Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 16, Issue 2, 2016
PRINT ISSN 2284-7995, E-ISSN 2285-3952

THE FORECASTS OF PIG MEAT PRICES IN THE EU - THE USE OF ADAPTIVE WINTER'S MODEL

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Abstract

Prices and factors which influence them are measurable thus it is appropriate to apply in this case a method of time series analysis for predicting the pig meat prices in the purchasing centre. In this paper adaptive models, which adjust to the changeable conditions, have been analysed including the changes in the trend level, accidental variations and seasonal variation. On the basis of estimated models the forecast of pig meat prices has been calculated. The ex post measurement of forecasts were used to asses a quality of models.

Key words**:** *EU, forecasts, pig meat prices, Winters model*

INTRODUCTION

The meat sector is one of the most important in European Union (EU) agriculture. Together the four main meat types — beef and veal, pig meat, poultry meat, and sheep meat / goat meat — account for one quarter of the total value of agricultural production. Half of all EU farms have livestock. Some 90 % of farmers with ruminant animals (cattle, sheep and goats) are specialist livestock producers. Meat is a major source of protein and constitutes an important part of the European diet. EU policies in the meat sector are designed to encourage the production of safe, nutritious and affordable meats. Recent changes to the common agricultural policy (CAP) underline these aims. Policies are geared increasingly towards meeting the needs of consumers, livestock producers and the environment in a balanced way [3,8,14].

Pig farmers in the EU have been complaining for several years about low pork prices, leading many to refer to the persistent low EU prices as a "pork crisis." In 2015, EU pork prices decreased 15 percent compared to the previous year. However, this reflects a range of price drops: while prices in some. Member States (MS) like Belgium and The Netherlands are down 20 percent, prices in Sweden

decreased only by 4 percent. The bottom of the EU pork price curve was reached in January 2015 after which prices slowly increased again. Price gaps between MS are large with Class E carcass prices varying from €121-122 in Belgium and The Netherlands to €145-147 in Germany and France, and from €154-155 in Spain and Romania up to €175 in Sweden and €186 in the United Kingdom [1, 5, 6, 14].

The blame for the pork price "crisis" is usually put on the Russian import ban, which began in January 2014. However, the perceived crisis also results from major production increases in some MS (Spain, Poland, Netherlands, and Germany) at a time when domestic consumption was under pressure from decreased consumer confidence due to the economic crisis and the Greek financial crisis. While the Russian trade embargo meant lost pork exports of 750,000 MT to Russia, these losses were mostly compensated by increased exports to Asia. Additionally, EU pig slaughter actually increased 2.8 percent in the first five months of 2015 as compared to 2014, compared to a 1.8 percent increase for 2014 compared to 2013. Combined with increased carcass weights, the 2015 increase in pork output is 3.7 percent compared to 2014. However, the outlook for EU pig markets is improving again as abundant 2015 grain and soybean crops are expected to lead to lower feed

prices, which should result in better margins for pig farmers [1, 2, 3, 5, 7].

MATERIALS AND METHODS

The characteristic feature of adaptive models is a fact that they show great flexibility and ability to adjust in case of irregular changes in trends or distortions and movements of seasonal variations. This fact makes an adaptive model a short-term prediction tool. In these models a big role is played by information from the past which include the predicted variable and prediction errors. This information allows for a choice of appropriate model and variables ensuring the most exact prediction. In adaptive models there is no set analytic figure, it is presumed that for each period the evaluation of trend and variations is built as a certain average of this kind of prices in previous periods. Adaptive models depend on the amount of information from the past used in determining current evaluations of a trend. More important is the latest information rather then farther past information which means that current signals are more important than outdated events [Nowak 1998]. These models gain more and more meaning as far as prediction of economic phenomena is concerned and are a good tool for prediction of agricultural processing. The group of adaptive models which are known as Winter's model deserve attention. Winter's model is used in case of time series including developing tendency, seasonal variations and accidental variations.

Due to the over fitting of seasonal variations there are two types of Winters model: additive model and multiplicative model. They are presented as follows:

Additive Winter's model:

$$F_{t-1} = \alpha\left(y_{t-1} - C_{t-1-r}\right) + \left(1-\alpha\right)\left(F_{t-2} - S_{t-2}\right)$$

$$S_{t-1} = \beta\left(F_{t-1} - F_{t-2}\right) + \left(1-\beta\right)S_{t-2}$$

$$C_{t-1} = \gamma\left(y_{t-1} - F_{t-1}\right) + \left(1-\gamma\right)C_{t-1-r}$$

