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AN ANALYSIS OF THE TURNOVER INDEX EVOLUTION IN METALLURGY DURING 2000-2012, THE CASE OF ROMANIA

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The economic crisis has left its mark on metallurgical activities, which have declined significantly with lasting implications. The magnitude of the economic crisis and its influence on industries on long-term trends is different.

The research carried out shows that for the evolution of metallurgy in January 2000 - November 2012, a valid model was not identified to describe the indices of turnover of the entire period, due to the discontinuity caused by the economic crisis. But there can be generated models of the evolution of annual turnover indexes for the period which precedes the economic crisis and models of evolution of value indexes of turnover in the period after the economic crisis.

Key words: metallurgy, economic crisis, turnover, Romania, ARIMA models

INTRODUCTION

Metallurgical industry is characterized by increased vulnerability to fluctuations in external demand and commodity prices, and in recent years this industry, along with the steel one had to face major difficulties, being forced to bear negative effect of price policies purchased electricity, as heavy consumers, and that of green certificates.

In analyzing the dynamics of turnover of metallurgy were included operators that are principally engaged in the metal industry. The data sources are the National Statistics Institute [1], the Ministry of Economy [2] and, Industry Statistical Bulletin [3], which used a sample statistical research, respectively simple random stratified sampling.

This article is a continuation of earlier concerns of the authors on this area, resulting in two articles published in Romania, in "International Metallurgy" first, "The Place of Metallurgical High Education in Higher Technical and Industrial Education in Romania" [4], published in 2010, and the second, "A Regression Analysis of Metallurgy Production Dynamics in Romania During 2000-2010" [5], published in 2012.

Methodologically, the paper is based on statistical analysis methods presented in the works of Isaic-Maniu, Mitrut and Voineagu [6], Gogonea [7] and Oprea [8]. As IT support in processing and analysis were used Excel and EViews.

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ASPECTS AND PECULIARITIES OF ITO OF METALLURGY ON DOMESTIC AND FOREIGN MARKETS

In the period under review, the turnover of metallurgical industry has evolved relatively synchronous sometimes, and sometimes different as compared to the total industry turnover and relative to other industries. To analyze these developments quantitative variables were used as index of turnover (ITO) calculated in order with the base year 2005.

Economic crisis has manifested differently on turnovers of steel industry on domestic and foreign markets. The evolutions of ITO accomplished in these markets are presented in Figure 1.General evolutions of the two indicators are similar to the evolution of total ITO of metallurgical industry, accomplished in this period. The amplitude changes as well as slopes of trends, recorded for the two indicators are different.

A first observation is that many times, the developments of the two indicators, from 2002 till 2005, were in antiphase. Such cases, in which the foreign market ITO (ITO_{M_FM}) has exceeded domestic market ITO achieved (ICA_{M_DM}) were manifest in June 2002 (ITO_{M_DM} = 44,4 < ITO_{M_FM} = 48,1) in the period December 2002 - March 2003 and from January till June 2005, the maximum difference recorded being in March 2005 (ITO_{M_DM} = 107,2 < ITO_{M_FM} = 129).

A second observation is that, from July 2005 until the economic crisis unleashed, increasing monthly average value ITO_{M_FM} (2,439 percentage points) was significantly higher than the values recorded ITO_{M_DM} (1,035 points). This led to the fact that when economic crisis unleashed, the impact on ITO_{M_DM} was much larger than impact on ITO_{M_FM}.Finally, after September

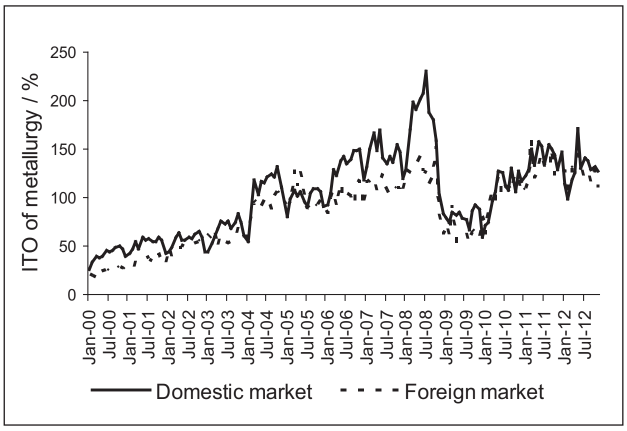

Figure 1 The evolution of ITO of metallurgy on domestic and foreign markets

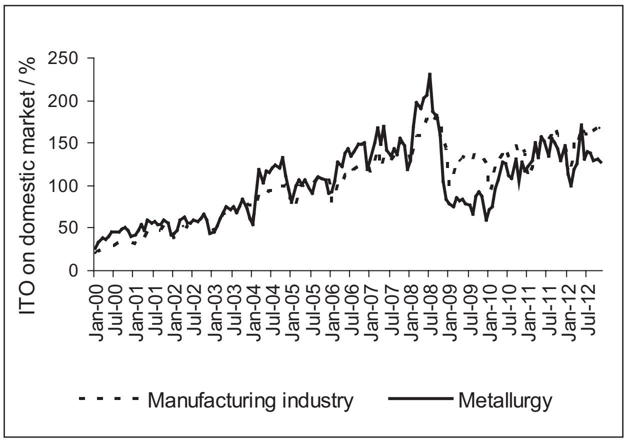

Figure 2 The evolution of ITO of metallurgy and manufacturing industry on domestic market

