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# **Evaluation of different predicting methods in forecasting Hungarian, Italian and Greek lamb prices**

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# Evaluation of different predicting methods in forecasting Hungarian, Italian and Greek lamb prices

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**Abstract** The Hungarian sheep sector has become a one-market sector, almost the whole amount of slaughter lamb went to Italy. It would worth to exploit possibilities in other European markets. Such markets can be the Spanish and Greek for "light" and the French, German and English markets for "heavy" lambs. The European lamb prices are characterized by large seasonal fluctuation and the degree and timing of changes are different. Due to these seasonal changes, the producers often suffer great losses. Study of the literature on lamb sales called for an analysis of price forecasting. In my study, I performed a forecasting of lamb prices in Hungary, Italy and Greek for the period between 1996 and 2007 based on the data of the European Committee. Among the forecasting methods, Seasonal Decomposition and SARIMA models are the most precise, producers can achieve a better market position by using these in the practice.

**Key Words:** forecasting, lamb prices, comparison

## Introduction

The European Union should rely permanently on import of lamb and goat. More than 90% of the Hungarian sheep meat export goes to Italy while the majority of the rest to Greek markets. Sheep sector has a greater importance than it could be expected based on the number of animals or its production value. Its job creating and maintaining nature is of grater significance than of any other animal husbandry branch.

Within the export of sheep products from Hungary, lamb (slaughter lamb) and live animal export are of determining importance. The market for live slaughter sheep was the Near East in the 1960s and 1970s, but this has ceased. Nowadays, the number of

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animals sold outside of the EU (in Croatia, Bosnia and Switzerland) is only some ten thousands (Nábrádi, 1998). More than 90% of the Hungarian sheep meat export goes to Italy. Accordingly, the market is quite limited with respect to demand and supply, selling weight and level of processing (Jávor *et al.*, 2001). In addition to the sole Italian market with a continuous demand for Hungarian lamb, other solvent European market possibilities meeting the transport regulations should also be seized. Such markets could be the Spanish and Greek "light" lamb markets with temporary demand and the French, German or Austrian "heavy" lamb markets.

European lamb prices show great seasonal fluctuation, the degree and time of changes varies among the different countries. Due to these price fluctuations, the sheep breeders frequently have large losses, therefore, the adaptation of production to seasons and the market research and technological development should all be improved. Simultaneously with opening to new markets, great attention should be paid to keeping the Italian market, since Bulgaria and Romania, which have joined the EU in January 2007, can be strong competitors for Hungary. One condition of maintaining our market position is to improve quality and uniformity of our products.

Study of the literature and our examination results in lamb trade inspired us to study the predictability of prices. In our study, We have performed a price forecast for Hungarian, Italian and Greek lamb for the period of 1998-2007 based on the database of the Sheep Product Council. Our aim was to provide decision support for farmers, so that they would inseminate and produce in harmony with the market requirements, thereby, the present uncertainty of sales would reduce and the profitability of sheep breeding would improve.

