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INDUSTRIAL INDICATORS AND THEIR INFLUENCE ON THE V4 COUNTRIES BUSINESS CYCLES*

Industrial indicators can be a useful alternative in measuring business cycles evolution instead of GDP in the V4 countries. The most popular among these alternative indicators is the index of industrial production used by the OECD. But this indicator does not fit all the countries in the world. For example, its application is not convenient in less industrialized countries. However, this is not the case of the V4 countries analyzed in this paper. The aim of our paper is to define the relationship between business cycles of the V4 countries and the selected indicators of industry. We try to find out whether these indicators can replace GDP and whether they are suitable for monitoring business cycles of the V4 countries.

Keywords: *GDP; industrial production; business cycle; V4 countries.*
JEL classification: E32, L16.

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ПРОМИСЛОВІ ІНДИКАТОРИ РОЗВИТКУ БІЗНЕС-ЦИКЛІВ У КРАЇНАХ ВИШЕГРАДСЬКОЇ ЧЕТВІРКИ

У статті показано, що індикатори розвитку промисловості в країні можуть бути використані як альтернатива показнику ВВП при аналізі бізнес-циклів країни. Найбільш популярним з таких альтернативних показників є індекс промислового виробництва, однак його є сенс використовувати лише для тих країн, промисловість яких вже досягла певного рівня розвитку. На прикладі країн Вишеградської четвірки продемонстровано залежність між циклом економічного розвитку країни та низкою промислових індикаторів. Проаналізовано, які з цих індикаторів і для яких країн можна використовувати замість показника ВВП в процесі моніторингу економічного розвитку.

Ключові слова: *ВВП; промислове виробництво; бізнес-цикл; країни Вишеградської четвірки.*
Рис. 1. Табл. 5. Літ. 18.

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ПРОМЫШЛЕННЫЕ ИНДИКАТОРЫ РАЗВИТИЯ БИЗНЕС-ЦИКЛОВ В СТРАНАХ ВЫШЕГРАДСКОЙ ЧЕТВЁРКИ

В статье показано, что индикаторы развития промышленности в стране могут быть использованы в качестве альтернативы показателю ВВП при анализе бизнес-циклов страны. Наиболее популярным из таких альтернативных показателей является индекс промышленного производства, который, однако, подходит далеко не всем странам, а только тем, в которых промышленность достигла определённого уровня развития. На примере стран Вышеградской четвёрки продемонстрирована зависимость между циклом экономического развития страны и рядом промышленных индикаторов. Проанализировано, какие из ряда таких индикаторов и для каких стран могут быть использованы вместо ВВП в процессе мониторинга экономического развития.

Ключевые слова: *ВВП; промышленное производство; бизнес-цикл; страны Вышеградской четвёрки.*

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Introduction. Economic cycle was at the forefront of economic research interests in the 1920s–1940s. The basic reason was the unstable economy and subsequently the Great Depression in the 1930s. It seemed like in the 1950s–1960s the economic cycle was "dead", however the oil crisis in 1970s revived it and at the same time new economic theories attempted to explain the causes of economic cycles (Kydland and Prescott, 1990). Economic cycles became more interesting mainly under the influence of the world financial crisis in 2007, which showed that developing countries are not necessarily the originators of recession, but it is the developed countries causing worldwide economic fluctuations. The topic of economic cycles opened up also the questions of how to track these cycles correctly and which indicator should be used to monitor the cyclical development of economy in the most precise manner. GDP was considered as the basic indicator of economic cycle for a long period, however now we can use other indicators, such as the index of industrial production or the complex index, composed of more elements from different economic areas (Gavurova et al., 2014).

The objective of this paper is to verify whether it is possible to use some of the industrial indices for monitoring the economic cycles in the V4 countries, as it is the industry that represents a significant part of the economy of these countries. Some industrial aspects of these countries are analyzed (Szabo et al., 2013) within a group of countries in transition. Based on the selected methods we will try to confirm or reject the hypothesis which says that the selected industry indicators behave in the V4 countries as coincident cyclical indicators.

Current possibilities for monitoring the economic cycles in the V4. Monitoring of economic cycles is generally performed by organizations such as the Eurostat, OECD or American Conference Board. In the case of V4, this issue is studied by economists also at the national level through statistical offices of a particular country or through national banks. Monitoring of economic cycles differs in these institutions mainly in the basic indicator representing the economic cycle.

