

# THE ANALYSIS OF STEEL PRODUCTION AND UTILIZATION OF PRODUCTION CAPACITY IN POLISH STEEL INDUSTRY

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The analysis of steel production volume in relation to the level of capacity utilization in Polish steel industry is the content of this publication. This publication is based on numerical data on the volume of steel production and the degree of capacity utilization. The time range of the analysis covered the period from 2000-2018, and the data presented concerned annual periods. The analysis of steel production volume in the context of the degree of capacity utilization (production capacity) is an important part of the productivity assessment. The choice of the steel industry as a research object was dictated by the importance of steel production volume for the development of steel users' markets. The main purpose of the work was to reveal the connections between the volume of steel production and the level of steel production capacity involved in Polish steel industry.

*Key words:* steel, production capacity, time, Poland.

## INTRODUCTION

After the transformation of the Polish economy, initiated in 1989, and in particular during the period of industrial restructuring, the importance of using production capacity in individual industry sectors increased. For Poland, the transition to a market economy meant an improvement in productivity as a condition for higher business efficiency. Productivity is a complex and multi-faceted concept. Productivity analysis is carried out in relation to the entire economy, the entire industry or individual industries, as well as individual enterprises and even jobs. In technical terms, this is the ratio of the results obtained to the expenditure incurred [1]. A broader view of productivity is associated with an assessment of the degree of capacity utilization in the production process. For example, an enterprise may have low productivity because it has high-value assets (technology) and does not sufficiently use it. The degree of matching production volume to existing production capacity is particularly difficult to achieve in the steel sector due to the technology used, which is a road technology and is a key barrier for many enterprises to enter the steel sector. The liquidation and withdrawal of the technology used in metallurgy is associated with a significant reduction in employment [2]. The sector in Poland currently employs approx. 25 000 people [3]. The liquidation of one blast furnace means the loss of 1 000 and more employees. During periods of declining steel demand and when the production capacity is not fully utilized, blast furnace repairs are carried out at the smelters or the furnaces are temporarily out of service, and employees are on (parking) holidays.

The volume of steel production is affected by the economic situation, which is manifested in an increase or decrease in production. The economic situation is an external factor, forcing steel producers to adapt the production volume to the needs of the market, which in the event of a decrease in steel demand results in incomplete use of production capacity. The emphasis on full utilization of production capacity appears primarily from foreign owners of shares in Polish steel mills. Foreign capital manages the largest steel mills in Poland. Strong international capital groups have been operating on the Polish steel market continuously since their privatization and restructuring (the process started in the 90s of the last century due to the change in the economic system in Polish economy) [2].

## METHODOLOGY OF ANALYSIS

Production capacity is a measure of the full utilization of existing technology by steel-making enterprises. Production capacity, production power, production potential are terms referring to the level of production capacity of the production enterprise [4]. Production capacity is a measure of the ability to produce a specific production volume over a given period of time - usually a year [5].

In the system of sectoral analysis, it is the use of steel production capacity in Poland in a given calendar year as an average level in relation to the full use of production capacity. The degree of capacity utilization is the production made by utilizing the production capacity. Full capacity utilization is 1 or 100 %. This publication assumes that the full production capacity of the steel sector in Poland is an opportunity to generate maximum production using real production capacity (percentage ratio) - Formula 1.

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$$U_{cpt} = \frac{P_{rt}}{C_{pt}} \quad (1)$$

where:

$U_{cpt}$  – ratio of utilization of production capacity in analyzed time ( $t$ ),

$P_{rt}$  – real production in analyzed time ( $t$ ),

$C_{pt}$  – production capacity in analyzed time ( $t$ ).

The analysis of the use of production capacity in Polish steel sector in 2000-2018 is expressed as a percentage of the share (involvement) of the production technology used to achieve a specific production volume (amount of steel produced). The analysis of the volume of steel production in the analyzed period from 2000 to 2018 was made in quantitative terms (physical, natural units: tonnes). Statistical data for the analysis was provided by the Polish Steel Association in Katowice (the data is the content of annual reports titled Polish steel industry).

