Relation between Composite Indicators and Estimates of Quarterly GDP Changes: Case of the Czech Republic

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Abstract

Gross Domestic Product (GDP) represents the basic indicator of macroeconomic performance of the Czech economy and its importance is growing. The need to get the information on its development as quickly as possible for the necessary government acts is unquestionable. Nevertheless, the time taken to publish its first quarterly estimate of growth rate is significantly longer (45 days after the reference quarter) in comparison to some other countries such as the USA and the United Kingdom.

The aim of this paper is to assess the relationship between composite leading indicator (CLI), composite coincidence indicator (CCI) and the development of GDP followed by verification of a predictive ability of these composite indicators. The relationships between GDP and indicators available in this 30-day period which could enter to this CLI and CCI are analysed by the advanced methods of time series analysis.

Keywords

Gross Domestic Product, composite indicator, business tendency surveys, co-integration analysis

JEL code

C43, C83, O47

INTRODUCTION

Preliminary estimates of quarterly Gross Domestic Product (GDP) are designed in many countries to meet the growing pressure on the fastest economic data. These estimates are usually based on incomplete data and various modelling techniques. It is necessary to find a compromise between the two most important requirements – timeliness and quality.

Quarterly GDP is part of the quarterly national accounts, which represent an interconnected system of data on transactions, accounts and balancing items collected on a quarterly basis. In the Czech Republic, these quarterly accounts as well as annual ones are published by the Czech Statistical Office. Regarding terminology, there are some terms used worldwide that the user may not clearly understand at a first glance. Such terms include so-called "flash estimates" which could be compared to our Czech

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preliminary estimates mentioned above. Eurostat (2003) defines a *flash estimate* as the "earliest picture of the economy with regard to the concepts of national accounts published as soon as possible after the end of the quarter". Another term that may confuse users is the *preliminary estimate* used by the Czech Statistical Office. However, its definition and publishing as the first estimate corresponds more to the term *flash estimate*.

Many authors have tried to construct an indicator that could predict the development of GDP in the near future with a certain amount of accuracy and quality and this paper deals with this idea as well. The aim of the paper is to construct and verify CLI that should anticipate and predict, how GDP will develop in the near future and CCI that should develop consistently with the economic cycle and that can be composed of economic indicators with data available in a period not exceeding 30 days after the end of the quarter.

The paper is organized as follows. The first section offers a summary of current knowledge on this issue, then the data and methods used for its evaluation and the course of the analysis itself are described. In the third section of this paper, key results of the analysis are presented with subsequent verification regarding the actual development of the business cycle that constitutes the last section. Finally, additional procedures linked to this analysis are suggested.

1 STATE OF THE ART

There are four main papers in the current research focused on preliminary estimates of GDP in the Czech Republic. The first attempt to construct GDP estimate was made by Jílek and Vojta (2001). They attempted to construct estimates of GDP at chain-linked prices (as aggregated GDP) without explicitly expressed structure by production or expenditure estimation method. The structure itself contains an algorithm calculating the estimate. The analysis is based on seasonally unadjusted estimate and GDP development is estimated in relation to the same period of the previous year. The algorithm consists of selection of monthly sales indicators for sectors most closely matching the profile manufacturing and reducible to fixed prices. As the next step annual indices of quarterly sales are calculated followed by the gross value added to the Sales ratio in previous years. The last step includes the calculation of shares of each sector on GDP at basic prices in the same quarter of the previous year and these shares represent weights used for summarization of the results for each sector.

The name *user signal estimate* used by Jilek and Vojta has its origin in the fact that this estimate can be realized by anybody with using the data publicly available and usually published and it does not use any additional information from the Czech Statistical Office.

This estimate has been improved by so-called *Improved User Signal Estimate* by the same authors (Jilek and Vojta, 2003).

In this case authors build on their previous work from 2001 and construct an improved estimate. The need of such estimate is justified by experimental calculations which results indicate high variances of signal estimates from current estimates of gross value added in individual sectors.

The authors decided to construct a global signal estimate and not to calculate individual industrial gross value added estimates. The global signal estimate is based on the total sales index calculated as a weighted average of industrial indices of sales, while the weights are represented by the shares of sectors in the gross value added. Unlike previous paper, the authors decided to assess the relationship of changes in sales and changes in GDP by decreasing scale constructed using simple regression relationship.

