# The mining industry and its position in the economic cycle of the EU countries

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*Over the last three years, the European Union has implemented several active measures necessary to strengthen the industrial base in Europe. Despite these processes, there are significant disparities between countries in the development of individual industries and their basic economic characteristics. The main objective of the contribution was to identify the relationship between the mining industry and the economic cycle of the EU countries. The mining industry is a specific type of industry in selected EU countries and is conditional on the existing mineral resources of the country. The time series of selected indicators of the industry as a whole, mining industry and GDP from the Eurostat database for Q1 2000-Q3 2016 were used for analysis purposes. An analysis of 296 time series with quarterly periodicity from 22 EU countries (including the UK) was performed. As declared by the results of our analysis, there are sectors with a strong impact on the economic cycle, on the other hand, the sectors that are developed independently of the cyclical development of the economy. Strong cyclical industries must constantly be monitored, as negative changes in these sectors will automatically deepen the recession phase of the economic cycle.*

***Key words:*** *Mining industry, economic cycle, cyclical indicators, GDP, cross-correlation.*

## Introduction

The processes of globalisation are associated with many economic, political, social and natural changes. They also have a significant impact on the industry sector. The industry is currently undergoing a rapid change that will also affect European citizens. Industry competitiveness is steadily increasing in EU countries thanks to EU initiatives (Simionescu et al., 2017). The industry is an essential part of the European economy: generates 24 % of GDP and employs up to 50 million people, which means one out of five jobs in the EU. It also has an enormous burden on the environment, which puts increased demands on resource efficiency (Škuta et al., 2017).

In connection with the narrowness and the finiteness of resources comes to the fore the issue of finding ways of increasing the competitiveness of industry and ensuring progressive and sustainable economic growth (Dirner and Pavelek, 2016; Slovak Innovation and Energy Agency, 2016). Sustainable economic growth in the country is conditioned by the diversification of the domestic production structure (Gavurová et al., 2016). This process is also facilitated by the development of modern, technically and knowledge-intensive industries and services (Klessmann, 2011; Erbach, 2016). The significant share of industry in economic growth also supports the creation of reserves for social development programs, growth in employment (including in other sectors) and related profit generation, etc.

The industry has a major impact on all dimensions of sustainable development - economic, social, environmental and institutional (Streimikiene et al., 2016; Balitskiy et al., 2016).
On the other hand, its state and development are determined by these factors:

- The growing globalisation of the world economy,
- The economic crisis and its impact on the availability of financial resources,
- Business development and global competition,
- The single market and regulatory frameworks,
- The availability of raw materials and energy and the requirements of their more efficient use,
- Technologies and innovations,
- Labor force qualification and skills, security issues, demographic change,
- Increasing demands for post-production services, and so on (Nemcová, 2012).

These factors are closely linked to the monitored indicators of the mining industry that we have used in our analysis. Technological developments and pressures from globalisation processes support the production of ever-new types of goods and services and the development of new business models for their delivery (European

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Commission, 2017). At the same time, the structure and nature of the links between individuals (workers, investors and consumers) and industry are changing. All European countries consume construction minerals in proportion to the size of their economies. Not all European Union countries are self-sufficient in aggregate minerals, some are deficient mainly due to geological and topographical reasons (Brown et al., 2016). In the European Union, a large and advanced part of the industry is made up of coal mining, a large and mature industry, employing almost 200,000 people in well-paid jobs, and much more in equipment and material suppliers. The EU is a major processor of most major mineral raw materials (Perez et al., 2013). Coal remains one of the EU's most important energy sources, meeting 17 % of EU primary energy demand in 2014; at 214 million tons of coal equivalent (Mtce) (EURACOAL, 2017). The impact of the financial and economic crisis and the subsequent recovery of the EU-27 industrial economy can be clearly seen in the two main economic indicators, namely the Industrial Production Index and the Industrial Domestic Output Index (The European Union, 2012). These indicators should be followed in the context of the development of the country's economic cycle.