## STEEL PRODUCTION AND STEEL PRODUCTION CAPACITY

The size (volume) of steel produced in the enterprises is influenced by external factors. External factors include factors related to the economy (indicators: GDP, investments, consumption, import, export), as well as the availability of natural resources (iron ore, energy, coal) and legal and administrative regulations (environmental policy, customs policy, tax system) and market conditions (steel demand, customer requirements - steel customers, competition on the steel market). The observation of the multiplicity of steel produced in Poland in the period from 2000 to 2018 indicates the occurrence of economic fluctuations in the production trend (Figure 1). The economic fluctuations are caused by a favorable or unfavorable situation in the national and global economy. A clear decline in steel production in Poland was recorded during the world economic crisis in 2008-2009 [6]. In the Polish steel sector, in the analyzed period from 2000 to 2018, 9 million tonnes of crude steel (9 027 915 tonnes) was produced on an annual average. The highest steel production in Poland was in 2007 – production reached the level of 10 631 621 tonnes. Production at a level higher than 10 million tonnes was also in 2004 and in the last two years 2017-2018. The lowest production level was in 2009 and amounted to 7 129 018 tonnes. In the same period, an assessment was made of the level of capacity utilization. The average annual level of capacity utilization in the steel sector in Poland in the period from 2000 to 2018 was 72 %. The lowest level of capacity utilization in the Polish steel sector was in 2009. The domestic economy was strongly influenced by the global economic crisis [6]. In 2009, the steel sector in Poland used only 57 % of its production capacity. The highest level of capacity utilization in the steel sector was 2004 – 84 % (Figure 2). In analyzed period, the utilization of production capacity in steel industry in Poland was not full.

On the basis of the average annual volume of steel production in Poland in the analyzed period and the av-

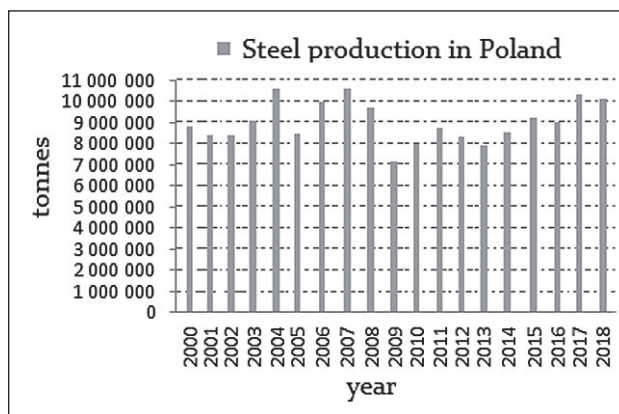


Figure 1 Steel production in Poland in the period from 2000 to 2018

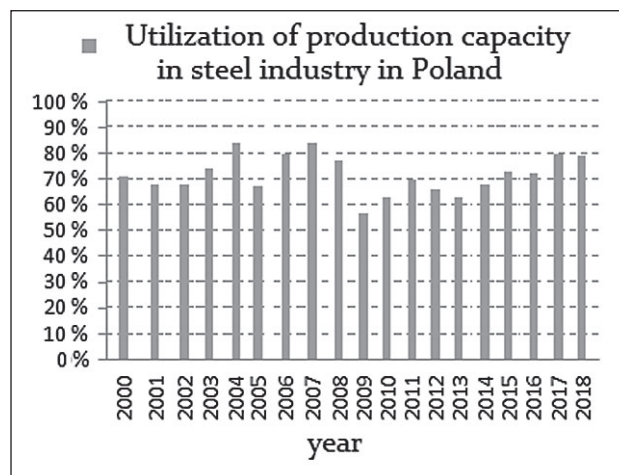


Figure 2 Utilization of production capacity in steel industry in Poland in the period from 2000 to 2018

