USING THE GINI COEFFICIENT AND LORENZ CURVE TO ASSESS THE CONCENTRATION LEVEL OF THE METALLURGICAL INDUSTRY IN EUROPE

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Abstract

The main purpose of this paper is to determine the concentration level of the metallurgical industry in Europe. The first part presents the overall situation in this sector in the 2007-2014 period. In the second part, the concentration of the metallurgical industry in Europe has been estimated using the Lorenz curve and the Gini coefficient based on Eurostat data. It has been noted that four countries with the most significant share in the metallurgical industry: Germany, Italy, France and Spain account for about 50% of European production and employment, which indicates a high concentration of the sector. It has been determined that since 2007 the level of concentration in terms of production and the number of persons employed has increased, which most likely is a reaction of the sector to the economic crisis of 2008.

Keywords: Metallurgy, industry, concentration, Europe

1. INTRODUCTION

Metals and steel, as well as concrete and wood, are key construction materials. Their advantages consist of their wide range of uses, affordability and significant recycling potential [1]. In line with the assumed classification, it is possible to divide the metallurgical industry into the following: manufacture of basic iron and steel and of ferro-alloys, manufacture of tubes, pipes, hollow profiles and related fittings of steel, manufacture of other products of first processing of steel, manufacture of basic precious and other non-ferrous metals, casting of metals [2]. The steel industry in the European Union receives support. For example, the European Globalization Adjustment Fund (EGF) was established, which supports laid-off workers. Companies operating in the manufacture of basic metals sector also receive support [3]. The metallurgical industry in the EU is of great importance for the European manufacturing industry, employment, innovation and sustainable development of the European Union [4]. It is a sector facing numerous challenges in relation to, among others, using EU structural funds, stimulating demand in associated sectors, such as the construction and automotive industries, increasing public support in investments in new technologies, introducing a sustainable steel production model [5]. The above activities may result in an improvement in the economic efficiency of enterprises [6]. Investments in new equipment, modernization of metallurgical processing and improvements to processes of obtaining metals have also contributed to the reduced negative environmental impact of steel plants [7]. Metallurgy, like other industries, has to respect the provisions of the EU's energy and climate policy [8]. The problem of environmental protection is of particular importance in countries such as Poland, Germany, Austria and the Czech Republic, which were the biggest emitters of greenhouse gases in the metallurgical industry [9].

The crisis on the US financial market, which later also moved on to European markets, led to a significant fall in industrial production and associated demand for steel [10, 11]. As a result, many plants were closed or reduced production, which resulted in job losses [12]. Therefore, one of the main challenges for this sector was the pressure to restructure and reduce production capacity. Companies made decisions relating to reducing costs and employment, dismantling production lines or temporarily shutting down production capacity [13]. The steel industry can demonstrate some successes associated with restructuring, such as: possibility of recycling 100% of the products, a reduction of CO2 emissions by the European metallurgical industry by 25%

since 1990 and further reductions by 2030 announced, as well as using largely renewable energy. In turn, there is a threat in the form of reduction in employment of 20% in 2007-2014 and a simultaneous fall in production of 20%, as well as higher costs in comparison with the US - twice higher in the case of electricity and three times for gas [14]. Therefore European steel plants face a threat in the form of high energy costs, economic and political uncertainty, and competition from third countries [15]. An increase in the concentration of production in this sector can constitute the basis for improving the competitiveness and efficiency of the metallurgical industry in relation to other supply chain parts [16].

The main aim of this article is to determine the level and dynamics of changes in concentration of the metallurgical industry in Europe in the 2007-2014 period.

2. METHODS

The study is based on the literature review method, the descriptive method, concentration measures (Gini coefficient, Lorenz curve).

Gini coefficient was used to assess concentration level of production value, number of enterprises, number of persons employed in metallurgy. It is strictly linked with the Lorenz curve (hence its second name - "Lorenz concentration ratio"). Since it is the most commonly used inequality measure, it contains many formal representations [1]:

$$G = \frac{1}{2\mu n^2} \sum_{i=1}^{n} \sum_{j=1}^{n} \left| x_i - x_j \right| \tag{1}$$

μ - average emission

n - sample size

Gini coefficient of 0 expresses egalitarian distribution, while a Gini coefficient of 1 expresses maximal inequality. This equation may be interpreted as half of the absolute production difference between all countries in relation to average production. This coefficient satisfies the Pigou-Dalton Principle of Transfers (it changes by transferring production from high-production countries to lower-production countries) and principles of symmetry, homogeneity, replication. It does not, however, satisfy the decomposition principle.

Lorenz curve illustrates accumulated percentage for subsequent countries in order from lowest to highest production. In a theoretical case, when production of all countries are equal, the Lorenz curve becomes a straight line at 45 degrees (curve of absolute equality). The greater diversity, the more the actual curve differs from the curve of absolute equality. The Gini coefficient is a quantitative measurement of this inequality, which equals 2 x the field between the actual curve and the curve of absolute equality. It may take values from 0 - absolute equality of production - to 1 - all production is accumulated in hands of one countries [9].

