

SEGMENTATION OF THE EU COUNTRIES IN TERMS OF THE METALLURGICAL INDUSTRY

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In this paper, the segmentation of the EU countries in terms of the production of crude steel conditioned by economic parameters was conducted. The study period concerned the years 2005-2014. 5 groups were distinguished, in which similar correlations between parameters occurred. Particular countries were affected differently by the economic crisis effects. The conducted segmentation of the countries for 2009-2011 allowed for a statement that major changes in the metallurgical production occurred in this period. The situation in the construction and industry was of particular importance; however, the strength of impact was varied. Generally, in countries affected by crisis in construction industry, crude steel production fell. As a result of the segmentation for 2005-2014, one group included countries with different levels of economic development. The most important factor was not the level of economic development, but its change. As a consequence, one group included countries with a stable economic situation, and another one countries affected by the economic crisis. There were also intermediate groups. For the segmentation for 2009-2011, regularities were even more visible.

Keywords: Steel industry, macroeconomic indicators, steel production, Ward method

1. INTRODUCTION

The production of iron and steel has influenced the development of civilization for several millennia as this raw material was used in agriculture, construction, industry, manufacturing of machines and devices and so forth and so on. Iron and steel, together with coal and cotton, played an important role in the industrial revolution [1, 2]. The production of steel increased very fast in the second half of the 20th century. At the same time, the share of the EU countries in the world steel production decreased. Increase in efficiency and effectiveness in this sector also occurred [3, 4, 5].

In Europe, metallurgical plants are concentrated mainly along coal deposits in Central and Eastern European countries. Therefore, after the accession of ten countries to the European Union, the importance of this sector increased. In the new Member States, however, restructurization was necessary, which mainly consisted in employment reduction and introduction of new technologies. These actions reduced the operating costs of companies and iron and steel production costs [6, 7]. Overall, the metallurgical industry was restructured worldwide [8]. China represents around 48% of the global market for steel. The Chinese market is closed to outside companies. Additionally, overproduction of steel and dumped prices that destabilize the global market also occur there [9, 10]. The EU is the second largest producer of steel in the world, with an output of over 150 million tonnes of steel a year, accounting for 11% of global output. Steel industry has a significant cross-border dimension: 500 production sites are split between 23 Member States, making it a truly European industry. The European steel sector finds itself in a very difficult situation. The economic crisis has led to a marked downturn in manufacturing activity and associated steel demand [11]. The largest steel industry in the EU was in Germany, followed by Italy, France, Spain, the United Kingdom, Poland and the Czech Republic. 25% of EU steel production was generated in Germany and as much as 75% in the seven largest domestic producers [12, 13].

The iron and steel market is influenced, to a great extent, by globalization, which contributes to the transfer of this industry to the regions with the lowest production costs. As a result, structural changes occur [14]. This sector is vulnerable to the general economic situation as well as industries basing on steel and metal. In times

of economic crises, these correlations are more noticeable [15, 16]. The steel market is not an isolated one, and the variables in this market are affected by other global factors. The demand for steel, and as a result, the volume of its production, is linked to changes in GDP and the developments in industrial production on a global and national scale [17].

2. METHODOLOGICAL BASES

The main aim of the paper is to conduct segmentation of the EU countries in terms of the economic parameters influencing the change in crude steel production volume. As a result, homogeneous groups of countries in which changes have been affected by similar parameters will be distinguished. Specific aims were also set in the paper. These are: showing the directions of changes in steel production and determining the influence of the economic crisis on the segmentation of countries in terms of changes in steel production volume. The period covered by the study is between 2005 and 2014, i.e. the years directly before the economic crisis, during the crisis, and the years of economic upturn. The sources of materials include literature, figures from the EUROFER, World Steel Association and EUROSTAT. The following methods have been used in this paper: descriptive, tabular, graphic and the Ward's segmentation method.

The Ward method for estimating distances between clusters uses a variance analysis approach and, thanks to this, allows for overcoming difficulties associated with the hierarchical nature of the algorithm. The intention was to minimize the sum of squares of deviations of any two clusters that can be formed at each stage. Distance d is a function of the incompatibility of a pair of objects since the longer the distance between two objects, the more they are dissimilar to each other. Therefore, objects that lie close to one another and at the same time are far from other objects that form a different cluster are grouped together. The distance function is defined on pairs of objects and takes values within the set of non-negative real numbers. The normalized Euclidean distance was used in the paper. As a result, 5 clusters were identified [18, 19]. In the Ward method, the dependent variable was crude steel production, while the dependent variables of GDP were export and import values, industrial and construction production value, and household consumption value.

