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FORECASTING THE SELLING PRICE OF TIMBER AUCTIONS

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Abstract: *This paper focuses on the development of an econometric model for the forecast of the closing price of timber auctions in the Maramures area, using the multiple linear regression model and taking into account six exterior variables. After applying the statistical tests, we defined the model which contains only four significant independent variables. The results can be used to forecast the closing prices for future auctions.*

Key words: *econometric model, forecast, multiple linear regression, timber auctions.*

1. Introduction

We have developed an econometric model to analyse the evolution of the closing prices (PA) for birch logs (first quality) at the Maramures auctions.

The prices are real for the main yearly auctions, in January-February (for the wood harvested in February, March and April) and September-October (for the felling carried out between October and January of the next year).

As explanatory variables, we have taken into account the following characteristics:

x_1 – the starting bid (*PP*) – lei/m^3

x_2 – the quantity of wood auctioned and sold (at all the analysed auctions the entire quantity was sold) (*QL*) – m^3

x_3 – number of participants (*NF*)

x_4 – number of steps is the auction from first call to the sale (*NP*)

x_5 – the selling price to the timber plants (*PV*) – lei/ m^3

x_6 – the costs for the felling company for harvesting, debarking, transporting to the road and to the factory (*CR*) – lei/ m^3

2. The econometric model

The model employed was the multiple linear regression using the formula:

$$y_t = a_0 + a_1 x_{1t} + a_2 x_{2t} + ... + a_k x_{kt} + \varepsilon_t$$

$$y_t = a_0 + a_1 x_1 + a_2 x_2 + a_3 x_3 + a_4 x_4 + a_5 x_5 + a_6 x_6 + \varepsilon_t$$

$$PA = a_0 + a_1 PP + a_2 QL + a_3 NF + a_4 NP + a_5 PV + a_6 CR + \varepsilon_t \qquad (1)$$

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To determine the value of the regression coefficients and the confidence interval, the Student test, the Fisher test, Standard Estimation Error, Coefficient of Determination (R^2) and the Correlation Report (R), we first used the Data Analysis / Regression option.

3. The steps in calculations

Then we made the calculations, following these steps:

1. Estimating the coefficients of the multiple regression model, using the formula:

$$Y = X \cdot a + \varepsilon$$
$$\hat{a} = (X'X)^{-1} X'Y \quad (2)$$

2. Determining the confidence interval of the coefficients:

$$ICa_i = \left[\hat{a}_i - \hat{\sigma}_{\hat{a}_i} t^{\alpha/2}_{grd.lib.};\ \hat{a}_i + \hat{\sigma}_{\hat{a}_i} t^{\alpha/2}_{grd.lib.}\right] \quad (3)$$

3. Calculating the Students ratios to determine if all the coefficients are significantly different from 0. Eliminating the insignificant variables. For this, we compared the Student ratios obtained with the formula

$$t^*_{a_i} = \frac{\hat{a}_i}{\hat{\sigma}_{\hat{a}_i}}$$

having the theoretical value

$$t^{\alpha/2}_{n-k-1} = t^{0.025}_{12-6-1} = t^{0.025}_{5} = 2{,}570 \quad (4)$$

We have retained as signifficant variables those which had the Student Ratio > 2.570.

4. To verify that the regression is globally significant, if the correct model is chosen, we calculated the Fisher Test.

We split the total variance (SST) in the sum of the explained variance by the regression model (SSE) and the residual variance (SSR) as follows:

SST = SSE + SSR

$$\sum_{t=1}^{n}(y_t - \bar{y})^2 = \sum_{t=1}^{n}(\hat{y}_t - \bar{y})^2 + \sum_{t=1}^{n}(y_t - \hat{y}_t)^2$$

We have calculated F* using the formula:

$$F = \frac{SSE/k}{SSR/(n-k-1)}$$

which we compared with the theoretical value

$$F^{\alpha/2}_{k,n-k-1} = F^{0.025}_{6,12-6-1} = F^{0.025}_{6,5} = 4{,}950 \quad (5)$$

Because F* = 155,78 >Fteor the regression is globally signifficant and therefore the model is well chosen.

5. To judge the quality of the adjustments, we have calculated the Determining Coefficient R2 using the formula

$$R^2 = \frac{\sum_{t=1}^{n}(\hat{y}_t - \bar{y})^2}{\sum_{t=1}^{n}(y_t - \bar{y})^2} \quad (6)$$

Because R^2 = 0,9946 it means that 99,46% of the total variance is explained by SSE, therefore the model is properly chosen. The correlation report R = $\sqrt{R^2}$ shows the intensity of the simultaneos correlation between Y and the explained variables. R = 0,9973 or 99,73% which defines a very strong correlation.