The study used data from mass statistics from Eurostat. These figures relate to production value, number of enterprises, number of persons employed from 2007 and 2014 in European Union member states. Production value measures the amount actually produced by the unit, based on sales, including changes in stocks and the resale of goods and services.

Number of persons employed is defined as the total number of persons who work in the observation unit (inclusive of working proprietors, partners working regularly in the unit and unpaid family workers), as well as persons who work outside the unit who belong to it and are paid by it (e.g. sales representatives, delivery personnel, repair and maintenance teams).

Number of enterprises: a count of the number of enterprises active during at least a part of the reference period.

Production value, number of enterprises, number of persons employed - covers quantities in the iron and steel industry NACE Divisions 24 Manufacture of basic metals. This division includes the activities of smelting and/or refining ferrous and non-ferrous metals from ore, pig or scrap, using electrometallurgic and other process metallurgic techniques. This division also includes the manufacture of metal alloys and super-alloys by introducing other chemical elements to pure metals. The output of smelting and refining, usually in ingot form, is used in rolling, drawing and extruding operations to make products such as plate, sheet, strip, bars, rods, wire or tubes, pipes and hollow profiles, and in molten form to make castings and other basic metal products.

3. RESEARCH RESULTS

Production value concentration is the basis for examining the economic concentration of the metallurgical industry. Production values for 2014 plotted on a Lorenz curve indicate high concentrations of this sector in EU member states (see **Figure 1**).

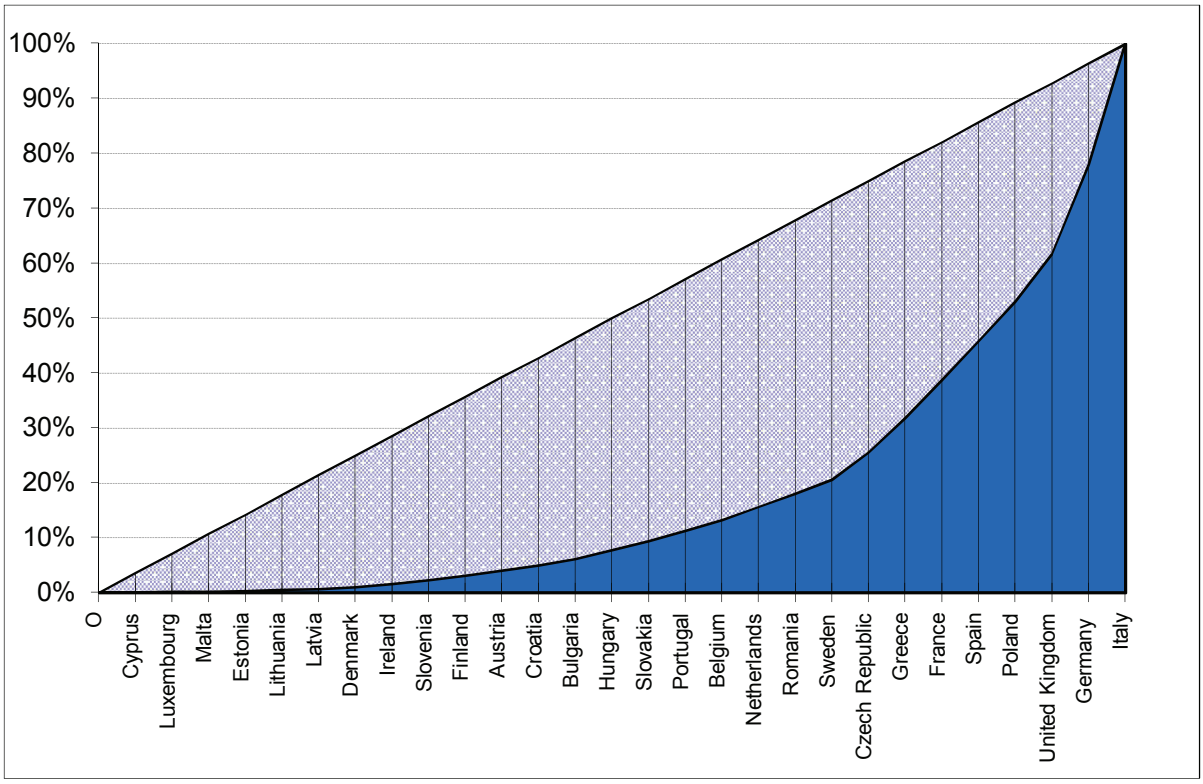

Figure 1 Production value concentration in 2014

Four countries: Germany, Italy, France and Spain are responsible for half of the production value in this industry. This observation is confirmed by the value of the Gini coefficient for the 2007-2014 period (see **Figure 2**).

