CZECH BUSINESS CYCLE CHRONOLOGY

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Abstract

Composite indicators as one of the tools of business cycle analysis are well discussed topic nowadays. They consist of several individual economic indexes and enable to monitor the state of economic activity (whether it is in the phase of expansion or recession) better than any of the individual time series itself.

There have been several attempts of constructing the composite indicators in the Czech Republic. These analyses were based mostly on the comparison of cross correlations between reference time series and individual economic indexes as they are easy to compute. However, cross correlations should be used only in combination with other criteria such as the average lead/lag time between the turning points.

This paper examines possibilities of non-parametric algorithm of the turning points analysis on dating the Czech business cycle indicators. The results are compared with the simplified method that uses cross correlations only.

Key words: dating business cycle, turning points, composite indicators

JEL Code: C32, E32

Introduction

In the context of recent economic recession public attention was focused on the business cycle analysis and possibility of forecasting the cycle movements. One of the methods used for the cycle analysis is based on the study of composite indicators which combine several individual economic indicators and which should enable to monitor the state of business cycle better than just by analyzing the individual time series.

The construction of composite indicators usually follows methodology created by the Organization for Economic Co-operation and Development (OECD) or by the Conference Board. Most of the analyses of the Czech business cycle use OECD methodology which will be employed in this paper as well. For more information about the Conference Board methodology see Ozyildirim et al. (2010).

OECD methodology (Gyomai and Guidetti, 2012) consists of five steps: 1. *pre-selection phase*, which is passed only by long time series of indicators that have justified economic relationship with the reference series, broad coverage of economic activity and high frequency of observations, 2. *filtering phase*, when the time series are seasonally adjusted and de-trended, 3. *evaluation phase*, when only the best individual indicators with the strongest relationship with the reference series are selected to be included in the composite indicator, 4. *aggregation phase*, when the composite indicators are created and 5. *presentation of the results*.

The authors of the Czech composite indicators usually simplify the evaluation phase of computational algorithm. OECD uses several methods how to evaluate the relationships between the time series: the average lead or lag times between the turning points, cross correlations and number of extra and missing cycles. Usually only cross correlations are used in the Czech business cycle analyses as they are easy to compute; see Czesaný and Jeřábková (2009) or Tkáčová (2012). However, it is recommended to use the cross correlations only in the combination with other criteria (Gyomai and Guidetti, 2012).

This paper follows up the topic of last year's paper focused on the filtering phase of OECD methodology (Vraná, 2013). It describes Bry-Boschan algorithm that enables the tracking and the analysis of the cycle turning points and applies this method to the economic indicators that were selected to be included in the composite leading indicator. We justify or disprove the inclusion of these indicators based on the turning point analysis and propose new structure of composite leading indicator. The performance of the new composite indicator is compared with the old one.

1 Methods of evaluation

1.1 Cross correlations analysis

Cross correlations analysis is one of the methods that can be used to determine the relationship between the reference series (usually GDP or index of industrial production) and the individual economic indicator in the evaluation phase of the OECD methodology.

Cross correlations measure linear dependency between the reference series and individual indicator with applied time-lag. Then the maximum of absolute value of cross correlation is found and the individual indicator can be included into one of the composite indicators (leading, coincident or lagging[1]) according to the time-lag where the maximal value appeared.

The advantage of cross correlation is that they are easy to compute and that their results can be quickly evaluated. However, cross correlations measure only general fit between individual indicators and the reference time series. The goal of the composite indicators is nevertheless to predict the turning points of the reference time series (when will the economy switch from the expansion phase into the contraction phase or vice versa) not to forecast the level of economy. This can cause problems, because the indicators can show strong linear dependency on the reference time series and still miss some of the cycles, contain extra cycles or the lead (lag) times of their turning points can significantly fluctuate.

1.2 Bry-Boschan algorithm

Other evaluation methods are based on the analysis of turning points of cycle components of reference time series and individual economic indicators. Not every peak or trough of the indicator is considered as the turning point. In 1946 Arthur Burns and Wesley Mitchell analyzed business cycles and laid the foundations of business cycle dating. The dating was executed manually and it required lots of personal judgment and therefore it wasn't quite objective.

Gerhard Bry and Charlotte Boschan introduced their algorithm for turning points detection in 1971. It was one of the first programmed approaches that were published and with the fast development of information technologies was than widely implemented. OECD and other organizations still use this algorithm with only slight changes. In the first proposal, Bry and Boschan used 12-month moving average, Spencer curve and short-term moving average of 3 to 6 month to detect the turning points. Nowadays none of these are necessary because some other techniques (like Hodrick-Prescott filter) are used to smooth the time series without shifting the turning points.

