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Indicators of industry and their prediction abilities of German business cycle

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Abstract: Industry forms an important part of the German economy and its development has a significant impact on the overall economic cycle of the country. The aim of the contribution is to identify industry indicators that would be able to predict the future development of the economic cycle in Germany. For the purposes of creating a composite indicator, the predictive capabilities of 170 indicators from various areas of industry for the quarters 2000-2022 from the European Commission database were examined. The leading capabilities of the indicators were investigated using methods such as the Hodrick-Prescot filter to select the cyclical component of the time series and cross-correlations using the Pearson coefficient to determine the relationship to the economic cycle of Germany. The industry indicators that have the highest level of predictive ability in relation to Germany's GDP include Employment expectations over the next 3 months, Assessment of the current level of stocks of finished products, Competitive position on foreign markets inside the EU over the past three months and an Industrial confidence indicator.

1 Introduction

Predicting the development of economic cycles is in the forefront of interest of many economists who are aware that it is a difficult path with an uncertain outcome. Predictions in general are associated with a high degree of uncertainty, which makes it impossible to create reliable models and procedures that would be valid over time. It is an ongoing process of searching for variables that can best predict the cyclical development of the economy at a given time. Industry indicators can be included among the groups of variables that are among the leading indicators of the economic cycle for a long time. It is the industry that forms the basis of many national economies, such as Germany, without a doubt and represents a high share of total production, employment and the creation of sustainable economic growth [1]. Industry is also a sector very sensitive to internal and external influences that can lead to fluctuations in the economic cycle. It is considered a sector that copies or even precedes the development of economic cycles. Cyclical fluctuations have a significant impact on decisions about production or reduction of activity in industrial enterprises.

Already the financial crisis in 2008 showed a strong degree of reaction of the industry to external changes which subsequently led to a drop in GDP in many countries of the world. Unexpected events such as the Covid 19 pandemic or the war in Ukraine also affected the development of industrial production. Germany has a special position in this system which results from its export-import relations with other European economies. For this reason, the development and prediction of the German business cycle is in the center of interest of many small and open economies, such as Slovakia.

Monitoring the cyclical development of industry indicators is, for example, a source of important information to support the development of future innovations, which is confirmed by studies conducted on data from Poland [2,3].

In addition to the business sector, information on cyclical development is also useful for the state in the process of preparing fiscal policy measures [4]. This issue is dealt with by several foreign studies such as Sala et al. or Buterin et al. [5,6].

Industry indicators can be found as components of composite leading indicators created by many economists as well as national and international institutions such as OECD or Eurostat. In the case of OECD, they are qualitative and quantitative industrial indicators that differ depending on the country [7]. In the case of Germany, industry is represented in the composite leading indicator by up to four indicators from the manufacturing sector, which confirms the strong position of this sector in predicting the economic cycle of Germany. Eurostat in the case of each country as well as Germany uses the Confidence indicator of industry as part of the composite indicator, which constitutes up to 40% of the total advance indicator Economic sentiment indicator [8].

Likewise, economists who deal with the creation of composite leading indicator at the national level confirm that specific industry indicators are suitable for predicting business cycles and are closely related to the industrial orientation of that country. In the case of the V4 countries, it is, for example, the study by Vraná [9]. Specifically for Poland, these are studies by Bandholz or Zalewski [10,11]. For Germany, industry indicators are found in the

composite indicators constructed by Wirtschaftswoche, Obrex or Handbuch [12-14].

Most authors use industry indicators as components of composite indicators. Nasiri et al. proposed an entire composite leading indicator from industry components, declaring that this indicator has the ability to predict the business cycle at a maximum of 4 and at least 1 period ahead [15].

A prerequisite for knowing the important industry for the economic cycle of the selected country is an in-depth analysis of the cyclical behavior of industry indicators in relation to the cyclical component of the GDP of the given economy. This contribution focuses on the identification of industry initiators that have an early potential for the development of the strongest European economy, which is Germany.