Both above papers permit to construct an estimate of roughly 50-day delay after the reference quarter. The obvious question is whether it would be possible to construct a preliminary estimate of GDP even earlier (e.g. about 30 days after the reference quarter).

According to this requirement, Jan Fischer (Jan Fischer et al., 2002) and his team contributed by analysis of the relationship among the business cycle balances and gross value added. The analysis deals

with an initial thesis stating that there is not enough information about production for construction the estimate until 30 days after the reference quarter. Regarding the international practice, it is usual to use a set of business cycle expectations.

The authors have compiled regression equations with industrial gross value added in manufacturing and in construction, respectively as a response variable and chosen combinations of business cycle expectations balances series as explanatory variables. The paper offers an important finding that the coefficient of determination is not a suitable indicator for assessing the quality of predictions. The essential issue is the low quality of pseudo-predictions.

The last existing attempt to construct quarterly preliminary estimates of GDP was made by Jakub Fischer (2005). This methodology regards the character and information capability of the official estimates and regression analysis is used.

Author used gross value added at basic chain-linked prices of 1995 as a response variable and chose 10 explanatory variables. Its list can be found in Fischer (2005).

Models and their suitability were assessed by construction of pseudo-predictions while all series have been reduced by the value of the last known quarter and after estimation of regression parameters the estimate for the last known quarter was constructed. All these estimates were confronted with the official 70-day estimate. Author chose pseudo-predictions' absolute deviation from official estimate as appropriateness criterion of the model. The best preliminary estimate was based on series of the lagged response variable, rail freight series and indicator of confidence in trade.

The main conclusion is the fact that it is not advisable to use only results of business tendency surveys for construction of the estimate and it is not appropriate to work with five-year and longer time series.

Regarding the issue of estimating the GDP changes utilizing composite indicators, there are several documents suggesting alternative approaches for its construction, such as OECD document (1998). This document generally deals with the construction of CLIs while using Phase Average Trend method to estimate long-term trend of considered economic indicators' time series and provides the calculation of the CLI for the United States.

According to the OECD methodology, CLIs are calculated for 33 OECD countries, 6 non-member countries (economies) and 8 aggregated zones on monthly basis. Table 1 shows the 5 selected countries with information on how long after the end of the reference quarter they publish the flash estimates of quarterly GDP and what is the experience with the composite indicators' construction except those calculated by OECD.

Table 1 Delays in the Transmission of the First GDP Release and Experience with Composite Indicators in Selected Countries

Country	Delay in days	Experience With Composite Indicators
Sweden	35	Only CLIs by OECD are constructed.
Austria	45	CLI constructed on monthly basis using real gross value added as a reference series. 13 indicators take part in the CLI from 91 indicators analysed.
Germany	45	Analysis of performance of leading indicator forecasts during financial crisis and performance of single and pooled leading indicators during pre-crisis and crisis period.
Italy	45	Analysis of 183 time series relevant to Italian economy on monthly basis. Combining of NBER methods and techniques of cyclical analysis.
Poland	61	Using of linear and non-linear dynamic factor modelling approaches. Predictive accuracy is confined to the in-sample-fit of the models.

Note: CIs are not designed for the purpose of the flash estimates of GDP in any of the selected countries.
Source: Eurostat; Altissimo, Marchetti, Oneto (2000); Bandholz (2005); Bierbaumer-Polly (2010); Drechsel, Scheufele (2010); own construction

2 DATA AND METHODOLOGY

The main core of this paper is to analyse relationships between appropriate and relevant time series consisting of both confidence indicators obtained from business tendency surveys, economic indicators and the cyclical component of GDP obtained from the quarterly GDP time series. The analysis is divided into two parts. The first part deals with development of time series on a visual basis, second part with co-integration analysis performed to identify type of relationship. In case of proving long-term relationship, EC model given by the formula (1) will be constructed. In the opposite case, VAR model (of size l) given by formula (2) depicting short-term relationships will be constructed. If it is proved that the considered indicator sufficiently enough explains development of GDP, the indicator would be classified as a candidate to join the composite indicator, either leading or coincidence.