## The mining industry and its critical areas in research studies

An increasingly important topic of the global mining industry is mining enterprises from emerging economies. Many low and middle-income countries (LMIC) rich in mineral raw materials have recorded strong economic growth in the last 10 years, accompanied by a rapid expansion in exports of minerals and an increase in the prices of these commodities (Lascsáková, 2010, 2016). Some studies (such as McMahon and Moreira, 2014) also state that countries rich in mineral raw materials (other than oil) have seen, in addition to economic growth, both the Human Development Index (HDI), respectively more positive values than HDIs in countries with a lower share of minerals. Similarly, the country's richness of raw materials can be reflected in other indicators of quality of life. The impact of the financial and economic crisis and the subsequent recovery of the EU-27 industrial economy can be clearly seen in the two main economic indicators, namely the Industrial Production Index and the Industrial Domestic Output Index (The European Union, 2012). These indicators should be followed in the context of the development of the country's economic cycle.

Critical aspects of the mining industry are reflected in a number of foreign research studies exploring various aspects of the sector's development. These research studies are highly heterogeneous in nature, determined by set research objectives and research processes. Their unified platform consisted of reflection on the worsening conditions for the development of mining industries in individual countries and the related existential risks of mining industries. For example, Jonek-Kowalska (2014, 2017) points to the fact that there are only a few countries in Europe where mining companies continue to operate as separate economic units but all of them have experienced serious financial problems in recent years. This was also reflected in the negative financial results of these companies. This fact is also reflected in the study by author Borshchevska (2015), who points to the reform processes in the Ukrainian mining industry and analyses their contribution to the restoration of the industry as a whole. The efficiency of the mining industry is also addressed by Baublys et al. (2015) and Starostka-Patyk and Grabara (2010), while fully underlining the role of renewable energy sources, the negative impact of the energy sector on the environment, energy security and other related processes and the active use of renewable resources. In studies Grabara and Grabara (2013), Baublys et al. (2015), they also appeal to support innovative activities in this sector. The study of Świadek and Szopik-Depczyńska (2014), which makes interesting recommendations for other countries, also provides an interesting insight into the application of innovation in this sector in terms of Polish companies. The institutional connection of the solved problem is also evident in the study by the Lithuanian authors Leonavičius et al. (2015), which, as in Baublys et al. (2015) and Grabara and Kuceba (2011) also calls for a complementary need for energy security solutions in connection with mining industries. The results of their studies indicate a lack of understanding of the perception of energy security by the public. Similarly, studies of other authors have a clear emphasis on the development of quality policies supporting progress in the development of the mining industry, and the authors draw attention to several risk factors for its development (e.g. Renn and Marshall, 2016; Strunz et al., 2016; Nawrocki and Jonek-Kowalska, 2016; Haftendorn et al., 2012).

High up-to-date solutions to the development of the mining industry, supported by the research studies presented, have been the main motive for the realisation of our research. Our ambition was to monitor the economic cycle of the EU countries and how the mining industry impacts on its development. Research studies of this nature are carried out singly, due to the methodological difficulty and availability of relevant data. The study by Polish experts (Lenart et al., 2016) focused on examining the characteristics of fluctuations in economic cycles of the Polish economy before and after the crisis. Their main finding was that the factors causing the fluctuations of the Polish economic cycle did not change after the economic crisis. For economic and raw material policy, the implementation of detailed and objective analyses of regional and sectorial trends in global mining is of utmost importance. This is also due to the strong impact of economic policy results on the strategies and activities of other sectors.

This is also reflected in our contribution, which is the thematic focus on the EU industry, with an emphasis on the mining industry. The main objective of the contribution was to identify the relationship between the mining industry and the economic cycle of the EU countries. Partial targets were aimed at identifying the relationship between industry as a whole and the economic cycle of the EU as well as between the industry as a whole and the mining industry. Consequently, we also focused on identifying the relationship between selected indicators of the mining industry and the economic cycle of the EU countries. The results of the analyses represent a valuable platform for the formulation of sectorial policies, strategic frameworks, regional development plans and concepts. We also see the importance of outputs of analyses of this nature in the process of creating national and international benchmarking and in the development of methodologies and a comparative database.