6. After eliminating the insignificant variables from the model (x_2 – the quantity of timber auctioned and sold (*QL*) and x_3 – the number of participating companies (*NF*)), we applied a new regression using the four remaining explanatory variables and calculated the new regression coefficients

$$y_t = a_0 + a_1x_1 + a_4x_4 + \\ + a_5x_5 + a_6x_6 + \varepsilon_t$$

$$PA = a_0 + a_1PP + a_4NP + \\ + a_5PV + a_6CR + \varepsilon_t$$

We have calculated the new coefficients with the formula:

$$\hat{a} = (X'X)^{-1}X'Y \quad (7)$$

Moreover, we recalculated the Student Ratios to verify that the coefficients are significantly different from 0 in the new regression. Because all the calculated values were higher than the theoretical value.

$$t^{\alpha/2}_{n-k-1} = t^{0.025}_{12-4-1} = t^{0.025}_{7} = 2{,}364 \quad (8)$$

We concluded that all 4 explanatory variables left in the model contribute to the determination of Y.

7. We drew the graphs which outline the evolution of the auction selling prices (PA-Y) and in relation to the explanatory variables left in the model:

x_1 – the starting bid (PP) – lei/ m3

x_4 – number of steps is the auction from first call to the sale (NP)

x_5 – the selling price to the timber plants (PV) – lei/ m3

x_6 – the costs for the felling company for harvesting, debarking, transporting to the road and to the factory (CR) – lei/ m3

8. We calculated the Fisher test for the new regression and we found that F*= 226,05 >

$$F_{k,n-k-1}^{\alpha/2} = F_{4,12-4-1}^{0.025} = F_{4,7}^{0.025} = 4{,}120 \tag{9}$$

Which means that the regression and the 4 explanatory variables are globally significant, so the liniar model is properly chosen.

9. We proceded with the prediction using the multiple regression using the formula

$$\hat{y}_t = \hat{a}_0 + \hat{a}_1 x_{1,t} + \hat{a}_2 x_{2,t} + ... + \hat{a}_k x_{k,t}$$

For the time unit *t+h* in the forecast is:

$$\hat{y}_{t+h} = \hat{a}_0 + \hat{a}_1 x_{1,t+h} + \\ + \hat{a}_2 x_{2,t+h} + ... + \hat{a}_k x_{k,t+h}$$

The error variance of the forecast is:

$$\sigma_{e_{t+h}}^2 = \sigma_\varepsilon^2 [X'_{t+h}(X'X)^{-1} X_{t+h} + 1] \tag{10}$$

By knowing the future values of the explanatory variables, we have obtained the forecasted values of Y, using matrix calculations as follows:

$$X_{t+h} = \begin{pmatrix} 1 \\ x_{1,t+h} \\ x_{2,t+h} \\ ... \\ x_{k,t+h} \end{pmatrix}$$

The trust intervals of the forecasts were obtained using the formula:

$$ICy_{t+h} = \hat{y}_{t+h} \pm \\ \pm t_{n-k-1}^{\alpha/2} \sqrt{\sigma_\varepsilon^2 [X'_{t+h}(X'X)^{-1} X_{t+h} + 1]} \tag{11}$$

Finally, we created the chart which underlines the forecasted evolution of PA with the superior and inferior limits of IC.

4. The primary regression

The initial model, with all 6 explanatory variables:

Table 1a

Nr. crt.	Period	y [lei/mc] PA	x1 [lei/mc] PP	x2 [mc] QL	x3 NF	x4 NP	x5 [lei/mc] PV	x6 [lei/mc] CR
1	2008 - ian.	211	202	3423	8	4	379	127
2	2008 - febr.	223	210	3815	11	6	378	126
3	2008 - sept.	218	210	4203	7	4	387	128
4	2008 - oct.	231	220	4655	10	8	389	128
5	2009 - ian.	220	209	3008	14	8	370	128
6	2009 - febr.	215	214	2991	6	3	370	126
7	2009 - sept.	206	200	3950	7	4	360	124
8	2009 - oct.	198	195	3883	6	3	355	124
9	2010 - ian.	192	180	3013	10	7	341	126
10	2010 - febr.	188	180	2915	9	6	345	127
11	2010 - sept.	199	190	3772	7	5	355	126
12	2010 - oct.	210	195	3718	8	7	365	125