2 Methodology

For the purposes of this study, 170 indicators presented by the European Commission for selected industrial categories were analyzed (Table 1). The period of 2000-2021 was selected and the data were processed with a quarterly periodicity, which ensured a sufficiently long time series to investigate the cyclical behavior of the indicators.

Table 1 List of monitored variables

Category	Type of indicators in category	Number of indicators
Business surveys		22
Production in industry: A: Total	Mining and quarrying	22
Turnover in industry: A: Total B: Domestic market C: Non domestic market	Manufacturing	34
Producer prices in industry: A: Domestic market B: Non domestic market	Electricity, gas, steam and air conditioning supply	36
Import prices in industry	Water collection, treatment and supply	20
Labour input in industry A: Employment B: Volume of work done C: Gross wages and salaries		36
Total		170

Source: own processing.

Due to the need to identify the relationship between the components of the industrial and economic cycle of Germany, which represents the economic cycle, the following methods were used: Seasonal cleaning of time series (seasonal indices) - it is necessary to obtain cyclical components from the original data, and therefore we need to seasonally smooth the time series. We will use the method of smoothing through seasonal indices. Trend elimination (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 smoothes the entire time series [16]. This allows us to obtain the cyclical components of time series, which are essential for the analysis of 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 [17]. The filter is defined as the solution to the following optimisation problem [18]:

$$y_t = \tau_t + c_t \quad (1)$$

$$min_{\{\tau_t\}}\left\{\sum_{t=1}^{T}(y_t-\tau_t)^2 + \lambda\sum_{t=2}^{T-1}[(\tau_{t+1}-\tau_t)-(\tau_t-\tau_{t-1}]^2\right\} \quad (2)$$

Where $\mathbf{y_t}$ is the original series, $\boldsymbol{\tau_t}$ is the trend component and $\mathbf{c_t}$ is the cyclical component. The method consists in minimising the deviation of the original series from the trend (the first term of the equation) as well as the curvature of the estimated trend (the second term). The trade-off between the two goals is governed by the smoothing parameter λ. The higher the value of λ, the smoother is the estimated trend.

To get optimal results for detrending, it has been suggested to choose λ=1600 for quarterly data and λ =14 400 for monthly data [16]. The advantage of the HP method is that no limitation is set on the length of the time series. However, there is a requirement that you should seasonally adjust each series before proceeding with the HP filter. The trend itself is not very interesting when analyzing cyclical behavior. Therefore, the rest of the study was done with the cyclic components of each series [19].

Cross correlation – enables the relationship between the reference series and the time series of the investigated cyclical indicators. Cross-correlations are performed with a five-period forward and backward lag using the Pearson correlation coefficient, which reflects the linear dependence between variables [20]. If this relationship is non-linear, which we find out with the help of the graph, we make it linear by transforming the variables (e.g. logarithm) and then calculate the new correlation. The relationship between industry indicators and the economic cycles of EU countries is determined based on the values of the mutual correlation of cyclical components. The monitored indicators can be considered as cyclical indicators if the second highest transition value in time 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 or the cyclical component of the Index of Industrial Production (IIP), which represent the business cycle of Germany.For cyclical indicators, it is possible to create three groups of indicators [21]:

1. **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 partially predict cycle development.
2. **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 EU countries.
3. **Delayed (lagging) Cyclical Indicators** - the highest crossover value (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) is reached at time t+1 to t+5. These indicators are developing late in the economic cycle, e.g. growth in employment and wages in the mining industry may be delayed by several quarters of GDP growth.
4. **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, resp. the decline in the indicator develops independently of the evolution of the economic cycle, and so, the indicator is not sensitive to changes in the economic cycle. Due to the different units of the partial indicators, their normalised values obtained by using the standardization method are used in the composition of the composite leading indicator [22].

3 Results and discussion

3.1 Reference series representing the business cycle

When we want to monitore and predict economic cycles, it is important to choose a reference series that will appropriately copy the development of the German economy. In general, such an indicator is considered GDP or IIP. For this reason, the relationship between the cyclical components of GDP an and IIP is investigated using the Pearson coefficient.