$$\Delta X_t = \phi_0 + \Omega D_t + \Gamma_1 \Delta X_{t-1} + \ldots + \Gamma_{p-1} \Delta X_{t-p+1} + \Pi X_{t-p} + a_t, \quad (1)$$

$$X_t = \phi_0 + \Omega D_t + \phi_1 \Delta X_{t-1} + \ldots + \phi_p \Delta X_{t-p} + a_t, \quad (2)$$

where: $\Gamma_i = -(I_l - \phi_1 - \ldots - \phi_i)$ for $i = 1, \ldots, p-1$ and $\Pi = -(I_l - \phi_1 - \ldots - \phi_p)$ are parametric matrices containing information about relationships among processes;
ϕ_0 stands for constants, D_t stands for deterministic component and $\{a_t\}$ is the Gaussian white noise process of size l.

2.1 Selection of appropriate data and its adjustments

2.1.1 Indicators of business tendency surveys

Relatio nships of confidence indicators' time series from business tendency surveys are analysed in the form of business cycle balances defined by the Czech Statistical Office (2012) and time series of quarterly GDP (at constant 2005 prices, seasonally adjusted) cyclic component (after Hodrick-Prescott filter application) are expressed as deviations from the trend (in %). Given the data available, chosen period is from 1st quarter of 2003 to 2nd quarter of 2012. It is a period characterized by initial high economic growth that went into an economic decline due to the economic and financial crisis in 2009.

Because of the quarterly estimate of GDP at chain-linked prices of 2005 being available since 1996 and confidence indicators in manufacturing, construction and trade being available even from 1993, the series starting in 1996 (in terms of GDP) were experimentally analysed with a higher degree of assumption to prove long-term relationship, unlike the shorter ones (from 2003) but that still remain crucial to this contribution. Reliability and usefulness of the estimates of enterprises and resulting aggregated indicators are discussed by Jílek, Pecáková and Vojta (2005).

As indicators of business tendency surveys are available in monthly values, it was necessary to convert them to quarterly values by using the chronological weighted averages to permit comparison with quarterly values of the cyclical component of the GDP. The disadvantage may be a loss of information that monthly data include. Jeřábková (2010) states that other complications include the fact that the GDP by sector calculation consists of gross value added of these sectors (including net taxes on products) but the questions in business tendency surveys concern e.g. aggregate demand or economic situations and not the gross value added development, thereby commensurability of both indicators is limited.

2.1.2 Economic indicators

It is appropriate to explore other candidates for the target leading and coincidence composite indicator respectively in addition to confidence indicators for the optimization of composite indicators. There are three types of economic indicators with regard to the development of GDP and its cyclical component respectively.

The first group is represented by the leading indicators. Their task is to predict turning points in the business cycle and they are considered to be the most important group. It is clear that the choice of spe-

cific indicators is a subjective issue but it is essential to comply with certain criteria of its selection, such as simple and timely availability, high frequency of detection and using indicators that are not subject to methodology changes. In the narrowest definition among these indicators I decided to classify building permits, the number of new contracts development and stock market index. Some authors include also the Industrial Production Index in their works. For this analysis the following indicators were chosen: building permits, new contracts in the construction, new domestic contracts in manufacturing, new contracts in manufacturing from abroad, Industrial Production Index and stock market index PX (all of them in the period from 1st quarter 2003 to 2nd quarter 2012).

The second group consists of so-called coincidence economic indicators with its goal to confirm or refute the actual course of the economic cycle. Their advantage is the fact that data are available before the estimates of GDP, although both are related to the same period. Again, the choice of these indicators is subjective. Regarding the data availability and assumptions of its development the used indicators are the unemployment rate, real GDP and the index of producer prices. Since I believe that it is not correct enough to include any component directly related to GDP into the composite indicator reflecting the development of GDP, I decided to include the following indicators to the analysis: unemployment rate, index of agricultural producer prices, index of industrial producer prices, index of construction prices and index of market services prices (all of them in the period from 1st quarter 2005 to 2nd quarter 2012).

The third group includes lagged indicators used to verify the course of economic growth backwards - consumer price index, money supply and retail sales. These indicators are not included in this contribution.

2.2 Visual analysis of selected indicators

Prior to the analysis of time series in terms of existing methods, the visual analysis was called being a good starting point for getting to know time series used with respect to its development and possible connection with the investigated business cycle.