## **Material and method**

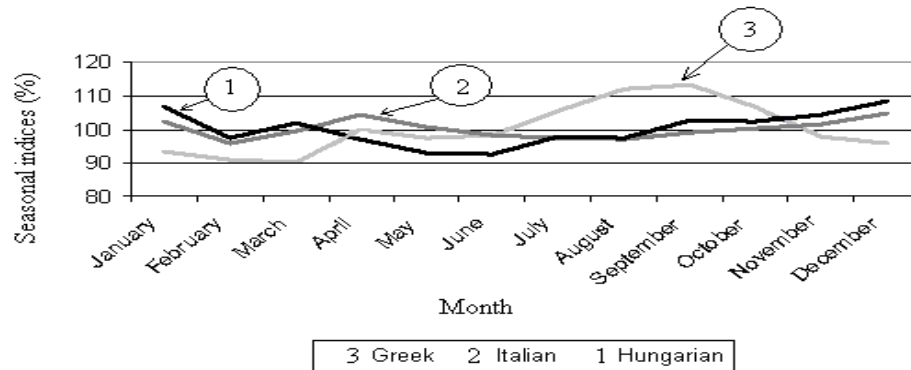
In the EU, with respect to the classification of sheep carcass, the prices refer to "heavy" lambs, larger than 13 kg and "light" lamb, smaller than 13 kg, depending on which one is more prevalent in the given member state. Based on this, two production zones can be differentiated in the EU in sheep meat production according to *Kilkenny (1990)*: the northern, including the northern part of France, where the slaughtered weight is 16-20 kg, and the southern, including the southern part of France, where seasonal consumption is more characteristic and the average slaughtered weight is 7-13 kg. In the southern countries, seasonal fluctuation can be observed in supply and slaughtering, although seasonality is characteristic to all countries to a certain degree (Nábrádi *et al.*, 2002). Our study was carried out based on the data of the European Committee for the period 1998-2007.

Statistical methods include special ones that advance future decision-making. The common characteristic of these predictions is that they are based on so-called time series, i.e. We know the past and present data of the investigated phenomenon, and We seek to draw conclusions for the future from them. Predictions differ according to the rate they take the changes of circumstances into consideration (Balogh, 2003; Balogh

and Ertsey, 2003). During the preparation of our study We investigated and compared different time series forecasting methods (Seasonal Decomposition, Fourier analysis, Moving average process, Box-Jenkins type time series models /ARIMA/, Winters' exponential smoothing, Seasonal Decomposition) in relation to their applicability in lamb price prediction. Estimation performed by the multiplicative variant of Seasonal Decomposition proved better than the additive one, therefore We chose this. In the course of additive estimation the square of the difference between original and estimated data far exceeded the one gained by multiplicative estimation. Based on decomposition, the estimation was prepared by taking the seasonal index related to the given time period into consideration. We broke down the trend-cycle effect into trend effect and cycle effect by fitting a trend line on the original data series. Then, dividing trend cycle values by trend values We received the values of cycle components. The values of cycle components in relation to time period  $n$  calculated in this way, were multiplied with the seasonal index and trend values relating to period  $n+1$ , and thus We received our estimated values for the coming 1 month. The essence of Fourier's transformation is that it maps a continuous function into the frequency space and breaks it down into the compound of sinus and cosinus functions. In fact, Fourier coefficients – described in the literature – serve as the amplitudes of trigonometrical functions (Debevec, 2006). The EXCEL FFT (Fast Fourier Transformation) function calculates these discrete Fourier coefficients. By this We can analyse the cycles of data series and We can describe them by function approximation, and We can provide further estimations. By the application of Discrete Fourier Analysis We reconstructed the original data series, and then minimized the original and reconstructed difference by a solver and perfected the approximation. Pre-estimation was prepared in two ways: by the further calculation of function values and fitting them to the previous year (Fourier 1) and to the first year (Fourier 2), by shifting. The first estimated value was approximated to the original values by a solver, and then We received the pre-estimation of the following data by altered amplitude and phase. Then the first 2 estimated values were approximated to the original ones by a solver and We received the third pre-estimated value by altered amplitude and phase. This process was repeated until We received 24 estimations. On the basis of the time series graphs - autocorrelation graphs (ACF) and partial autocorrelation functions (PACF) - We can establish the probability of fitting the appropriate order and degree of successful ARIMA processes (Ketskeméty and Izsó, 2005). On the grounds of our data We verified the probability of ARIMA (1,0,0) model, but We performed our calculations for further three models: ARIMA (1,1,0); ARIMA (1,1,1); ARIMA (1,0,1)). Besides general ARIMA models We examined the accuracy of SARIMA model's forecast that take into account the seasonal character of the time series, which in our case has a great importance in lamb trade. (Winston, 2003). Out of smoothing methods, We used Winter's one, which prognosticated time series applying trends and seasonality as well. WINTER's exponential smoothing was performed by using the usual literatural descriptions (Winston, 2003).