The most often used indicator of monitoring the cyclical development of an economy is the gross domestic product at constant prices, generally considered to be the widest indicator of economic activity (Czesany and Jezabkova, 2009a). However, in the analyses it is not used in the condition of original data, but its time series are adjusted and only its cyclical component is selected (Czesany and Jezabkova, 2009b). Monitoring of cyclical development of the V4 economies through their GDP is performed by the Eurostat. This organization claims that GDP is a high quality indicator, which describes the cyclical behavior of an economy in the best manner and it allows setting the turning points, which indicate economic growth or downturn. However, the disadvantage of GDP is its time availability (Ozyildirim, Schaitkin and Zarnowitz, 2008). Currently it is presented in the form of quarterly data and is available with a delay of one or two quarters, which is a problem mainly in case of cyclical behavior prediction for a selected economy. Also, the Czech statistical office (CSO) agrees with the importance of tracking the cyclical behavior of economy through GDP, but it introduces it in a different form. CSO first creates individual indicators for each GDP components and then groups them into the composite indicator of GDP (Czesany, Machackova and Sedlacek, 2007).

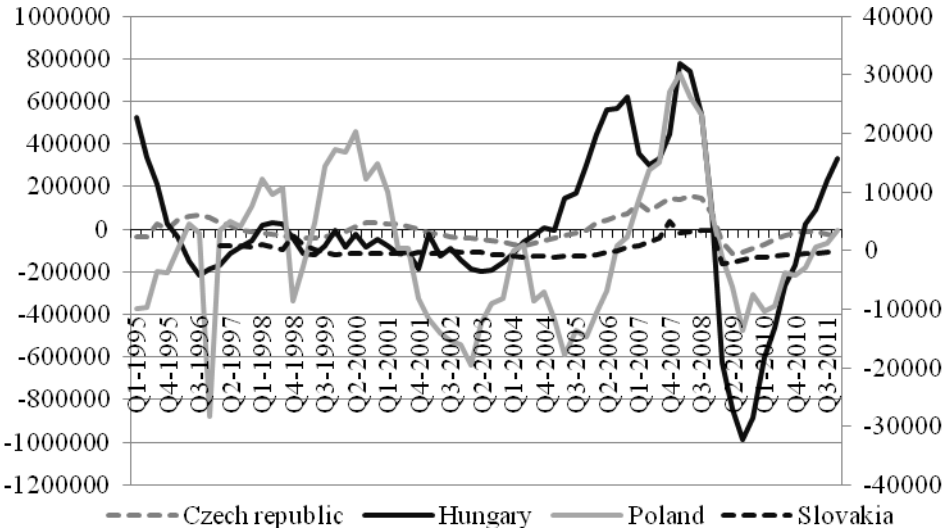

Figure 1. **Cyclical component of GDP for the V4 countries**

Another option of tracking economic cycles is to use industrial indicators, as industry represents a significant part of economy in most countries and therefore represents a significant part of GDP. The most often applied out of these indicators is the industrial production index. Its advantage compared to GDP is that it is available in the form of monthly data, which allows more detailed analyses and more precise prediction, as the signals on cycle changes can be observed on the monthly basis (OECD, 2008). This advantage of the industrial production index was used by the OECD for monitoring the cyclical behavior of economy for a long time. This institution considered the index of industrial production as the basic cyclical indicator until March 2012, mainly due to its faster and more frequent time availability as compared to GDP (OECD, 2012a). The OECD, in general, does not deny the significance of GDP and states that in the ideal case GDP at constant prices should be used for tracking economic cycles of countries (Tuveri, 1997). The OECD studied different methods that could be used to generate monthly estimates of GDP based on the official quarterly estimates of GDP in 2011. This study showed that it is possible to work out monthly GDP data at high quality results. Starting from March 2012 the OECD stopped using the industrial production index as the main indicator of an economic cycle and replaced it with GDP (OECD, 2012b). Certain disadvantages of using the industrial production index for V4 have been also detected by Czech authors who claim that the index of industrial production is inappropriate mainly due to the fact that it does not sufficiently follows the trend of Czech, as well as of Slovak economies (Czesany, Machackova and Sedlacek, 2007). Another reason is that the industrial production index may in some countries act as a leading indicator, so it does not evolve concurrently but with a lead compared to GDP development, which makes it unusable as a coincident indicator. Another issue can also be seen in the size of cross correlation, which in case of low values indicates weak relation between the index of industrial production and GDP and that makes it again unusable as a coincident cyclic indicator. Among other problems related to the industrial production index

belongs the fact that it indicates more turning points than GDP and therefore it might be a source of false signals (Kl'ucik, 2009).

