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SEASONALITY IMPACT ON VARIANCE OF METALLURGICAL INDUSTRY INDEX IN EUROPEAN UNION

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***Abstract*—**Metallurgical industry is a significant activity for the present and future of each member state of the EU. Due to increasing efficiency and competitiveness manifested in the industry, this assertion is justified by the role of jobs multiplier, industrial production and gross added value, contributing to economic development. This context has led to a study that involves monthly evolutionary trend analysis of the sample variance of index productions in industry manufacture of basic metals under the impact of seasonality, for EU countries. Application and interpretation of econometric models are trying to capture aspects of developments during 2000-2015, given the international situation with the economic crisis and economic and financial decisions specific to each EUcountry.

***Keywords*—**economic crisis, EU, metallurgical industry, production index, sample variance

I. INTRODUCTION

The importance of metallurgical industry in a country's economic development, starts with its definition: "Metallurgy is a branch of industry which includes processes for obtaining metals from ores and other substances containing metals. Metallurgy includes ore processing, extraction of metals from ores, metal refining, production of metal alloys, metal manufacturing using high pressure, production of cast metal parts, thermal, thermochemical and thermomechanical processing, welding and soldering metals and alloys, surface coating metal parts with layers of other metals by diffusion of substances (metallic or non-metallic) in the superficial layer of metal objects. [1]"

The metallurgical industry has an important role in international competitiveness, being one of the basic industries for other industries and economic sectors [2].

Some waste can be reused in other manufacturing processes, which sometimes requires a maximum security transportation [3]-[5]; In the early '90s, both Western specialists [6] and [7] and from other countries, estimated that funds of over 200 billion dollars are needed to reduce the effects of pollution and for ecological reconstruction [8]-[11].

The impact of the 2008 economic crisis is felt differently across industries and on their development [12], so, as a consequence, on metallurgy. However, the effects of the crisis on metallurgy manifest differently from country to country and at EU level.

Trends of evolution in the metallurgical industry from EU countries are addressed through monthly data on volume index of production in industry manufacture of basic metals. The analysis period is established from January 2000 to September 2015. We used the fixed base method to determine indices, so they are set to the value of monthly metallurgical production of 2010.

"The objective of the production index is to measure changes in the volume of output at close and regular intervals, normally monthly. It provides a measure of the volume trend in value added over a given reference period."[13]

The metallurgy approach in terms of highlighting its role and place in the context of economy and at European level, considers its strategic orientation towards:

1) *a significant volume of raw materials and semi-products that can be provided from internal and/or external sources;*
2) *a high concentration leading to a trade surplus;*
3) *a production value and structure that would lead to covering of domestic needs, taking into account the strategy that domestic consumption is lower than production;*
4) *identifying financing policies, specifically applicable to the profitability and liquidity of economic operators, as a fundamental component of the management process.*

II. METHODOLOGY

In order to obtain a clearer image of output fluctuations in the metallurgical industry through monthly indices between EU countries, we analyzed monthly evolutionary trends of sample variance (SV) of index productions in industry manufacture of basic metals.

Also, we followed the evolutionary appearance of this indicator under the impact of seasonality, for those EU countries.

Monthly fluctuations evidenced by the volume index of production in industry manufacture of basic metals during the period analyzed, includes different trends and scales, from one country to another, especially after the economic crisis.

The issues are synthesized by highlighting the degree of dispersion of indices with fixed base calculated compared to 2010 through sample variance of index productions in industry manufacture of basic metals.

In this context, following the establishment of seasonal influence, the trend of evolution was analyzed through treatment of dynamic series with a multiplicative model:

$$\mathbf{y_t = y_{Tt} \cdot y_{St} \cdot y_{Rt}} \quad (1)$$

This model includes three components: trend (T), seasonal component (S) and the residual component (R).

