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Modeling and Forecasting of Food Imports in Albania

ALMA BRAIMLLARI (SPAHO)[1*], ENXHIA SALA[1]

[1]Department of Applied Mathematics; Faculty of Natural Sciences, University of Tirana, Tirana, Albania

Abstract

International trade plays a very important role in the development of all economies, including Albania. The aim of this study is to model and to forecast the value of food imports in Albania using time series models. The main purpose of this study is to find the most appropriate model for forecasting the value of food imports. The monthly data of food imports are taken from the Albanian Institute of Statistics and are covering the period of time January 2005 – October 2016. The two methods used in this research are Holt-Winters Method with trend and seasonality, and seasonal ARIMA model. The forecasting accuracy measures indicated that the forecasts obtained from Holt-Winters were more accurate than the forecasts of the best fitted seasonal ARIMA. These findings are useful for customers, producers, wholesalers, retailers and policymakers.

Keywords: unit root test, stationarity, seasonality, Holt-Winters method, seasonal ARIMA.

1. Introduction

Trade is an important part of the total development effort and national growth of all economies including Albania. Albania's geographical location offers a trade potential, especially with the European Union market and the free trade agreements with all Balkan countries have created opportunity for trade development all over the region. Albania has had a negative balance trade.

Prediction is very important for decision making in food industry. The decision making in this industry involves planning of uncertainty, finding of the optimal level of production, finding the optimal order quantity and even strategic planning for capacity expansion. The cost of underestimation or overestimation can be very high; therefore, accurate forecasts are very important. Accurate short-term forecasts are considered necessary by producers, clients and customers particularly during the periods with the highest demand.

Seasonal autoregressive integrated moving average (SARIMA) methodology and Holt-Winters' method can be applied to model and to forecast the exports and imports of products. SARIMA methodology has been applied for modeling and forecasting of imports of products from several countries. Using the yearly data of Pakistan imports for the period 1947-2013, [2] found that the ARIMA(2,2,2) model fitted best to the data and to forecast the imports. In their study, [3] with the monthly data of Bangladesh total imports used the Holt-Winters' method with trend and seasonality, SARIMA $(0,1,1)(1,0,0)_{12}$ and a Vector auto regression (VAR) model to model the data. The VAR model was selected as an appropriate model for forecasting the total imports in Bangladesh.

In this study, Holt-Winters' method and SARIMA methodology has been applied for modeling and forecasting of monthly imports of food, beverages and tobacco products in Albania.

2. Material and Methods

In this study two methods are used to model and forecast the food imports: Holt-Winters' trend and seasonality method and seasonal ARIMA model. The aim is to find an appropriate model that has forecasting errors as small as possible.

2.1. Holt-Winters Trend and Seasonality method

The Holt-Winters' method with trend and seasonality is based on three smoothing equations, one for the level, one for the trend, and one for seasonality. Depending on whether seasonality is modeled in an additive or multiplicative way there are two different Holt-Winters' methods. The basic equations for the Holt-Winters' method with trend and additive seasonality is:

$$Level: \quad L_t = \sim(Y_t - S_{t-s}) + (1-\sim)(L_{t-1} + b_{t-1})$$

$$Trend: \quad b_t = \quad (L_t - L_{t-1}) + (1- \quad)b_{t-1}$$

*Corresponding author: Alma Braimllari (Spaho); E-mail: alma.spaho@unitir.edu.al

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$$Seasonality: \quad S_t = \gamma(Y_t - L_t) + (1-\gamma)S_{t-s}$$

$$Forecast: \quad F_{t+m} = L_t + mb_t + S_{t-s+m}$$

where s is the length of seasonality (number of month in a year), L_t represents the level of the series, b_t the trend, S_t is the seasonal component and F_{t+m} is the forecast for m period ahead [4].

2.2. Seasonal autoregressive integrated moving average (SARIMA) models

Stationarity is required for fitting a time-series into SARIMA framework. A time series is called stationary if the mean, variance, and covariance of the underlying series do not depend on time (time invariant). To determine the stationarity, the time plot, autocorrelation function (ACF) and partial autocorrelation function (PACF) can be used as a first attempt. The Augmented Dickey Fuller (ADF) unit roots test can be used to detect the stacionarity of a time series. The ADF unit roots test performs a regression model of the form

$$\Delta X_t = \alpha_0 + \alpha_1 t + \gamma X_{t-1} + \sum_{i=1}^{m} {}_i \Delta X_{t-i} + u_t$$

where m indicate the lag order, and $\Delta X_t = X_t - X_{t-1}$. The null hypothesis is: the time series $\{X_t\}$ has a unit root or the series is not stationary (H_0: $\rho = 0$ and H_a: $\rho < 0$). If the p value is less or equal to 5%, the null hypothesis is rejected and is concluded that the time series is stationary.