Table 1b

Nr. crt.	Period	y theoretic	e^2 $(y - y\ teor)^2$	$(y - ymed)^2$	$(yteor - ymed)^2$
1	2008 - ian.	211,8163	0,6663	3,0625	6,5858
2	2008 - febr.	221,7849	1,4764	189,0625	157,1245
3	2008 - sept.	217,2935	0,4991	76,5625	64,6984
4	2008 - oct.	231,8638	0,7462	473,0625	511,3840
5	2009 - ian.	220,3473	0,1206	115,5625	123,1505
6	2009 - febr.	214,5834	0,1736	33,0625	28,4451
7	2009 - sept.	206,3020	0,0912	10,5625	8,6907
8	2009 - oct.	199,1923	1,4217	126,5625	101,1565
9	2010 - ian.	191,0890	0,8299	297,5625	329,8216
10	2010 - febr.	189,2311	1,5155	451,5625	400,7582
11	2010 - sept.	197,4284	2,4700	105,0625	139,7506
12	2010 - oct.	210,0680	0,0046	0,5625	0,6691
	Total	2511	**10,0150**	**1882,2500**	**1872,2350**
			SSR	SST	SSE

y - closing prices (*PA*) for birch logs (first quality) at the Maramures auctions.
x_1 – the starting bid (*PP*) – lei/ m^3
x_2 – the quantity of wood auctioned and sold (at all the analysed auctions the entire quantity was sold) (*QL*) – m^3
x_3 – number of participants (*NF*)
x_4 – number of steps is the auction from first call to the sale (*NP*)
x_5 – the selling price to the timber plants (*PV*) – lei/ m^3
x_6 – the costs for the felling company for harvesting, debarking, transporting to the road and to the factory (*CR*) – lei/ m^3

5. The final regression

The new regression with the four explanatory variables left in the model and the forecast values for *PA* for the 4 auctions in 2011 calculated with Data Analysis/Regression are:

Table 2

		y	**x1**	**x4**	**x5**	**x6**	
		[lei/mc]	[lei/mc]		[lei/mc]	[lei/mc]	
Nr crt	Period	**PA**	**PP**	**NP**	**PV**	**CR**	**y th**
1	2008 - ian.	211	202	4	379	127	210,9648
2	2008 - febr.	223	210	6	378	126	220,9432
3	2008 - sept.	218	210	4	387	128	217,7288
4	2008 - oct.	231	220	8	389	128	233,0496
5	2009 - ian.	220	209	8	370	128	219,4440
6	2009 - febr.	215	214	3	370	126	214,5032
7	2009 - sept.	206	200	4	360	124	206,4011
8	2009 - oct.	198	195	3	355	124	199,4155
9	2010 - ian.	192	180	7	341	126	191,0597
10	2010 - febr.	188	180	6	345	127	189,2785
11	2010 - sept.	199	190	5	355	126	198,1565
12	2010 - oct.	210	195	7	365	125	210,0550
13	2011 - ian.		192	5	372	125	206,4500
14	2011 - febr.		188	4	377	127	201,3669
15	2011 - sept.		196	6	385	126	214,4771
16	2011 - oct.		190	4	387	127	206,1183

y - closing prices (*PA*) for birch logs (first quality) at the Maramures auctions.
x_1 – the starting bid (*PP*) – lei/ m^3
x_4 – number of steps is the auction from first call to the sale (*NP*)
x_5 – the selling price to the timber plants (*PV*) – lei/ m^3
x_6 – the costs for the felling company for harvesting, debarking, transporting to the road and to the factory (*CR*) – lei/ m^3

