ALTERNATIVE TO THE CONSTRUCTION OF CZECH COMPOSITE INDICATORS

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Abstract

The study of composite indicators is one of the methods used for the business cycle analysis which, in the context of recent economic recession, draws wide attention.

The composite indicators combine several individual economic indexes and can be divided into the leading, coincident and lagging ones with regard to the reference time series (usually GDP or industrial production index).

The attempts of constructing the composite indicators for Czech economy have been based mostly on the OECD methodology with only slight alterations so far. This traditional approach uses algorithms like Hodrick-Prescott filter for the decomposition of the time series. However there are other very often neglected ways how to compute the cyclical component, e.g., analysis of month-to-month or year-to-year growth rates of the individual economic indexes.

We compare traditional methodology and usage of month-to-month (and year-to-year) growth rates and discuss how these approaches affect the structure and performance of leading composite indicator constructed for the Czech Republic.

Key words: business cycle analysis, composite indicators, month-to-month growth rates, year-to-year growth rates

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Introduction

The business cycle analysis is well discussed topic nowadays. One of the methods used for the analysis is a construction of composite indicators which combine several selected individual economic indexes. The composite indicators should enable to monitor the state of business cycle better than just by analyzing the individual time series. The construction of composite indicators in the Czech Republic usually follows OECD methodology with only slight alterations; see Czesaný and Jeřábková (2009) or Tkáčová (2012).

This paper summarizes the computational algorithm used for the construction of composite indexes and provides some alternatives to the phase of the seasonal decomposition of the time series. Usually methods like Hodrick-Prescott filter are used for the decomposition. We provide comparison of this traditional approach to the usage of month-to-month and year-to-year growth rates. We discuss the differences in the timing of the cycles and in the selection of the individual indexes for the composite indicators. We illustrate these algorithms with the construction of leading composite indicators for Czech Republic and compare their performance.

1 Business and growth cycles

The traditional business cycle consists of sequences of expansions and contractions in economic activity. The recessions (or the larger downturns – depressions) mean the decline in absolute level of economic output. Most European economies experience rather slowdowns (declines in growth rates) than the real declines in the level. These slowdowns and speedups are referred to as growth cycles. Nowadays usually the growth cycles are analyzed and the slowdowns are often treated like recessions. However, as Zarnowitz and Ozyildirim (2006) point out, all recessions involve slowdowns but not all slowdowns involve recessions and therefore the growth cycles are more numerous than the business cycles. Also the dating of the turning points can be affected as will be shown.

2 Methodology of composite indicators construction

Most of the attempts at constructing the composite indicators for Czech Republic have followed the OECD methodology. The methodology consists of the pre-selection, filtering, evaluation and aggregation steps (Gyomai, 2012) which will be described in this section in a rather simplified manner (Czesaný, 2009).

2.1 Pre-selection

When constructing the composite indicators the eligible individual series has to be selected first. This selection is highly dependent on the reference time series. Usually GDP or index of industrial production is used as reference series. The GDP should respond to the cyclical movements better but it is quarterly statistics and it is necessary to convert it to the monthly estimates. OECD had used the industrial production index until March 2012 and then switched to the adjusted monthly GDP. We will use the index of industrial production 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.

2.2 Filtering

The second phase of the composite indicator construction is called the filtering. The main task of this stage is to decompose the individual time series. The series have to be seasonally adjusted and the trend component has to be removed. OECD has used *Hodrick-Prescott filter* to de-trend the series since December 2008.

Hodrick-Prescott filter divides the series into two parts (τ_t - trend component and c_t - the cyclical component) and optimizes expression

$$\min_{\tau_t}\left[\sum_t\left(y_t-\tau_t\right)^2+\lambda\sum_t\left(\tau_{t+1}-2\tau_t+\tau_{t-1}\right)^2\right]. \tag{1}$$

It minimizes the difference between the trend and the original series and smoothes the trend as much as possible at the same time. The λ parameter prioritize the latter from the two contradictory goals – the higher the λ, the smoother the trend.

