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Composite Reference Series and Composite Leading Indicator for Slovakia

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1. Introduction

This paper summarizes the results of composite leading indicator (CLI) construction for the Slovak economy based on a composite reference series. The main part of this paper was presented at the "*5th Eurostat Colloquium on Modern Tools for Business Cycle Analysis*" in September 2008 [1]. The methodology of the leading indicator composition is based mostly on the experience of other countries (see references). Of course, the relations between the economic variables are for each country specific. There were some attempts of building a leading indicator in Slovakia in the past; however the research in this area was not based on a systematic long-run approach [2]. The research in this area was connected with problems such as short time series or instability of macroeconomic conditions related with the economic transition to market economy. Furthermore, statistical data have been continuously revised as a consequence of the necessity to harmonize the methodology for compilation of the system of national accounts. By now the OECD researchers have constructed the only regularly published leading indicator for Slovakia. Institute of Informatics and Statistics (INFOSTAT), the research institution of the Statistical Office of the Slovak Republic, is intending to create and use its own composite leading indicator. The business cycle analysis of individual and aggregate economic indicators can bring new information about so far non-exploited economic relations. The author expects that the composite leading indicator will improve also the quality of short-term prognoses of the Slovak economy as a whole or its individual sectors.

The paper is divided into three main parts: description of the used methodology, description of achieved results and comparison of the results regarding the political cycle of Slovak economy and leading indicators of three remaining Visegrad group countries (OECD leading indicators).

2. The methodological procedure

The procedure used for the construction of the Slovak leading indicator follows partly the OECD system of leading indicators [3, 4, 5]. The basic premises of the business cycles analysis were set by the National Bureau of Economic Research (NBER) in the first half of 20th century [6, 7, 8]. The OECD system recommends various methods in each step of the composite leading indicator construction. Our procedure can be decomposed into the following steps:

1. Creating a database of monthly time series;
2. Decomposition of time series (determining the trend, seasonal, cycle and irregular components);
3. Smoothing of cyclical components;
4. Selecting the series for composite reference series;
5. Composing the composite reference series;
6. Correlation analysis;
7. Selecting the composite leading indicator components;
8. Construction of the composite leading indicator.

At the first stage of the process a database of monthly time series is created. It contains monthly time series from different sectors of economy (industry, construction, trade

and services), balance of payments, foreign trade, state budget and economic expectations obtained through business cycle surveys. The time series are available through dissemination by the Statistical Office of the Slovak Republic, National Bank of Slovakia, the Ministry of Finance and other resources. Nowadays the database contains more than 200 time series. The beginning of time series was set to January 1998. An earlier point would not be a good choice because of the lack of time series quality due to the economic transition and related methodological problems. The time series entered the database as seasonally unadjusted and in the form of 2000-base indices at constant prices.

In the second stage each of the database series has to be decomposed into four basic components – trend, seasonal and cyclical (including irregular). Various well-known methods were tested for seasonal adjustment – Census X12, X11 (Historical) and Tramo/Seats. Although all the methods yielded very similar results, the Tramo/Seats method was finally chosen for the seasonal component estimation. The seasonal adjusted series by Tramo/Seats were a bit smoother and also this package is now recommended by Eurostat.

Several tools are disposable also for the detrending of the series. Those include Hodrick-Prescott filter (HP filter), X12 Henderson Moving Average, Tramo/Seats, Christiano-Fitzgerald filter, Baxter King filter and a simple moving average. X12 Henderson Moving Average and simple average gave very unsatisfying results. The former one estimated a cyclical component with too many turning points (random-like cyclical component), which means that the estimated trend-cycle component was not smooth enough. The latter shortened too much the series (extrapolation needed) and moved the turning points to a later point. The results of the other filters were very similar (with default parameters), but with regards to the pros and cons (i.e. simplicity, transparency) of each method mentioned, finally the HP filter was chosen as the most appropriate tool for detrending all series in the database.