6. The charts

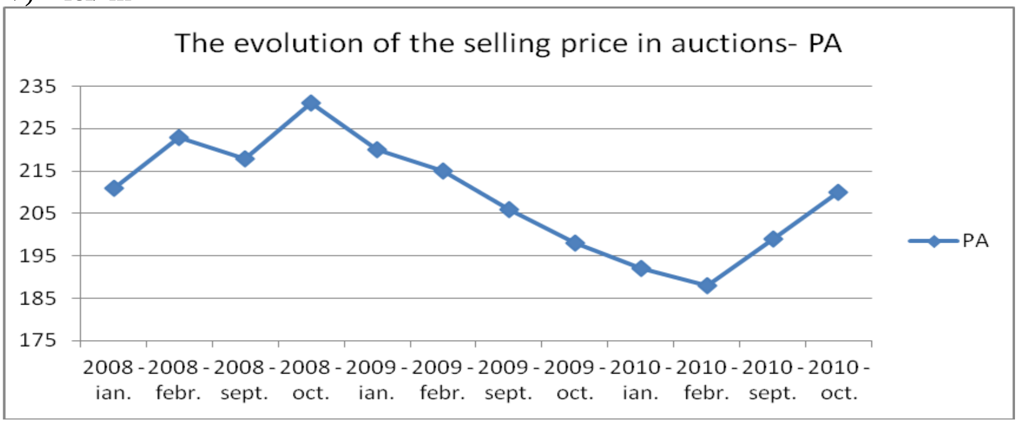

Fig. 1. *Chart 1 outlines the evolution of PA*

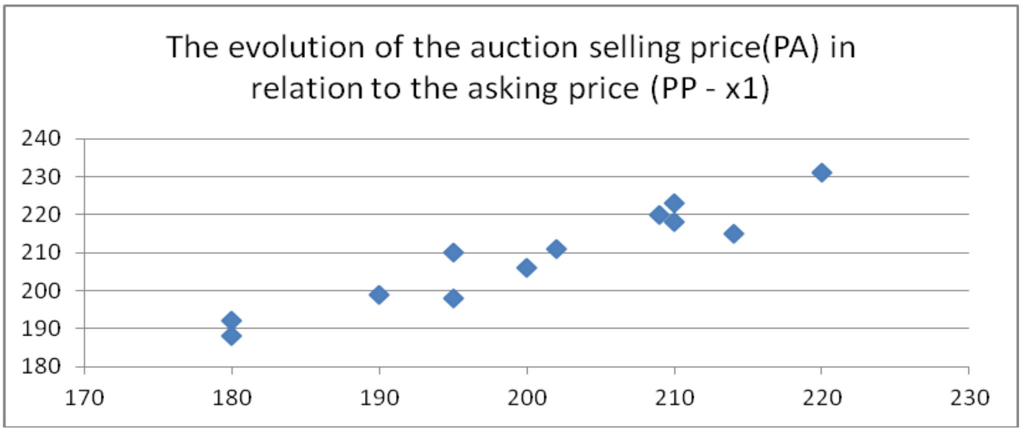

Fig. 2. *Chart* 2 *outlines the evolution of PA in relation to* x_1

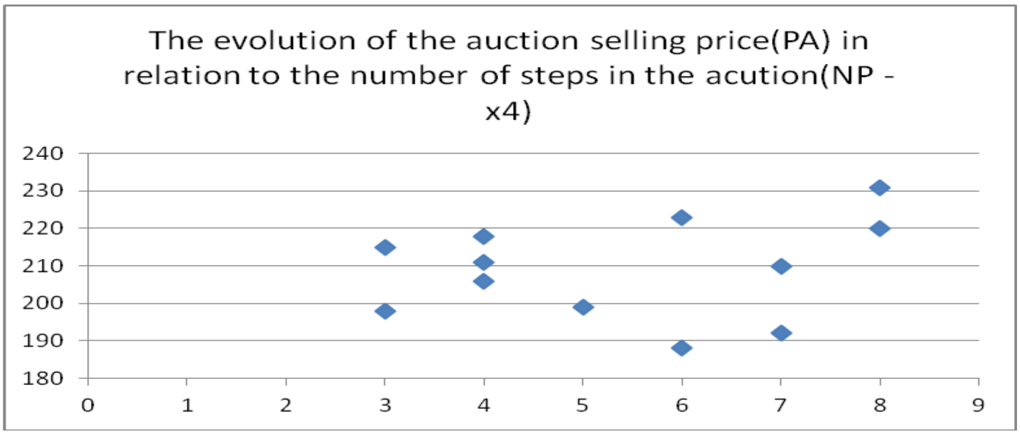

Fig. 3. *Chart* 3 *outlines the evolution of PA in relation to* x_4

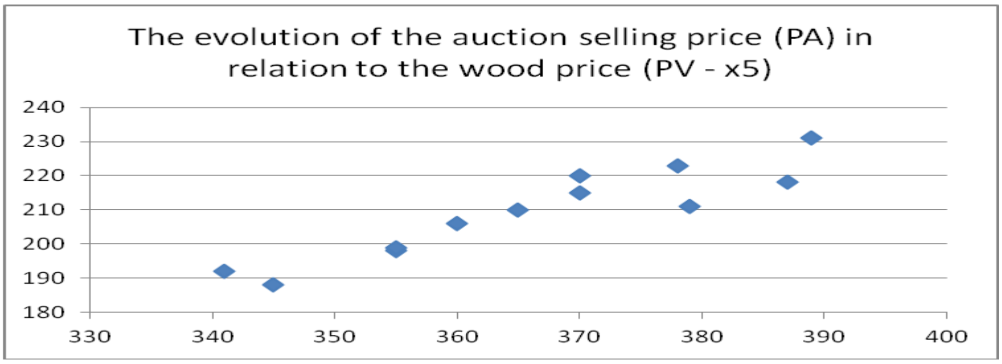