Based on the significant position of industry in the economic cycle of Germany, it can be assumed that the IIP will behave as a concurrent indicator. This means that the highest value of the cross-correlation will be at time t. The probability of this result also increases due to the fact that we follow quarterly time series and not monthly. In the case of monthly data, there would be a greater probability of catching a lead, but this lead would be relatively short (1-2 months).

Table 2 presents the results of the cross-correlation of these indicators at time t-5 to t+5.

Table 2 The result of the cross-correlation between the cyclical component of GDP (Index, 2015=100) and cyclical component of IIP (Index, 2015=100) in the period Q1 2000- Q4 2022

Time	Cross correlation
t-5	-0,08
t-4	0,11
t-3	0,11
t-2	0,50
t-1	0,64
t	**0,92**
t+1	0,63
t+2	0,33
t+3	0,35
t+4	0,11
t+5	-0,08

Source: own elaboration.

The results from Table 2 show a strong correlation between GDP and IIP. This means that it is appropriate to use any of these time series for monitoring and forecasting the business cycle of Germany. Scientific studies more often work with GDP predictions. For this reason, we will also consider GDP as a reference serie in our contribution.

3.2 Industrial indicators used by Eurostat and OECD in forecasting the business cycle of Germany

It currently uses Eurostat and OECD industry indicators to predict the German business cycle at the international level. These selected industrial indicators have not changed over time for a long time and therefore it is important to know their predictive abilities in the present. Table 3 presents the results of cross-correlations for four industry indicators used by the OECD and the Industrial confidence indicator used by Eurostat.

Table 3 The result of the cross-correlation between the cyclical component of GDP and cyclical component of industry using by OECD and Eurostat in the period Q1 2000- Q4 2022

Indicators	**Leading period (correlation value)**
OECD indicators of industry (components of CLI)	
Manufacturong survey - export order books: level sa (% balance)	t (0.707)
Manufacturing survey - export order books: expectation (% balance)	t-1 (0.685)
Manufacturing survey - new orders	t (0.704)
Manufacturong survey - finished goods stocks: level (% balance) inverted	t-2 (0.72)
Eurostat: Industrial confidence indicator	t-2 (0.679)

Source: own calculation.

For the monitored period from Q1 2000 to Q4 2022, it was demonstrated that currently all investigated industry indicators can be considered cyclical as they show a

significant relationship with the cyclical component of Germany's GDP. However, the nature of the cyclical behavior of the selected variables indicates that three indicators behave in relation to the cyclical component of Germany's GDP as concurrent indicators and also two variables have the nature of leading indicators. This means that two indicators used by the OECD can provide sufficiently high-quality information about the possible future development of the economic cycle of Germany, namely the Manufacturing survey - new orders and Manufacturing survey - export order books: expectation and the Industrial confidence indicator used by Eurostat for prediction. These indicators can provide the most accurate prediction approximately more than one quarter ahead. For this reason, it is possible to consider them as indicators that can tell us about the future direction of the economic cycle of Germany. The other two OECD Manufacturing indicators can be used to monitor, but not to predict, the German business cycle.

3.3 Industrial indicators showing a prediction before the economic cycle of Germany

In order to determine the cyclical behavior of individual industry indicators in relation to GDP, cyclical componentswere selected for all 170 indicators. These were indicators from the Business Survey category focused on the industry, where there were data of a qualitative and quantitative nature focused on expectations of new orders, competitive position or expectations of employment development. The second large group consisted of indicators focused on production in industry, turnover in industry, producer prices, import prices and labor input in industry in various categories of industry as manufacturing, mining and quarrying, electricity, gas, steam and air conditioning supply and water collection, treatment and supply. The cross-correlation results between the cyclical components of the variables indicated several significant findings. Most industry indicators showed a concurrent relationship with GDP. These were indicators from the turnover in industry and producer prices group. Labor market indicators were mostly lagged indicators. The largest group of leading indicators was in the Business Survey group.