The construction of line diagram represents the key outcome and recommendation used by Czesaný, Jeřábková (2009) as well. This diagram clearly and unequivocally helps to find the location of turning points and the prevailing trend of the time series. It is also useful to combine identifiable information from a diagram with the calculated correlation coefficient between the assessed series and the number and the business cycle and to assess whether it makes sense to assign an indicator to further analysis.

2.3 Co-integration analysis as a tool of relationship analysis

Co-integration analysis has become a relatively new tool for the analysis of the time series relationship. Arlt (1997) states that time series are co-integrated if the deflection of time series' direction is only short-term, fades away over time and there is a limit that cannot be exceeded. Then it can be said that time series are located in equilibrium representing a state that the system is constantly attracted to. It is important to distinguish between stationary and non-stationary time series for analysing the time series. Co-integration is an attribute needed to perform meaningful relationships analysis among time series. For more details see Arlt and Arltová (2009).

2.4 Construction of composite indicators

Composite indicator represents an indicator composed of partial indicators of the economic cycle. This reflects the development of the economies much better than individual indicators considered separately. However, selection of the sub-indicators is not random. It is based both on its economic significance, relevance value, prediction capability and on their degree of correlation with the business cycle and even on the resulting relationship between the business cycle and these indicators for the purpose of this

paper. Composition of the composite indicators in each country differs due to the significance of various indicators considered for the given economy.

Generally, there are three groups of indicators formed on the basis of its relationship to economic development. It includes leading indicators designed to predict turning points of the business cycle. Furthermore, there are coincidence indicators ordered to confirm or refuse the position of the economy and the last group are lagging indicators (this paper does not deal with them), that verify the current development of the business cycle. Tkáčová (2012) provides an overview of composite indicators' creation approaches.

3 RESULTS

This chapter introduces the most relevant results of the analysis that was at first performed for the relationships between business cycle and business tendency surveys' confidence indicators, as well as for the relationships between the business cycle and economic indicators preceding this cycle and indicators developing coincidently with the business cycle.

3.1 Relationships between business cycle and business tendency survey's indicators

The main finding is the fact that statistically significant dependence of GDP on all confidence indicators measured by business tendency survey was proved. In the analysis of its dependence on all these indicators together (except the confidence indicator in manufacturing because of its stationarity and except for the aggregate confidence indicator because of the duplicity) it is shown that GDP depends on its lagged value, on confidence indicators in trade, in services, in construction and consumer confidence indicator's lagged value. Although any long-term relationship was not shown, it can be stated that aggregate confidence indicator is an appropriate sub-indicator for CLI. VAR models for all partial indicators showed that statistically significant dependence exists between GDP and the corresponding number of partial confidence indicators, as well as in the case of examining the relationship between GDP and all these sub-indicators together, where the relationships were identified too, although only short-term. It is definitely caused by the relatively short time series and it can be assumed that there will be the evidence of long-term relationships in the future.

3.2 Relationships between business cycle and leading and coincidence economic indicators

From selected indicators which precede business cycle only one will not be included in the CLI, namely New Contracts in the Construction, as between its time series and GDP series have not been identified even any statistically significant short-term relationships. In the analysis of the relationship between GDP and all leading indicators its series were nonstationary, this indicator explains the development of GDP (albeit temporarily) with high, 5-quarter lag. Another such indicator is the Building Permit that relatively poorly explains GDP development (or its first difference). There is also very low correlation coefficient indicating very weak indirect linear dependence between the range of GDP values and range of Building Permits indicator's values.

Using the VAR model, short-term relationships between GDP and sectional coincidence economic indicators were modelled and although Market Services and Construction Work Price Indices did not seem to be appropriate for participation in the CCI by visual analysis, co-integration analysis refuted its ability to explain GDP development and therefore they will be included in the composite indicator. Composite indicators were constructed by 3 basic steps – normalization, weighting and aggregation. The resulting CLI (see Figure 1) was constructed with equal weights due to its better relationship to the business cycle, while CCI (see Figure 2) was constructed with different weights (derived by the correlation coefficient value between business cycle series and the relevant economic indicator's series) due to the same reason. Overview of all selected indicators for composite indicators' construction including used weights is represented by Table 2 in the case of CLI and by Table 3 in the case of CCI.