At this stage the cyclical component of each series can be easily computed. The seasonal (S_t), trend (T_t) and original series (Y_t) are known. In a multiplicative relation between these components, the cyclical component (including the irregular one - CI_t) can be computed as:

$$\mathbf{CI_t = Y_t / (S_t * T_t)} \qquad (1)$$

Author's previous paper [1] dealt with the problem of random component removal by using the Months for Cyclical Dominance method. First the minimum amount of months was determined, in which the average change of trend-cycle component dominated that of the average change of irregular component. The resulting amount of months was then applied as one-side simple moving average to remove the random noise. That method has several disadvantages. Firstly, the time series are shortened at one side and need an extrapolation. Second, a different span of simple moving average is applied on each of the series, so several series can show a false lead in the correlation analysis.

This problem can be easily overcome using the 13-term symmetric Henderson moving average applied to all cyclical series. As stated in [9] this method's properties provide the:

- Elimination of random variations;
- Preservation of sharpness and timing of the turning points.

The 13-term symmetric moving average will ensure the required smoothness of all time series without shifting the peaks and troughs. Also there is no need to extrapolate missing observation as it was in the case of a simple moving average. In the simple moving average each observation is given equal weight. In the case of a symmetric moving average the weights are symmetric about the central observation (see Table 1). In addition we need to apply asymmetric weights at the start and at the end of the series. The central observation is

given the largest weight (see bold weights in Table 1) in order to preserve the right timing of the turning points.

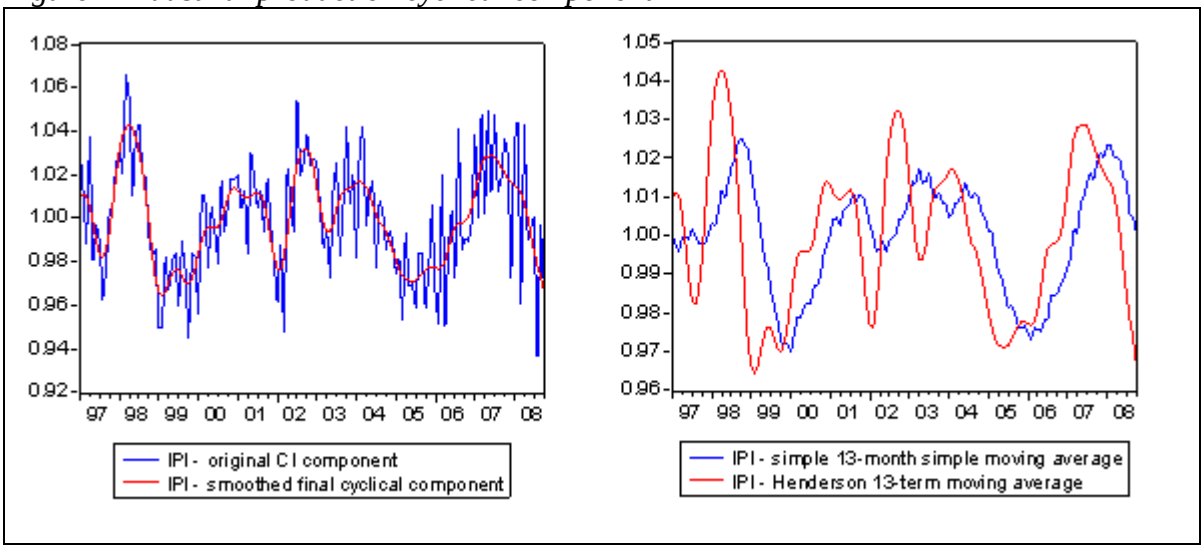
The following weights of the symmetric (first row) and asymmetric 13-term Henderson moving average filter were used (reversed at the end of the series) [10]:

Table 1

n-12	***n-11***	***n-10***	***n-9***	***n-8***	***n-7***	***n-6***	***n-5***	***n-4***	***n-3***	***n-2***	***n-1***	***n***
-0,02	-0,03	0,00	0,07	0,15	0,21	**0,24**	0,21	0,15	0,07	0,00	-0,03	-0,02
	-0,02	-0,03	0,00	0,07	0,15	0,21	**0,24**	0,21	0,14	0,06	-0,01	-0,03
		-0,01	-0,02	0,00	0,07	0,15	0,21	**0,23**	0,20	0,14	0,05	-0,02
			-0,01	-0,02	0,00	0,07	0,14	0,21	**0,23**	0,20	0,13	0,04
				-0,02	-0,02	0,00	0,07	0,15	0,22	**0,24**	0,22	0,15
					-0,04	-0,04	0,00	0,08	0,17	0,25	**0,29**	0,28
						-0,09	-0,06	0,01	0,12	0,24	0,35	**0,42**

In the Figure 1 we can see the original cyclical component of Industrial production (index) including the random component and the final smoothed cyclical component (graph left). The shift of the turning points using simple moving average is clearly seen on the graph right.