## Data and methodology

The time series of selected indicators of the industry as a whole, mining industry and GDP from the Eurostat database for Q1 2000 - Q3 2016 were used for analysis purposes. An analysis of 296 time series with quarterly periodicity from 22 EU countries (including the UK) was performed. From the mining industry, all available data that Eurostat reports on the NACE Rev. 2 classification of economic activities were examined in the Mining and Quarrying category. In each EU country for which data were available, 10 indicators of the mining industry were analysed, namely: Production, Employment, Wages and Salaries, Volume of Work done, Domestic output price index, Total output price index, Turnover domestic market, Turnover non-domestic Market, Turnover total.

Because of the need for identifying the relationship between the components of the mining industry and GDP, which represents the economic cycle, the following methods were used:

**Seasonal adjustment of time series** (seasonal indexes) – it is required to obtain the cyclical components from the original data, and therefore we need to smooth the time series seasonally. We will use the method of smoothing through the seasonal indexes.

**Elimination of trend (Hodrick-Prescott filter)** – one of the reasons for choosing the HP filter was the fact that it can eliminate the trend component in one operation and at the same time smooth the entire time series (Schlicht, 2005). This allows us to get the cyclical components of the time series, which are inevitable for the analysis of the economic cycles. The disadvantage of the HP filter is a "problem of ends" that can be solved by predictions, for example, using the extrapolation method (Kranendonk et al., 2004).

**Cross-correlation** – enables us to express the relation between the reference series and the time series of the studied cyclical indicators. The cross-correlations are performed with the lag of five periods forward and backwards, by applying the Pearson correlation coefficient, which reflects the linear dependence between the variables (Marek, 2007). If this relation is non-linear, which we will find out through the graph, we will make it linear by the transformation of the variables (e.g. logarithm), and then we will calculate a new correlation.

The relationship between the indicators of the mining industry and the economic cycle of the EU countries is determined on the basis of the cross-correlation values of the cyclical components. The monitored indicators can be divided into:

1. **Cyclical Indicators** - if the second highest crossover value[4] at *t*-5 to *t*+5 is greater than 0.55. These indicators show a cyclical relationship with the reference series, which is the cyclical component of GDP. For cyclical indicators, it is possible to create three groups of indicators:
   a. **Leading Cyclical Indicators** - The highest crossover value is achieved at time *t*-1 to *t*-5. These indicators evolve in advance of the development of the country's economic cycle and can be used to predict cycle development partially.
   b. **Coincident Cyclical Indicators** - the highest crossover value is achieved at time *t*. This is a set of indicators that are evolving in line with the economic cycle of the EU countries.
   c. **Delayed (lagging) Cyclical Indicators** - the highest crossover value is reached at time *t*+1 to *t*+5. These indicators are developing late in the business cycle, for example, the growth in employment and wages in the mining industry may be delayed by several quarters of GDP growth.

2. **Non-cyclical Indicators** - if the greatest cross-correlation value at t-5 to t+5 was less than 0.55. This set of indicators does not develop in any relation to the country's economic cycle. This means that growth,

[4] The second highest cross-correlation value is tracked to confirm or displace the cyclical relationship. If only the highest value could be observed, it could only be a random high correlation at a given time without cyclic behaviour of the indicators.

respectively the decline, of the indicator develops independently of the evolution of the economic cycle, and so, the indicator is not sensitive to changes in the economic cycle.

## Results and discussions

The results of the analyses were structured in three areas, which represent separate sections. The main research trajectory was the exploration of the relationship between the mining industry and the economic cycle of the EU countries.

### State of the industry as a whole in the economic cycle of the EU

In the EU, industry plays a different role and importance. In order to determine the relationship between the EU industry and the economic cycle, cross-correlations were made with time shifts between the cyclical component of output in the industry as a whole and the cyclical component of GDP at constant prices for 2010. The results are shown in Table 1.