The third option in tracking economic cycles is using the composite coincident indicators as it is done by the American Conference Board. This indicator is composed of cyclical coincident indicators which copy the development of economic cycle and are able to confirm or reject the position of an economy (Conference Board, 2001). In the case of Slovakia, the Infostat is inclined towards this option and besides the complex indicator applies also the index of industrial production (Kl'ucik and Haluska, 2008; Tkacova and Banociova, 2013).

The methodology used. While examining the relation of the selected industrial indicators and economic cycles of the V4 countries, currently represented by GDP, it is necessary to realize that the time series which we are going to use, must be adjusted in the form of cyclical components of the given indicators. That means that time series need to be adjusted by the seasonal component, trend and coincidence component. After the selection of appropriate industrial indicators, we need to smooth time series through seasonal indices (by this we will remove the seasonal component) and to apply the Hodrick-Presscot filter (HP), to remove a coincidence component and trend within one operation (Schilcht, 2005). After that we will stay with the cyclic component which we will use for the analysis of relation towards GDP (in case of GDP we work with cyclical components as well). We will use Pearson's correlation coefficient for the verification of relation between GDP and the selected indicators, which states the weight of linear relationship between variables (Lubos, 2007). If needed, some indicators might be logarithmized, to provide the correct calculation of a given correlation coefficient. As we want to verify if a given indicator shows sufficient concurrence with GDP development and does not behave as e.g. leading or lagging indicator, we will apply cross correlations for 5 periods forward and backwards. The conditions for including industrial indicators in the groups of leading, coincident or lagging indicators are the following:

1. Coincident indicators (the highest absolute value of correlation coefficient is in the time t and the second highest absolute value of correlation coefficient must be at least 0.55).

2. Lagging indicators (the highest absolute value of correlation coefficient is on the right side from t and the second highest absolute value of correlation coefficient must be at least 0.55).

3. Leading indicators (the highest absolute value of the correlation is on the left side from t and the second highest absolute value of correlation coefficient must be at least 0.55).

We have chosen the secondary data for our analysis, obtained from the OECD and Eurostat databases, in order to get the longest possible time series. In most cases it was times series from 1991 until 2012 with quarterly periodicity. We could not use monthly data because we verified the relationship with GDP, which is currently available only on the quarterly basis. Out of the industrial indicators, we have chosen those used in monitoring of economic cycles most often, such as manufacturing production (2005 = 100), industrial production (2005 = 100), the index of industrial production (2005 = 100), the industrial confidence indicator (crude steel production, thousands tons), industrial turnovers (intermediate products and capital goods (total market,

domestic market, non-domestic market, 2005 = 100)). The relation of these industrial indicators towards the economic cycle of the V4 countries is also studied by the Eurostat and the OECD.

The impact of the selected industrial indicators on the economic cycles of the V4 countries. After the application of the selected methods, we got results of cross correlations for each of the V4 countries. Based on the results presented in Tables 1–4, we are able to assess, which indicators behave in line with the development of GDP and which act with a delay or in advance as compared to the economic cycle of V4.

In case of the Czech economic cycle, we have smoothed the time series of the selected economic indicators and analyzed their cyclical components in relation to the cyclical component of GDP through cross correlations. The results of these correlations, with the range of 5 quarters forward and backwards are shown in Table 1. It shows that the maximum values of cross correlations for each tracked industrial indicator were achieved in time $t - 1$ and their absolute values were above 0.55. That means that in the case of Czech economic cycle, the industrial indicators are in lead as compared to the development of the cyclical component of GDP by one quarter and therefore have the ability to predict future development of the economic cycle. However, they cannot be used as the coincident indicators which would replace the monitoring of the economic cycle in Czech Republic through GDP. Out of the tracked industrial indicators, the highest value of the cross correlation showed the industrial turnover (domestic market) and the lowest value of correlation coefficient was shown by the indicator of crude steel production. The index of industrial production, which is used worldwide as an alternative to GDP, in the case of Czech Republic reported the value of the cross correlation at 0.745 and did not behave as the coincident indicator, due to which we have excluded it as an alternative to GDP for monitoring of Czech economic cycle. With the above said we have confirmed the opinions of Czech economists, such as (Czesany, Machackova, Sedlacek, 2007), who state that the index of industrial production is not a proper tool for monitoring Czech economic cycle, as the industry does not sufficiently copy the development of Czech economy.