Fig. 4. *Chart* 4 *outlines the evolution of PA in relation to* x_5

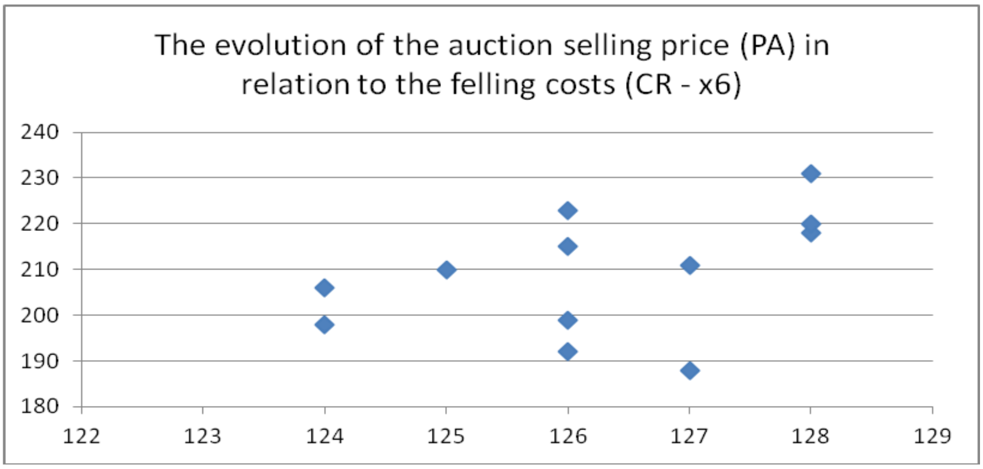

Fig. 5. *Chart* 5 *outlines the evolution of PA in relation to* x_6

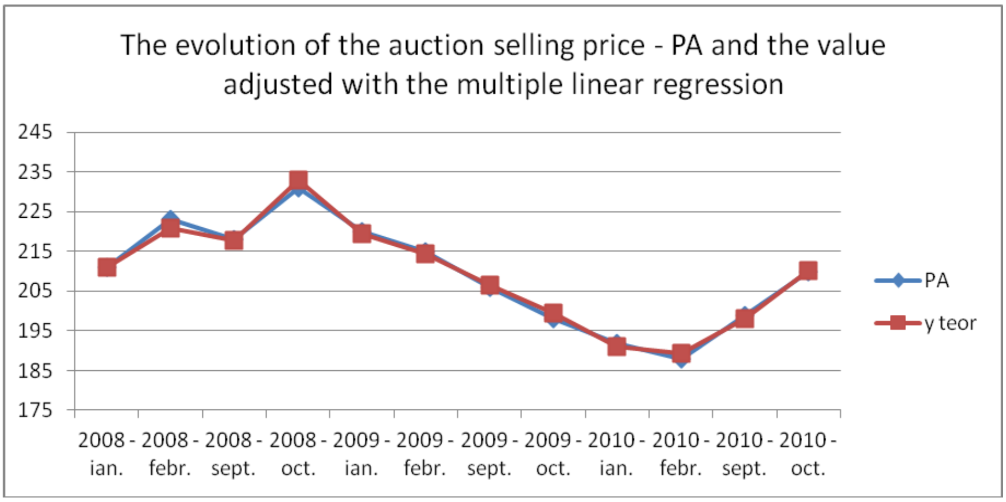

Fig. 6. *Chart* 6 *outlines the observed values of PA in parallel to the theoretical values, obtained by the multiple linear regression*