*Tab. 1. Results of the cross-correlation between the cyclical component of total industry and GDP in EU countries.*

| Countries | t-5 | t-4 | t-3 | t-2 | t-1 | t | t+1 | t+2 | t+3 | t+4 | t+5 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 0,017 | 0,220 | 0,453 | 0,686 | 0,864 | 0,957 | 0,838 | 0,595 | 0,313 | 0,031 | -0,185 |
| Belgium | -0,229 | -0,058 | 0,146 | 0,406 | 0,680 | 0,833 | 0,795 | 0,548 | 0,237 | -0,065 | -0,291 |
| Czech Republic | 0,127 | 0,339 | 0,570 | 0,754 | 0,848 | 0,807 | 0,664 | 0,457 | 0,232 | 0,013 | -0,188 |
| Denmark | -0,012 | 0,157 | 0,290 | 0,496 | 0,705 | 0,840 | 0,791 | 0,692 | 0,486 | 0,231 | 0,070 |
| Estonia | -0,343 | -0,352 | -0,347 | -0,313 | -0,248 | -0,153 | -0,019 | 0,139 | 0,324 | 0,509 | 0,667 |
| Finland | -0,140 | 0,078 | 0,336 | 0,591 | 0,817 | 0,925 | 0,794 | 0,570 | 0,339 | 0,082 | -0,153 |
| France | -0,052 | 0,177 | 0,437 | 0,697 | 0,894 | 0,975 | 0,835 | 0,593 | 0,312 | 0,034 | -0,194 |
| Germany | -0,088 | 0,145 | 0,409 | 0,655 | 0,864 | 0,941 | 0,786 | 0,522 | 0,233 | -0,039 | -0,274 |
| Greece | 0,509 | 0,525 | 0,520 | 0,543 | 0,596 | 0,568 | 0,476 | 0,345 | 0,225 | 0,160 | 0,028 |
| Hungary | -0,016 | 0,182 | 0,422 | 0,630 | 0,786 | 0,859 | 0,726 | 0,524 | 0,333 | 0,167 | 0,058 |
| Ireland | -0,220 | -0,125 | 0,054 | 0,171 | 0,316 | 0,414 | 0,428 | 0,498 | 0,514 | 0,431 | 0,276 |
| Italy | -0,213 | 0,020 | 0,302 | 0,607 | 0,848 | 0,951 | 0,838 | 0,591 | 0,297 | 0,034 | -0,157 |
| Latvia | 0,548 | 0,676 | 0,754 | 0,793 | 0,762 | 0,650 | 0,475 | 0,269 | 0,034 | -0,205 | -0,421 |
| Luxemburg | 0,129 | 0,197 | 0,288 | 0,379 | 0,500 | 0,544 | 0,478 | 0,294 | -0,023 | -0,253 | -0,371 |
| Netherlands | -0,128 | 0,047 | 0,211 | 0,383 | 0,499 | 0,496 | 0,289 | 0,096 | -0,067 | -0,250 | -0,264 |
| Poland | 0,117 | 0,313 | 0,518 | 0,637 | 0,711 | 0,725 | 0,579 | 0,318 | 0,046 | -0,242 | -0,452 |
| Portugal | -0,043 | 0,126 | 0,304 | 0,432 | 0,566 | 0,630 | 0,502 | 0,331 | 0,144 | -0,050 | -0,152 |
| Slovakia | -0,201 | -0,120 | 0,216 | 0,519 | 0,706 | 0,723 | 0,667 | 0,501 | 0,332 | 0,113 | -0,068 |
| Slovenia | 0,077 | 0,259 | 0,472 | 0,690 | 0,858 | 0,894 | 0,732 | 0,473 | 0,200 | -0,022 | -0,213 |
| Spain | 0,339 | 0,502 | 0,651 | 0,748 | 0,769 | 0,693 | 0,532 | 0,314 | 0,085 | -0,127 | -0,294 |
| Sweden | -0,308 | -0,075 | 0,236 | 0,547 | 0,785 | 0,927 | 0,879 | 0,683 | 0,433 | 0,168 | -0,090 |
| UK | -0,018 | 0,169 | 0,373 | 0,592 | 0,762 | 0,846 | 0,768 | 0,581 | 0,297 | 0,010 | -0,222 |

*Source: own processing*

Based on the results in Table 1 it is clear that the industry has a strong cyclical relationship in almost all countries surveyed. Non-cyclically, the industry indicator was conducted in Estonia, Luxembourg, the Netherlands, Greece and Ireland, where the second highest cross-correlation value was below 0.55.