Multiplicative Winter's model:

$$F_{t-1} = \frac{\alpha \cdot y_{t-1}}{C_{t-1-r}} + \left(1-\alpha\right)\left(F_{t-2} + S_{t-2}\right)$$

$$S_{t-1} = \beta\left(F_{t-1} - F_{t-2}\right) + \left(1-\beta\right)S_{t-2}$$

$$C_{t-1} = \frac{\gamma \cdot y_{t-1}}{F_{t-1}} + \left(1-\gamma\right)C_{t-1-r}$$

Where:

F_{t-1} – smooothened value of the variable predicted in moment *t-1*,

S_{t-1} – evaluation of the trend growth for moment *t-1*,

C_{t-1} – evaluation of the seasonality factor for moment *t-1*,

r – the length of season cycle (the number of cycle phases),

α – constant of the smoothness of the trend level ,

β – constant of the smoothness for trend changes

γ – constant of the smoothness for seasonal variations,

y_t^* - forecast for moment $t>n$.

Parameters α, β, γ have their values set within the <0, 1> limit. In literature there are different suggestions concerning the estimation of F_1, S_1, C_1 starting values thus it is suggested to accept as follows:

F_1 – the first value of forecasted variable, which is y_1, or the average of changeable variable in the first cycle,

S_1 – the difference of first and second value of the predicted variable that is y_2-y_1, or the difference of the average values of the changeable variable set in the first and second cycles.

C_1 – the average of differences on the basis of time sequence, (for additive model) or quotient (for multiplicative model) referring to the same phase of the season cycle of the values of the predicted variable as well as the smoothened values of the trend.

The estimation of α, β, γ parameters is based on experiments dealing with the minimisation of the average error in the past forecast, for the forecast with one-cycle advance. The forecast for each model is estimated according to the formulas:

Additive Winter's model:

$$y_t^* = F_n + S_n(t-n) + C_{t-r}$$

Multiplicative Winter's model:

$$y_t^* = \left[F_n + S_n(t-n)\right] \cdot C_{t-r}$$

Where *n* is the number of items in time sequence of the forecast variable [2,7,13,15].

The quality of forecast is linked to the forecast accuracy on the basis of ex post errors. The aim of this measurements is a h synthetic description of the empirical distribution of the deviation of the forecasted variable realisation reached in the past in the period of time from which the statistic data was collected. To measure the quality of the forecast the following measurements have been used: the prediction load (*u),* standard deviation of the forecast errors (*S_p),* relative forecast error (*w*)* and Thiel factor (*I^2)*:

$$u = \frac{1}{m}\sum_{t\in I_p}\left(y_t - y_t^*\right) \qquad w^* = \frac{S_p}{\bar{y}_{t\in I_p}}$$

$$S_p = \sqrt{\frac{1}{m}\sum_{t\in I_p}\left(y_t - y_t^*\right)^2} \qquad I^2 = \frac{mS_p^2}{\sum_{t\in I_p} y_t^2}$$

where: I_p –the period of empirical verification of the forecast

These measurements allow for deciding whether the forecast is acceptable and establish the rate of the deviation of the forecasted variable in comparison with ready formed forecast [13].

RESULTS AND DISCUSSIONS

In this paper the average pig meat prices in UE-27, Poland and Romania were considered, the data were taken from Polish Ministry of Agriculture and Rural Development.

In the analysed period, from January 2012 to December 2015, the average pig meat prices in UE-27 was 160.54 euros/100kg. Prices in Romania were a little bit higher then prices in UE-27 and Poland. It does not mean that while farmer's income in Romania were also higher. The relationships between farmer's income and costs of produce weren't taken under consideration by author in this paper (research).

Analysing price volatility in time the fluctuation can be easily observed, which are related to the pig cycle (Fig.1). It is well known that pig production is closely linked to the pig cycle, which determines pig meat prices pigs and pig population. From 2014 growth of pig population can be observed, the results of this situation is a decrease while pork prices in procurement. In May and June 2015 pig population in the EU amounted to 138.8 million units, an increase of 2.4 million or 1.8 percent more than last year. In the 2014 an increase in population was 1.4 million, or 1 percent. Compared the first half of 2015 to the first half of 2014 slaughter of pigs in the EU rose by 4.9 million units, or about 4.1 percent. to 126.6 million animals. At the same time, pig meat production in the EU increased by 560 thousand. tons, or about 5.2 percent. to 11.4 million tonnes. According to the European Commission in the third quarter it increased by 1.7 percent compared with the first quarter and in the fourth quarter by 1.8 percent.