## Results and discussion

The seasonal fluctuation of the average prices of nine years can be useful information for the producers. The deviation from the trend can help in production organization and adaptation to markets even if the average price trends in a year are different from the average of the nine years. As there is a tight correlation between the Italian and the Hungarian prices, the data presented in the figures are useful also for the Hungarian producers. According to the two-peak curve, the highest prices occur in the Easter and Christmas periods as compared to the trend. Based on the data, it can be observed that February, July and August are (surprisingly) the bottom ends for the Italian market (Figure 1).



**Figure 1: Changes in season indices based on data of the period 1996-2007**

Source: own calculations based on the data of the European Committee

In the Hungarian slaughter lamb trade, there are three major periods due to the seasonal demands in the export markets: Easter, Ferragusto and Christmas. Due to the seasonal effect, the lamb prices in Hungary are reducing from the beginning of the year (Figure 1). The increase of prices starts usually a few weeks before Easter simultaneously with the increase in the number of exported animals. In harmony with the Hungarian breeding traditions, conditions and the species characteristics of sheep, the supply of lambs is the largest in the Easter period. Usually, this period is characterized by an excess supply even in Europe in spite of the great demand, which frequently results in lower prices. For increasing the turnover from lamb sales, it would be desirable to have a more balanced export through the course of the year. In the second half of the year, the supply is lower and the prices are more favourable. The single market for the lamb sales increase the defenselessness of the sector, therefore, in addition to the Italian markets, it would be necessary to increase the export to other countries, where lambs of higher weight are preferred. Such markets could be France, England, Austria or Germany. The evaluation of Greek prices is also important for us, as it can be a good supplementary market, the peak and low prices are in different months there than in Italy. The tendency of Hungarian prices generally follows that of

the Italian market (*Figure 1*). The increase of lamb prices starts already in September similarly to the Italian prices. The high Easter prices in Hungary are usually followed by a large drop in prices, similarly to the Italian prices, but its degree is even higher. In the Southern-European countries the demand for lambs increases with the approach of the holidays at the end of the year.

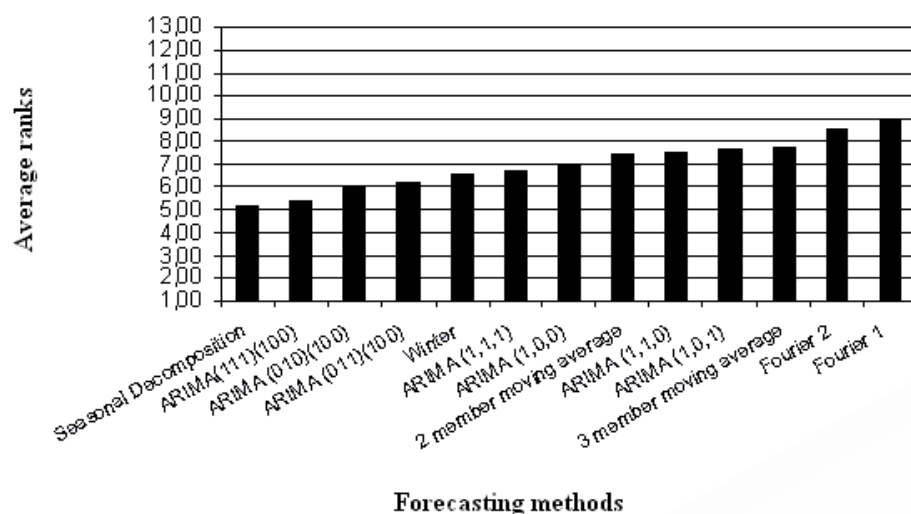
For forecasting the data, the models most fitting to the time series trend were selected within the different methods, that is why the number of models for the three databases is different. In all cases (Hungarian, Italian, Greek forecast) We used Seasonal Decomposition, Winter's exponential smoothing, Fourier analyses and method of moving average. Selection of the general ARIMA models, which disregard seasonality, was based on the autocorrelation graphs and partial autocorrelation functions for fitting the appropriate order and degree of successful ARIMA models. We selected 4 models this way. In case of the Greek database 2, the Hungarian database 3, and in case of the Italian database 4 SARIMA models had been selected suggested by the X-12 REGARIMA program. Finally from the five forecasting methods applied for lamb prices, We have set up 12 (Greek case) 13 (Hungarian case) and 14 (Italian case) competitive models for forecasting lamb prices.