We have also assessed the relation between the cyclical components of GDP and selected the industrial indicators for Hungary. The results of cross correlations are shown in Table 2. The results of the cross correlations values as well as the placement of their maximum are different in the case of Hungary. We have found out that 6 out of 8 tracked indicators report the maximum values of cross correlations above the level of 0.8, showing a strong relationship of these indicators with the development of GDP and also these indicators show a character of coincident cyclical indicators. That means that most of Hungarian industrial indicators evolve in line with the economic cycle, which is represented by GDP. The index of industrial production belongs to these indicators. Based on the high value of the correlation coefficient at the time of concurrence (0.841), we can recommend this indicator as an alternative to GDP, when it comes to monitoring Hungarian economic cycle. The industrial confidence indicator in Hungary behaved as the leading indicator with the lead of 2 quarters and the production of crude steel led the development of GDP by 1 quarter. The OECD considers crude steel production to be a significant indicator for Hungary, so they included it to the basic components required of the leading composite indi-

Table 1. **Results of cross correlations between the cyclical component of GDP at constant prices in 2005 and the cyclical components of the selected industrial indicators for Czech Republic,** *authors' calculations*

Indicator	t-5	t-4	t-3	t-2	t-1	t	t+1	t+2	t+3	t+4	t+5
Manufacturing production	0,163	0,318	0,499	0,656	*0,744*	*0,693*	0,536	0,342	0,152	-0,016	-0,164
Industrial production	0,110	0,278	0,468	0,642	*0,746*	*0,710*	0,561	0,374	0,172	-0,007	-0,159
Index of industrial production	0,112	0,279	0,468	0,641	*0,745*	*0,706*	0,558	0,371	0,165	-0,013	-0,159
Industrial confidence indicator	0,184	0,338	0,474	*0,582*	*0,596*	0,467	0,247	0,016	-0,173	-0,333	-0,432
Industrial turnover (total market)	0,268	0,443	0,618	0,753	*0,825*	*0,762*	0,590	0,362	0,118	-0,118	-0,317
Industrial turnover (domestic market)	0,206	0,384	0,604	0,776	*0,887*	*0,882*	0,730	0,517	0,283	0,062	-0,138
Industrial turnover (non-domestic market)	0,288	0,443	0,566	*0,659*	*0,689*	0,590	0,426	0,218	-0,006	-0,224	-0,397
Crude steel production	0,092	0,243	0,406	*0,551*	*0,577*	0,465	0,260	0,038	-0,100	-0,180	-0,235

Table 2. **Results of cross correlations between the cyclical component of GDP at constant prices in 2005 and the cyclical components of the selected industrial indicators for Hungary,** *authors' calculations*

Indicator	t – 5	t – 4	t – 3	t – 2	t – 1	t	t + 1	t + 2	t + 3	t + 4	t + 5
Industrial production	-0.134	0.106	0.396	0.655	*0.810*	*0.837*	0.695	0.475	0.245	0.077	-0.023
Manufacturing production	-0.107	0.136	0.424	0.675	*0.818*	*0.831*	0.677	0.452	0.227	0.062	-0.029
Index of industrial production	-0.134	0.105	0.394	0.652	*0.810*	*0.841*	0.702	0.482	0.258	0.088	-0.011
Industrial turnover (total market)	-0.108	0.133	0.412	0.671	*0.830*	*0.863*	0.727	0.504	0.273	0.093	-0.015
Industrial turnover (domestic market)	-0.085	0.061	0.297	0.553	*0.742*	*0.829*	0.730	0.551	0.329	0.142	0.029
Industrial turnover (non-domestic market)	-0.124	0.132	0.415	0.667	*0.815*	*0.835*	0.698	0.475	0.253	0.083	-0.016
Industrial confidence indicator	0.242	0.401	0.545	*0.631*	*0.612*	0.472	0.235	-0.037	-0.260	-0.377	-0.382
Crude steel production	-0.116	0.088	0.312	0.525	*0.686*	*0.661*	0.500	0.268	0.078	-0.023	-0.022

cator (CLI), used in the world as one of the basic indicators for economic cycles prediction (OECD, 2013).

