage” is the storing of products in order to take advantage of expected higher prices later in the season or, in some cases, in subsequent years“. In Lattakia region the more profit party of the market chain was intermediaries and farmer suffer from them. Deepak et al. (2007) viewed: ‘marketing intermediaries in developing countries as parasites, taking advantage of farmers weak bargaining power and poor economic conditions“ so, Agriculture Marketing Information System (AMIS) may improve farmers market position. To make an AMIS more economically sustainable and effective, one has to provide basic information on prices and market conditions free to all the target participant and the extension services (Dinar, 1996). Therefore the aim of this paper is to develop model which could help to the farmers in the decision making process and improve the income of citrus producers from one side and increase its contribution to the national economy from the other.

In Syria the MIS is arranged by Ministry of Agriculture. The data are collected as daily prices for all main Syrian markets. The collected data are stored in archive. But they are no available in electronic format and they are not published. That’s why there is a lack of information for stakeholders.

To find the appropriate way there is necessary to collect and process the data of the farmers. Aker and Mbiti (2010) found that mobile phones have spread from urban centers to rural areas as well as from the wealthy to the poor in developing countries, as a tool for collecting and disseminating of marketing data. Users who implement a MIS should find that they are better able to:

- a) make informed marketing decisions;
- b) negotiate with others in the marketing chain;
- c) organize production and sale; and
- d) facilitate group discussion and decision-making (Shepherd, 1997).

Citrus prices in Syria have seasonal Characteristics

and more fluctuation between the months and markets, the price fluctuation risk of agricultural products has become one of the main risks faced by agricultural producers (Chuan, Junye, Min, 2010).

Price fluctuation and changes was very important issues to the farmers in Lattakia region, the increased price of the commodity has generated significant discussion on the causes and on making appropriate decision (Timmer, Dawe, 2007, World Bank, 2008, Sugden, 2009).

The analysis of price volatility is necessary to develop bidding strategies or negotiation skills in order to maximize profit (Kuwornu et al., 2011). White and Dawson (2005) indicated that, planting decisions are taken on the basis of expected prices at harvest time; hence forecasting food prices will give farmers the opportunity to take informed decisions regarding planting in the future. Autoregressive integrated moving average (ARIMA) models (Tomek, Myers, 1993) lead to more accurate estimates. One of the most important and widely used time series models is the (ARIMA) model, which serves as a benchmark model for creating linear models because of it theoretical elaborateness and accuracy in short term forecasting (Jhee, Shaw, 1996). Nochai and Nochai (2006) in this paper was forecasting oil palm price of Thailand in three types as farm price, wholesale price and pure oil price for the period of five years, 2000 – 2004. Applying ARIMA model Hossian et al. (2006) forecasted three different varieties of pulse prices namely motor, mash and mung in Bangladesh with monthly data from January 1998 to December 2000; Pargami et al., (2013), in this research showed that SARIMA parametric model enjoys the most power in modeling the time series of monthly retail prices and, the most appropriate model for forecasting the monthly retail price of Privileged Sadri rice. Felipe et al., (2012) based on the daily prices of soybeans of the years 2000 (from January) to 2011 (until October) describe short-term forecasts by using ARIMA model, and it was observed that the ARIMA (5,0,0) or simply AR (5), responded as the best model. Seasonal ARIMA (SARIMA) model is described by Sampson et al. (2013): „Among the seasonal decomposition models of forecasting, Seasonal Autoregressive Integrated Moving average (SARIMA) method could enable producers achieve better market positions by adopting the practice. The SARIMA model is an extension of the ARIMA model into capturing

both seasonal and non-seasonal behavior of a time series data". Adanacioglu and Yercan (2012) this paper analyse the seasonal price variation of tomato crop and to develop a Seasonal ARIMA (SARIMA) model to forecast the monthly tomato prices at wholesale level in Antalya, SARIMA (1, 0, 0) (1, 1, 1)₁₂ model was selected as the most suitable model to forecast of tomato prices.