Among the countries with the strongest cyclical relationship of industry to GDP were Czech, Hungary, Belgium, Germany, France, Italy, Slovenia, Austria, Sweden, the United Kingdom and Denmark, where the cross-correlation value reached 0.8. The strongest industry-related link to the country's economic cycle was achieved in France with a cross-correlation value of up to 0.975.

In most countries, the indicator of the industry appears to be a parallel indicator. This means that production in industry evolves in parallel with the growth or decline of the country's economic cycle. In the Czech Republic, Spain and Latvia, even industrial indicators show a certain level of advance over economic developments in the country. It is, therefore, possible, based on industrial production, to expect economic growth or decline.

**Relationship between industry and the mining industry**

The mining industry is a specific type of industry in selected EU countries and is subject to existing mineral wealth of the country. We expect that in countries with sufficient raw materials the relationship between the industry as a whole and the mining industry will be demonstrated, which can be verified through the data in Table 2.

*Tab. 2. Results of cross-correlation between the cyclical component of the total industrial production and industrial production in the mining industry*

| Countries | t-5 | t-4 | t-3 | t-2 | t-1 | t | t+1 | t+2 | t+3 | t+4 | t+5 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | -0,122 | -0,059 | 0,040 | 0,161 | 0,292 | 0,330 | 0,293 | 0,160 | 0,081 | 0,011 | 0,022 |
| Belgium | -0,299 | -0,154 | 0,110 | 0,397 | 0,502 | 0,581 | 0,469 | 0,309 | 0,189 | 0,022 | -0,116 |
| Czech Republic | -0,107 | -0,064 | 0,040 | 0,136 | 0,196 | 0,241 | 0,247 | 0,232 | 0,091 | -0,038 | -0,185 |
| Denmark | 0,155 | 0,155 | 0,189 | 0,144 | 0,079 | 0,234 | -0,074 | -0,216 | -0,122 | -0,190 | -0,199 |
| Estonia | -0,149 | 0,094 | 0,263 | 0,358 | 0,478 | 0,557 | 0,480 | 0,404 | 0,255 | 0,093 | -0,072 |
| Finland | 0,048 | 0,087 | 0,192 | 0,175 | 0,220 | 0,263 | 0,201 | 0,132 | 0,068 | -0,110 | -0,222 |
| France | -0,334 | -0,109 | 0,172 | 0,449 | 0,656 | 0,772 | 0,723 | 0,576 | 0,418 | 0,230 | 0,027 |
| Germany | -0,422 | -0,175 | 0,071 | 0,304 | 0,423 | 0,503 | 0,629 | 0,632 | 0,501 | 0,352 | 0,182 |
| Greece | 0,129 | 0,058 | 0,192 | 0,127 | 0,062 | 0,290 | 0,002 | -0,089 | -0,100 | -0,046 | -0,103 |
| Hungary | -0,103 | -0,331 | -0,424 | -0,409 | -0,336 | -0,090 | 0,180 | 0,411 | 0,517 | 0,535 | 0,453 |
| Ireland | 0,295 | 0,363 | 0,313 | 0,158 | -0,048 | -0,274 | -0,262 | -0,363 | -0,467 | -0,391 | -0,214 |
| Italy | 0,178 | 0,217 | 0,323 | 0,378 | 0,398 | 0,350 | 0,245 | 0,170 | 0,081 | 0,019 | -0,091 |
| Latvia | -0,170 | 0,021 | 0,217 | 0,350 | 0,531 | 0,621 | 0,570 | 0,473 | 0,358 | 0,278 | 0,205 |
| Luxemburg | -0,150 | -0,287 | -0,276 | -0,181 | -0,219 | -0,042 | 0,024 | 0,055 | 0,159 | 0,296 | 0,385 |
| Netherlands | -0,261 | -0,355 | -0,201 | -0,148 | 0,157 | 0,651 | 0,205 | -0,070 | -0,112 | -0,266 | -0,176 |
| Poland | -0,099 | -0,091 | 0,019 | 0,273 | 0,456 | 0,623 | 0,637 | 0,434 | 0,215 | 0,029 | -0,091 |
| Portugal | -0,356 | -0,331 | -0,228 | -0,166 | -0,008 | 0,191 | 0,276 | 0,432 | 0,483 | 0,457 | 0,196 |
| Slovakia | -0,159 | 0,091 | 0,262 | 0,413 | 0,169 | 0,149 | 0,094 | 0,008 | -0,036 | 0,012 | 0,029 |
| Slovenia | -0,059 | -0,109 | 0,026 | 0,129 | 0,201 | 0,211 | 0,114 | 0,084 | 0,011 | -0,070 | -0,133 |
| Spain | -0,054 | 0,206 | 0,461 | 0,679 | 0,809 | 0,844 | 0,755 | 0,560 | 0,299 | 0,044 | -0,163 |
| Sweden | -0,027 | 0,139 | 0,290 | 0,472 | 0,613 | 0,651 | 0,485 | 0,196 | -0,087 | -0,315 | -0,378 |
| UK | -0,153 | -0,055 | 0,011 | 0,010 | 0,056 | 0,127 | 0,023 | -0,050 | -0,071 | -0,127 | -0,101 |