Out of the V4 countries, Poland has the biggest economy. Compared to other thee countries, it is the less open economy, which could be one of the reasons why it was able to keep the same, even though low level of economic growth at the time of the world financial crisis, while the other countries reported the decline in GDP. Polish economy is also oriented on industry, approximately to the same extent as the other V4 countries. Therefore, we have again tracked if the industrial indicators report the concurrence with GDP as it was in Hungary or if they advance GDP, as it happened in Czech Republic. The results of cross correlations for Poland are shown in Table 3. It shows that most of the indicators reported a lead compared to GDP development and therefore fulfilled the conditions for being included between the leading cyclical indicators. That means we can use them for prediction of the economic cycle, however, not as an alternative to GDP. The industrial confidence indicator reported even bigger lead, of two quarters, compared to the other indicators. In case of Poland, it is the first time when one of the indicators does not behave as a cyclic one. Namely, it is the production of crude steel, where the value of the cross correlation has not even reached the set limit of 0.55 and therefore this indicator does not show any relationship towards Polish economic cycle.

The last monitored economy is Slovakia. The results of cross correlations between the cyclical components of GDP and the selected industrial indicators are shown in Table 4.

As the share of industry represented in the period from 1995 until 2010 on average around 38% of GDP, we have assumed that industrial indicators will report a strong relation with the development of Slovak economic cycle. However, Table 4 shows that in case of Slovakia the values of cross correlations were a little lower compared to the other V4 countries. Except for two indicators, all other selected industrial indicators behaved as leading indicators with a lead of one quarter. The index of industrial production also belongs to that group and therefore it is not suitable for monitoring the cyclical development in Slovakia. It is more appropriate to use it for cycle prediction. Industrial confidence indicator and crude steel production have not fulfilled the conditions for inclusion into the cyclical indicators.

Comparison of industrial indicators' impact on the economic cycles in the V4 countries. Tables 1–4 show that industrial indicators do not evolve similarly in each of the V4 countries. Differences are in the indicator's character in relation to GDP (coincident or leading indicator), in the size of lead/concurrence, as well as in the maximal achieved value of the cross correlation. Table 5 compares the cross correlations based on the industrial indicators of the V4 countries.

Industrial indicators in the V4 countries act in general as leading indicators and report a lead, most often of 1 quarter. High value of cross correlation allows using most of the tracked indicators for the prediction of economic cycle development. In case of Czech Republic, Poland and Slovakia, these characteristics can be seen in the indicators such as industrial production, manufacturing production, the index of industrial production and indicators related to industrial turnover. In case of Hungary, these indicators appeared to be linear and the index of industrial production even complied with the conditions to be used as an alternative to GDP when monitoring

Table 3. **Results of cross correlations between the cyclical component of GDP at constant prices in 2005 and the cyclical components of the selected industrial indicators for Poland,** *authors' calculations*

Indicator	t-5	t-4	t-3	t-2	t-1	t	t+1	t+2	t+3	t+4	t+5
Industrial production	0.252	0.389	0.534	0.685	*0.745*	*0.690*	0.475	0.206	-0.055	-0.291	-0.438
Manufacturing production	0.290	0.429	0.575	*0.712*	*0.764*	0.704	0.486	0.215	-0.047	-0.281	-0.437
Index of industrial production	0.249	0.388	0.533	0.690	*0.748*	*0.694*	0.479	0.210	-0.050	-0.289	-0.434
Industrial turnover (total market)	0.190	0.355	0.531	0.677	*0.725*	*0.681*	0.513	0.228	-0.060	-0.338	-0.549
Industrial turnover (domestic market)	0.085	0.280	0.483	0.661	*0.751*	*0.748*	0.597	0.314	0.047	-0.239	-0.458
Industrial turnover (non-domestic market)	0.288	0.409	0.545	*0.651*	*0.656*	0.572	0.393	0.120	-0.168	-0.416	-0.609
Industrial confidence indicator	0.516	0.613	0.673	*0.721*	*0.709*	0.649	0.520	0.305	0.054	-0.213	-0.436
Crude steel production	0.062	0.174	0.315	0.399	*0.511*	*0.474*	0.303	0.078	-0.193	-0.369	-0.472