When a time series is not stationary usually non seasonal and seasonal differencing at the appropriate lag can be applied to achieve stationarity.

The multiplicative seasonal autoregressive integrated moving average model is given by

$$\phi(B)\Phi(B^s)(1-B)^d(1-B^s)^D X_t = \theta(B)\Theta(B^s)Z_t$$

where $\{Z_t\}$ is a sequence of uncorrelated random variables with zero mean and constant variance σ^2 (white noise), s is the seasonal period, B is the backward shift operator ($B^k X_t = X_{t-k}$ and $B^k Z_t = Z_{t-k}$), $\phi(B) = 1 - \phi_1 B - \cdots - \phi_p B^p$, $\theta(B) = 1 + \theta_1 B + \cdots + \theta_q B^q$,

$\Phi(B^s) = 1 - \Phi_1 B^s - \cdots - \Phi_P B^{Ps}$ and

$\Theta(B^s) = 1 + \Theta_1 B^s + \cdots + \Theta_Q B^{Qs}$ [1; 5].

The Akaike's Information Criterion (AIC) is useful for determining the order of a SARIMA model, and it can be written as $AIC = -2\log(L) + 2k$ where L is the likelihood for a SARIMA model, k is the number of estimated parameters in the model (including σ^2, the variance of the residuals). For small sample sizes, that is, if n/k is less or equal to 40, the corrected AIC should be used instead $AIC_C = -2\log(L) + \frac{2kn}{n-k-1}$ where n is the sample size after differencing. The good models are obtained by minimizing either the AIC or AIC_c value.

The residuals of the SARIMA model are used for the diagnostic checking. The Ljung-Box test is used to the residuals to determine if the residuals are random and that the model provides an adequate fit to the data in the study. The Jarque-Bera test was used to test the normality distribution of the residuals of the model. The Lagrange Multiplier (LM) for autoregressive conditional heteroscedasticity (ARCH) test was used to test the conditional heteroskedasticity of the residuals.

2.3. Forecasting accuracy measures

To evaluate the performance of the best fitted or forecasted model are used three measures of accuracy: Mean Absolute Error (MAE), Root Mean Square Error (RMSE) and the Mean Absolute Percentage Error (MAPE), defined respectively by the following equations:

$$MAE = \frac{1}{n}\sum_{i=1}^{n} | y_i - \hat{y}_i |$$

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n} (y_i - \hat{y}_i)^2}$$

$$MAPE = \frac{1}{n}\sum_{i=1}^{n} \frac{|y_i - \hat{y}_i|}{y_i} \cdot 100\%$$

2.4. Data

The data of food Imports used in this study, measured in ALL millions, cover the period January 2005-October 2016 and are taken from the Albanian Institute of Statistics. Imports of group of commodities food, beverages and tobacco consists of four sections: live animals and animals products, vegetable products, edible oils and prepared foodstuffs, beverages and tobacco.

The data set has 142 observations and the in-sample data cover the period January 2005-October 2015, whereas the out-of-sample data cover the period November 2015-October 2016.

The R software was used to analyze, model and forecast the monthly data of food Imports in Albania.

3. Results and Discussion

The value of food imports and the value of food exports from January 2005 to October 2016 are shown in Figure 1, indicating that Albania has had a negative balance trade related to food products and the gap between food imports and food exports is still wide. Total value of food import varied from 3110.625 ALL million at July 2005 to 9559.215 ALL million at December 2013.