*Source: own processing*

Based on the results outlined in Table 2, it is possible to identify those countries where industrial production in the mining industry has a cyclical relationship with production in the overall industry. These are the countries: Poland, Germany, France, Spain, Latvia and Sweden. There was a strong relationship between the mining industry and the overall industry. In the case of Poland and Germany, production in the mining industry develops late for total production in industry.

**Relation of the indicators of the mining industry to the economic cycle of the EU countries**

According to the classification of economic activities Nace Rev. 2, used by Eurostat 10 indicators of the mining industry were identified in the production sector, the labour market, producer price indices and indicators of turnover. After selecting their cyclical components the cyclical, resp. anti-cyclical relationship of these indicators was determined. Table 3 gives a numerical indication of the indicators of the mining industry.

*Tab. 3. Indication of the indicators of the mining industry.*

| No. | Indicator | No. | Indicator |
|---|---|---|---|
| **1** | Production | **6** | Non-domestic output price index |
| **2** | Employment | **7** | Total output price index |
| **3** | Wages and salaries | **8** | Turnover domestic market |
| **4** | Volume of work done | **9** | Turnover non-domestic market |
| **5** | Domestic output price index | **10** | Turnover total |

*Source: own processing*

From the results presented in Table 4, it is clear that the relationship between the cyclical components of the indicators of the mining industry and the cyclical component of GDP varies depending on the EU country. In countries like Poland, Greece, Italy, Luxembourg, Slovenia, the UK and Denmark, no cyclical relationship was identified for one indicator of the mining industry.

*Tab. 4. Resulting relationship between cyclical components of mining industries and GDP in countries.*

| **Countries** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
|---|---|---|---|---|---|---|---|---|---|---|
| Austria | a | a | a | a | a | Dci | a | a | a | a |
| Belgium | Cci | a | a | a | a | a | a | - | - | a |
| Czech Republic | a | a | a | a | a | a | a | a | Cci | Cci |
| Denmark | a | - | - | - | a | a | a | a | - | a |
| Estonia | a | a | a | a | a | Lci | a | a | a | a |
| Finland | a | a | a | a | Dci | a | a | Cci | a | Lci |
| France | Cci | a | Dci | a | a | a | a | Dci | Cci | Dci |
| Germany | Dci | a | Cci | a | a | a | Dci | Dci | a | Dci |
| Greece | a | a | a | a | a | a | a | a | a | a |
| Hungary | a | Lci | a | a | a | a | a | a | a | a |
| Ireland | a | a | - | - | a | Dci | Dci | a | a | Cci |
| Italy | a | a | a | a | a | a | a | a | a | a |
| Latvia | Cci | Dci | Dci | Lci | Dci | a | Dci | Cci | a | Cci |
| Luxemburg | a | a | a | a | a | a | a | - | - | - |
| Netherlands | a | a | a | a | Dci | a | Dci | a | a | a |
| Poland | a | a | a | a | a | a | a | a | a | a |
| Portugal | a | Dci | Dci | Dci | a | - | - | Cci | a | a |
| Slovakia | a | Dci | Dci | Dci | a | a | a | a | a | a |
| Slovenia | a | a | a | a | a | a | a | a | a | a |
| Spain | Lci | a | a | Cci | a | a | a | Lci | a | a |
| Sweden | Cci | a | Dci | Dci | - | - | - | a | Cci | Cci |
| UK | a | a | a | a | - | - | - | a | a | a |