Bry-Boschan algorithm (Bry and Boschan, 1971) consists of 6 steps:

1. Identification of points higher (or lower) than 5 months on either side.
2. Enforcement of alternation of turns by selecting highest of multiple peaks (or lowest of multiple troughs).

[1] The leading composite indicator should be able to predict future states of economic activity. The coincident indicator serves mainly to confirm the hypothesis about the state the economy is currently in. It also may replace GDP or industrial production index as the reference series for the evaluation of the individual indicators (this approach is used in USA by the Conference Board). The lagging indicator should certify the cycle behavior and the dating of the turning points.

3. Elimination of turns within 5 months of beginning and end of series.
4. Elimination of peaks (or troughs) at both ends of series which are lower (or higher) than values closer to end.
5. Enforcement of minimum cycle duration of 15 months by eliminating lower peaks and higher troughs of shorter cycles.
6. Elimination of phases whose duration is less than 5 months.

The algorithm also suggests the best practices for dealing with anomalous situations (e.g. double turns). Implementation of Bry-Boschan algorithm gave similar results as the manual analysis of the cycle and enabled to process the large datasets very quickly.

2 Application of Bry-Boschan algorithm

2.1 Data

Bry-Boschan algorithm will be illustrated with the cycle analysis of selected economic indicators. We analyze dataset of 83 individual economic indicators which are available from January 2002 to August 2012.

Usually GDP or index of industrial production (IIP) is used as reference series. GDP should respond to the cyclical movements better but it is quarterly statistic and it is necessary to convert it to the monthly estimates. OECD had used the IIP until March 2012 and then switched to the adjusted monthly GDP. We will use the IIP because it shows strong co-movements with GDP series and it is available monthly so we won't need to arbitrary change the reference series.

Cross correlations were used as a pre-selection method: only individual indexes with maximal absolute value of cross correlations higher than 0.6, which occurred when the individual index was shifted forward in time, would be dated by Bry-Boschan algorithm. Only 10 out of 83 individual indexes passed the criteria (tab. 1); for more details see Vraná (2013). As Czech economy is small and open, several of the selected indexes are indicators of German economic activity.

2.2 Cycle Chronology

We demonstrate the Bry-Boschan algorithm in detail on three selected time series: index of industrial production (reference series), German business expectations indicator and industrial producer price index – installation of industrial machinery and equipment (fig. 1).

Over the period from January 2002 to August 2012 the Bry-Boschan algorithm found three cycles measured from peak to peak in IIP time series. The average length of the cycle phase is 17.3 months. When working with growth cycles, the phase of expansion is usually longer than the phase of the contraction. This is obvious also in our data: the average duration of the expansion phase is 22.7 months and the average duration of the contraction phase is 12.0 months.

Tab. 1: Cross correlations and average lead (-) or lag (+) time of 10 selected individual indicators.

Economic indicator	Cross correlations		Average lead/lag time of turning points
	Max. value	Lead time	
New orders in industry	0,70	-1	1,83
New orders in industry - Manufacture of electrical equipment	0,73	-1	0,00
Industrial producer price index - Electrical equipment	0,79	-2	-2,50
Industrial producer price index - Installation of industrial machinery and equipment	-0,77	-5	-4,00
Composite confidence indicator	0,88	-1	-0,43
Business confidence indicator	0,90	-1	0,00
IFO (DE) - R 1 : Business climate	0,86	-3	-4,00
IFO (DE) - R 2 : Business situation	0,89	-1	-2,50
IFO (DE) - R 3 : Business expectations	0,71	-5	-4,67
Stock market index PX	0,83	-3	4,50