Figures 1-4 illustrate the development of selected industry indicators and Germany's GDP. The Industrial confidence indicator is one of the components of the Economic sentiment indicator (ESI). The ESI is constructed by Eurostat on a monthly basis and is a composite indicator that captures the confidence of selectet economic subjects across sectors such as industry, construction, services and consumers.

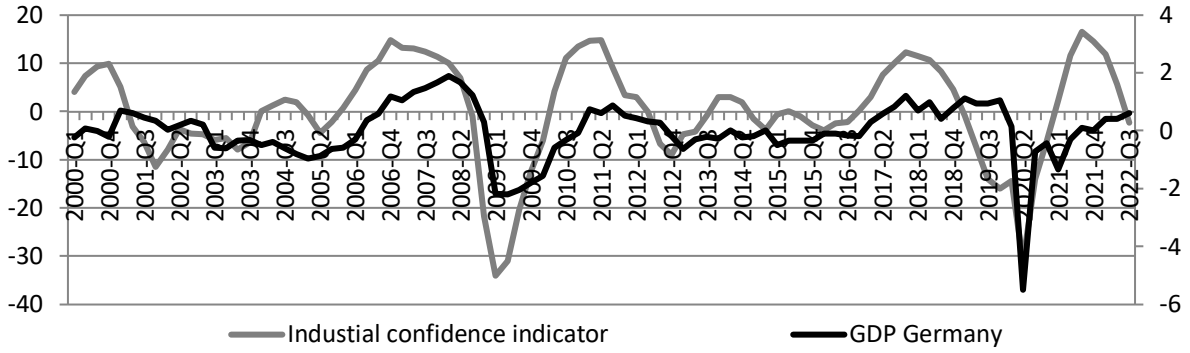

Figure 1 Development of the cyclical components of GDP (index, 2015=100) and Industrial confidence indicator for Germany
Note: All series have been seasonally adjusted, detrended and normalised.
Source: own calculation.

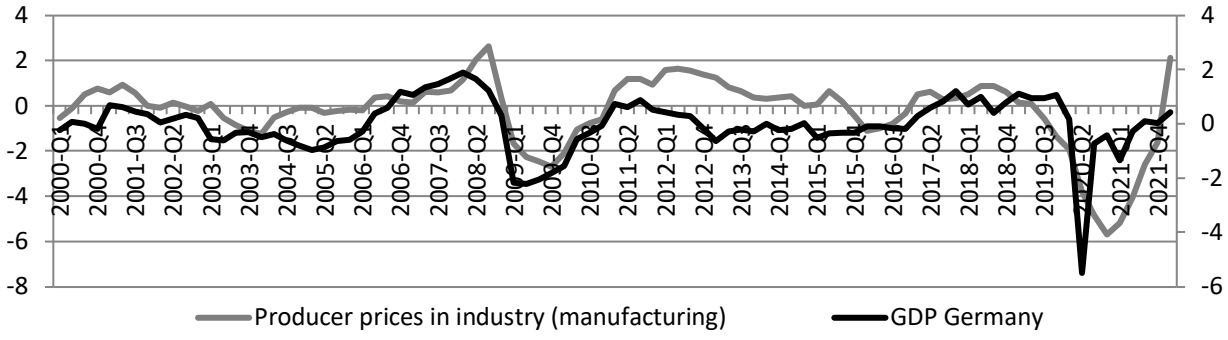

Figure 2 Development of the cyclical components of GDP (index, 2015=100) and Producer prices in manufacturing for Germany
Note: All series have been seasonally adjusted, detrended and normalised.
Source: own calculation.