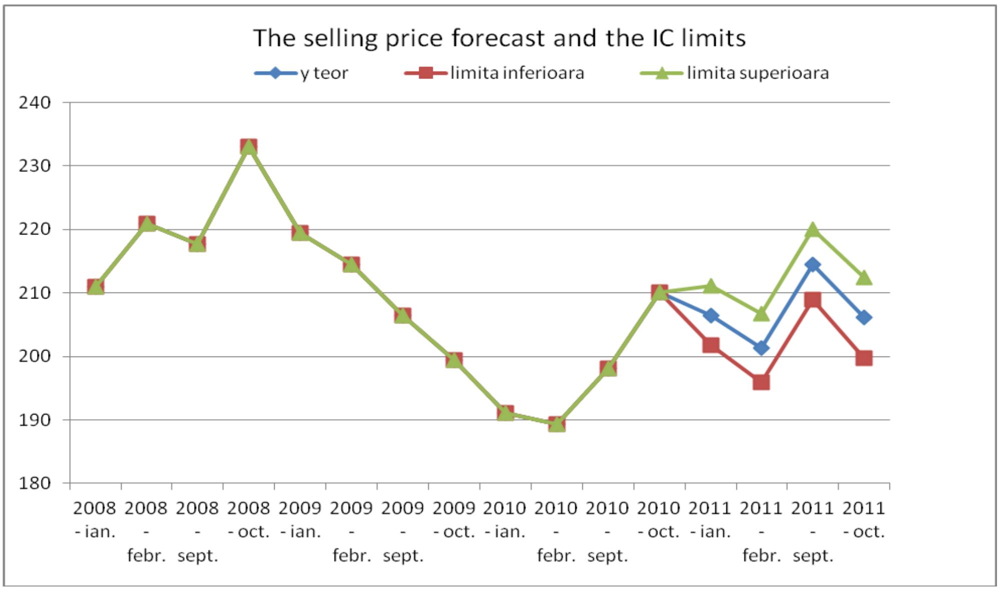

Fig. 7. *Chart 7 outlines the forecasted evolution of PA, with the upper and lower limits of IC*

7. Conclusions

The initial econometric model with 6 explanatory variables x_1 – the starting bid (*PP*) – lei/ m^3, x_2 – the quantity of wood auctioned and sold (at all the analysed auctions the entire quantity was sold) (*QL*) – m^3, x_3 – number of participants (*NF*), x_4 – number of steps is the auction from first call to the sale (*NP*), x_5 – the selling price to the timber plants (*PV*) – lei/ m^3, x_6 – the costs for the felling company for harvesting, debarking, transporting to the road and to the factory (*CR*) – lei/ m^3 was statistically tested to ensure its validity.

After the testing, only x_1, x_4, x_5 and x_6 proved to be significant and were used to develop the forecast model for the selling prices for 2011.

We intend test this forecast model for a greater time span and on other types of wood auctions. After the publication of the official data regarding the auctions in 2011, we will be able to perform the necessary adjustments.

References

1. Duguleană, L.: *Metode de previziune economic*. Editura Universităţii Transilvania din Braşov. 2011.
2. Duguleană, L.: *Econometrie*. Curs pentru Învăţământ la Distanţă, Editura Universităţii Transilvania din Braşov. 2009.
3. Duguleană, C.: *Introducere în economia aplicată*, Editura Infomarket, Braşov, 2004.
4. Dor, E.: *Econometrie*. Collection Synthex, Pearson Education France, 2009.
5. Fernandes, M.: *Statistics for Business and Economics*. www.bookboon.com, 2009.
6. Hayashi, F.: *Econometrics*. Princeton University Press, 2000.
7. Wooldridge, J.: *Introductory econometrics: a modern approach*. South-Western, Cengage learning, 2009.

8. Makridakis, S.: Wheelwright, S., Hyndman, R.: *Forecasting: methods and applications*. Wiley, 1998.
9. Evans, M.: *Practical business forecasting*, Blackwell Publishers, 2002.
10. Armstrong, J. S.: *Research needs in forecastin*g. International Journal of Forecasting, Volume 4, Issue 3, 1988, pp. 449-465.
11. Smith, C. D., Mentzer, J. T.: *Forecasting task-technology fit: The influence of individuals, systems and procedures on forecast performance*. International Journal of Forecasting, Volume 26, Issue 1, January–March 2010, pp. 144-161.
12. Ord, J. K.: *Future developments in forecasting: The time series connexion*. International Journal of Forecasting, Volume 4, Issue 3, 1988, pp. 389-401