Figure 1 Industrial production cyclical component



3. Composite reference series

We have available all final cyclical components of the time series in our database. The next crucial step is to select a reference series. We can use an individual reference series or a composite series for our leading indicator. In the previous author's paper [1] both of the examples were presented. This paper focuses only on the construction of the composite reference series.

The structure of the Slovak economy partly determines the components of the reference series. Industrial production with over 30% share on Gross Domestic Product

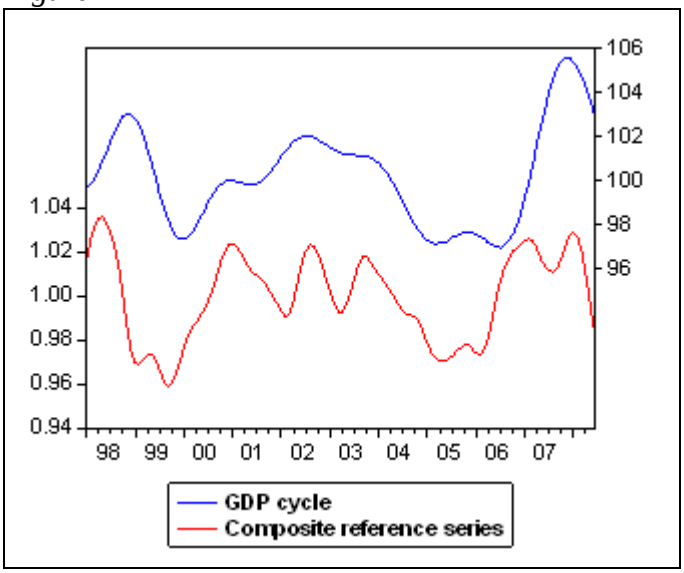
(GDP) formation at constant prices is chosen to be the first component. The composite reference series should contain also information from other economic areas. Unfortunately we have not sufficient monthly data for services (except expectations from 2002), so we can use only series from other economic sectors such as construction or trade. The aim is to collect the most reliable monthly indicators and simultaneously gather the relative highest proportion on GDP formation. Other aggregates that shall be included in the composite reference series are from the areas of monetary and external trade sectors. The following indicators are to be included in the composite reference series: industrial production, construction production, turnover in retail trade, wholesale trade, transport, hotel and restaurants, M2-liquid liabilities and export of goods.

There are several possibilities how to compose the reference series, e.g. simple or weighted average or sophisticated methods like principal component analysis, factor analysis etc. The combined procedure of the principal component analysis and weighted average procedure was used [11]. There is to distinguish between two different kinds of indicators in our potential reference series: aggregates of economic sectors (industry, construction and other sectors) and other aggregates (export, M2). Different weights should be applied to each sector variable by the approximated ratio on GDP formation at constant prices. The average sector weights between the years 2005-2007 were used. The economic sectors were given weights according to following ratios: Industry (35%), Construction (6%) and other sectors data – turnover in retail trade, wholesale trade, transport and hotel and restaurants (together 17% - approximated according to the sector's ratio on production). The result is an aggregate indicator of economic sectors. When we add two remaining indicators M2 and export of goods we can derive the first main component with help of the principal component analysis. The first component is used as a proxy variable for computing the weights of all three aggregate indicators applying the correlation analysis. The coefficients of correlation present the factor loadings for each component series. The final composite reference series is:

$$\mathbf{CLI = (0.915 * economic\ sectors + 0.626 * export\ of\ goods + 0.861 * m2)/2.402} \qquad (2)$$

The GDP is contemporary the most reliable indicator that reflects the state of the economy as a whole, so we can compare the GDP cycle with the final composite reference series cycle to see the differences. The *Figure 2* shows that the shape of both cycles is very similar. The cyclical component of the GDP was derived applying the Christiano-Fitzgerald filter as results of the other filters were unsatisfactory. Following this conclusions the final composite reference series is a very good proxy variable for the whole economy.