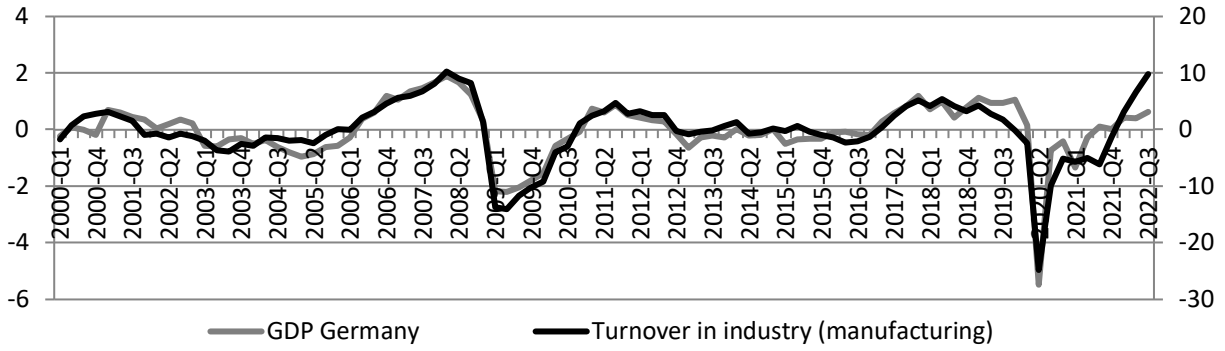

Figure 3. Development of the cyclical components of GDP (index, 2015=100) and Turnover in industry for Germany
Note: All series have been seasonally adjusted, detrended and normalised.
Source: own calculation.

Figure 4. Development of the cyclical components of GDP (index, 2015=100) and Employment in industry for Germany
Note: All series have been seasonally adjusted, detrended and normalised.
Source: own calculation.

According to Figures 1-4, the Industrial confidence indicator is ahead of the development of Germany's GDP. This was also confirmed by the value of the cross-correlation, which was at the level of 0.687 at time t-2. The Turnover in industry indicator (manufacturing) showed a concurrence with GDP with a cross-correlation value of 0.85 at time t. Producer prices in industry (manufacturing) showed a lag for GDP at the level of 0.652 at time t+1. The development of the employment in industry indicator in the area of manufacturing was also delayed, where a delay of t+2 was recorded at the level of 0.689.

Table 4 shows the time of prediction in quarters for two groups of monitored indicators, where the advance behavior of selected indicators was recorded. This is the area of Business Survey and Manufacturing. The most lead indicators with a lead time of one to two quarters appeared in the Business Survey category.

Table 4 Results of the predictive capabilities of the Business Surveys Indicators from industry and chosen Indicators of production in industry

Business Survey indicators		**Indicators of production in industry**	
Indicator	**Time of prediction**	**Indicator**	**Time of prediction**
Production development observed over the past 3 months	**t-2**	Total (Mining and quarrying)	t
Employment expectations over the next 3 months	**t-1**	Mining of coal and lignite	x
Assessment of order-book levels	t	Extraction of crude petroleum and natural gas	n
Assessment of export order-book levels	t	Mining of metal ores	n

Assessment of the current level of stocks of finished products	**t-2**	Other mining and quarrying	**t-1**
Production expectations over the next 3 months	**t-2**	Total (Manufacturing)	t
Selling price expectations over the next 3 months	t	Manufacture of food products	t
Industrial confidence indicator	**t-2**	Manufacture of beverages	x
Assessment of current production capacity	t	Manufacture of tobacco products	x
Duration of production assured by current order-books, months	t	Manufacture of textiles	t
New orders in recent months	-	Manufacture of wearing apparel	x
Export expectations for the months ahead	**t-2**	Manufacture of leather and related products	t
Current level of capacity utilization (%)	t	Manufacture of wood, paper, printing and reproduction	t
Competitive position over the past 3 months: on the domestic market	**t-2**	Manufacture of paper and paper products	t
Competitive position on foreign markets inside the EU over the past three months	**t-2**	Printing and reproduction of recorded media	t
Competitive position on foreign markets outside the EU over the past three months	x	Manufacture of chemicals and chemical products	t
Factors limiting the production - None	t	Manufacture of basic pharmaceutical products and pharmaceutical preparations	x
Factors limiting the production - Insufficient demand	t	Manufacture of rubber and plastic products	t
Factors limiting the production - Labour	t	Manufacture of other non-metallic mineral products	t
Factors limiting the production - Equipment	x	Manufacture of basic metals	t
Factors limiting the production - Other	t	Manufacture of fabricated metal products, except machinery and equipment	t
Factors limiting the production - Financial constraints	n	Manufacture of computer, electronic and optical products	t

Note 1: t: concurrency, t-1, t-2, t-3: leading period length in quarters, x: indicators do not show cyclic relation, n: no data
Source: own calculation

Table 5 shows the results of cross-correlations and lead time for the six industry indicators that showed the best predictive abilities in the period under review. In the future, these indicators have the potential to form components of composite indicators designed to predict the economic cycle of Germany.

