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CORRELATIONS BETWEEN METALLURGICAL, MACHINERY AND CONSTRUCTION SECTORS DURING THE LATEST ECONOMIC CYCLE

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The purpose of this article is to highlight the correlations from the latest economic cycle (2001-2014) between the metallurgical, the construction and the machinery sectors in the European Union, in general, and in Romania, in particular. Using ANCOVA models, this analysis has three major objectives: first, to show that the machinery industry and the construction sector have a general impact on the metallurgy industry, regardless of the business cycle phases; secondly, to underline that the size of this impact differs across these phases and, thirdly, to illustrate that the relations between the three sectors were quite different in Romania and in the European Union. The interpretation of the results shows that the assumptions are largely confirmed.

Keywords: metallurgical sector, machinery, constructions, business cycle, Ancova models

INTRODUCTION

Nowadays, the metallurgical sector is one of the most important fields, being the basis to support other key sectors of the contemporary economic system. Its importance derives mainly from the connection with the construction sector and the machinery industry [1]. The mutual relations between the three sectors are relatively dynamic over an economic cycle. In this paper, the authors intend to analyse the link between them during the latest economic cycle, which began in 2001. The Austrian business cycle theory argues that the artificial reduction of the interest rate, made by the central banks, induces significant fluctuations in the economic system, generating a boom phase, characterised by a significant increase in the industrial production and in the commodity prices [2], followed by a phase of recession and one of economic recovery. Applying this theory to the economic reality of the past decade and a half clearly shows that both the world economy and that of the EU have passed through all three phases: boom (2001-2007), recession (2008-2010) and slow recovery (2011-2014).

Given that the economic system is interconnected, this cyclical dynamics has marked both the metallurgical sector [3] and the areas closely linked to it, namely the construction sector and the machinery industry, whose evolutions have been influenced by this latest economic cycle. The analysis starts from three fundamental hypotheses:

H1: The machinery industry and the construction sector have significantly influenced the development of the European metallurgical industry (model 1).

Based on this assumption the authors aim to demonstrate that the two industries, machinery and construction, influence the metallurgical industry, in general, without taking into account thebusiness cyclephases.

H2: At the European level, the metallurgical sector has been significantly influenced by changes in production from the machinery and construction sectors, faithfully following the business cycle phases (model 1). Based on this hypothesis the authors aim to demonstrate that, at European level, the influence of the two industries on metal production is different in time, depending on the business cycle phases.

H3: There are significant differences between the average production index of the metallurgical industry in Romania and that at European level. These differences are influenced by the evolution of the production of machines and construction during the three phases of the economic cycle (model 2). The article aims to show that there are significant differences between the average metal production in Europe and that of Romania, under the simultaneous influence of the two determinant industries (construction and machinery) during the 3 phases of the economic cycle.

RESEARCH METHODOLOGY

Sample: In order to test the three research hypotheses, the study has included into the analysis most of the EU countries, with the exception of Croatia, Cyprus, Luxembourg, Malta, Slovakia and Slovenia, for which the series of data regarding the indicators considered in the analysis could not be found. The final sample includes 22 EU countries, including Romania, for which 1,232 country observations were collected (quarterly, for the period 2001-2014Q3). Depending on the business cycle phases, the number of the observations can

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be structured as follows: 616 observations for the Boom Phase, 265 observations for the Recession Phase, 351 for the Recovery Phase.

Table 1 **Variables included in the analysis**

Variables	Symbol	Type
Manufacturing metals production	Metal	Dependent variable
Manufacture of machinery and vehicles	Machin	Independent variables
Production in construction	Construct	Independent variables
Cycle Phase 2 – Recession (a Dummy variables: 1 if it is True, 0, otherwise); Growth Phase (or Boom Phase) is the reference category (C_1)	C_2	Control variable
Cycle Phase 3 – Recovery (a Dummy variables: 1 if it is True, 0, otherwise)	C_3	Control variable
Romanian Effect (a Dummy variables: 1 if it is True - Romanian, 0, otherwise – other country from EU)	RO	Control variables

The data are from the Eurostat database. Since the absolute values for the two industries (metallurgy, machinery) and the construction sector did not cover the entire analysed period (2001-2014), we considered half-yearly growth indexes, the reference year being 2010. The period 2001- 2014 was divided into three intervals, which overlap the phases of the economic cycle. The C1 phase covers the growth period: 2001-2007. The C2 phase includes the crisis period (2008-2010), and the C3 phase overlaps the slow recovery period, between 2011 and 2014.