Source: Own calculations

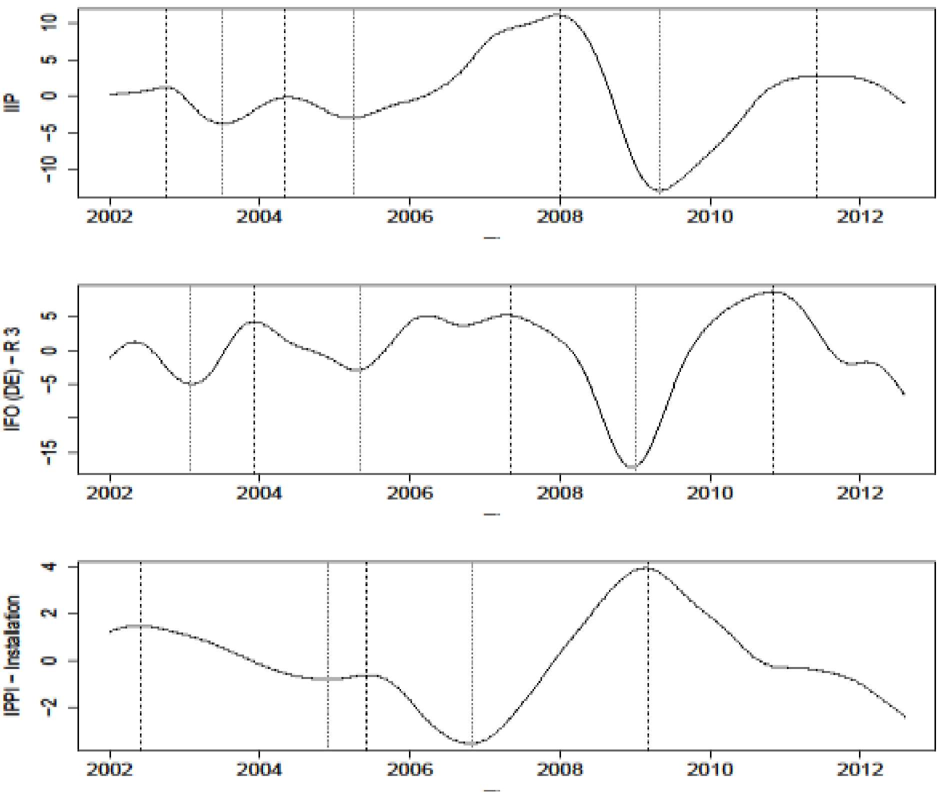
The series of German business expectations includes double turn: peaks in April 2006 and in May 2007. However, the minimum cycle duration is 15 months, so the lower of these two peaks (April 2006) had to be eliminated. The trough in October 2006 couldn't be accepted either, because the turns have to alternate. IFO Business expectation is indicator with highest average lead time when compared to the reference series (lead of 4.67 months).

The industrial producer price index – installation of industrial machinery and equipment shows strong countercyclical behavior. It tends to increase when the economy is slowing down and vice versa. This is indicated by the negative value of cross correlation as well. Countercyclical indexes can be also included in the composite indicators, but they have to be inverted first. However, this price index skips some of the cycles of IIP.

The other individual indicators don't miss any cycles indicated by IIP, but index of new orders in industry - manufacture of electrical equipment contains one extra cycle.

The turning point with the lowest spread among all the 10 individual indicators was the trough in May 2009 (measured in IIP) – this means that the switch between the cycle phases took place almost together in all the series. The turning point with the highest spread was the peak in May 2004 (in IIP).

Fig. 1: Cycle components of index of industrial production, German business expectations indicator and industrial producer price index – installation of industrial machinery and equipment with emphasized peaks and troughs, which were detected by Bry-Boschan algorithm.



Source: Own calculations

The average lead/lag times of all analyzed indicators (tab. 1) prove, that the cross correlations alone cannot determine, which time series should be included in leading, coincident or lagging composite indicators. Cross correlations measure only general fit between individual indicators and the reference time series not the relationship between the turning points, which is essential for the right selection.

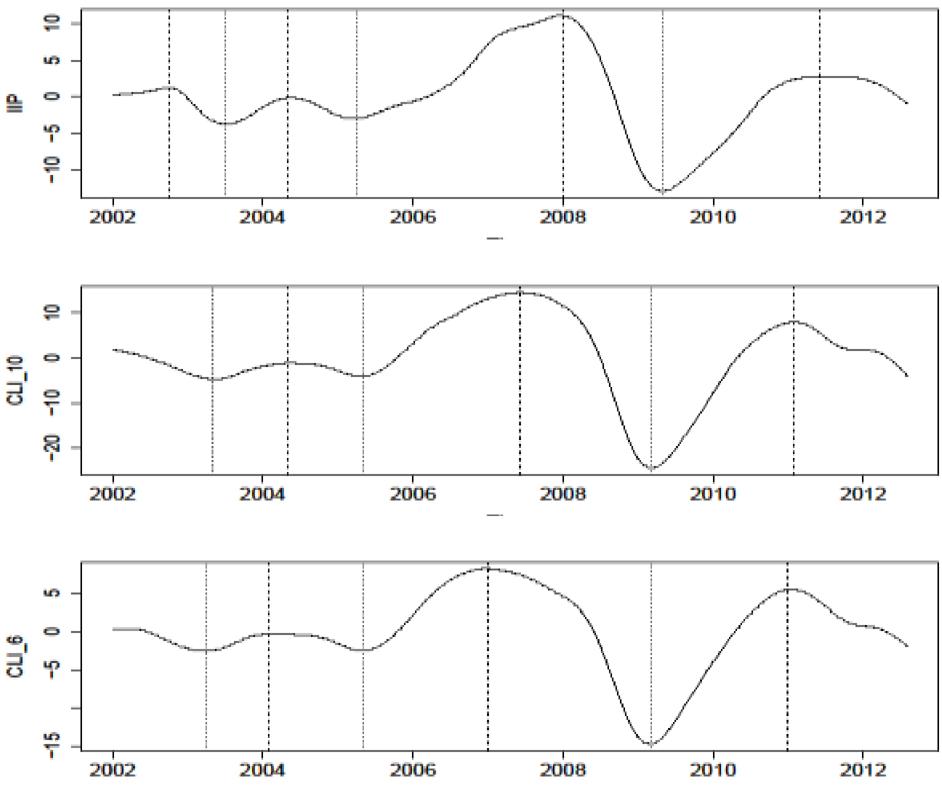
Only 6 out of 10 indicators (that were indicated as leading ones by cross correlations) show the lead in turning points: both industrial producer price indexes, composite confidence indicator and the three IFO indicators. The other indicators behave more like coincident or lagging ones, when their turning points are considered.