Figure 2



4. The construction of the leading indicator

All potential individual components of the leading indicator are at this stage available in the final form. A correlation analysis can detect a relation with the reference series. To have full information about the possible relation we need to apply a cross correlation analysis. The coefficients represent the correlation with various time shifts from 0 to 24 months.

According to the original theory developed by the NBER the resulting cyclical time series can be divided into three groups – leading, coincident and lagging. The leading indicator components ought to have an economic interpretation. That means they should be carrying information about an early stage production process, economic expectations (e.g. business and consumer surveys), sensitive information about economy performance (stock prices) or other signals of coming changes on the market [4, 5, 12]. Our cyclical analysis identified about 60 leading indicators. Only a minority of them is interpretable regarding the general economic theory. Coincident movements with the reference series are showing about 50 variables. Employment indicators, which are commonly considered as coincident, are showing lags in the case of Slovakia cycles. Other lagging indicators are from the field of prices, interest rates and wages.[1] The overview of some of the results is in the *Table 2*. Interesting is the leading character of food industry indicators. It seems that the food industry slowdown or acceleration indicates a coming slowdown or an acceleration of the economy. This may not be a coincidence, because this phenomenon occurs in foreign trade, production and also in consumer prices. This needs future research, but for now the author decided not to include those leading series in the composite leading indicator.

[1] However it is not to expect that the results will confirm all the assumptions of the theory, especially in the case of the Slovak economy, which is a very small and open economy facing continual economic changes. We have to keep also the fact in our minds that we are trying to observe not the relations between indicators, but the relative relations of their cyclical components and this changes slightly the general view at the whole problem.

Table 2

Lagging	No. of months	Leading	No. of months
Consumer price index	12	Export of food	16
Production price index	14	Import of food	16
Employment in construction	8	Loans granted to households	8
Employment in industry	11	Loans granted to non-financial corporations	8
Employment in retail trade	12	State budget revenues (grants)	5
Employment in wholesale	12	State budget revenues (non-tax)	12
State budget revenues (personal income tax)	14	SAX index	6
State budget revenues (corporate income tax)	16	Total volume trade	8
Wages in transport	15	M1 - money supply	8
Wages in industry	12	Orders placed with suppliers (retail trade survey)	7
Wages in retail	17	Production of food	8
Wages in wholesale	15	Consumer price index (food)	10

Contrary to the previous paper [1] the two basic conditions for time series to enter the leading indicator were removed. First one was the condition of minimum leading time of 5 months and the second the minimum of correlation coefficient of 0.55. Similarly also the scoring method in the process of leading indicator construction is exempted. Instead a few simple and transparent rules and conditions were set to simplify the whole selection process. The basic conditions for leading series are:

1. Economic interpretation of the leading series
2. Correspondence to the reference series turning points
3. Minimum of leading time more than 4 months

Based on the first experience with the business cycle analysis the economic interpretation is preferred to the very sensitive statistical characteristics. Later in the paper we will see a demonstration proving that the results do not suffer from setting up the new presumptions. We also have to think about other statistical qualities of data, for example timeliness, frequency of revisions or authenticity of series – level of transformation of original series through extrapolation.

Above mentioned criteria offer us the following set of leading indicator components:

Loans granted to households - Loans of households could be regarded as a strong accelerator of economic activities, mainly in the consumption sector or in construction. The curve of the cyclical component covers sufficiently the reference series turning points. Its leading time is 8 months and the correlation coefficient is 0.63. The National Bank of Slovakia publishes the data right after the end of the next month.

Exports of goods – The Standard International Trade Classification (SITC) sections 0, 1, 2, and 5 - It contains exports of food and live animals, beverages and tobacco, crude materials and chemicals. Its leading time is 14 months. It can be understood as a signal of better conditions in some economic sectors, and its cyclical performance as a signal for the whole economy (positive or negative). The indicator shows correlation of 0.58. The main disadvantage lies in its updates with monthly frequency. Data are available approximately with one-month delay after the reference series by the Statistical Office of Slovakia.

Money M1 – Deposits – It is to be considered as so-called prime mover [4]. This indicator contains information about the monetary policy. Decrease or increase of money supply indicates a slowdown or acceleration of various subjects' economic activities. This series has a lead of 8 months and is published approximately 30 days after the end of reference month. It has a correlation coefficient of 0.63. Data are available through the National Bank of Slovakia.