Table 2 Overview and Weights of Selected Economic Indicators Entering CLI

Leading Composite Indicator	Weight
Aggregate Confidence Indicator	0.2
New Contracts from Domestic Manufacturing	0.2
New Contracts from Abroad Manufacturing	0.2
Industrial Production Index	0.2
Stock Market Index PX	0.2

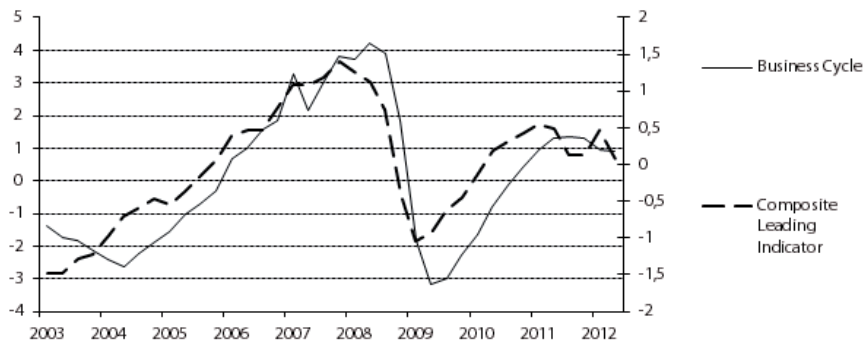
Source: Own calculation

Table 3 Overview and Weights of Selected Economic Indicators Entering CCI

Coincidence Composite Indicator	Weight
Unemployment Rate	0.3287
Agricultural Producer Price Index	0.3434
Manufacturing Producer Price Index	0.3099
Construction Work Price Index	0.0015
Market Services Price Index	0.0165

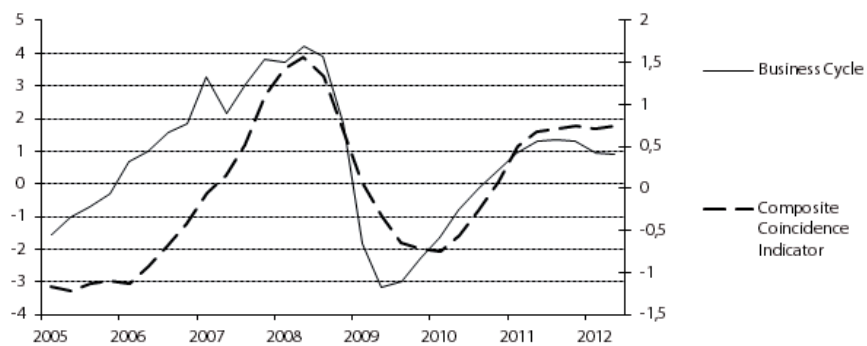
Source: Own calculation

Figure 1 Development of the Composite Leading Indicator (equal weights) and Business Cycle (in % of trend)



Source: Own construction

Figure 2 Development of the Composite Coincidence Indicator (different weights) and Business Cycle (in % of trend)



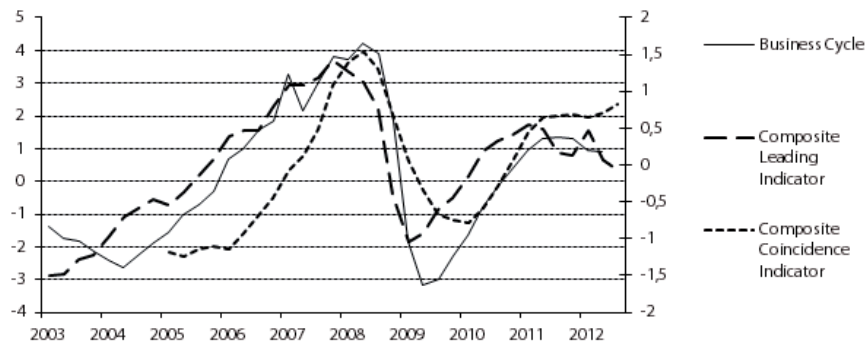
Source: Own construction

4 VERIFICATION OF THE RESULTING COMPOSITE INDICATORS REGARDING THE ACTUAL DEVELOPMENT OF THE BUSINESS CYCLE

All previous calculations and analyses included periods with beginnings chosen regarding the data availability. The last period was the second quarter of 2012. During writing this paper, monthly and quarterly values of considered coincidence and leading indicators of third quarter of 2012 were published and it allows usage of developed composite indicators to verify the quality of the estimation of quarterly GDP change for the third quarter of 2012.