Between 2007 and 2014 an increase in the Gini coefficient from 0.64 to 0.7 has been observed. A unique change was observed in 2008, which was related to the global economic crisis and associated problems in the metallurgical industry, as well as consequential structural changes. Since 2009, the level of concentration of production value in the surveyed countries has remained practically unchanged (**Figure 2**).

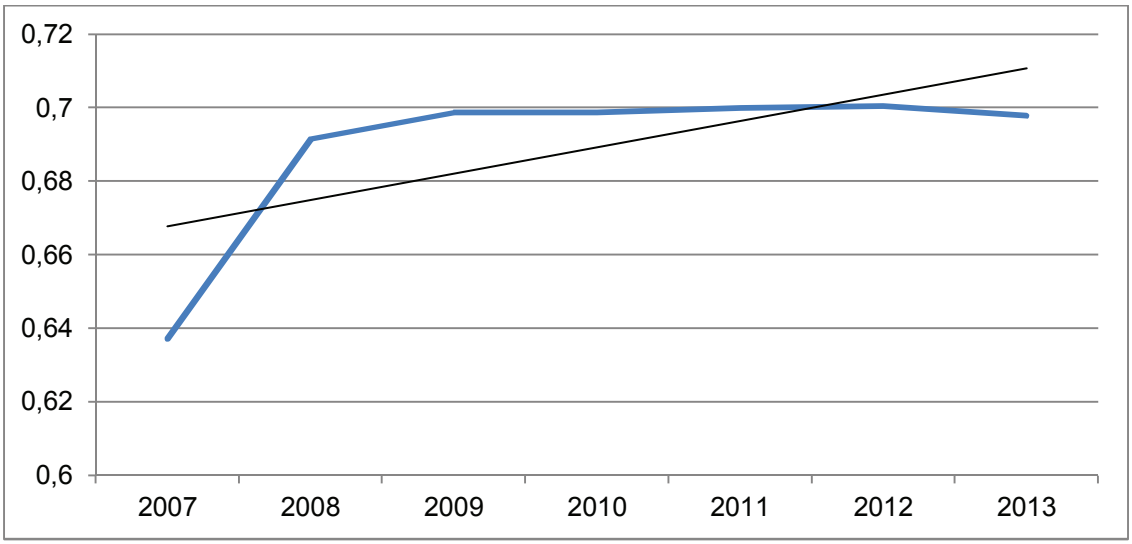

Figure 2 Gini coefficient for production value

Concentration trends in the industry are also reflected in the number of persons employed in individual countries. On the basis of this value, it is possible to conclude that the concentration process, which began in 2008, continued uninterrupted until the end of the researched period. It is, however, somewhat different in nature than production value. The concentration of this indicator saw a jump in 2008, while in the case of the number of persons employed the events of 2008 acted as an impulse, whose effect can be observed until 2013 (**Figure 3**).