After the trend component is estimated it is subtracted from the original data set (this is called the *deviation cycle* then). Then the cycle components of all the individual indicators are found and turning points are detected. Not every peak or trough of the cycle is considered as the turning point though. For more information how to reveal the turning points see Bry and Boschan (1971).

2.3 Evaluation

The cycle components of all the individual indicators are compared to the reference series. OECD uses several methods how to evaluate their relationship: the average lead (lag) times between the turning points, cross correlations and number of extra and missing cycles. Usually only cross correlations are used in Czech business cycle analyses.

Then the selected individual indicators are divided into groups of leading, coincident and lagging ones and the composite indicators are created. 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 the USA by the Conference Board). The lagging indicator should certify the cycle behavior and the dating of the turning points.

2.4 Aggregation

The selected individual indicators are standardized first. OECD doesn't use any weights when aggregating the indicators; however the weights are already included in the standardization step (the original series are in fact weighted by the inverse value of their standard deviation).

The Czech composite indicators are usually created as the sum of the selected standardized individual indexes (Czesaný, 2009).

3 Alternatives to the filtering step

As was mentioned above, the main task of the OECD's filtering step is to de-trend the time series with Hodrick-Prescott filter. We compare this approach to the simpler method: usage of the growth rates.

The month-to-month growth rates tend to be unstable and therefore they need to be smoothed. Zarnowitz and Ozyildirim (2006) discuss how smoothing with fairly long moving averages affects the results of the business cycle analysis in a negative way, because the procedure runs a certain risk of distorting the patterns and the timing of turning points. Instead of moving average we use the Hodrick-Prescott filter as described above (however only to smooth the series). In this case it is sufficient to use very low values of the λ parameter so we would get rid of the high frequency fluctuations and the cycle movements would remain with the series.

To avoid the erratic movements of growth rates (and the need of smoothing them) it is possible to compute growth rates over longer periods, in this paper we use year-to-year changes. These series show the similarity to the shape of cycle component calculated with the previous methods (from the original series with Hodrick-Prescott filter and by smoothing the month-to-month growth rates).

3.1 Time shift of turning points

Dates of the business cycle turning points may not coincide with dates of the growth cycle turning points. The dates of the growth cycle turning points are identified from the deviation cycle which was described above. The turning points of the cycle computed from the month-to-month series differs even more as the cycle has slightly distinct interpretation.

As the deviation cycle is created by subtracting the trend component from the business cycle it leads the business cycle in peaks and lags in troughs. The month-to-month growth rates start to decrease when the business cycle is still rising however its growth tends to slow down. When the growth rates fall bellow one the business cycle is in its maximum and starts to decline and vice versa. In other words the dates of the peaks and troughs of the growth rates correspond to the inflection points of the business cycle. This has to be considered when interpreting the results of cycle analysis based on the growth rates.

Fig. 1: Comparison of deviation cycle and smoothed month-to-month growth rates of industrial production index

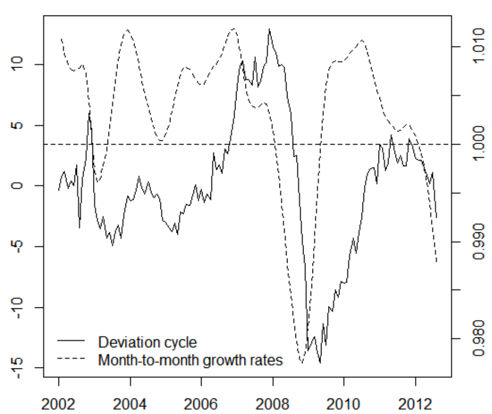

Fig. 2: Comparison of deviation cycle and year-to-year growth rates of industrial production index

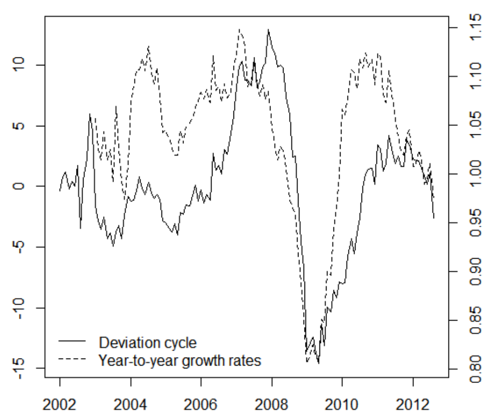

Figure 1 compares the timing of the deviation cycle with the cycle computed by smoothing the growth rates of the index of industrial production. The latter seems to be in lead; however this is caused by the different interpretation of these two cycles as was mentioned above. The most obvious drops in the deviation cycle match with the periods when the smoothed growth rates were below one.