2009 ITO_{M_DM} and ITO_{M_FM} register values and have similar evolutions, contributing approximately equally to form the total ITO performed by metallurgy.

Interesting conclusions can be drawn from the comparative analysis of evolutions of ITO performed on domestic and foreign markets in metallurgy and manufacturing. In the analyzed period between the evolution of ITO of metallurgy, on the domestic market (ITO_{M_DM}) and the evolution of ITO performed by manufacturing industry in the same market (ITO_{P_DM}) there are not very great differences except for one period (Figure 2). This is just the period following of the beginning economic crisis. Thus, while in the period December 2008 - February 2010 ITO_{M_DM} recorded values between 59,4 % (august 2009) and 89,4 % (March 2009) towards the year 2005, the ITO_{P_DM} recorded values between 105,8 % (January 2009) and 150,4 % (October 2009).

Regarding ITO evolution achieved by each of the two industries in foreign market (ITO_{M_FM} respectively ITO_{P_FM}) between October 2008 and November 2012, the differences are obvious (Figure 3). While evolution of ITO_{M_FM} has been strongly influenced by the economic crisis, ITO_{P_FM} has increased continuously being virtually uninfluenced by it.

From the above, we can draw at least two conclusions on the contribution of the turnover performed in domestic and in foreign markets on total turnover of metallurgy and, respectively, of manufacturing industry.

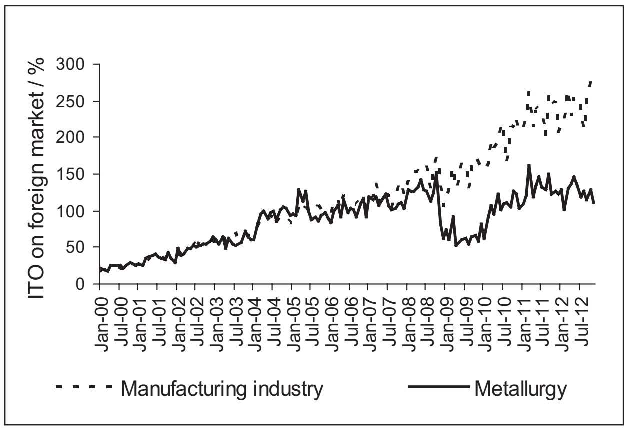

Figure 3 The evolution of ITO of metallurgy and manufacturing industry on foreign market

A first conclusion is that after the beginning of the economic crisis at the end of 2008, the metallurgical industry declined significantly both on domestic market and foreign markets. A second conclusion highlights the important contribution of turnover of manufacturing industry achieved, in foreign markets, in the period after October 2008 to achieve total turnover of the industry at that time. Consequently, the upturn of total ITO of manufacturing industry is due to external market results, which not only offset the decline in domestic market during the economic crisis, but also ensured the continuing growth ITO in that period.

ARIMA MODELS OF THE ITO EVOLUTION ACCOMPLISHED IN METALLURGY FROM JANUARY 2000 TILL NOVEMBER 2012

The facts presented so far show that, unlike industries analyzed for metallurgical industry evolution from January 2000 till November 2012 we did not identify a valid model which describes the evolution of ITO throughout the period. In this chapter we test the existence of some ARIMA models to describe evolution of ITO in this period. Autoregressive models (AR, MA, ARIMA, etc.) are detailed in the fundamental work of Box, Jenkins and Reinsel [9], Bierens [10] and Oprescu's [11].

Empirical data series containing monthly values of ITO, entitled icam, contains 151 records. The first transformation is to identify and eliminate seasonality. Scaling factors are presented in Table 1. By their application to the icam series we get icamsa series.

Table 1 **Ratio to Moving Average, Original Series: icam, Adjusted Series: icamsa, Scaling Factors**

Month	Scaling Factors	Mounth	Scaling Factors	Month	Scaling Factors
January	0,881	May	1,120	September	1,021
February	0,928	Jun	1,055	October	1,073
March	1,099	July	1,027	November	0,977
April	1,012	August	0,986	December	0,854

On this basis was generated, by applying first differences, the series:

$$d\_icamsa = icamsa - icamsa(-1) \qquad (1)$$

For the analysis of stationary of icamsa and d_icamsa series, we used Augmented Dickey-Fuller test (ADF) and correlogram analysis. The results obtained for a significance level á = 0,05 are shown in Table 2.