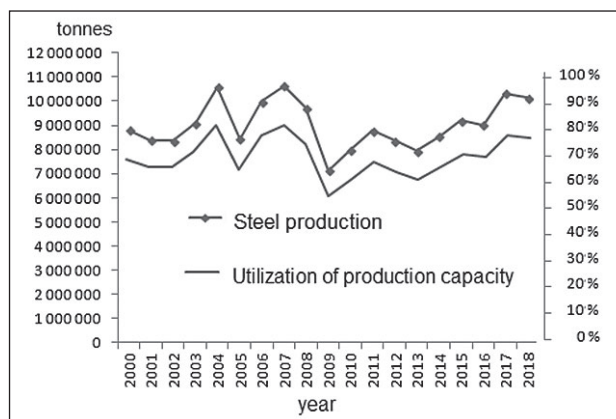
erage annual level of capacity utilization, the maximum steel production volume was determined, i.e. the production volume that would be realized at full production capacity. The maximum average annual steel production in the analyzed period would be 12 538 771 tonnes of steel (Figure 3).

Figure 4 compares the volume of steel produced with the level of capacity utilization in steel industry in Poland in the period from 2000 to 2018. This statement was the basis for determining whether an increase or decrease in capacity utilization translates into an increase or decrease in steel production in the period adopted for analysis. Based on the analysis of trends in the phenomena studied, it can be concluded that the increase or decrease in the volume of steel produced in Poland is associated with an increase or decrease in the use of production capacity.

The correlation, established using the Pearson coefficient  $r$  [7], between the features: steel production volume and the level of capacity utilization by steel mills is very strong because it is 0,993 (it is in the upper range from 0,91 to 1). The relationship between the features (analyzed phenomena) is directly proportional, which means that the increase in steel production has (positively) an increase in the use of production capacity. In order to determine the scope of changes for each of the



**Figure 3** Actual steel production in Poland and full steel production in situation 100% utilization of production capacity in steel industry in Poland in the period from 2000 to 2018



**Figure 4** Relation of steel production to utilization of production capacity in Poland in the period from 2000 to 2018

studied phenomena, real values were compared with the averaged values for each of the studied phenomena at the adopted time (2000-2018). The differences between actual and average values obtained in each analytical year are presented in Table 1. Such formulas and information are used in Table 1:

column no 2: volume of steel production in actual year minus averaged volume of steel production (9 027 915 tonnes) in the analyzed period, column no 3: utilization of production capacity in actual year minus averaged value of utilization of production capacity (71,79 %) in analyzed period, column no 4: directions of two values from columns 2 and 3: the same (Yes) or different (No), column no 5: trends of two analyzed situations from columns 2 and 3: increase (↑) or decrease (↓).

**Table 1** The differences between actual and average values of steel production and utilization of production capacity in steel industry in Poland in the period from 2000 to 2018

1 year	2 tonnes	3 %	4	5
2000	-227 915	-0,8	Yes	↓↓
2001	-627 915	-3,8	Yes	↓↓
2002	-659 949	-3,8	Yes	↓↓
2003	79 469	2,2	Yes	↑↑
2004	1 564 795	12,2	Yes	↑↑
2005	-583 568	-4,8	Yes	↓↓
2006	963 723	8,2	Yes	↑↑
2007	1 603 705	12,2	Yes	↑↑
2008	699 697	5,2	Yes	↑↑
2009	-1 898 897	-14,8	Yes	↓↓
2010	-1 034 891	-8,8	Yes	↓↓
2011	-248 747	-1,8	Yes	↓↓
2012	-669 768	-5,8	Yes	↓↓
2013	-1 077 579	-8,8	Yes	↓↓
2014	-469 448	-3,8	Yes	↓↓
2015	170 112	1,2	Yes	↑↑
2016	-13 380	0,2	No	↑↓
2017	1 301 856	8,2	Yes	↑↑
2018	1 128 703	7,2	Yes	↑↑

Analyzing the data contained in Table 1, it was found that apart from 2016, in the analyzed period there is a consistency of directions of changes in the phenomena studied. The increase in the volume of steel production in a given calendar year is accompanied by an increase in the utilization of production capacity in smelters. In the period from 2000 to 2018, ten situations concerned a decrease in the direction of changes in both phenomena studied, and eight situations were described as an increase (only in 2016 the decline in steel production volume compared to the average annual production volume was accompanied by an increase that was insignificant: 0,2 %) capacity utilization.