Table 4. **Results of cross correlations between the cyclical component of GDP at constant prices in 2005 and the cyclical components of the selected industrial indicators for Slovakia,** *authors' calculations*

Indicator	t-5	t-4	t-3	t-2	t-1	t	t+1	t+2	t+3	t+4	t+5
Index of industrial production	0.000	0.156	0.403	0.569	*0.669*	*0.578*	0.403	0.144	-0.087	-0.301	-0.425
Industrial production	0.009	0.162	0.405	*0.568*	*0.677*	0.565	0.396	0.138	-0.090	-0.331	-0.441
Manufacturing production	0.024	0.179	0.393	0.573	*0.674*	*0.608*	0.413	0.190	-0.027	-0.234	-0.385
Industrial confidence indicator	0.362	0.412	*0.452*	*0.453*	0.413	0.169	-0.161	-0.422	-0.463	-0.553	-0.578
Industrial turnover (total market)	0.175	0.318	0.491	0.616	*0.699*	*0.627*	0.404	0.134	-0.104	-0.321	-0.517
Industrial turnover (domestic market)	0.075	0.186	0.350	0.529	*0.691*	*0.677*	0.492	0.270	0.044	-0.200	-0.404
Industrial turnover (non-domestic market)	0.223	0.375	0.542	*0.627*	*0.659*	0.558	0.328	0.046	-0.183	-0.373	-0.553
Crude steel production	0.219	0.266	0.326	*0.476*	*0.500*	0.236	-0.086	-0.161	-0.280	-0.491	-0.511

Hungarian economic cycle. Industrial confidence indicator did not evolve that clearly as it did in other V4 countries. While in Hungary and Poland this indicator reported a lead of 2 quarters, in case of Czech Republic it was 1 quarter. In Slovakia it did not report any signs of cyclical nature. Crude steel production, used as an indicator, did not behave the same in relation to economic cycle in all V4 countries. In Poland and Slovakia it behaved as a non-cyclical indicator and in case of Czech Republic and Hungary it showed a character of the leading indicator, even though with the lower value of cross correlation than in the case of other industrial indicators.

Table 5. **Maximal values of cross correlations and time of their achievement for the selected industrial indicators in relation to GDP (cyclical components) in the V4 countries,** *authors' calculations*

Indicator	Czech Republic		Hungary		Poland		Slovakia	
	MC	time	MC	time	MC	time	MC	time
Industrial production	0.746	t-1	0.837	t	0.745	t-1	0.677	t-1
Manufacturing production	0.744	t-1	0.831	t	0.764	t-1	0.674	t-1
Index of industrial production	0.745	t-1	0.841	t	0.748	t-1	0.669	t-1
Industrial turnover (total market)	0.825	t-1	0.863	t	0.725	t-1	0.699	t-1
Industrial turnover (domestic market)	0.887	t-1	0.829	t	0.751	t-1	0.691	t-1
Industrial turnover (non-domestic market)	0.689	t-1	0.835	t	0.656	t-1	0.659	t-1
Industrial confidence indicator	0.596	t-1	0.631	t-2	0.721	t-2	0.453	t-1
Crude steel production	0.577	t-1	0.686	t-1	0.511	t-1	0.500	t-1

MC – maximal value of cross correlation.

In general, a given hypothesis that the selected industrial indicators behave as a coincident cyclical indicator in the V4 countries can be therefore rejected.

Conclusion. Based on the analysis of relation between the selected industrial indicators and GDP in the V4 countries, we can summarize that these indicators are not suitable as an alternative to GDP in monitoring economic cycles in the V4 countries. In Poland, Czech Republic and Slovakia, these indicators behave with a lead compared to GDP and not as coincident cyclical indicators. However, based on the high values of the cross correlations and the size of their lead, they can be used for short-term prediction of economic cycles in these countries. In case of Hungary most of these indicators behaved in coincident and therefore the industry in this country really develops in line with GDP, without any time lead or delay. Only in this country it is possible to replace GDP by one of the industrial indicators. Based on our results, the results by the OECD and theoretical recommendations, the index of industrial production would be used as such indicator. That would allow monitoring the economic cycle in Hungary even on the monthly basis.

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