3 Composite leading indicator

We proved that not all the individual economic indicators with strong correlation with reference time series show also the corresponding shifts in turning points. We can also compare the performance of composite leading indicator (CLI) that was constructed based on cross correlations only with CLI that uses also turning points analysis. We can assume that the latter one will predict the turning points of the whole economy (measured here by IIP) better than the first one, although it was the primary goal of both of them.

The first composite indicator (CLI_10) includes all 10 economic indicators, which achieved maximal absolute value of cross correlations higher than 0.6 when shifted forward in time. The second one (CLI_6) contains only subselection of the discussed indicators – only those with positive average lead time of the turning points.

Fig. 2: Cycle component of index of industrial production and composite leading indicators with emphasized peaks and troughs, which were detected by Bry-Boschan algorithm.



Source: Own calculations

Both constructed composite indicators shows significant lead when compared with IIP cycle. The average lead time (tab. 2) is equal to 2.3 and 4.0 months for CLI_10 and CLI_6, respectively.

The indicators don't miss any of the cycles (except the first peak, which is too close to the beginning of the time series). They manage to indicate all the cycle turning points in advance, except the trough in April 2005 – the troughs of both CLIs were lagged by one month. The lead/lag times of the turning points are rather unstable: from -7 to +1 month for CLI_10 and even more erratic for CLI_6 (from -12 to +1 month). Both indicators were able to predict the peak in January 2008 and the following slowdown of the economy, which can be linked to the global financial crisis.

Tab. 2: Dates of the turning points of index of industrial production cycle and composite leading indicators and leads (-), coincidences (0) and lags (+) in months relative to IIP cycle turns.

Peak/Trough	Turning point dates			Leads, coincidences and lags	
	IIP	CLI_10	CLI_6	CLI_10	CLI_6
P	Oct-02	-	-	-	-
T	Jul-03	May-03	Apr-03	-2	-3
P	May-04	May-04	Feb-04	0	-3
T	Apr-05	May-05	May-05	+1	+1
P	Jan-08	Jun-07	Jan-07	-7	-12
T	May-09	Mar-09	Mar-09	-2	-2
P	Jun-11	Feb-11	Jan-11	-4	-5

Source: Own calculations

We can also use cross correlations to assess the linear relationship between the IIP cycle and the composite indicators. The maximal cross correlation (0.97) of CLI_10 appears when the indicator is shifted 3 month forward in time. The maximal cross correlation of CLI_6 is lower (0.95), but it occurs with 4-month lead time. This means that there is high general fit between the values of IIP cycle and constructed composite indicators. However, the ability to predict the turning points between expansion and contraction phases of economy remains the key asset of leading composite indicators.

Conclusion

This paper focused on the evaluation phase of the OECD methodology of composite indicators construction. In this phase cycle components of all evaluated individual indicators are compared to the reference series. Their relationship can be described by several methods: the average lead (lag) time between the turning points, cross correlations and number of extra and missing cycles. The selected individual indicators are then divided into groups of leading, coincident and lagging ones and the composite indicators are created.

In the Czech Republic it has become common practice to use only cross correlations to test the relationship between individual indicators and the reference series. This paper compared results of the cross correlation analysis with the Bry-Boschan algorithm for tracking turning points of the cycle component. It has proved that cross correlations gave different results than the turning points analysis and also provided less information about the relationship between the reference series and individual indicators.

Two versions of the leading composite indicators were constructed – the first one was based only on the information from cross correlations analysis and the second one used the analysis of the turning points as well. Although the second composite indicator included fewer individual indicators, its prediction capabilities were much better.

The analysis of cross correlations is handy method that can be utilized to reduce the number of the individual indicators, which will have their turning points tracked and analyzed.

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