For the evaluation of the forecasting ability of the models, the value of January 2005 was estimated based on the data of the preceding period from January 1998 until December 2004. Then, the value of February 2005 was estimated based on the period between January 1998 and January 2005, and so on until December 2006. The question emerged, what aspects render a given prediction better than another one. The question seems to be easy, but the answer is difficult. Therefore We considered the prediction should not deviate from the original data, i.e. we should be able to estimate the future values as precisely as possible.

In order to rank the various methods We made the following steps:

1. We calculated deviations between the original and predicted data
2. Based on the absolute value of deviations, on the grounds of data calculated for the periods methods were ranked.
3. We summarized these ranks.
4. From the summarized ranks we calculated the average ranks of the methods.

The results are presented in *Figure 1*, *Figure 2*, *Figure 3*.



**Figure 1: Average ranks of forecasting methods of Hungarian lamb prices**

Source: own calculations based on the data of the European Committee

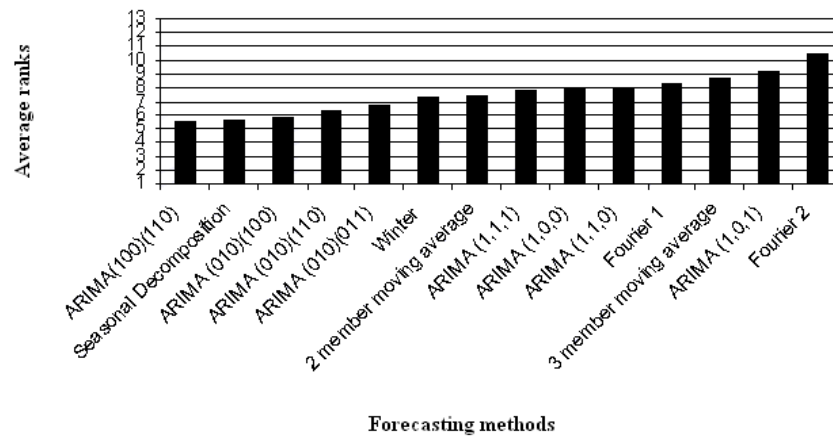
By the examination of ranks it can be established, that those methods were ranked on the first three places that handle seasonality. In forecasting of Hungarian data method of Seasonal Decomposition and ARIMA (111)(100) and ARIMA (010)(100) models were the most suitable (*Figure 1*). Fourier and 3-member moving average methods were the worst prediction methods. Fourier method provides more accurate result in case of long-term prediction due to its methodological background. After We had calculated the deviations between the original and predicted data, we counted first the percentages of deviations and then the averages. The best tree methods were presented in *Table 1* with regard to the forecast errors.

**Table 1: Average percentages of forecast errors based on the Hungarian prices**

Method	Percentage(%)
Seasonal Decomposition	3,98
ARIMA(111)(100)	4,96
ARIMA (010)(100)	4,98

In forecasting of Italian data ARIMA (100)(110) model, method of seasonal Decomposition and ARIMA (010)(100) and ARIMA (010)(110) models were the most suitable (*Figure 2*).