3. RESULTS

In the years 2005-2014, production of crude steel in EU countries decreased significantly. A significant decline in steel production was observed in 2009, during the onset of the economic crisis (a decrease by 30%). Having recovered from the economic crisis, steel production remained at a level of approx. 1700 million tonnes a year, however, this result represented merely 80% of steel production in 2007. **Table 1** shows the dynamics of changes in crude steel production in most EU countries, excluding those with very low volumes of production of this raw material. The list includes 22 countries, and excludes: Cyprus, Denmark, Estonia, Ireland, Lithuania and Malta.

Table 1 presents the dynamics of changes in crude steel production in different EU countries. The countries were sorted in decreasing order according to the dynamics for 2005-2014. The biggest production increase was recorded in Croatia and Portugal. However, these were countries with small steel production volume. In turn, the biggest decreases were in Bulgaria, Latvia and Greece, that is also in countries with small production volume. In the leading steel-producing countries on the EU market, apart from Poland and Austria, the production fell. In different periods, the dynamics changed. The period before the economic crisis, when steel production in most countries increased, was most favorable. As a consequence of the economic crisis, production fell in all countries, except Croatia, Slovenia and the Netherlands. The exit from the crisis was an opportunity to restore production; however, in most countries there were decreases in production. This situation is affected by the relationships on the global market, and also economic relationships in the individual EU countries.

The aim of the conducted segmentation is to check the relationships between the change in crude steel production and changes in economic parameters. It allowed for grouping the countries into segments with similar regularities. Segmentations were conducted for 2005-2014 and for the period of economic crisis (2009-2011). **Table 2** shows the division of the countries into groups using the Ward method based on crude steel production dependent on economic parameters (see **Table 2**). It can be seen that generally one group included countries with different levels of economic development. The only exception was group 1 in segmentation for 2005-2014. These were countries with a great connection of industry and construction and steel production. In this group, the average production decrease in construction industry was 4%, industry 7%, and steel industry 6%. In 2015-2014, 9 countries were included in group 2. These were countries with large steel production decreases, such as Greece and Latvia, and also countries that maintained or slightly increased production, such as Austria and Slovakia. In this group, there was also a strong connection between construction and steel production and a lesser connection in the case of industry based on imported steel. The third group included four countries where the industry was more closely related to steel production and less to construction. Moreover, these countries were in a good economic situation. In group four, there were three countries experiencing economic problems in the construction and industry sectors (average decreases of 40% and 9% respectively), which also translated into steel production. In these countries steel was exported, as exemplified by Portugal. In group five, there were two countries with varied production, in which construction and industry generated fewer products (average decreases of 35% and 14% respectively). In both countries the signs of economic slowdown were visible in years 2005-2014.

Table 1 The dynamics of changes in crude steel production in EU countries in 2005-2014

Countries	Dynamics of changes in crude steel production in years (first year in period =100)			
	2005-2008	2009-2011	2012-2014	2005-2014
Croatia	121.92	107.87	173.96	228.77
Portugal	143.25	96.28	106.59	147.02
Austria	108.01	98.42	105.38	112.02
Slovenia	110.12	103.58	96.39	109.95
Slovak Republic	100.09	94.50	110.91	104.91
Poland	116.70	90.24	97.29	102.46
Netherlands	99.05	101.23	100.39	100.65
Luxembourg	117.68	97.64	86.99	99.95
Germany	102.94	96.62	96.97	96.45
United Kingdom	102.13	70.10	127.25	91.10
Czech Republic	103.20	87.41	96.01	86.61
France	91.78	88.26	102.30	82.87
Italy	104.22	93.94	82.53	80.80
Finland	93.21	90.24	95.51	80.33
Spain	104.57	83.18	91.51	79.59
Sweden	90.23	93.51	93.48	78.87
Belgium	102.43	75.20	91.34	70.36
Hungary	107.10	82.59	65.30	57.76
Romania	80.18	72.39	86.64	50.29
Greece	109.31	78.08	52.84	45.10
Latvia	92.30	89.45	38.73	31.98
Bulgaria	68.24	62.78	73.29	31.40

Source: Own analyses based on data of EUROFER and World Steel Association.

Table 2 Segments of countries in the Ward's classification method in terms of the production of crude steel conditioned by economic parameters

Group of countries	Segments of countries in years	
	2005-2014	2009-2011
Group 1	France, Luxembourg, Netherlands, United Kingdom	Croatia, Latvia, Netherlands, Spain, Portugal, Greece, Slovenia
Group 2	Belgium, Bulgaria, Czech Republic, Germany, Greece, Latvia, Hungary, Austria, Slovak Republic	Italy, Slovak Republic, Austria, France
Group 3	Poland, Romania, Finland, Sweden	Czech Republic, Hungary, Romania, Bulgaria
Group 4	Italy, Portugal, Slovenia	Poland, Germany, United Kingdom, Belgium
Group 5	Spain, Croatia	Luxembourg, Finland, Sweden

Source: Own analyses.