The SARIMA model was used by Cahndran and Pandey (2007) to forecast potato wholesale price of Delhi market. They found that the SARIMA model (1,1,1) (1,0,0)₁₂ fits well for short-term seasonal price forecasting. Luo et al., (2013) concluded that SARIMA model (1,0,1) (1,1,1)₁₂ as a well fitting for short-term vegetable prices forecasting and warning.

In Syria the MIS is arranged by Ministry of Agriculture. The data are gathered as daily prices for all main Syrian markets. The collected data are stored in archive. But they are no available in electronic format and they are not published. That's why there is a lack of information for stakeholders. Using the SARIMA model as a part of AMIS for citrus crop should help to provide information about expected prices and their seasonal volatility. According these information farmers could decide which market and intermediary provide them the best option to yield the profit. To provide all needed information the AMIS should consist of three parts: database of citrus products (contains the daily prices and quantities traded. This part is working in this moment, but the data are not published.), database of citrus producers and market research database. The last mentioned one should contain predicted (expected) and real minimum and maximum prices, theoretical and real supply and demand for given markets.

The objective of this paper is to verify the Seasonal ARIMA (SARIMA) models as a tools of AMIS to predict future prices of lemon Autochthonin Lattakia region in Syria, R. A. The predicted monthly prices may help farmers in choosing the right time and place for selling their citrus fruits.

Materials and methods

There were stated research question: Are the ARIMA, resp. SARIMA models suitable to be part of the Agricultural Marketing Information System (AMIS)?

The main aim of the paper is to verify using of SARIMA model as tools of Agricultural Marketing Information System (AMIS) for citrus price forecasting in Lattakia region, R. A. Syria. The purpose of the SARIMA model is forecasting the price during the year with the price volatility. The SARIMA model is based on the prices from previous years.

Materials

The market data are gathered by the Ministry of Agriculture, Lattakia Agricultural Economic Directorate and Marketing Department in Syria. The extension officers collect data from main wholesale markets. The data are available for daily maximum and minimum prices and production quantity for each regional wholesale market. These data were obtained by one of the authors (H. Sulaiman) during his visit in Syria. There were available data with daily prices for several varieties of lemon traded at local market. The data were not available in electronic form, so there was necessary to transfer them to the MS Excel. Then the data were transferred to the monthly average prices of lemon Autochton on Lattakia market for years 2010 – 2013. There were 48 observations with an average of 33.31 and the minimum value of 16 recorded in the year 2012 and maximum value 83,7 recorded in the year 2013, and the dispersion of the values of this series for an average by the value of standard deviation of 19,05, which gives an idea about the degree of non-homogeneity of the sample of data. SARIMA model was created in SW Minitab and use monthly data described above.

Lemon Autochton variety is one of the most important varieties for 35,000 family in Lattakia region. Its annually production in Lattakia is about 50,000 tonnes and lemon Autochton is produced over the whole year, unlike the other varieties (CBS, 2014). But there is also big volatility of prices during the year caused by limited possibilities to time and storage the harvest. It is very important to bring analysis of the prices and find appropriate model providing important information (forecasted prices) for the farmer and all the market chain of lemon Autochton.

| Year Month | 2010 | 2011 | 2012 | 2013 |
|---------------|-------|-------|-------|-------|
| January | 17.10 | 17.70 | 16.00 | 23.30 |
| February | 21.50 | 19.80 | 17.00 | 26.00 |
| March | 18.40 | 19.80 | 19.60 | 25.90 |
| April | 18.60 | 20.10 | 28.10 | 26.30 |
| May | 28.20 | 22.60 | 48.00 | 29.70 |
| June | 34.30 | 37.80 | 57.70 | 49.60 |
| July | 65.80 | 42.40 | 47.80 | 55.70 |
| August | 53.40 | 63.80 | 65.50 | 83.70 |
| September | 60.60 | 57.30 | 60.10 | 75.20 |
| October | 17.10 | 16.30 | 17.10 | 21.40 |
| November | 18.00 | 18.40 | 19.30 | 24.20 |
| December | 17.30 | 17.40 | 18.30 | 20.00 |

Source: Agricultural Directorate in Lattakia

Table 1: Lemon Autochthon monthly prices 2010-2013 (in SYP/Kg).