SAX index – The Slovak share index contains information about changes of share prices and assets connected with investments in included shares, i.e. banks shares, shares of industry corporations etc. The index is an expectation sensitive indicator [4]. Data are

available through Bratislava Stock Exchange on a day basis. This indicator leads the reference series by 6 months with a correlation coefficient of 0.65.

Orders placed with suppliers – Retail trade confidence survey – Is a part of the Retail trade confidence indicator. The respondents (business) express their expectations of increasing or decreasing the requirements on suppliers in the near future. It has a lead of 7 months and a correlation coefficient of 0.35.

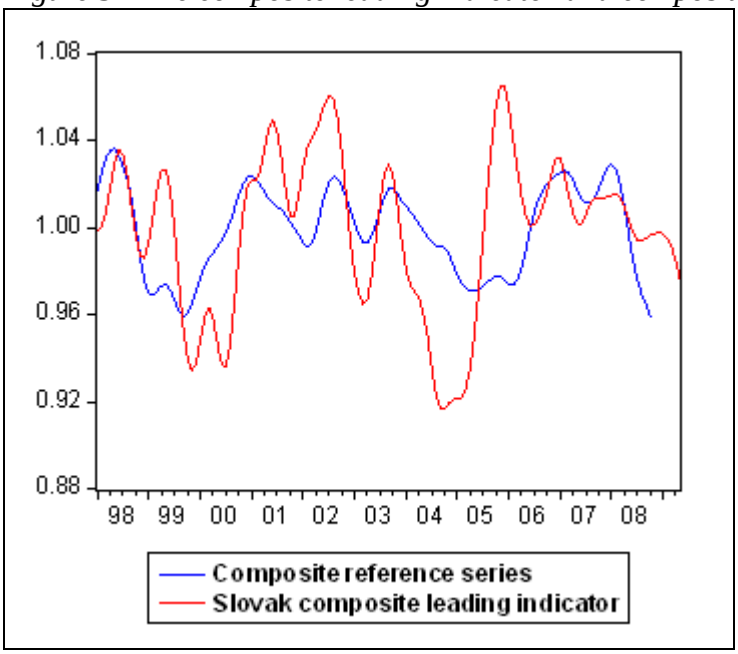
The content of the leading indicator shows a sound picture of the whole economy area. It contains information from the areas of consumption, production, external trade and monetary area. This is in compliance with the content of the reference series that contains similar areas. On the other side the contribution of the production side of the economy is in the reference series much broader.

Once the final set of indicators time series was reached, we can equalize the phase differences by taking lags. All of the five series named above can enter the leading indicator. As mentioned in the phase of the composite reference series construction we have a few optional methods. We can use a simple average with the same weights, different weights or other method. The author decided again to combine two methods: the principal component analysis and weighted average [11]. The first component (output of the principal component analysis) estimated out of the five time series can be used as a leading indicator. But the first component serves again only as a proxy variable for computing the weights of all individual indicators. The correlation coefficients, computed between individual indicators and the first component, are used as weights. The equation for the leading indicator computation is:

$$\mathbf{CLI = (0.304 * loans + 0.779 * exports + 0.762 * m1 + 0.522 * sax + 0.806 * orders)/3.173} \quad (3)$$

The leading indicator is 7 months ahead of the composite reference series. The results are displayed on the *Figure 3*.