Table 5 Leading indicators of German business cycle

Indicators	**Leading period (correlation value)**
Industry, Employment expectations over the next 3 months, Balance	t-1 (0.703)
Industry, Assessment of the current level of stocks of finished products, Balance	t-2 (0.628)
Industrial confidence indicator, Index, 2015=100	t-2 (0.687)
Competitive position on foreign markets inside the EU over the past three months, Index, 2015=100	t-2 (0.602)
Manufacturing survey - export order books: expectation (% balance)	t-1 (0.685)
Manufacturing survey - finished goods stocks: level (% balance) inverted	t-2 (0.72)

Source: own calculation

4 Conclusions

Industry is still an integral part of the economy of many countries, among which Germany undoubtedly belongs, and plays a significant role in the creation of the country's GDP. From this point of view, it is important to know if there are sectoral indicators that could tell us about the possible future development of the country's business

cycle. The aim of this contribution was to identify groups of indicators that have the ability to predict the development of the German economy. By analyzing 170 indicators, we came to the conclusion that indicators from the field of business research have the best predictive ability. These are primarily expectations of future orders or finished products, as well as expectations of employment in industry. The confidence indicator in industry was also significant. In the study, we also focused on monitoring the predictive capabilities of currently used industrial indicators used by the OECD and Eurostat.

Based on the analysis of these indicators we can claim that the Manufacturing survey indicator - new orders, Manufacturing survey indicator – expectation from OECD and the Industrial confidence indicator used by Eurostat are suitable for predicting the German business cycle. Other industrial indicators used by the OECD and Eurostat currently do not have the ability to predict the development of Germany's GDP. This means that there is an assumption that over time there is a change in the predictive abilities of industry indicators and for the needs of reliable prediction they must be changed in consideration of current developments.

The results of this study make it possible to create a composite indicator for the economic cycle of Germany in the future. However, for an overall view of the country's economy, it is necessary to supplement the analysis with other important sectors in addition to industry.

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References

[1] HERMAN, E.: The Importance of the Manufacturing Sector in the Romanian Economy, *Procedia Technology*, Vol. 22, No. 1, pp. 976-983, 2016. https://doi.org/10.1016/j.protcy.2016.01.121

[2] PACHURA, A.: Innovation and change in networked reality, *Polish Journal of Management Studies*, Vol. 15 No. 2, pp. 173-182, 2017. https://doi.org/10.17512/pjms.2017.15.2.16

[3] ŚWIADEK, A., SZOPIK-DEPCZYŃSKA, K.: Business cycle and innovation activity of industrial enterprises in Poland-Mazowieckie region case, *Journal of International Studies*, Vol. 7, No. 3, pp. 90-99, 2014. https://doi.org/10.14254/2071-8330.2014/7-3/8

[4] HORNSTEIN, A.: The Business Cycle and Industry Comovement, *FRB Richmond Economic Quarterly*, Vol. 86, No. 1, pp. 27-48, 2000.

[5] SALA, M., TORRES, T., FARRÉ, M.: Characterization of cyclical phases in the manufacturing industry in Spain, *Journal of Industrial Engineering and Management*, Vol. 7, No. 4, pp. 961-994, 2014. https://doi.org/10.3926/jiem.1092

[6] BUTERIN, V., ŠKARE, M., BUTERIN, D.: Macroeconomic Model of Institutional Reforms' Influence on Economic Growth of the New EU Members and the Republic of Croatia. *Economic Research-Ekonomska Istraživanja*, Vol. 30, No. 1, pp. 1572-1593, 2017. https://doi.org/10.1080/1331677X.2017.1355260

[7] OECD: OECD Composite Leading Indicators: Reference Turning Points and Component Series – OECD, [Online], Available: https://www.oecd.org/sdd/leading-indicators/oecdcompositeleadingindicatorsreferenceturningpointsandcomponentseries.htm [10 Dec 2023], 2023.