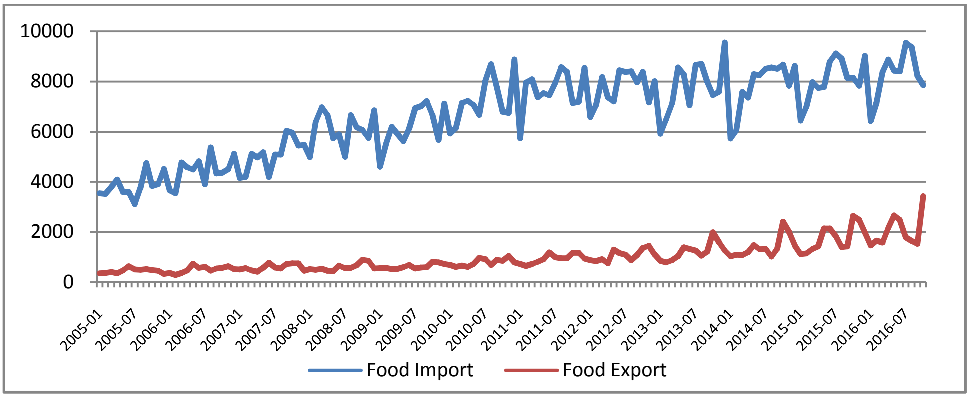

Figure 1. The value of food exports and food imports

Figure 2 indicates the percentage of food imports to total imports from January 2005 to October 2016. Average percentage of food, beverage and tobacco imports to total imports during the study period resulted 17.5% and the standard deviation was 1.72%.

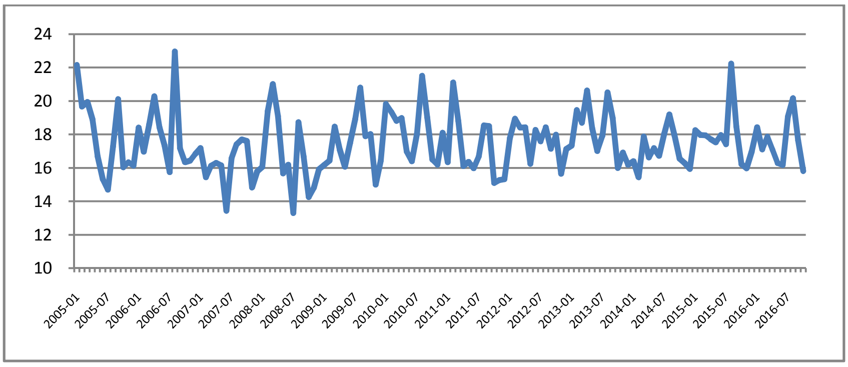

Figure 2. Percentage of food imports to total imports in Albania

As Figure 3 indicates, the section with highest value of food imports is prepared foodstuffs, beverages and tobacco, followed by section vegetable products and then live animals and animals' products and edible oils.

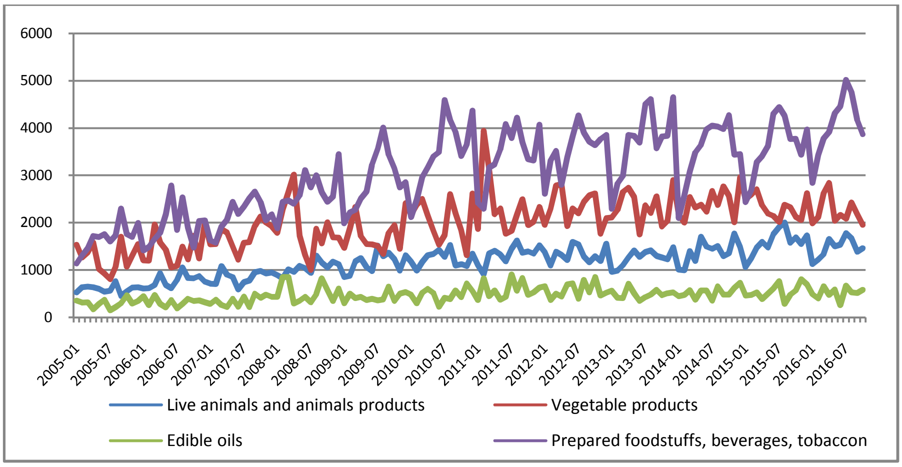

Figure 3. Time series of each section of food imports

During October 2016, 16.84% of food imports were from Italy, 12.2% from Greece, 7.6% from Serbia, 5.4% from Poland, 5.16% from Turkey, 4.8% from Germany, 4.6% from Brazil, 3.7% from Macedonia, whereas the other part from other countries. During all the period of study, average imports from Italy of this group of commodities was 16.45%, whereas from Greece was 15.02%.