Seasonal Autoregressive Integrated Moving Average (SARIMA) Model

There is a number of studies using the ARIMA models for prices forecasting. Numerous studies have shown this method is effective compared with the other methods. Mishra and Singh (2013) say that: „the econometric model ARIMA is a time series which was introduced by Box and Jenkins, (1970). The model is one of the most popular methods for forecasting, generally a non-seasonal time series can be modeled as a combination of past values and errors, which can be denoted as ARIMA (p, d, q) which is expressed in the following form:

$$X_t = \theta_0 + \Phi_1 X_{t-1} + \Phi_2 X_{t-2} + \dots + \Phi_p X_{t-p} + e_t - \theta_1 e_{t-1} - \theta_2 e_{t-2} - \dots - \theta_q e_{t-q} \dots E_q$$

Where X_t and e_t are the actual values and random error at time t, respectively, Φ_i (i = 1,2,...,p) and θ_j (j = 1,2,...,q) are model parameters, p and q are integers and often referred to as orders of autoregressive and moving average polynomials respectively. The random errors e_t are assumed to be independently and identically distributed with mean zero and the constant variance, σ^2 . Similarly a seasonal model is represented by SARIMAs (p, d, q) x (P, D, Q) model, where P = number of seasonal autoregressive (SAR) terms, D = number of seasonal differences, Q = number of seasonal moving average (SMA) terms. Basically this method has four phases: model identification, diagnostic, parameter estimation and checking.

Seasonal Autoregressive Integrated Moving Average Model

SARIMA (p,d,q) (P,D,Q)s

$$\Phi_p(B)\Phi_P(B^s)(1-B)^d(1-B^s)^D Z_t = \delta + \theta_q(B)\Theta_Q(B^s) a_t$$

$\Phi_p(B) = \{\Phi_1, \Phi_2, \dots, \Phi_p\}$ Autoregressive parameters

$$\Phi_p(B) = 1 - \Phi_1 B - \Phi_2 B^2 \dots \dots \dots - \Phi_p B^p$$

$\theta_q(B) = \{\theta_1, \theta_2, \dots, \theta_q\}$ Moving Average Parameters

$$\theta_q(B) = 1 - \theta_1 B - \theta_2 B^2 \dots \dots \dots - \theta_q B^q$$

B Back displacement parameters where:

$$BZ_t = Z_{t-1}$$

$$B^2 Z_t = B(BZ_t) = BZ_{t-1} = Z_{t-2}$$

$$B^m Z_t = Z_{t-m}$$

this time series $\{Z_t\} = \{Z_{t-p}, Z_{t-p}, Z_{t-p}, Z_{t-p}, \dots\}$

Where the values:

Autoregressive seasonal factor

$$\Phi_p(B^s) = 1 + \Phi_1 B^s + \Phi_2 B^{2s} + \dots \dots + \Phi_p B^{ps}$$

$$\Theta_Q(B^s) = 1 + \theta_1 B^s + \theta_2 B^{2s} + \dots \dots + \theta_Q B^{Qs}$$

$a_t \sim WN(0, \sigma^2)$ White Noise series

It is a series of observations uncorrelated (independent), and have identical distributions with the value of average of zero and a constant variance

$a_t \sim WN(0, \sigma^2)$ (I.I.D) Independent Identically Distributed

$$E(a_t) = 0 \forall t$$

$$Cov(a_t, a_s) = \begin{cases} \sigma^2 & \forall t, \forall s, t = s \\ 0 & \forall t, \forall s, t \neq s \end{cases}$$