Figure 3 - The composite leading indicator and composite reference series

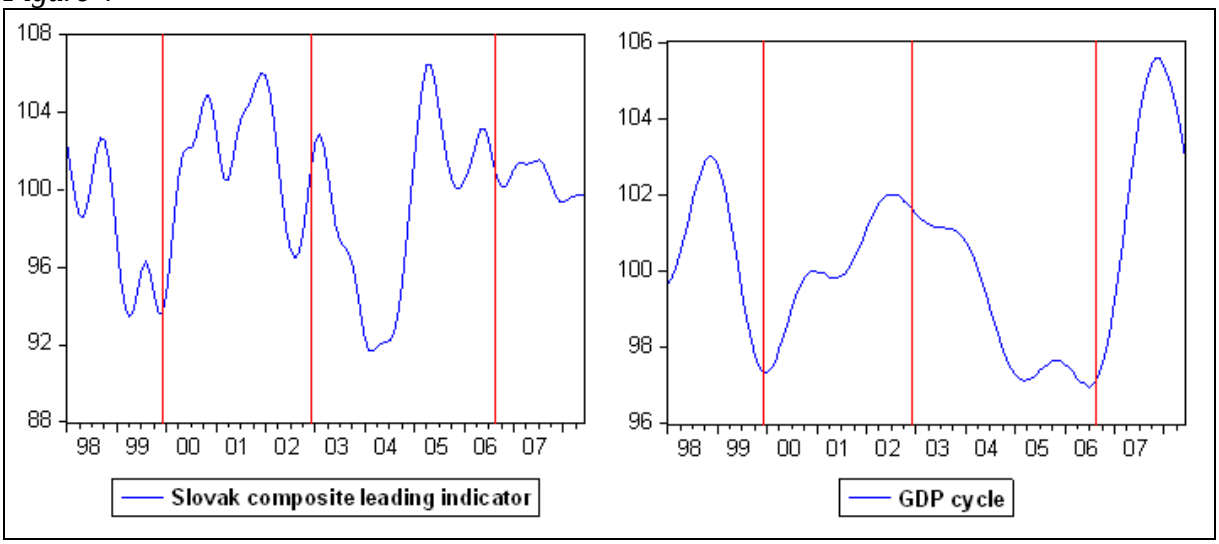


5. *The business cycle and political cycle in Slovakia*

The period of 1998-2008 can be divided into three distinguishable sub-periods from the economic and political cycle point of view. The first period 1998-1999 is part of the first political cycle (1994-1999) and is connected mainly with economic and politic instability (deficit in foreign trade, high inflation rate, high government debt) which ended in a trough in 1999. The second period contains two political cycles (1999-2002, 2002-2006) and is characteristic by the continuity of its economic policies (reforms). The third period begins with another trough in 2006 and is not ended yet. The vertical line in *Figure 4* depicts all the political cycles.

In order to check the ability of the indicator to track the government performances we tried to compare the political cycle with our leading indicator and the GDP cycle. On the *Figure 4* left we can see that the economic deviation cycle (leading indicator) begins fall or rise shortly before or after the political cycle. The graph on the right comparing the political and GDP cycle yields slightly different results. The political and economic deviation cycle are changing almost simultaneously. From 1999 the government policy was aiming at the economic takeoff and was successful. This phase finished at the end of 2002 (peak) then the economy faced another reforms from which the main profits came after the election in 2006. A new peak passed during 2007 and now the economic cycle has been decreasing. Once the business environment is set (and steady), the business cycle analysis is not appropriate to check the government performance. This is true at least when we consider the economic transition of Slovakia and the business environment formation through the years 1999 – 2004. The small and open economy of Slovakia is more dependent on the performance of other EU countries (future research needed). Although it is very important to measure the government policy impacts on economy, they are not tractable through the aggregate business cycle indicators. Policies directed at categories such as investments, employment, wages and other aggregates take effect with different time delay, which is an ingredient of the business cycle theory developed by NBER [12].