3.1. Results of Holt-Winters method

The estimated Holt-Winters' model with trend and additive seasonality is:

$$L_t = 0.1392319(Y_t - S_{t-12}) + (1 - 0.1392319)(L_{t-1} + b_{t-1})$$

$$b_t = 0.0457299(L_t - L_{t-1}) + (1 - 0.0457299)b_{t-1}$$

$$S_t = 0.3928074(Y_t - L_t) + (1 - 0.3928074)S_{t-12}$$

The figure 4 indicates the in-sample data, and the point and interval forecasts obtained from Holt-Winters with trend and seasonality model:

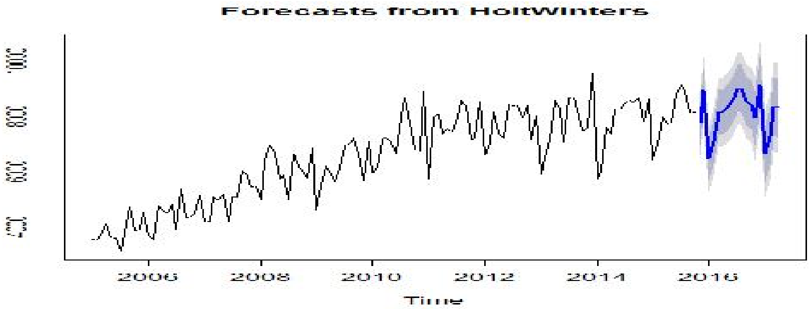

Figure 4. Forecasts from Holt-Winters method (the blue line)

3.2. Results of SARIMA model

The time series of food imports shows an increasing trend until year 2012 and then the trend is slowdown. The plot of food imports indicates non stationarity in mean but stationarity in variance. To test the stationarity of the data, ADF test was conducted. The results of ADF test (with intercept and trend) about the food imports time series indicated a value of ADF of -0.775 with p-value 0.9615 at lag 12, so the null hypothesis of unit root cannot be rejected at 5% level, indicating that the food imports series in not stationary.

To achieve the stationarity of the food imports series, a non seasonal differencing at lag 1 is applied to the original time series. The ADF test statistics for the differenced series was found to be -5.58 with p-value 0.01 at lag 12. This indicated that the data now are stationary. The respective ACF plot of the differenced series showed significant spikes at lag 12, 24, 36,... etc, indicating seasonality in the data.

Based on the values of the AICc, it is found that SARIMA(0,1,2)x(0,1,2)$_{12}$ model with the lowest value of AIC$_C$ = 1834 was the best fitted SARIMA model to the food imports data. The results of SARIMA model are shown in Table 1:

Table 1. Results of best fitted SARIMA model

SARIMA model	Coefficient	Standard error
MA1	-0.6458	0.1003
MA2	-0.1764	0.0962
Seasonal MA1	-0.8298	0.0953
Seasonal MA2	0.3716	0.1230

The results of ADF test for the residuals of the best fitted SARIMA model indicated a ADF value of -2.18 and p-value 0.03 at lag 12, so the residuals series is stationary. The ACF and PACF plots of the SARIMA residuals up to lag 40 indicated that none of the autocorrelations was significant at 5% level. This confirms that the SARIMA model obtained was an appropriate model for fitting the food imports data.

The results of Ljung-Box test indicated a value of statistics of 23.62, df = 20 and p-value 0.26, that is the model is appropriate to the data. The results of Jarque-Bera test indicated a value of Chi-squared statistics of 1.014, df = 2, and p-value 0.602. The results of ARCH-LM test, with null hypothesis: no ARCH effects of best fitted SARIMA model indicated a chi-squared value of 6.33, df = 12, and p-value 0.9.

The figure 6 shows the in-sample values of food imports, and the point and interval forecasted values based on the best fitted SARIMA model.

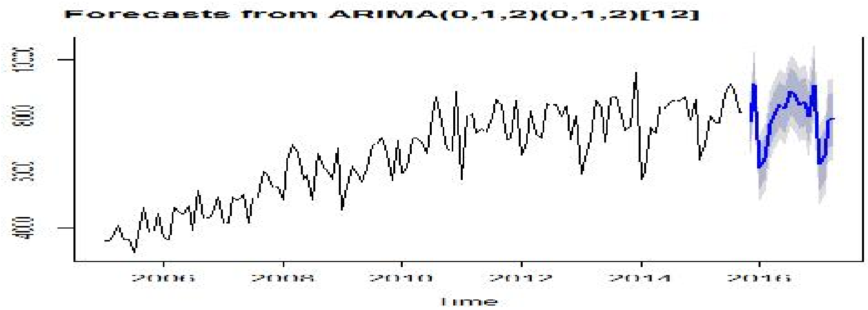

Figura 5. Forecasts obtained from SARIMA model

3.3. Comparison between Holt-Winters and SARIMA models

The forecasting performance of the two models has been compared with respect to three measures of accuracy: MAE, RMSE and MAPE. The results are shown in Table 2:

Table 2. In-sample accuracy measures

Measure	Holt-Winters	SARIMA(0,1,2)x(0,1,2)$_{12}$
MAE	483.365	390.285
RMSE	601.838	532.072
MAPE	7.45	5.95

For forecasting, a model that fits best to the in-sample data does not necessarily provide more accurate forecasts. Therefore, the performance of out-of-sample forecasts is used to help for the selection of a time series model.

The true out-of-sample data and the forecasted values obtained from two methods are given in the Table 3:

Table 3. Out-of-sample real data and forecasts

Month	Actual Data	Holt-Winters	SARIMA(0,1,2)x(0,1,2)$_{12}$
2015-11	7832.939	7757.212	7780.233
2015-12	9019.898	8955.558	9140.587
2016-01	6428.647	6473.125	6146.411
2016-02	7157.858	7107.544	6495.179
2016-03	8385.965	8169.186	7710.929
2016-04	8877.056	8141.084	8018.768
2016-05	8434.32	8312.215	8411.306
2016-06	8404.736	8572.539	8259.405
2016-07	9537.672	9009.479	8867.107
2016-08	9379.229	9025.683	8791.555
2016-09	8229.005	8552.583	8400.561
2016-10	7856.277	8419.391	8497.086

The table 4 indicates the out-of-sample accuracy measures. The results of Table 4 indicate that the Holt-Winters method gives the minimum values for all three measures of forecast error. The Holt-Winters model of the value of food imports is an appropriate model for forecasting monthly food imports of Albania.

Table 4. Out-of-sample accuracy measures

Measure	Holt-Winters	SARIMA (0,1,2)x(0,1,2)$_{12}$
MAE	270.500	407.572
RMSE	350.231	498.796
MAPE	3.15	4.91

The table 5 gives the forecasted values of food imports obtained from the two models for the period November 2016- April 2017 and also the percentage of change compared to the respective month of one year before.

Table 5. Forecasts obtained from the models

Month	Holt-Winters		$SARIMA(0,1,2)x(0,1,2)_{12}$	
	Value	% of change	Value	% of change
2016-11	7933.942	1.29	7960.452	1.63
2016-12	9132.288	1.25	9113.151	1.03
2017-01	6649.855	3.44	6249.412	-2.79
2017-02	7284.274	1.77	6573.202	-8.17
2017-03	8345.916	-0.48	7821.442	-6.73
2017-04	8317.814	-6.30	7912.739	-10.86

The percentage of change obtained from Holt-Winters model indicates that the value of food imports will increase slightly during the first four months of the forecasting period of time and for the two other months the percentage of change will decrease.

4. Conclusions

This study is a first attempt to model food imports using the monthly data for the period January 2005 – October 2016 and to forecast food imports for six coming months using the Holt-Winters and SARIMA methodology.

Albania has had a negative balance trade related to food products and the gap between food imports and food exports is still wide. The food imports from 2005 to October 2016 was dominated by two sections: the prepared foodstuffs, beverages and tobacco, and vegetables products.

Fluctuations in the value of food imports are a matter of concern for customers, producers, wholesalers, retailers, and policymakers.

The plot of food imports shows trend and seasonality. Two models are obtained during the analysis of the data: Holt-Winters with trend and additive seasonality and with smoothing parameter α =0.139, β = 0.0457, γ = 0.393 and $SARIMA(0,1,2)x(0,1,2)_{12}$ model with AICc value of 1834. The three forecasting accuracy measures indicated that $SARIMA(0,1,2)x(0,1,2)_{12}$ model was the best fitted model for in-sample data, whereas Holt-Winters model was the best model for forecasting the monthly value of food imports.

The value of food imports is influenced by other macroeconomic variables like food export, exchange rate ALL/Euro, inflation rate, gross domestic product, foreign direct investments and money supply. In the future research, other models such as VAR can be used to model and forecast the food imports, considering other macroeconomic variables.

5. References

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