The proposed model for this series is: SARIMA (2,1,0) (1,0,1)₁₂

$$(1 - \Phi_1 B - \Phi_2 B^2)(1 - \Phi_1 B^{12})(1 - B)z_t = (1 - \theta_1 B^{12})$$

$$a_t(1 - \Phi_1 B - \Phi_2 B^2 - B + \Phi_1 B^2 + \Phi_2 B^3 - \Phi_1 B^{12} + \Phi_1 \Phi_1 B^{13} + \Phi_2 \Phi_1 B^{14} + \Phi_2 B^{13} - \Phi_1 \Phi_1 B^{14} - \Phi_2 \Phi_1 B^{15})z_t = (1 - \theta_1 B^{12})a_t$$

By calculation was found:

$$z_t = (1 + \Phi_1)Z_{t-1} + (\Phi_2 - \Phi_1)Z_{t-2} - \Phi_2 Z_{t-3} - \Phi_1 Z_{t-12} - (\Phi_1 \Phi_1 + \Phi_2)Z_{t-13} + (\Phi_1 \Phi_1 - \Phi_2 \Phi_1)Z_{t-14} + \Phi_2 \Phi_1 Z_{t-15} + a_t - \theta_1 a_{t-12}$$

Results and discussion

Forecasting prices by using ARIMA model

There are three stages of modeling as suggested by Box and Jenkins to find the fitting ARIMA model. They are identification, diagnostic, estimation and checking.

Model Identification

The time series were analyzed by using the Statistical software (MINITAB). The selected sample is a time series data of the prices of the Citrus Lemon Autochthon. In different seasons of the year over the four years from 2010 to 2013. There are 48 observations based on monthly prices. The seasonal component is illustrated by figure 1, where horizontal axis represents the time and the prices are on vertical axis.

The seasonality which is obvious at the figure 1 is caused by fluctuation of supply of lemon Autochthon at Lattakia. These oscillations are repeated regularly and in the same part of each year. The prices decrease after the time of harvest, when there is high saturation of the market and in the opposite before the harvest the prices reach the maximum because the lack of stocks.

The following figure 2 shows the auto-correlation function of the sample to build an appropriate model.

The parameters of the model can be obtained from the figure 2 which shows that the correlation

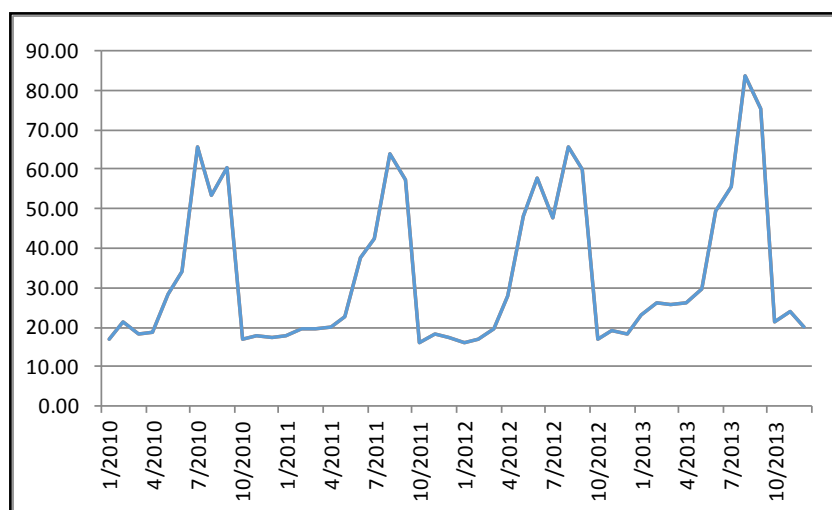
between values and previous values remains within the deviation and this chart can be seen as a model for the sinus damping to find the parameters of the model.

Partial self-correlation is represented by the figure 3.