**Figure 2: Average ranks of forecasting methods of Italian lamb prices**

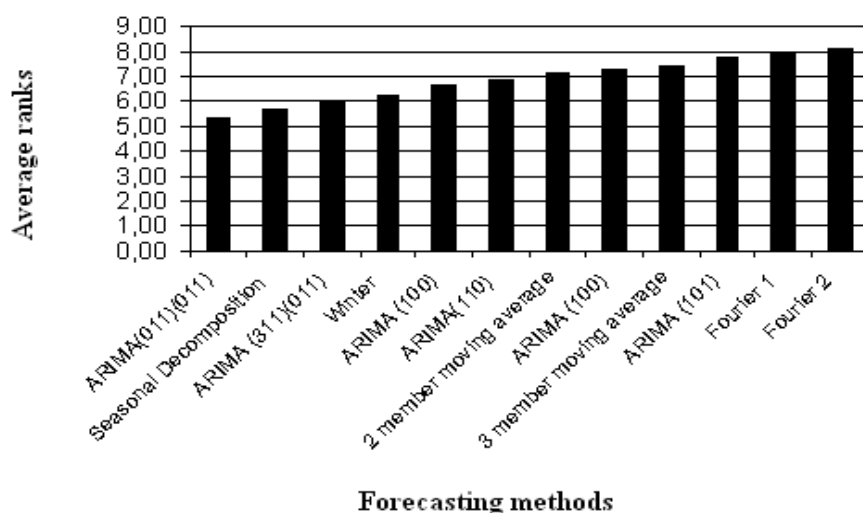
Source: own calculations based on the data of the European Committee

After We had calculated the average percentages of deviations between the original and predicted Italian prices, we found that Seasonal Decomposition seasonal proved to be the most suitable for the prediction of lamb prices, followed by ARIMA (100) (110) and ARIMA (010)(110) models (*Table 2*).

**Table 2: Average percentages of forecast errors based on the Italian prices**

Method	Percentage(%)
Seasonal Decomposition	4,70
ARIMA(100)(110)	4,94
ARIMA (010)(110)	5,12

In forecasting of Greek data ARIMA (011)(011), ARIMA (311)(011) and Seasonal Decomposition models were the most suitable (*Figure 3*).



**Figure 3: Average ranks of forecasting methods of Greek lamb prices**

Source: own calculations based on the data of the European Committee

After We had calculated the average percentages of deviations between the original and predicted Italian prices, we found that Seasonal Decomposition seasonal proved to be the most suitable for the prediction of lamb prices, followed by ARIMA (100) (110) and ARIMA (010)(110) models (*Table 3*).

**Table 3: Average percentages of forecast errors based on the Greek prices**

Method	Percentage(%)
Seasonal Decomposition	4,25
ARIMA (311)(011)	4,61
ARIMA (011)(011)	3,68

When studying the ranks, it can be stated that the methods in the first three places for all time series were methods which deal with the issue of seasonality. For forecasting the Hungarian data, the most suitable methods proved to be Seasonal Decomposition, ARIMA (111)(100) and ARIMA (010)(100) models.

## Conclusions

By the compare of forecasting methods used in Hungarian, Italian and Greek lamb price prediction it can be established, that in short-term (one-month) forecasting of lamb price, between methods we examined, Seasonal Decomposition and SARIMA models, that take seasonality into consideration, gave the most exact prediction in

lamb price forecast. On the basis of the types of prediction models we can state that Seasonal Decomposition proved to be the most suitable for the prediction of lamb prices. The most unpunctual predictions were given by Fourier models and by the 3-member average.

We ranked all the methods by average forecast errors, based on the ranks, groups were formed by cluster analysis among the methods. Among the methods treating seasonality, Seasonal Decomposition and SARIMA models were classified into the same group in all cases (Hungarian-Italian-Greek prices). This also proves the differences between methods. We can state as well, that no significant differences exist between SARIMA and Seasonal Decomposition methods. Based on the precision of the examination, the possibilities of forecasting could be exploited in the practice, thereby, the producers could have a better market position compared to their present situation.

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