Table 2 **Unit root and correlation analysis for icamsa and d_ icamsa series**

icamsa series			d_icamsa series		
Null Hypothesis ICAMSA has a unit root			Null Hypothesis D_ICAMSA has a unit root		
ADF	t-Statistic	Prob	ADF	t-Statistic	Prob
-1,955	-2,880	0,306	-6,369	-2,880	0,000
Correlation analysis			Correlation analysis		
Order	AC	PAC	Order	AC	PAC
1	0,954	0,954	1	-0,156	-0,156
2	0,919	0,095	2	-0,177	-0,206

As can be seen from Table 2, for icamsa series, null hypothesis is accepted, because ADF_statistic = –1,955001 > t_Statistic = – 2,880591. The same conclusion can be drawn from the correlogram analysis (autocorrelation coefficient orders 1 and 2 have values very close to 1).

Unlike icamsa, the D_icamsa series is stationary. In this case, because ADF_statistic = –6,369492 > t_Statistic = – 2,880591 the null hypothesis is rejected and alternative hypothesis is accepted (d_icamsa has a not unit root). Also autocorrelation coefficients have values close to 0. Graphical representation of the two series is shown in Figure 4.

Starting from correlogram analysis of d_icamsa series were identified two valid models ARIMA (10,1,1) for which Pr ob (F_statistic = 0,0002 > 0,05), and ARIMA (3,1,1) for which Pr ob (F_statistic = 0,0021 > 0,05). Model parameter values are presented in Table 3. As can be seen, except the constants C, in both models the other coefficients are statistically significant (Pr ob $< \alpha = 0,05$).

Although both models, the analysis of residue series revealed that it invalidates the hypothesis of autocorrelation (residues are not autocorrelatied) and the hypothesis of homoscedasticity (residues have average 0 and constant dispersion), it is not checked the hypothesis of normality distribution.

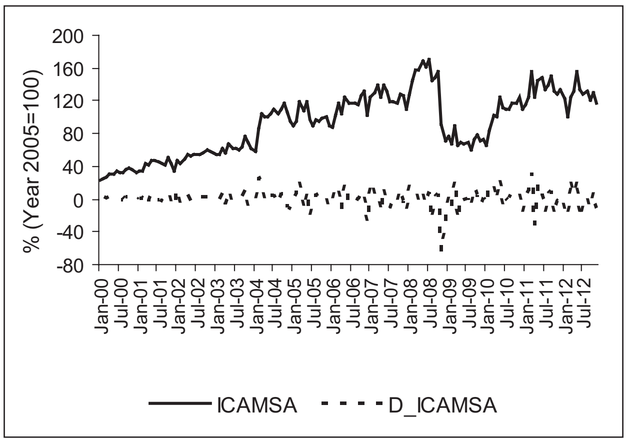

Figure 4 Graphical representation of icamsa and d_icamsa series

Table 3 **Comparative presentation of models ARIMA (10,1,1) and ARIMA (3,1,1)**

ARIMA(10,1,1)				ARIMA(3,1,1)			
Variable	Coeff.	t-Stat	Prob.	Variable	Coeff.	t-Stat	Prob.
C	0,640	1,221	0,229	C	0,571	0,666	0,505
AR(1)	0,395	2,554	0,012	AR(3)	0,281	3,528	0,000
AR(3)	0,277	3,883	0,000	MA(1)	-0,174	-2,143	0,033
AR(10)	-0,228	-3,157	0,002				
MA(1)	-0,620	-4,061	0,000				
DW stat	1,903	Prob (F-stat)	0,000	DW stat	1,903	Prob (F-stat)	0,0002

Because the values of Jarque-Bera statistics are 170,417 (Probability = $0,00 < \alpha = 0,05$) for ARIMA(10,1,1) and 203,7159 (Probability = $0,00 < \alpha = 0,05$) for ARIMA(3,1,1), results that the two models, although valid, cannot be used to analyze evolution of ITO of metallurgy in analyzed period.

A first conclusion is that due to the outbreak of economic crisis, between November 2008 and January 2009 the collapse of total ITO of metallurgy is significant and therefore has resulted into a discontinuity which prevents getting a single model for the whole period.

Taking this into account, in the analysis of icamsa and d_icamsa data series (Figure 4), we remove the period between November 2008 and January 2009, and from d_icamsa series, two series of data were generated. The first series d_icamsa_a contains data for the period January 2000 October 2008 and the second series d_icamsa_b contains data for February 2009 November 2012 period.