DATA ANALYSIS METHODS

In order to obtain the research results, we have resorted to Ancova models that use country effects [4] and dummy variables for each business cycle phase [5].

$$Metal=\beta_0+\beta_1\cdot Machin+\beta_2\cdot Construct+\beta_3\cdot C_2\cdot Machin+\beta_4\cdot C_2\cdot Construct+\beta_5\cdot C_3\cdot Machin+\beta_6\cdot C_3\cdot Construct+\varepsilon \quad (1)$$

Where, β_0 is the constant of the model and it shows the average value of the metal production index at European level, without taking into account the influence of the factors proposed in the model; β_1 is a parameter of the model that captures the influence of the Machine on metal production; β_2 is a parameter of the model that captures the influence of the Construct on metal production; ε is the error component caused by the influence of other random factors that are not included in the model; β_3 is the parameter of the model that shows how much the influence of Machine on the metals' production (Metal) differs in the recession phase (C_2) compared to the growth phase (C_1); β_4 is the parameter of the model that shows how much the influence of Construct on the production of metal (Metal) differs in the recession phase (C_2) compared to the growth phase (C_1); β_5 the parameter of the model that presents how much the influence of Machine on metal production differs in recovery phase (C_3) compared to the growth phase (C_1); β_6 is the parameter of the model that presents how much the influence of Construct on the production of metal (Metal) differs in the recovery phase (C_3) compared to the growth phase (C_1).

$$Metal=\beta_0+\beta_1\cdot Machin+\beta_2\cdot Construct+\beta_3\cdot C_2\cdot Machin+\beta_4\cdot C_2\cdot Construct+\beta_5\cdot C_3\cdot Machin+\beta_6\cdot C_3\cdot Construct+\beta_7\cdot RO+\varepsilon \quad (2)$$

Where, β_0, β_1, β_2, β_3, β_4, β_5 and β_6 preserve the same meanings as in the model (1) and β_7 is the parameter of the regression model and indicates the difference between the average value of metal production (Metal) index in Romania and the average value of metal production (Metal) index in Europe (change in the constant).

RESULTS

Descriptive analysis

In terms of significance, the data that were used are relevant, the connection between the three sectors being significant. From the point of view of data correlation, one can notice a strong correlation between the machinery and metallurgical sector (r=0,607) and a weak one between the metallurgical and the construction sector (r=0,191). The explanation can be found in the particularities of consumption in the construction sector. The authors took into account the growth indexes of metal production, which reflect the evolution of production and not metal consumption. But in constructions, entrepreneurs work on a pre-contract basis, placing purchase orders for the next season at the end of the current season (October-November), when metal prices decrease. For example, the emergence of the 2008 crisis and the drastic reduction in the demand for constructions affected the metallurgical sector only in 2009, because the metal production for the 2008 constructions had been contracted at the end of 2007.

Quantitative analysis

Parameter estimates for the proposed models: The application of the three ANCOVA models has generated the results shown in the table below, which presents the estimations of regression model parameters.

Model 1:

$$Metal=50{,}179+0{,}594\cdot Machin-0{,}020\cdot Construct-0{,}197\cdot C_2\cdot Machin+0{,}137\cdot C_2\cdot Construct-0{,}264\cdot C_3\cdot Machin+0{,}222\cdot C_3\cdot Construct+\varepsilon \quad (3)$$

Interpretation: At European level, during the analysed period, the average value of Metal is 50,179 (under the influence of business cycle phases). But at European level (+Romania), an increase of 1 in Machine in the C_1 phase (growth) generates an increase in Metal of 0,594, and an increase of 1 in Construct in the C_1 phase (growth) determines a decrease in Metal of 0,020. These

Table 2 **Parameter estimates**

Metal – dependent variable	Model 1		Model 2	
	β_i	Sig.	β_i	Sig.
Intercept	50,179	0,00	49,916	0,00
Machin	0,594	0,00	0,609	0,00
Construct	-0,020	0,12	-0,026	0,04
C_2·Machin	-0,197	0,00	-0,211	0,00
C_2·Construct	0,137	0,00	0,149	0,00
C_3·Machin	-0,264	0,00	-0,261	0,00
C_3·Construct	0,222	0,00	0,214	0,00
RO	-	-	-11,542	0,00
R^2	0.420		0,429	
Observations	1232		1232	