If the time series was random the large amounts of data would be correlated with each close to zero. If the correlation is not heading toward reasonable rate of zero it indicates instability data. The figure 3 shows that the link between the value and the previous value regardless of changes, so the time series are stable. It is clear that the autocorrelation function geometrically decrease after one slow degree, and this guide for the stability of the time series. The fact that the first delay in the red line cuts the blue line can take advantage of it to build a model.

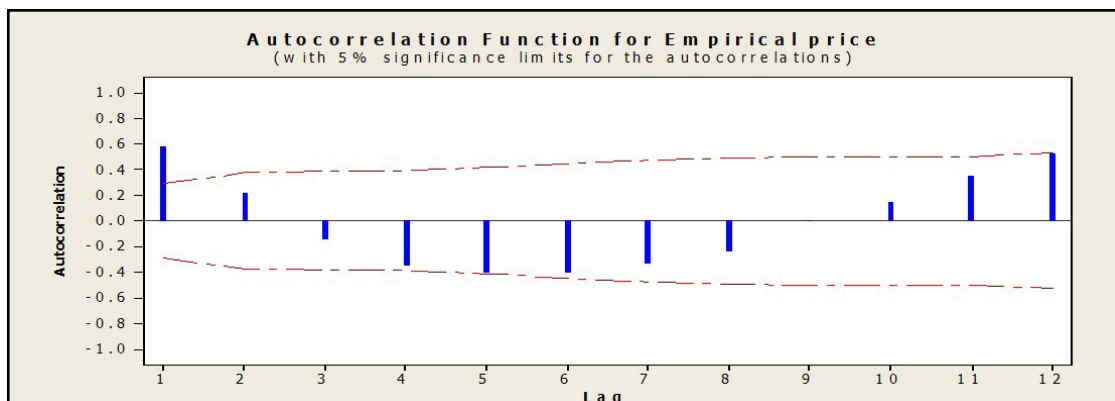
There was made a comparison between the numbers of SARIMA models to choose the best model. The predicted data should be closer to the real values. The values of MSE and MAE are the tools which was adopted to provide information about the most appropriate model.

From the table 2, there was found that the values of MSE and MAE of the SARIMA model $(2, 1, 0) * (1, 0, 1)$ are the smallest compared with the other values. It indicates the most suitable model for the given time series. This model should be able to predict reliable future values.



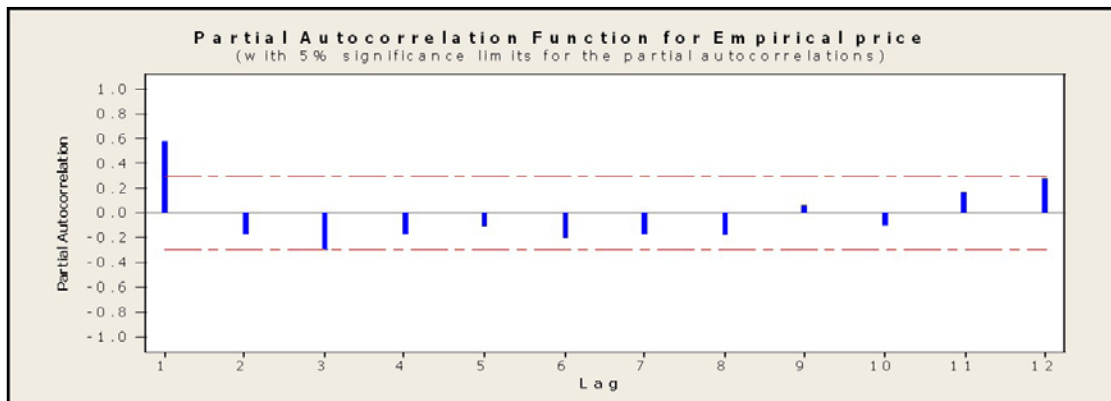
Source: processed in MS Excel, based on data of Agricultural Directorate in Lattakia

Figure 1: Prices of lemon autochthon in Lattakia 2010 – 2013 in SYP/Kg.