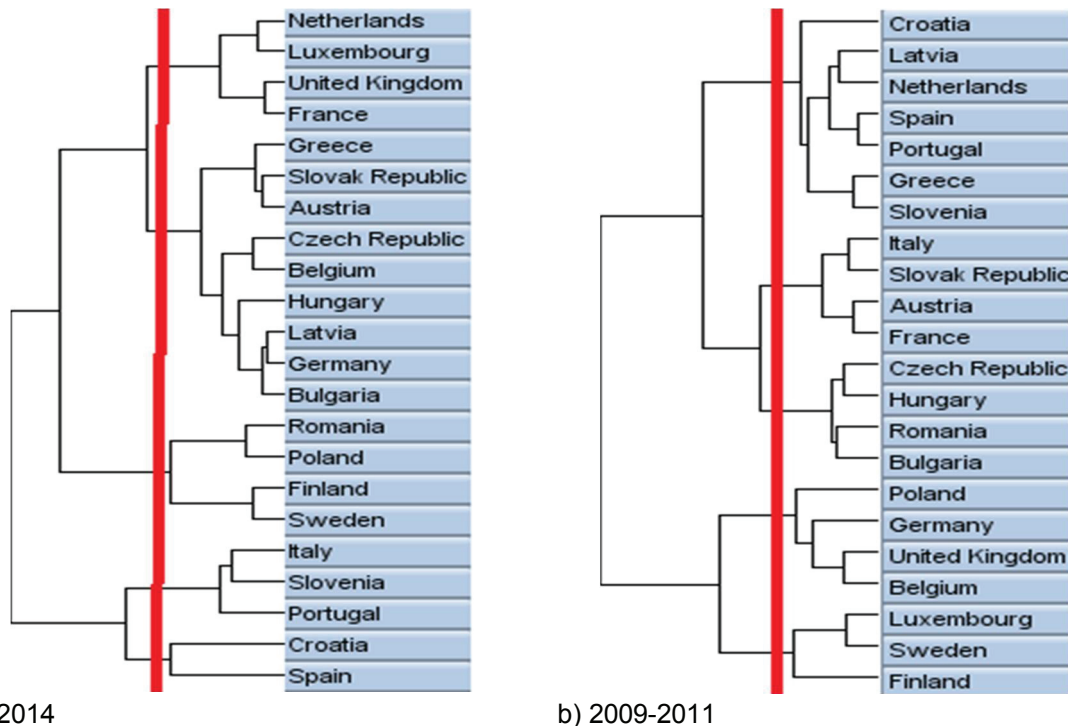


Figure 1 Connection trees in Ward's classification in 2005-2014 i 2009-2011

Source: Own analyses

In the period of the economic crisis (years 2009-2011 were adopted for this period), the grouping of countries changed (see **Figure 1**). It turned out that the stabilization of the economic situation affected segmentation. Countries experiencing economic crisis effects recorded a decrease in steel production. In 2009-2011 the worst economic situation was in group 1, where the average decrease in value generated in construction was 40%, and in industry 10%, with the average decline in steel production of 10%. Despite the great economic problems, falls in the metallurgical sector were not very large. Group 2 included countries with a fairly stable situation in which steel production decreases were proportional to the deterioration of the situation in industry and construction. In the third group, the biggest falls in steel production were recorded, which was very much related to the decline in construction production and less to industrial change. Groups 4 and 5 included countries with the most stable economic situation, where the falls in steel production were the smallest. There was a strong connection between steel production and industrial production, and a smaller connection with construction.

4. CONCLUSION

Crude steel production in the EU decreased in the years 2005-2014; nevertheless, these changes occurred with varying intensity in particular countries. In this period, there was an economic crisis, which additionally allowed for determining the regularities between economic situation and steel production. The use of segmentation through the Ward method allowed for grouping the countries into segments with similar correlations. Adoption of the years 2005-2014 for research, and later only the period 2009-2011, showed changes in grouping of the countries. In the period of economic crisis, the grouping was better because one group included countries experiencing similar effects of the economic slowdown. Various connections between industrial production and steel production were also noticed. There were groups in which there was a stronger connection between construction and steel industry, but also segments with closer industrial connections. In addition, these connections were more or less proportional. Construction and industry sectors were generally most closely linked to changes in steel production in the EU. The influence of the stabilization of economic situation on changes in steel production was also noted in particular countries. The less stable the economic situation was, the greater the declines in steel production were.

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