Although the two new series are generated from a stationary series their stationary analysis were also made. For the significance level á = 0,05 the results are shown in Table 4.

Table 4 **Unit root and correlation analysis for d_icamsa_a and d_icamsa_b series**

d_icamsa_a series			d_icamsa_b series		
Null Hypothesis ICAMSA has a unit root			Null Hypothesis D_ICAMSA has a unit root		
ADF	t-Statistic	Prob	ADF	t-Statistic	Prob
-13,992	-2,889	0,000	-7,972	-2,929	0,000
Correlation analysis			Correlation analysis		
Order	AC	PAC	Order	AC	PAC
1	-0,315	-0,315	1	-0,200	-0,200
2	-0,078	0,197	2	-0,379	-0,436

For the period January 2000 October 2008 correlogram analysis of the d_icamsa_a series, and after testing several models we focused on at two of them, which meet the tests of validity and the normality of residues. The estimation results for these models are presented in Table 5.

Table 5 **Comparative presentation of ITO models, in metallurgy, from January 2000 till October 2008**

ARIMA(10,1,7)				ARIMA(3,1,1)			
Variable	Coeff.	t-Stat	Prob.	Variable	Coeff.	t-Stat	Prob.
C	1,149	3,358	0,001	C	1,130	2,547	0,012
AR(1)	-0,316	-3,259	0,001	AR(1)	-0,290	-3,024	0,003
AR(10)	-0,250	-2,300	0,023	MA(10)	-0,285	-2,600	0,011
MA(7)	-0,235	-2,175	0,032				
R-squared		0,202547		R-squared		0,157797	
DW stat	2,171	Prob (F-stat)	0,0001	DW stat	2,192	Prob (F-stat)	0,0003
Residuals Sample 2000:12 2008:10							
Mean	-2E-12	Std. Dev	6,740	Mean	-0,006	Std. Dev	6,561
Skewness	0,346	Kurtosis	3,690	Skewness	0,305	Kurtosis	3,398
Jarque-Bera	3,792	Prob	0,150	Jarque-Bera	3,398	Prob	0,182

In view of the presented in Table 5 and in particular that R_sqared of the first model is greater than for the second model, we consider that the two models ARIMA (10,1,7) give a better description of the evolution of ITO achieved in metallurgy between January 2000 October 2008.

Similarly, the d_icamsa_b data series was analyzed for the period February 2009 November 2012. A model describing, in good condition, the evolution of ITO of metallurgy between February 2009 and November 2012, is the ARIMA (2,1,1). The estimation results for this model are presented in Table 6. The model is statistically valid. Except for the coefficient C, which is not statistically significant (Prob = 0,2013>0,05), the other two coefficients satisfy the validity test.

Residues values are normally distributed. Jarque-Bera statistic has the value of 1,824276 (Probability = 0,401664 > 0,05) and therefore the null hypothesis of normality of residues for significance level α = 0,05 is accepted.

Table 6 **Characteristics of ARIMA model of ITO of metallurgy between February 2009 and November 2012**

Dependent Variable D_ICAMSA_B					
Method: Least Squares			Sample(adjusted) 2009:4 2012:11		
Variable	Coeff.	Std.Error	t-Stat	Prob.	
C	1,0538	0,8114	1,2987	0,2013	
AR(2)	-0,3463	0,1465	-2,3634	0,0229	
MA(1)	-0,3173	0,1490	-2,1291	0,0393	
R-squared		0,21003	Schwarz criterion	7,7249	
DW stat		1,745127	Prob (F-stat)	0,0079	
Residuals Sample 2000:12 2008:10					
Mean	-0,229	Std.Dev	10,232	Jarque- Bera	1,824
Skewness	-0,495	Kurtosis	2,878	Probability	0,401

The conclusion of this chapter is that the discontinuity caused by the outbreak of the economic crisis hinders the achievement of a single acceptable model that characterizes evolution of ITO accomplished in metallurgy during January 2000 November 2012 period. But can be generated models of ITO in the period before crisis and models of ICA, in the period after the economic crisis started.

In the above, model ARIMA (10,1,7) was identified for the first period and the model ARIMA(2,1,1) for the second period.

CONCLUSIONS

In order to describe evolution of metallurgical industry in January 2000 - November 2012 period it was not identified a valid model that describes the evolution ITO throughout the period. This is due to the outbreak of economic crisis that produced a discontinuity in the data series preventing us from a single model, so the period November 2008 - January 2009 was removed and two new sets of data were generated. The first series contains data for January 2000 October 2008 period and the second series contains data from February 2009 November 2012 period. Thus, the model generated to describe evolution of ITO achieved by metallurgy in January 2000 October 2008 period is the model ARIMA (10,1,7), and the model that describes evolution of ITO in metallurgy industry in February 2009 November 2012 period is the model ARIMA (2,1, 1).

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