Source: processed in SW Minitab, based on data of Agricultural Directorate in Lattakia

Figure 2: ACF of lemon autochton price.



Source: processed in SW Minitab, based on data of Agricultural Directorate in Lattakia

Figure 3: PCF of lemon autochton price.

| MODEL | SARIMA (2,1,0)*(1,0,1) | SARIMA (2,1,1)*(1,0,1) | SARIMA (2,1,0)*(2,0,1) | SARIMA (2,1,0)*(2,1,1) |
|-------|---------------------------|---------------------------|---------------------------|---------------------------|
| MSE | 69.99 | 70.23 | 72.20 | 70.73 |
| MAE | 53.20 | 55.69 | 55.98 | 53.75 |

Source: processed in SW Minitab, based on data of Agricultural Directorate in Lattakia

Table 2: The value of MSE and MAE for considered SARIMA models.

Estimation of parameters and Model Diagnosis

As the best model was found multiplier seasonal model SARIMA (2,1,0) * (1,0,1)₁₂. The model is based on the rank of the model AR, MA based on the form of the autocorrelation function when matching the values of autocorrelation coefficients and partial autocorrelation for the time series after taking the first and seasonal differences which found in the figures (2), (3) and from the clear that the autocorrelation function (ACF) and partial autocorrelation function (PCF) gradually decreasing (behave like sine function)

and through this indicator can be note that the best model is the multiplier Seasonal model from the class SARIMA (2,1,0) * (1,0,1)₁₂

Parameters of the modeal are introduced in the Table 3.

The values were equal:

$$\Phi_1 = -0.3692$$

$$\Phi_2 = -0.1607$$

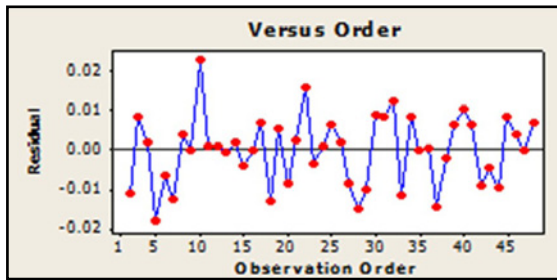
$$\Phi = 0.9937$$

$$\Theta = 0.8248$$

| Type | Coef | SECoef | T | P |
|----------|---------|--------|--------|-------|
| AR 1 | -0.3692 | 0.1532 | - 2.41 | 0.020 |
| AR 2 | -0.1607 | 0.1528 | - 1.05 | 0.299 |
| SAR 12 | 0.9937 | 0.0181 | 54.99 | 0.000 |
| SMA 12 | 0.8248 | 0.1724 | 4.78 | 0.000 |
| Constant | -0.0070 | 0.2933 | - 0.02 | 0.981 |

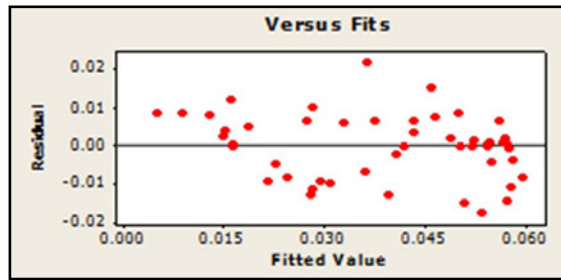
Source: processed in SW Minitab, based on data of Agricultural Directorate in Lattakia

Table 3: Estimated parameters.