*a – Anticyclical indicator, Lci – Leading cyclical indicator, Cci – Coincident cyclical indicator, Dci – Delayed (lagging) cyclical indicator*
*Source: own processing*

This means that the development of these indicators in the country is not in any way related to the development of GDP. The largest number of indicators showed cyclical behaviour against GDP in Germany, France, Latvia and Sweden, where there were more than five cyclical indicators. In Latvia, it was up to eight indicators of the mining industry. From the group of cyclical indicators, the largest number of indicators behaved as delayed cyclical indicators. This means that this group of indicators develops with a certain time delay compared to the evolution of the cyclical component of GDP. Frequently, the price index indicators have been most frequently developed. Followed by labour market indicators such as Wages and salaries, Volume of work done and Employment. Figure 1 illustrates the development of the cyclical component of GDP and employment, which has been a strong lagged indicator for Latvia.

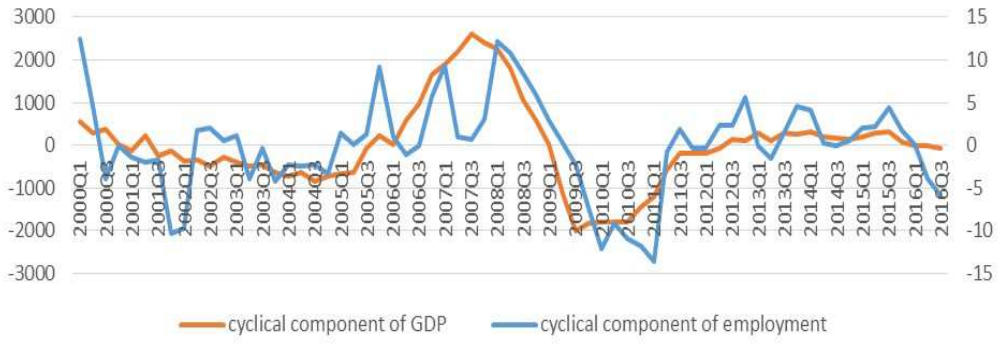


*Fig. 1. Development of the cyclical component of GDP and the cyclical component of employment in the mining industry in Latvia.*
*Source: own processing*

Employment indicators, in most cases, appear to be delayed cyclical indicators. Under the influence of the economic downturn, which is associated with a lack of demand, the business sector limits production and subsequently leads to redundancies. This will be reflected in the fall in employment. If the economy is growing, GDP is on the increase; employers are creating new jobs, which will also show up in employment statistics with a certain delay (several months). In Latvia, employment indicators actually developed delays with a one-quarter delay and a cross-correlation value of 0.715 at t+1. An even stronger relationship was reached for the Wages and salaries indicator. There was a delay of t+2 with a cross-correlation value of 0.855. The group of parallel indicators included production indicators and, in particular, turnover whose development was in line with the evolution of GDP. Figure 2 shows the parallel development of the cyclical component of the production index and the cyclical component of GDP in France.

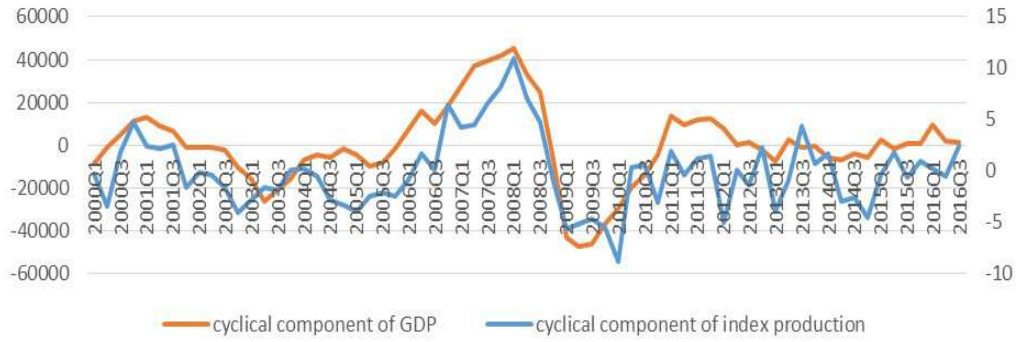


*Fig. 2. Development of the cyclical component of GDP and the cyclical component of the production index of the mining industry in France. Source: own processing*