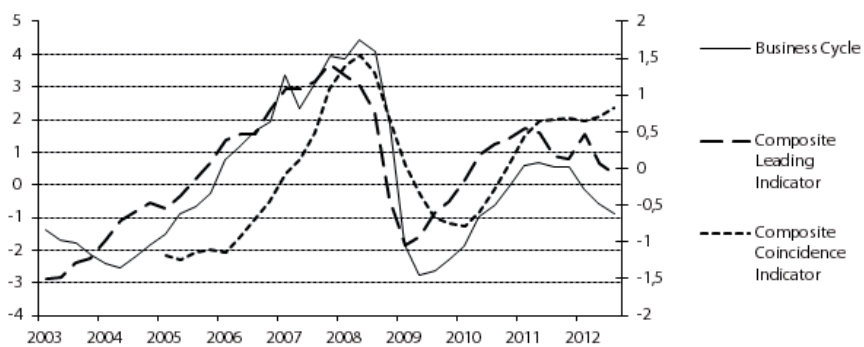
The value of the CCI is 0.833 in the third quarter of 2012 and 0.702 in the second quarter of 2012. From these values it is possible to conclude that GDP should increase quarter to quarter. If we look at the CLI and assuming that its value outpaces GDP usually about 2 quarters, this GDP growth assumption is confirmed. CLI's value is 0.063 in the second quarter of 2012 and -0.064 in the third quarter of 2012, so it is apparent that in the fourth quarter of 2012 and in the first quarter of 2013 GDP should decline. For illustration, see Figure 3 including business cycle, CLI and CCI.

Figure 3 Development of the Composite Leading Indicator, Composite Coincidence Indicator and Business Cycle (in % of trend)



Source: Own construction

Figure 4 Development of the Composite Leading Indicator, Composite Coincidence Indicator (right axis) and Business Cycle (in % of trend, left axis) including 3rd quarter of 2012



Source: Own construction

On 15th November 2012 (45 days after the end of the third quarter of 2012) a preliminary estimate of quarterly GDP, that declined by 0.3% quarter to quarter, was published by the Czech Statistical Office. Its seasonally adjusted value is 893.973 million CZK and value of the cyclical component expressed as

a deviation from the trend is 0.699%. Figure 4 captures the evolution of business cycle including third quarter of 2012 and the development of both composite indicators.

According to these results, the assumption of moderate business cycle growth is refuted. In the first quarter, CLI showed a blip that indicated business cycle could increase. It was also supported by the coincidence composite indicator's value increase but the reality consisted in the decrease of the business cycle. In conclusion, the constructed composite indicators are needed to be approached with caution. It is required to follow the individual economic indicators' (in the composite indicators entered) development and subject these composite indicators to regular revisions.

CONCLUSION

The issue of quarterly estimate of GDP is a relatively wide range of possible approaches to achieve this goal. Perhaps the biggest challenge is the lack of long time series that would certainly prove the presence of long-term relationships between GDP and economic indicators analysed. Another issue is the choice of economic indicators that vary in authors different approaches. For example, some indicators included are directly related or taking part in actual GDP, while this paper deals only with the basic economic indicators that can be found in macroeconomic textbooks and regarding data availability and timeliness. In this paper, majority of selected indicators affects manufacturing hence manufacturing has relatively important position in the Czech economy since there is more than one third of gross value added created in this industry.

In relation to the form of this analysis, it is necessary to emphasize the need of regular revisions of these composite indicators and the need of updating the weights used. However, it is necessary to treat these indicators with sufficient margin and to monitor the development of sub-indicators as a complementary source of data.

This contribution should serve rather as starting a new approach to the estimation of the development of quarterly GDP (using time series methods) that has to be further expanded and improved in the issues mentioned above. For further research it is also offered, in addition to the identifying the direction of GDP development, its quantification with subsequent validation and comparison with real development as well.

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