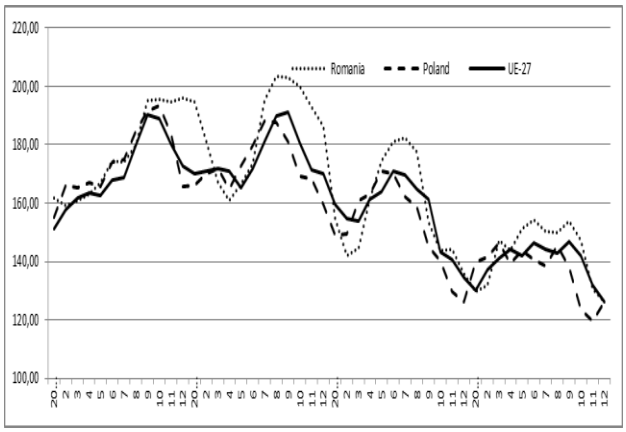

Fig.1. Pig meat prices in UE-27, Romania and Poland in period January 2012 – December 2015.
Source: Polish Ministry of Agriculture and Rural Development, http://www.minrol.gov.pl/Rynki-rolne/Zintegrowany-System-Rolniczej-Informacji-Rynkowej/Biuletyny-Informacyjne/Rynek-wieprzowiny, 11.02.2016

To predict the pig meat prices the Winter's additive and multiplicative model have been used. Model's parameters α, β, γ were chosen by the method which deals with the minimisation of the value of the $\sum_{t=1}^{n}\left(y_t - y_t^*\right)^2$. The values of model's parameters as well the value of $\sum_{t=1}^{n}\left(y_t - y_t^*\right)^2$ (which was used as a tool of evaluation of the quality of model's) are

presented in Table 1.

Table 1. The parameters of Winter's model for pig meat prices.

	UE (a)	UE (m)	Romania (a)	Romania (m)	Poland (a)	Poland (m)
A	0.915	0.672	1	0	1	0.164
B	0.289	1	0.196	1	0.259	1
Γ	1	0.281	0	0.281	0	0.281
$\sum_{t=1}^{n}\left(y_t - y_t^*\right)^2$	1,817.31	1,935.34	4,737.536	2,232.26	2,924.228	2,962.46

a – additive , m – multiplicative.
Source: Own calculations

On the basis of estimated models the forecasts of pig meat prices were calculated for the first half of 2016 years (Tab.2). The obtained values of forecasts suggest further declines in the pig meat prices in the EU-27, Romania and the slight increase of prices in Poland (based on the additive model).

Table 2. The forecasts of the pig meat prices for period January 2016 – June 2016.

	I	II	III	IV	V	VI	average
UE-27 (a)	123.48	120.73	117.98	115.23	112.48	109.73	116.61
Poland (a)	129.10	131.97	134.85	137.73	140.60	143.48	136.29
Romania (a)	120.00	113.79	107.57	101.35	95.13	88.91	104.46
UE-27 (m)	119.86	126.22	119.86	113.50	107.14	100.78	114.56
Poland (m)	124.73	126.22	124.73	123.24	121.75	120.27	123.49
Romania (m)	125.08	126.22	125.08	123.93	122.79	121.64	124.12

a – additive , m – multiplicative.
Source: Own calculation.

To determine the quality of forecasts, the standard deviation of the forecast errors (Sp), relative forecast error (w*), load of prediction (u) and Thiel factor (I2) has been calculated. The results for are presented in table 3.

Table 3. The measurements of the forecast accuracy according to Winter's model.

	UE (a)	UE (m)	Romania (a)	Romania (m)	Poland (a)	Poland (m)
u	-0.23	-0.58	0.36	0.48	-0.45	-1.54
S_p	6.22	6.49	10.04	9.97	7.89	8.03
w^*	4%	4%	5%	5%	5%	5%
I^2	0.00	0.00	0.00	0.00	0.00	0.00

Source: Own calculation.

Comparing the values of each measurements for each model we can conclude:
1.In UE-27 and Poland the predicted prices of pig meat in period January 2012-December 2015 were slightly higher than the real (the negative value of u parameter), forecasts of pig meat prices calculated on the basis of each model can be accepted due to the fact that the maximum value of relative forecast error do not exceed 5%
2.The value of Thiel factors (I2) equal 0 and it allows for the recognition of the forecast as a very accurate.

CONCLUSIONS

Adaptive models presented in this article are a good tool for short-term forecast of agricultural prices.
These models can be applied to the description of monthly pig meat prices and the predicted values which are obtained on the basis of Winter's model are characterized by a great accuracy.
Due to slight differences between the chosen measurements of the accuracy of the forecast of the choice of the model depends on the person preparing the forecast.
The main aim of the research was to determine the forecasts of pig meat prices for the first half of 2016 in the EU, Romania and Poland. It should also be remembered that the general level the pig meat prices are also

affected by prices of means of production, weather conditions, pig cycle and the currently realized instruments of the Common Agricultural Policy.

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