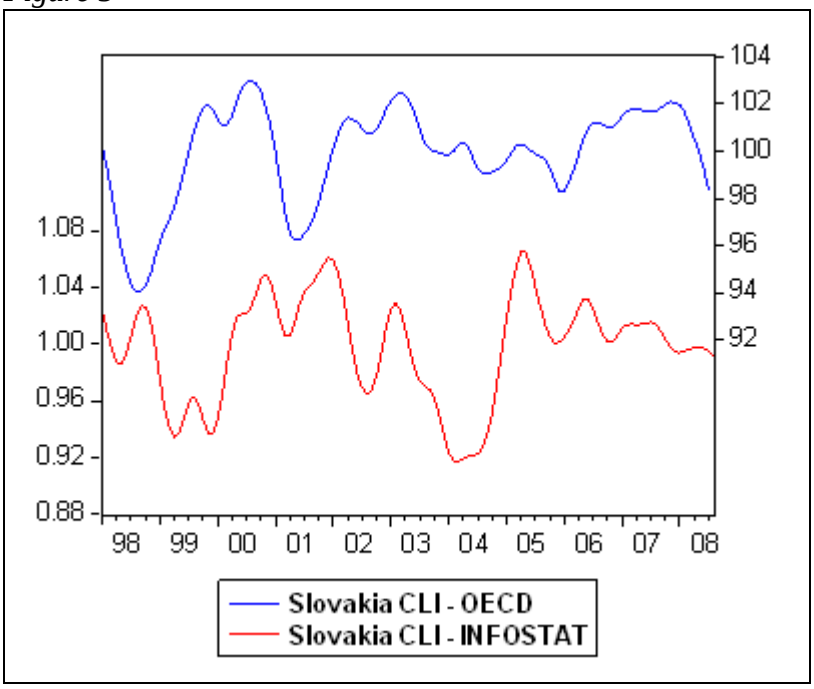
Figure 4



6. *The comparison with OECD – composite leading indicator for Slovakia and synchronization with other countries*

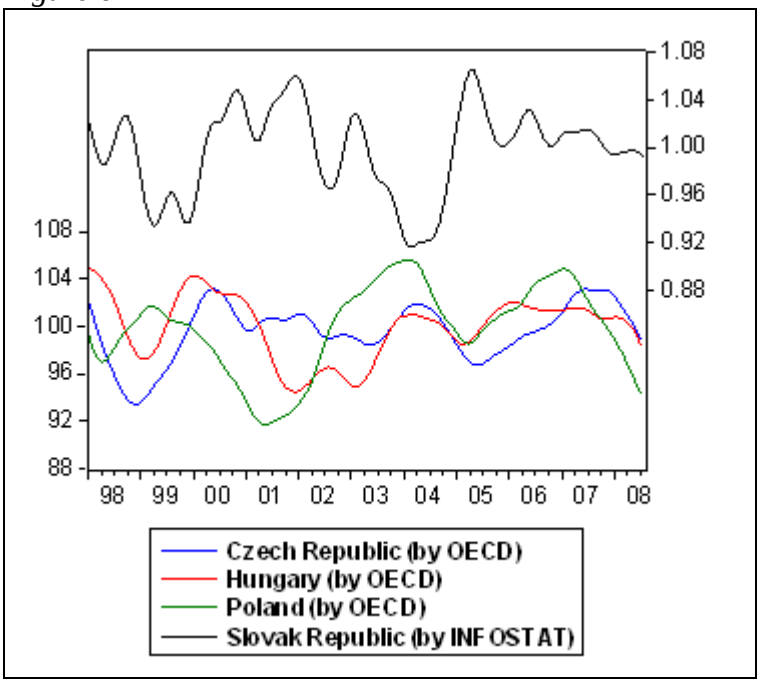
We try to compare our indicator with the one made by the OECD and also try to identify some synchronization signals with other countries – the Visegrad Four [13].

Figure 5



As we can see (*Figure 5*) before 2000 the turning points between the INFOSTAT leading indicator and OECD-leading indicator for Slovakia differ significantly, but later the consistency is distinguishable. In the *Figure 6* we see that opposite the previous comparison no clear similarity between the deviation cycles of Visegrad countries and Slovak leading indicator is to be seen. Although Slovakia became the EU-member together with the Czech Republic, Poland and Hungary in 2004 and foreign trade among these four countries has been increasing and with the other EU-members as well, the synchronization of business cycles is not apparent. The main reason lies probably in different political cycle regime inside these four countries. The question is what the membership in the European Economic and Monetary Union (EMU) will bring for Slovakia since 2009. Probably the impact of new currency in Slovakia on business relations with other countries outside the EMU will not have such an impact as the EU-membership.

Figure 6



7. Conclusions

The composite leading indicator based on a composite reference series offers a new view on relations within the Slovak economy. The next research phases will be based on verification of these results. The main goal is the stability of its content and a sound methodology aimed most at transparency and simplicity. To improve the whole process of construction of the leading indicator we will try to update and extend our database with new time series. Among other possibilities of methodological process improvement we can mention different tools for detrending or for construction the leading indicator, e.g. factor analysis. Since the beginning of 2009 the EU countries are facing a revision of NACE classification of economic activities. This will probably result in small revisions of the content of our leading indicator. However this version should be permanently verified and updated in the next research phases. Verification of its reliability and predicative ability requires a long-term experimental application, including many revisions as confirmed by experience of other countries. The new composite leading indicator of the Slovak economy renews and at the same time completes model tools used for analyses, flash estimates and short-time prognoses of development of the Slovak economy.

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