results prove that at the level of the European economy, the strong dynamics from the growth period of the machinery sector has influenced the production of the metallurgical sector to a larger extent in comparison with the construction sector. In the C_2 phase (recession), a variation of 1 in Machine determines a change of 0,197 in the opposite direction in Metal compared to the growth period (C_1), at European level (+ Romania), and a change of 1 in Construct in the phase C_2 (recession) generates a change of 0,137 in the same direction in Metal compared to the C_1 period, at European level (+ Romania). So, during recession, the sharp decline of the machinery industry diminished its influence on the development of metallurgical production, reversing the trend. The influence of the construction sector remained low and relatively constant. In the C_3 phase (recovery), an increase of 1 in the Machine index determines a reduction of 0,264 in Metal compared to the period of growth (C_1), at European level (+Romania). A possible explanation could be found in the role played by any crisis in restructuring a company's activity. The normal tendency in such situations is to look for efficient solutions by reducing costs, both through the introduction of new technologies and through the relocation of production. In terms of machinery production during the last decade, the trend in the EU is correlated with the global one and it reflects the relocation of the production of heavy energy consuming-components (engines, bodies) in the emerging countries from Asia, especially in China. This situation generates the negative link between the evolution of the machinery index (machine) and the metallurgical industry index (metal). Regarding the construction sector, Model 2 shows that, at European level (+Romania), a change of 1 in Construct in the C_3 phase (recovery) determines a change of 0,222 in the same direction in the Metal index, which is slightly higher than in the C_2 phase and substantially different from the C_1 phase. This can be precisely explained by synchronizing the reinforcing steel consumption and the evolution of the construction sector. The crisis has changed entrepreneurs' consumption behavior in the case of iron: they have generally given up pre-contracting concrete, which has synchronized and positively correlated the production of the two sectors.

Model 2:

$$\text{Metal}=49{,}916+0{,}609\cdot\text{Machin}-0{,}026\cdot\text{Construct}-0{,}211\cdot\text{Machin}+0{,}149\cdot\text{Construct}-0{,}261\cdot\text{Machin}+0{,}214\cdot\text{Construct}-11{,}542\cdot\text{RO}+\varepsilon \quad (4)$$

Interpretation: In Europe (excluding Romania), during the analysed period, the average value of the Metal index, without the influence of the two sectors (machinery and construction) is 49,916 (under the influence of the business cycle phases), with 11,542 superior to the Metal index from Romania, throughout the whole economic cycle. However, at European level, an increase of 1 in the Machine index during the C_1 phase (growth) causes an increase of 0,609 in Metal, and an increase of 1 in Construct in the C_1 phase (growth) leads to a reduction of 0,026 in Metal. At European level, an increase of 1 in Machine in the C_2 phase (recession) generates a reduction of 0,211 in Metal compared to the period of growth (C_1), and an increase of 1 in Construct during the C_2 phase (recession) causes an increase of 0,149 in Metal, compared to the C_1 period. At European level, an increase of 1 in Machine during the C_3 phase (recovery) leads to a reduction of 0,261 in Metal compared to the growth period (C_1), and an increase of 1 in Construct during the C_3 phase (recovery) causes an increase of 0,214 in Metal compared to the C_1 period. The fact that the constant is lower for Romania shows that the influence of the two sectors, machinery and construction, is stronger than the European average.

DISCUSSIONS AND CONCLUSION

This analysis shows that the first hypothesis is confirmed. As we have shown in our analysis, only 50,179 of the growth index can be explained with the help of other factors than those analysed. As we can see in model 1, the two sectors, machinery and constructions, have influenced the metal production in the EU. The machinery sector has influenced much stronger the growth variations, being one of the most dynamic sectors of the European industry.

The second hypothesis was partially confirmed. The evolution of the EU steel industry, which corresponded to the business cycle phases of the European economy during the period 2001-2014, was differently influenced by the evolution of the two heavy metal-consuming sectors, machinery and constructions. The influence of oscillations in the construction sector was more moderate than we had expected. On the one hand, as already stated, this is caused by the specific aspects of contracting and supplying. The supply with raw materials (especially reinforced concrete) in constructions is based on pre-contracting, which occurs a year before the construction operations. This introduces a correlation lag. On the other hand, the metals used in construction do not require special quality standards and therefore, they can be easily imported from emerging markets (China, Turkey, Ukraine), thus counteracting variations in price and quantity on European markets.

Because of these influence factors, the obtained results were quite less significant, this being one of the research limitations. Instead, the metal used in the machinery industry imposes higher quality standards, which reduces demand elasticity at imports. Therefore, the influence of the oscillations of machinery production was much stronger on the EU metallurgical sector. By conducting the analysis on the business cycle, one can noticethat in the growth phase, the machinery sector has the greatest positive influence on metallurgical production. This influence normally decreases during the recession phase and, somehow surprisingly, in the recovery phase. A possible explanation could be found in the car market's shifting consumption towards cheaper cars, produced outside the EU, which required a reduction of production in the machinery sector and the relocation of car production in countries such as China, Turkey, Morocco etc.

The third hypothesis, related to Romania, is confirmed. The combined effect of the two sectors (machinery and construction) is higher than in Europe. In a subsequent study, we shall analyse the influence of each sector and determine if there is a correlation with the European average.

This study has certain limitations. Perhaps the results would have been more relevant if the analysis had been conducted not on growth indexes but on absolute values. The lack of complete data series represented a limit in this case. On the other hand, another limit is given by the fact that the model has not included a lag for the construction sector.

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Note: The responsible translator for English language is Lecturer Sorina Chiper, PhD, from "Alexandru Ioan Cuza" University of Iasi, Romania