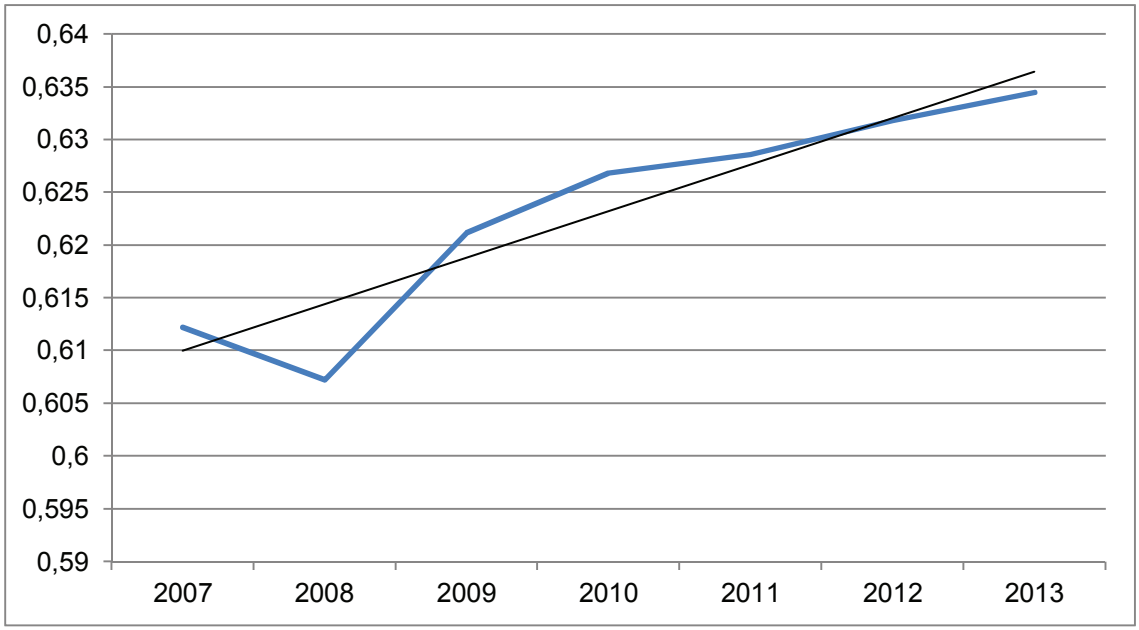

Figure 3 Number of persons employed concentration

Changes in the concentration of the number of persons employed are not as significant as in the case of production value (0.03 to 0.06 in the period in question), but they are felt (**Figure 4**). A graphical comparison of the number of persons employed concentration for the beginning and end of the researched period is shown in **Figure 4**. A shift in the Lorenz curve towards the so-called curve of absolute equality indicates an increase in the concentration of the observed characteristic.

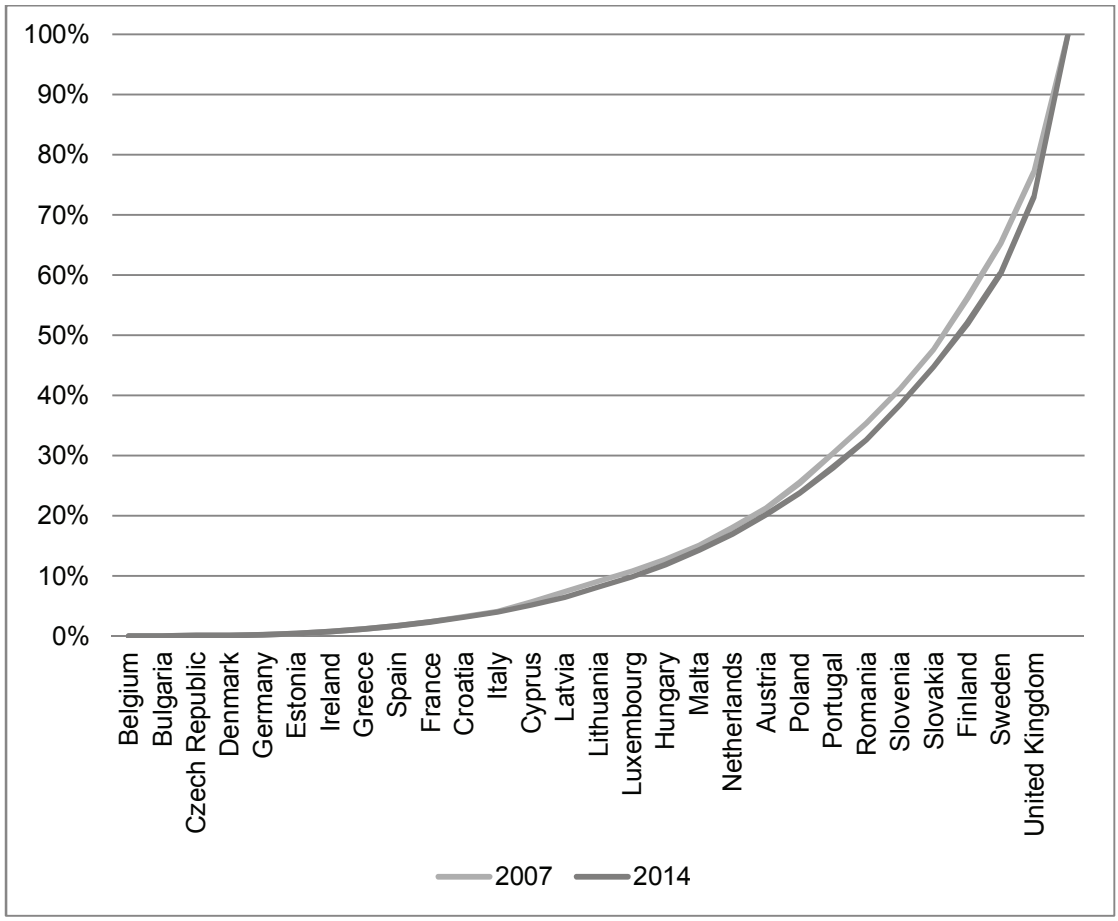

Figure 4 Number of persons employed 2007, 2014

4. CONCLUSION

The presented information makes it possible to draw the following conclusions:

1) The Gini coefficient calculated for production value, number of persons employed and number of enterprises concentration reaches a value between 0.6 and 0.7, which points to advanced processes of concentration in the European metallurgical industry. Based on production value, it has been found that over half of European metallurgical production is concentrated in four countries.
2) In the case of production value and number of persons employed, an increase has been noted in the Gini coefficient after 2008. This means that the economic crisis of this period was a catalyst for change in this economic sector.

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