[8] EUROPEAN COMMISSION: *Industry in Europe. Facts & figures on competitiveness & innovation*, Luxembourg, Publications Office of the European Union, 2017. https://doi.org/10.2777/899824

[9] VRANÁ, L.: On extending composite leading indicators by international economic series, *Statistika*, Vol. 98, No. 2, pp. 113-13, 2018.

[10] BANDHOLZ, H.: *New Composite Leading Indicators for Hungary and Poland*, ifo Working Paper, No. 3, ifo Institute - Leibniz Institute for Economic Research at the University of Munich, Munich, 2005.

[11] ZALEWSKI, K.: Forecasting Turning Points with Composite Leading Indicators - the Case of Poland, *Ekonomia Journal*, Vol. 24, pp. 61-9, 2009.

[12] WIRTSCHAFTSWOCHE: *Serie Frühindikatoren (VII). Earlybird-Indikator: Früher Vogel*, [Online], Available: http://www.wiwo.de/politik/konjunktur/seriefruehindikatoren-vii-earlybird-indikator-frueher-vogel/10306798.html [11 Aug 2014], 2014.

[13] ORBEX, *What Is ZEW Economic Sentiment Index & Levels to Watch*, [Online], Available: https://www.orbex.com/blog/2016/10/what-is-zew-economic-sentiment-index [12 Dec 2016], 2016.

[14] Handbuch, H.: Wirtschaftsindikatoren unter der Lupe. [Online], Available: https://www.helaba.de/blueprint/servlet/resource/blob/helaba/53736/8bde1b386ce4db24e31740b7d71bb4b6/report---helaba-handbuch---30-11-2009-data.pdf [9 Dec 2009], 2009.

[15] NASIRI, H., TAGHIZADEH, K., AMIRI, B., SHAGHAGHI SHAHRI, V.: Developing Composite Leading Indicators to Forecast Industrial Business Cycles in Iran, *International Journal of Research in Industrial Engineering*, Vol. 6, No. 1, pp. 69-89, 2017. https://doi.org/10.22105/riej.2017.48026

[16] SCHILCHT, E.: Estimating the Smoothing Parameter in the So-called Hodrick-Prescott filter, *Journal of the Japanese Statistical Society*, Vol. 35, No. 1, pp. 99-119, 2005. https://doi.org/10.14490/jjss.35.99

[17] KRANENDONK, H., BONENKAMP, J., VERBRUGGEN, J.*: A Leading Indicator for the Dutch Economy*, Methodological and Empirical Revision of the CPB System, CESifo Working Paper No. 1200, 2004.

[18] HODRICK, R., PRESCOTT, E.: *Post-War U.S. Business Cycles: An Empirical Investigation*, Discussion Papers 451, pp. 1-16. 1981.
[19] NILSSON, R., BRUNET, O.: *Composite Leading Indicators for Major OECD Non-Member Economies*: Brazil, China, India, Indonesia, Russian Federation, South Africa, Paris: OECD Publishing, 2006.
[20] GOGTAY, N.J., THATTE, U.M.: Principes of Correlation Analysis, *Journal od the Association of Physicians of India*, Vo. 65, pp. 76-82, 2017.
[21] BEHUN, M., GAVUROVA, B., TKACOVA, A., KOTASKOVA, A.: The impact of the manufacturing industry on the economic cycle of European union countries, *Journal of competitiveness*, Vol. 10, No. 1, pp. 23-39, 2018. https://doi.org/10.7441/joc.2018.01.02
[22] OECD: *Handbook on Constructing Composite Indicators: Methodology and User Guide*, Paris: OECD Publishing, 2008.

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