From the types of models used to describe the trend (T), the following linear model was chosen:

$$\begin{aligned} \mathbf{y} &= \mathbf{\hat{a} + \hat{b} \cdot t + \varepsilon} \\ \mathbf{y} &= \mathbf{\hat{y} + \varepsilon} \end{aligned} \quad (2)$$

In model (2), $\hat{a}$ and $\hat{b}$ are real coefficients, and ε represents the influence of factors that can affect the result variable y, but whose variation in time is considered insignificant (constant).

To validate the model (2), the ANOVA methodology was used, based on [4] and [5], the test hypotheses being:

H_{01}: the model is not statistically significant (the test statistic, $F_{statistic}$, has a lower value than the critical value F_{critic}).

H_{11}: the model is not statistically significant (the test statistic, $F_{statistic}$, has a higher value than the critical value F_{critic}).

For model (2) the determination coefficient (R square) was also calculated, having the form:

$$\mathbf{R^2 = \frac{\Delta^2_{y/x}}{\Delta^2_y} = \frac{\sum_{i=1}^{n}(\hat{y}_i - \bar{y})^2}{\sum_{i=1}^{n}(y_i - \bar{y})^2}} \quad (3)$$

Considering that the data set includes 192 elements and the chosen confidence level is 95%, for testing the H_{01} hypothesis, $F_{critic} = 3.92$, and the critical values for the bilateral t test are $t_{critic} = \pm 1.972$.

Also, the statistical significance of the $\hat{b}$ the coefficient was tested (gradient of the regression line). To achieve this, the t test (Student) was used, the test statistic being:

$$\mathbf{t_c = \frac{b}{s_b}}, \quad \mathbf{s_b = \sqrt{\frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{n-k-2}} \Bigg/ \sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2}} \quad (4)$$

The test hypotheses are:

H_{02}: the value of coefficient $\hat{b}$ is not statistically significant, respectively $t_c \in (-1.972; 1.972)$.

H_{11}: the value of coefficient $\hat{b}$ is statistically significant, respectively $t_c \notin (-1.972; 1.972)$.

Data series were processed in EViews and Excel [6].

III. RESULTS AND DISCUSSIONS

In the period 2000-2008, the degree of spreading of fixed base index values of metallurgical production for the EU countries, calculated from 2010, was very high.

Thus, in May 2000 extreme values of the indices were registered, the minimum of 49.5%, in Estonia and the maximum of 249.8% in Denmark, which resulted in a variation of 41.62%.

Compared with 2010, metallurgical production of each country, each with its own peculiarities, it is quite poor, with inefficient use of resources.

The economic crisis of 2008 brings destabilization in metallurgical production, too.

Thus, given that Portugal has the highest index of production of 174.10%, and Hungary the lowest (83.8%), in July 2008, one can note the attempt to stabilize production in each country in the EU.

This is justified by the significant decrease in violations, translated into a reduced value of the variation coefficient of 17.23%, explained by the convergence of evolutionary rates.

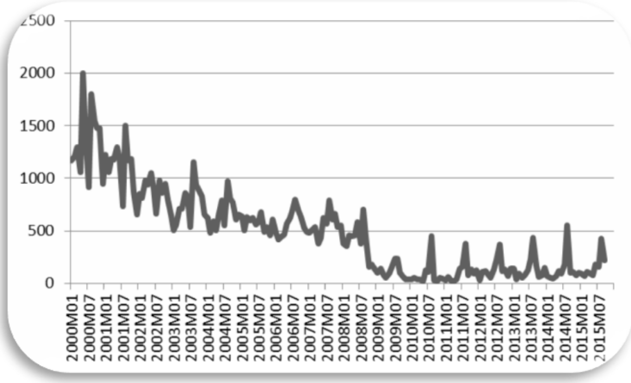

Fig. 1 Evolution of SV of index productions in industry manufacture of basic metals

The dispersion after 2009 reveals a slight tendency to exit the crisis (Fig. 1), also confirmed by values greater than 100% of the indices for most EU countries, established in March 2011 for all countries.

The recovery process of the metallurgical production process is thus argued by increases until the summer of 2012, supported by the above unit indices with fixed base calculated from 2010.