The advantage of the year-to-year growth rates is that they are much less erratic than the month-to-month growth rates and so they don't need to be smoothed or otherwise adjusted. The figure 2 compares the deviation cycle and the year-to-year growth rates of the index of industrial production and proves that the timing of these two series is much more similar then in the previous case.

4 Czech composite leading indicator construction

We presented three algorithms how to measure the cycle component of the time series: deviation cycles, smoothed month-to-month growth rates and year-to-year growth rates. We showed that the timing of the turning points may vary when using these methods. In this section we discuss if the dependencies between the cycle components of the individual indicators are changed as well and illustrate these dependencies with the selection of the components for the Czech composite leading indicator (CLI).

In the section on methodology we mentioned several evaluation methods how to determine the relationship between the reference series and the economic indicators. We use cross correlations to assess the influence of the described algorithms. The cross correlations measure the linear dependency between the reference series and individual indicator with applied time-lag. Then the maximum of absolute values of cross correlations is found and the individual indicator is included into one of the composite indicators (leading, coincident or lagging) according to the time-lag where the maximal value appeared.

Tab. 1: List of the individual economic indexes chosen for the Czech leading composite indicators

Economic indicator	Deviation cycle	Month-to-month growth rates	Year-to-year growth rates
Sales in industry - Manufacture of motor vehicles, trailers and semi-trailers	-	x	x
New orders in industry	x	-	-
New orders in industry - Manufacture of electrical equipment	x	x	x
New orders in industry - Manufacture of machinery and equipment n.e.c.	-	x	-
New orders in industry - Manufacture of motor vehicles, trailers and semi-trailers	-	-	x
Export - Road vehicles (including air-cushion vehicles)	-	-	x
Industrial producer price index - Electrical equipment	x	x	x
Industrial producer price index - Motor vehicles	-	x	-
Industrial producer price index - Installation of industrial machinery and equipment	x	-	x
Composite confidence indicator	x	-	x
Business confidence indicator	x	-	x
IFO (DE) - R 1 : Business climate	x	x	x
IFO (DE) - R 2 : Business situation	x	-	x
IFO (DE) - R 3 : Business expectations	x	x	x
Stock market index PX	x	x	x

We perform the analysis on the dataset of 83 individual economic indicators which are available from the January 2002 to the August 2012. All the series were seasonally adjusted by the Czech Statistical Office. The industrial production index was chosen as the reference series because (unlike the GDP) it is monthly and therefore doesn't need any further arbitrary adjustments.

Individual indexes are included in the leading composite indicator if the maximal absolute value of the cross correlations is higher than 0.6 and occurs when the individual index is shifted forward in time.

Table 1 provides an overview of the selected components for the leading composite indicators. Their structures vary depending on the method of construction. Only 10 out of 83 individual indexes pass the criteria and are included in the CLI with the traditional approach (deviation cycle). Even less indexes (only 8) are selected when using smoothed month-to-month growth rates. If the year-to-year growth rates are used, the CLI is composed of 12 individual indexes. There are 5 of these economic indexes which appear in all computed leading composite indicators regardless of the method used: new orders in industry - manufacture of electrical equipment, industrial producer price index - electrical equipment, German business climate and business expectations indexes and PX stock market index.