### SIMULATION OF FULL VOLUME STEEL PRODUCTION

Steel production volume simulation with the full involvement of the steel sector’s production capacity was performed for the historical period. The calculations were made based on the following formula:

$$P_{max t} = \frac{P_{rt}}{U_{cpt}} \tag{2}$$

where:

$P_{max t}$  – maximum production in analyzed time ( $t$ ), other marks like in formula (1).

For the analyzed period, the maximum volume of steel production for each year is summarized in Table 2. The predicted maximum production volume (with full use of production capacity) would reach 13 million tonnes of steel produced annually by steel mills in Poland. On average, steel mills in Poland produce 3 543 041 tonnes of steel too little in relation to the level of production capacity.

Actual volumes steel production in Poland in the period from 2000 to 2018 and loss of volumes of steel production are presented in Figure 5.

### CONCLUSION

The relationship between production volume and capacity utilization is part of the productivity analysis.

Table 2 **Maximum volume of steel production for Poland in the period from 2000 to 2018**

Year	The maximum volume of steel production in year tonnes	Difference from actual steel production in year tonnes
2000	12 394 366	-3 594 366
2001	12 352 941	-3 952 941
2002	12 305 833	-3 937 866
2003	12 307 276	-3 199 892
2004	12 610 369	-2 017 659
2005	12 603 503	-4 159 156
2006	12 489 548	-2 497 910
2007	12 656 691	-2 025 071
2008	12 633 262	-2 905 650
2009	12 507 049	-5 378 031
2010	12 687 340	-4 694 316
2011	12 541 669	-3 762 501
2012	12 663 859	-4 305 712
2013	12 619 582	-4 669 245
2014	12 585 981	-4 027 514
2015	12 600 038	-3 402 010
2016	12 520 189	-3 505 653
2017	12 912 214	-2 582 443
2018	12 856 479	-2 699 861

There are various methods for calculating the production capacity (the indicator method is used in this paper). The scope of the analysis of the occurrence of the relationship between the volume of production and the use of production capacity may relate to the enterprise or industry. This work performed an analysis for the steel sector in Poland in the period from 2000 to 2018. General conclusion based on the analysis performed: both in the historical period for a given steel production volume in Poland, the production capacity is not fully used. In the analyzed period from 2000 to 2018, 71,79 % of production capacity was used for average annual steel production of 9 027 915 tonnes of steel. In the analyzed period, the utilization of production capacity was not fully. Obtained simulation causes that steel production in Poland in particular years should be above 12 million tonnes. The maximum steel production in realized simulation was 12 912 214 tonnes steel in 2017 (Table 2).

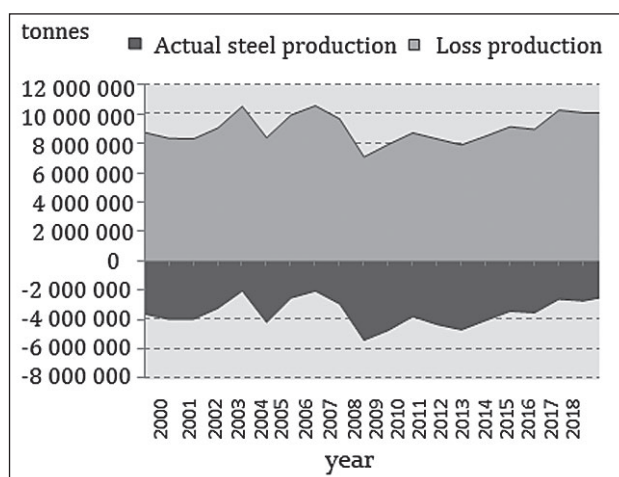


Figure 5 Actual steel production and loss steel production in Poland in the period from 2000 to 2018

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**Note:** The responsible for English language J. Jamrozik, Jawornik, Poland.