The production index in the mining industry developed in France with the economic development of the country, which represents GDP. The cross-correlation value at time *t*, i.e. at time of concurrence, was 0.8027. The group of industrial production indicators generally evolves in parallel or even ahead of the economic cycle. The Industrial Production Index is also used as an alternative indicator for monitoring the EU economic cycle (OECD, 2008). In the case of France, a strong concurrence of the overall industry indicator, as well as production in the mining industry with the cyclical development of France, was identified. Leading indicators are among the most important group of cyclical indicators. For their help, it is possible to predict the development of the economic cycle of the country in the short term. From the economic nature of the indicators, it is possible to refer to the predominant indicators of production in the mining industry and the domestic turnover in Spain and the total turnover in Finland. Figure 3 describes the development of the cyclical component of GDP and the cyclical component of industrial production in Spain.

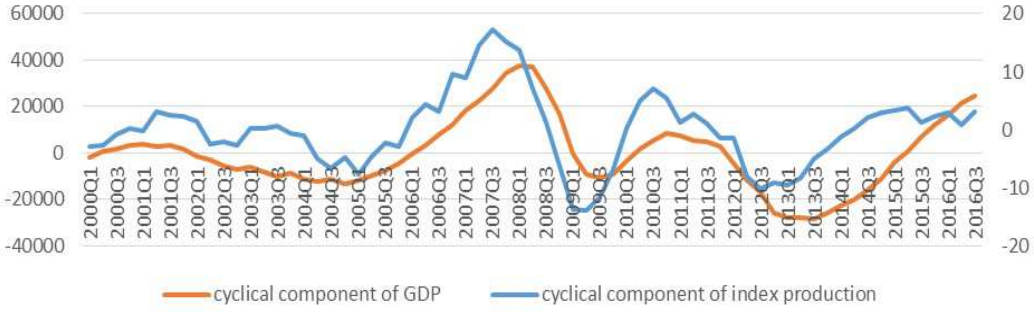


*Fig. 3. Developments in the cyclical component of GDP and the cyclical component of the production index in the mining industry in Spain. Source: own processing.*

It can be seen from Figure 3 that production indices are actually evolving in advance of the development of the country's economy. In Spain, the production indicator in the mining industry reached two quarters before the country's economic cycle, with a cross-correlation size of 0.8162. There is a strong lead in Figure 3 in the run-up to the 2008 financial crisis. This indicator even predicted a recovery and a subsequent fall in the time of the debt crisis.

## Conclusion

Globalization processes are associated with processes of constant change, changing environmental, economic and social conditions. This has an impact on various industries. In the paper, we focused on analysing industry developments in relation to the EU economic cycle. The mining industry has been the priority of our research project. For economy and country policies, it is very important to know the cyclical behaviour of the various sectors of the economy, in order to determine their impact on the economy as a whole. There are sectors with a strong impact on the economic cycle, on the other hand, sectors that develop independently of the cyclical development of the economy. If the country's raw material base is linked to export processes, it is positive for the development of the economic cycle. This fact is confirmed by our research findings. If the raw material base is used only for domestic consumption purposes, there is no significant cyclical impact on

the economy. At present, the use of alternative energy sources is at the forefront, resulting in a decreasing impact of the mining industry on the economy. This consistent fact also confirms the results of our analyses. For this reason, continuous monitoring of the cyclical behaviour of individual sectors of the economy in countries and their forecasting is necessary. Strong cyclical industries must be continuously monitored, as negative changes in these sectors will automatically deepen the recession phase of the economic cycle. On the contrary, support for strong cyclical sectors by the state can contribute to the economic growth of the country. There should not be too many strong cyclical sectors in the country because, in the case of a recession, it is very problematic to return to the original position in the economic cycle. The contribution of the entire contribution is also a presentation of the methodology to identify and monitor the cyclical behaviour of individual sectors in the country.

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