Thus, in January 2009, Denmark has a rate of 94.70% (maximum compared to the other EU countries), while the lowest index was established for Romania by 57.10%. The coefficient of variation of 13.56% shows the impact of the economic crisis on the metallurgical industry in EU countries. The impact on production intensity for all European countries is similar and it is evidenced by the coefficient of variation of 11.05% established in June 2010, when the recovery from the crisis led to establishing the most significant production index for metallurgical industry in Estonia at 137.10% and the lowest index of 83.50% in Finland, compared to the other EU countries.

In April 2011, the lowest variation of the indexes with fixed base compared to 2010 is reached for EU countries throughout the analysis period from 2000 to 2015 (4.43%). A sharp decline in the degree of dispersion can be observed and it is explained by increasing production fairly constant at the EU level with a tendency towards a rational and efficient use of resources. At that time, Poland is the country that scores best in this direction, with the highest index of 117.50% compared to the other EU countries and the Netherlands with a score of only 98%.

From April 2011 to September 2015, compared with 2010, positive average increases were registered in: Bulgaria, Denmark, Germany, Greece, Hungary, Netherlands, Austria, Poland, Portugal, Finland, United Kingdom. In other EU countries production decreases were recorded between 0.28% (Romania) and 5.6% (France) on average. The worst period for production was registered between August 2012 and February 2013.

The amplitude of variation of sample variance, is shown by chart 2. Compared to 2010, it describes two suggestive periods:

1) 2000-2008, when metallurgical production has fluctuated with maximum amplitude in May 2005 (200%) and lowest in January 2003 (70.34%);

2) 2008-2015, a period of recovery and fairly stable, rational development, when the maximum amplitude is 100.70% in August 2014 and the minimum of 17.10% in January 2011.

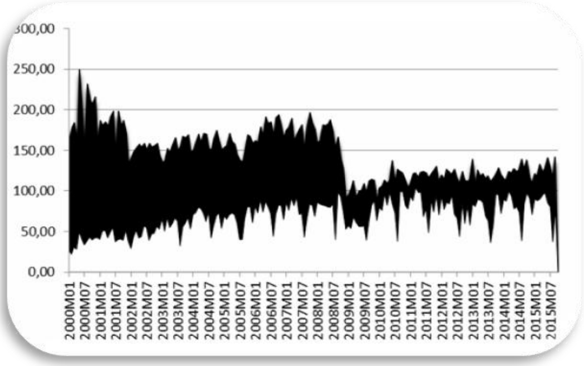

Fig. 2 Evolution of variation intervals of SV of index productions in industry manufacture of basic metals

Also, Fig. 1 and 2 highlights seasonal fluctuations in the evolution SV of index productions industry manufacture of basic metals.

TABLE I
SEASONAL ADJUSTMENT FACTORS FOR SAMPLE VARIANCE OF INDEX PRODUCTIONS IN METALLURGY

Month	Scaling factors	Month	Scaling factors	Month	Scaling factors
M01	0.77	M05	0.89	M09	1.08
M02	0.75	M06	1.21	M10	1.01
M03	0.82	M07	1.25	M11	0.85
M04	0.76	M08	2.44	M12	0.90

Dynamic series presents seasonal fluctuations, which requires a smoothing process, so it is necessary to estimate the trend.

SV analysis requires writing a multiplicative model that is the basis of seasonality elimination process.

$$\mathbf{SV_t = SV_{Tt} \cdot SV_{St} \cdot SV_{Rt}} \quad (5)$$

Estimating seasonal component involves measuring the seasonal effect through seasonality factors.

The evolution of seasonal factors causes the significant amplitude of 1.69 percentage points.