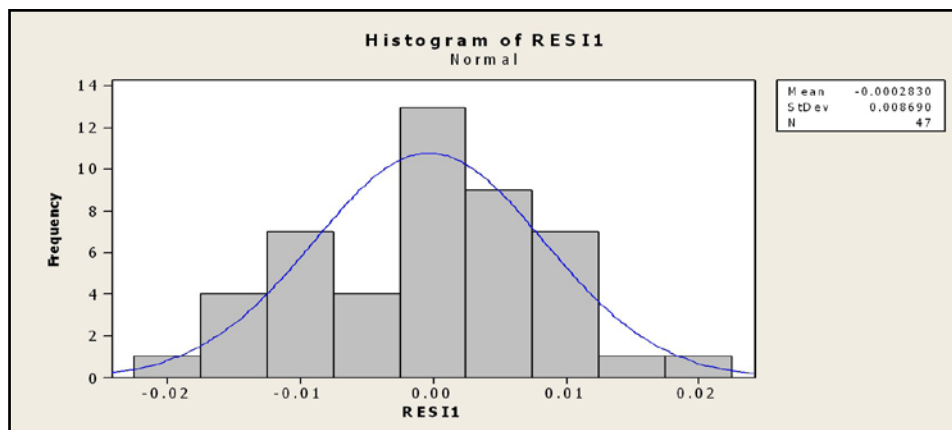
Source: processed in SW Minitab, based on data of Agricultural Directorate in Lattakia

Figure 4: Residuals vs. the order of the data.



Source: processed in SW Minitab, based on data of Agricultural Directorate in Lattakia

Figure 5: Residual vs. the fitted values



Source: processed in SW Minitab, based on data of Agricultural Directorate in Lattakia

Figure 6: Histogram of residuals.

By compensation, we find that the equation of the model are:

$$z_t = 0.6308z_{t-1} + 0.2085z_{t-2} + 0.1607z_{t-3} - 0.9937z_{t-12} - 0.6268z_{t-13} - 0.2072z_{t-14} - 0.1597z_{t-15} + a_t - 0.8248a_{t-12}$$

Verification (Checking) of the model

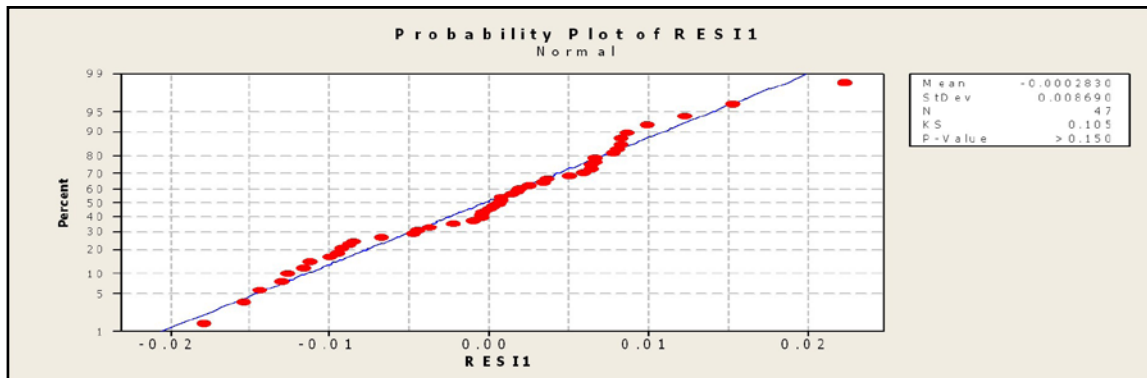
The residual were examined to verify suggested form of the model. The normality of distribution, its independency and homoscedasticity were tested.

The figure 4 shows the residuals versus

the appropriate values. There is no trend or a specific oriented residuals. This fact also indicates that there was chosen appropriate model form.

There is no visible orientation of residuals at figure 5 as well, which indicates that the residuals are independent and random.

The figure 6 is the histogram of residuals with the drawing of normal distribution curve and this shows that the residuals have normal distribution.