Tab. 2: Performance of the leading composite indicators measured by the cross correlations (CLI_d – deviation cycle method, CLI_m – smoothed month-to-month growth rates method, CLI_y – year-to-year growth rates method)

CLI	t-5	t-4	t-3	t-2	t-1	t	t+1	t+2	t+3	t+4	t+5
CLI_d	0.822247	0.866444	0.893725	**0.917840**	0.907997	0.871654	0.811660	0.740945	0.660851	0.566754	0.459323
CLI_m	0.769698	0.847380	0.902597	**0.928573**	0.920188	0.876461	0.793498	0.683586	0.556300	0.420702	0.285017
CLI_y	0.831735	0.875076	0.898832	**0.920931**	0.898732	0.870353	0.792451	0.715948	0.607833	0.497732	0.370570

However different the structures of the leading composite indicators are, their performance measured by the cross correlations is almost identical. All the leading composite indicators reach their maximum of cross correlations in time t-2 (two-month lead) as is shown in the table 2. Even the values of the maximal cross correlations are very similar; from 0.918 for the deviation cycle to 0.929 for smoothed month-to-month growth rates.

Although it is necessary to keep in mind that the cross correlations are not the only measure for the component selection and should be used only in the combination with other criteria (e. g., average lead/lag times between the turning points).

The composite leading indicator created by method of smoothed month-to-month growth rates has the highest maximal value of the cross correlations but it also provides most of the missing or extra signals (see figure 3) and therefore it probably wouldn't be good predictor of the cycle turning points. The lead time of the CLI from the year-to-year growth rates seems to be more stable than the lead time of the deviation cycle CLI.

Fig. 3: Comparison of the reference series (index of industrial production) and the composite leading indicator (for deviation cycle method, smoothed month-to-month growth rates method and year-to-year growth rates method)

Conclusion

The basic principles of the business cycle analysis with composite indicators were described in this paper. We focused on the OECD methodology and its alterations which are usually used in the Czech Republic and tried to suggest different approaches how to de-trend time series: smoothed month-to-month growth rates and year-to-year growth rates. We discussed that these methods affected the dating of the cycle turning points as well as the relationships between the individual economic indicators (therefore the structure of the composite indicators would vary).

The proposed algorithms were much simpler (at least the year-to-year growth rates was because it didn't need any additional adjustments) yet gave very similar results as was shown on the example of leading composite indicator for Czech economy.

The dependencies between the individual time series (or the composite indicators) and the reference series were measured only by the cross correlations. The next possible extension of this work would be to verify presented results with proper analysis of the cycle turning points.

References

Bruno, G., & Otranto, E. (2004). Dating the Italian business cycle: a comparison of procedures. *Istituto di Studi e Analisi Economica, Working Paper, 41*, 25.

Bry, G., & Boschan, C. (1971). Cyclical analysis of time series: selected procedures and computer programs. *National Bureau of Economic Research*, 216.

Czech Statistical Office. (2012). *Business cycle surveys - Methodology.* Retrieved 5 25, 2013, from http://www.czso.cz/eng/redakce.nsf/i/business_cycle_surveys

Czesaný, S., & Jeřábková, Z. (2009). Kompozitní indikátory hospodářského cyklu české ekonomiky. *Statistika*(3), 256-274.

Gyomai, G., & Guidetti, E. (2012). OECD System of Composite Leading Indicators. *OECD Publishing*, 18.

Levanon, G. (2010). Evaluating and comparing leading and coincident economic indicators. *Business Economics, 45*(1), 16-27.

Nilsson, R., & Gyomai, G. (2011). Cycle extraction: A comparison of the Phase-Average Trend method, the Hodrick-Prescott and Christiano-Fitzgerald filters. *OECD Publishing*, 23.

Ozyildirim, A., Schaitkin, B., & Zarnowitz, V. (2010). Business cycles in the euro area defined with coincident economic indicators and predicted with leading economic indicators. *Journal of Forecasting, 29*(1-2), 6-28.

Ravn, M., & Uhlig, H. (2002). On adjusting the Hodrick-Prescott filter for the frequency of observations. *Review of Economics and Statistics, 84*(2), 371-376.

Tkáčová, A. (2012). Kompozitný predstihový indikátor hospodárskeho cyklu českej ekonomiky. *Politická ekonomie*(5), 590-611.

Zarnowitz, V., & Ozyildirim, A. (2006). Time series decomposition and measurement of business cycles, trends and growth cycles. *Journal of Monetary Economics, 53*(7), 1717-1739.

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