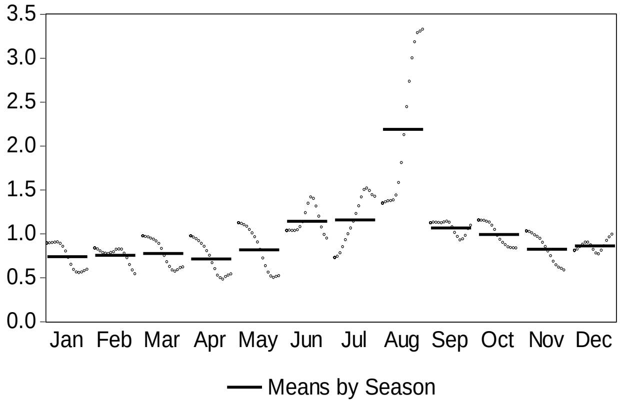

Fig. 3 Evolution of seasonal factors for SV of index productions in industry manufacture of basic metals

The influence of seasonality on SV of index productions in industry manufacture of basic metals(Fig. 3) in January-May and November is quite small, the seasonal factors being close to 1.00. In other months (June to October), in average, SV is above the long-term trend, emphasizing the phenomenon of seasonality. This is the result of a rather limited work in metallurgy, following the performance of leave

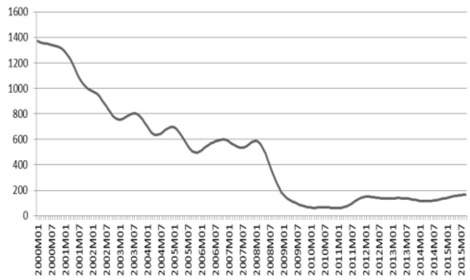

Fig. 4 Evolution of sample variance trend in industry manufacture of basic metals *(SV_tc)*

This statement is supported by the value of the seasonality index of August (most affected by seasonality), when SV is above long-term trend with 144%.Using seasonality indices, dynamic series was subject to seasonality elimination that led to the establishment of a trend (Fig. 4).

The trend of sample variance highlights that economic crisis in 2008 has a significant impact on the metallurgical industry. Its evolution during the analyzed period is characterized by a tendency of linearity. This is given by a linear model established through linear regression equations:

$$\mathbf{SV = 1114.25.10 - 6.60 \cdot t} \quad (6)$$

For linear model (6), because $F_{statistic} = 1064.51 > F_c = 3.9\,2$, the null hypothesis H_{01} is rejected and is accepted hypothesis H_{11}, and in conclusion, the model is statistically valid. The same conclusion is reached taking into account that critical probability of 4.05E-79<0.05. For this model R^2=0.85

In the case of regression coefficient ($\hat{b}$), $t_c =$ and because $t_c \notin (-1.972; 1.972)$ the null hypothesis H_{02} is rejected and is accepted hypothesis H_{12}, and in conclusion, the value of regression coefficient is statistically valid.

In (6) the negative regression coefficient -6.60 represents the tendency to reduce the degree of dispersion of index values compared to the average index. This reduction is a positive development of metallurgical production compared to 2010 as all countries based on resources and production efficiency and competitiveness.

Seasonality is a process faced by metallurgical production in all European countries but it has not a significant negative influence because the attenuation process was continually monitored.

IV. Conclusion

In the period 2000-2015 significant monthly oscillations from country to country within the EU in terms of volume index of production in industry manufacture of basic metals were recorded. It is impressive, especially after the economic crisis. This issue observed by analyzing the sample variance of index productions in industry manufacture of basic metals is confirmed and supplemented by confronting the metallurgical production with the phenomenon of seasonality. The exclusion of seasonal influences yielded a trend showing a decrease of metallurgical industry production index variation. The situation highlights:

1) the tendency to homogeneity, meaning, especially after 2008, a progressive metallurgical activity oriented towards competitiveness and efficiency; this is very important given that, at EU level, the development of any production runs from the perspective of sustainability; metallurgy, through its resources and processes it runs, it is very close to this goal;

2) the mitigation of this phenomenon in order to obtain better results in the future was continuously monitored and conducted in accordance with country-specific policies. Dispersion degree analysis of SV of index productions in industry manufacture of basic metals may lead in the future to research that includes an analysis of metallurgical production movement between EU countries from this perspective through import and export.

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