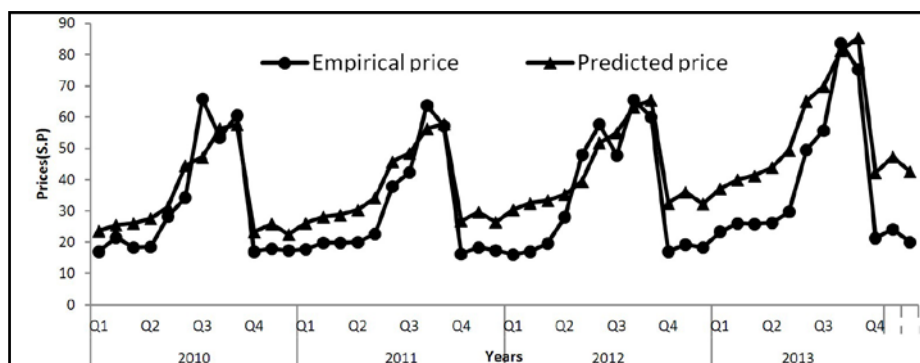
Source: processed in SW Minitab, based on data of Agricultural Directorate in Lattakia

Figure 7: Distribution of residuals.

| Year \ Month | 2010 | 2011 | 2012 | 2013 |
|--------------|-------|-------|-------|-------|
| January | 2014 | 2015 | 2016 | 2017 |
| February | | | | |
| March | 23.62 | 26.16 | 30.33 | 37.18 |
| April | 25.48 | 28.11 | 32.54 | 40.04 |
| May | 26.07 | 28.80 | 33.44 | 41.39 |
| June | 27.52 | 30.33 | 35.25 | 43.87 |
| July | 31.39 | 34.13 | 39.49 | 49.39 |
| August | 44.42 | 45.85 | 51.82 | 65.11 |
| September | 47.19 | 48.51 | 54.96 | 69.78 |
| October | 56.24 | 56.25 | 63.26 | 81.32 |
| November | 57.59 | 57.85 | 65.53 | 85.45 |
| December | 23.23 | 26.85 | 32.54 | 42.26 |

Source: own calculation, based on data of Agricultural Directorate in Lattakia

Table 4: predicted prices by SARIMA model in SYP/Kg.



Source: own calculation, based on data of Agricultural Directorate in Lattakia

Figure 8: Empirical monthly Prices of Lemon Autochton Compared with Predicted one in SYP/Kg for years 2010 - 2013.

Figure 7 shows the normality of distribution of residuals of this model. There are not outliers. And according to Kolmogorov - Smirnov test for the residuals, we find that the P-value greater than 0.05 and therefore accept the null hypothesis that mean residuals are subject to the normal distribution.

According to the developed SARIMA model the prices for Lemon Autochthon for four years, coming from the 2014 until 2017 were predicted. The results are presented in Table 4. The figure 8 shows comparison of predicted (ex post forecasting) and real values for years 2010 – 2013. There is obvious that series for the predicted period follow the same behavior of the original series.

Conclusion

The aim of the paper was to verify the SARIMA model as appropriate tool of Agricultural Marketing Information System. According to that there was also stated the research question: Are the ARIMA, resp. SARIMA models suitable to be part of the Agricultural Marketing Information System (AMIS)? To answer this question there was developed model for Lemon Autochthon price forecasting. The model was tested, if it is able to predict the price during the year with its seasonal volatility. Data were provided by Munther Kheirbek from Syrian ministry of Agriculture.

The variety of lemon Autochthon was chosen because represents most important commodity

for local farmers and it is produced during the whole year. Farmers can harvest the yield three times or even four times if there is a good weather.

There is no function AMIS in Lattakia which would help to the farmers and in this situation the intermediaries have the highest profit in the marketing chain.

As the best model was found the multiplier Seasonal model from the class SARIMA (2,1,0) * (1,0,1)₁₂ which has been chosen in order to determine the course of the prices for the next 4 years. It shows that any significant changes will not occur in lemon Autochthon prices by the end of 2017 while the increase in real prices of input is taken into account because now Syria suffer from inflation, so in fact the decrease of income of citrus growers may bring out the farmer group who is unwilling to continue to produce citrus.

According to the obtained results can be stated that the SARIMA model is able to predict the prices of citrus on Lattakia market and when the missing Agricultural Marketing Information System is created it should be taken into account.

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