# Assessment of the Ability of the Business and Consumer Surveys to Predict the Gross Value Added of the Czech Republic

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***Abstract***

Business and Consumer surveys are designed to signal turning points and provide in advance the information about potential changes in the economic cycle. The authors, using advanced methods of time series analysis, especially Granger causality and vector autoregressive models, deal with the question of to what extent the results of the surveys in the form of confidence indicators are able to outpace the development of the Czech economy represented by gross value added. In addition, the authors, experimenting with the structure of surveyed questions and used weights, propose some modifications in the construction of confidence indicators as stipulated by the European Commission with the aim to improve their forecasting abilities.

***Keywords***

*Business and consumer survey, gross value added, vector autoregressive model, Granger causality, economic sentiment indicator, stationarity test of variables*

***JEL code***

*C10, C22, C51, C52, C83*

## INTRODUCTION

Business and Consumer Surveys (hereafter referred to as BCS) compiled under the Joint Harmonised EU Programme of Business and Consumer Surveys (hereafter referred as the BCS programme) provide mainly qualitative information on a wide range of variables useful for monitoring economic developments and detection of turning points in the economic cycle.

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The results are widely used for qualitative and quantitative analysis, surveillance and short-term forecasting by the Directorate General for Economic and Financial Affairs (hereafter referred to as DG ECFIN), European Central Bank, central banks, research institutes and financial institutions.

Compared to traditional statistical surveys, which usually cover only variables on one aspect of an enterprise's activity, BCS, especially business tendency surveys collect information about a wide range of variables selected for their ability, when analysed together, to give an overall picture of a sector of the economy. Moreover, the range of information covered by business tendency surveys goes beyond variables that can be easily captured in conventional quantitative statistics. Qualitative information may be collected for variables that are difficult or impossible to measure by conventional methods (e.g. capacity utilisation, factors limiting production, production capacity, expectation for the immediate future and others).

From the respondents' point of view, the provision of qualitative information within BCS is less burdensome and time consuming comparing to the provision of accounting or other quantitative information for conventional quantitative statistics. This enables BCS to conduct monthly surveys as early as in the first two or three weeks of each month and publish the results already before the end of month.

The BCS are therefore appreciated for high frequency, timeliness and harmonisation at least among the Member States and candidate countries.

The BCS programme was launched by the Commission decision of 15 November 1961. The first survey was the harmonised business survey in the manufacturing industry conducted in 1962. Since then, the sector coverage as well as geographical coverage has widened considerably covering now besides manufacturing sector, construction sector, retail trade, services sector and consumers of all Member States and candidate countries.

As the results of BCS are often used as a tool for forecasting of economic development represented by the development of the basic macroaggregates – gross domestic product (hereafter referred to as GDP) and / or gross value added (hereafter referred to as GVA) – in our work we first focused on the evaluation of the Czech Economic Sentiment Indicator's ability to predict the development of country's GVA. Afterwards, we tested several alternative approaches to the design of ESI in order to construct a model that would offer better conformity with the development of the original GVA time series.

Our analysis is based on the Granger causality test and the construction of standard vector autoregressive (hereafter referred to as VAR) models.

The paper is divided into the three chapters. The first one provides brief information on the organisation of the business and consumer surveys in the Czech Republic and mentions the connection between business tendency surveys, consumer opinion surveys and business cycle.

The second chapter describes the methods employed in the analysis and necessary adjustments of analysed data.

The last chapter presents the most important outcomes of the analysis.

Conclusion summarises the work done, results, findings for further thoughts and plans for further work.

## 1 RELATION OF BUSINESS TENDENCY AND CONSUMER OPINION SURVEYS TO BUSINESS CYCLE

### 1.1 Business and Consumer Surveys in the Czech Republic

The business tendency surveys in the Czech Republic are carried out by the Czech statistical office (hereafter referred to as CZSO), while the consumer opinion survey is conducted by the private market research organisation GFK Czech Republic. Both surveys are conducted according to a common methodology stipulated by the BCS programme.

The harmonisation within the BCS programme is governed by two basic principles:

1. all the national institutes involved in the BCS programme are obliged to use the same harmonised set of questions; and

2. they should conduct the surveys and transmit the results to DG ECFIN in conformity with the common timetable.

The BCS programme allows the national institutes to include additional questions, beyond the harmonised ones, in their questionnaires. The CZSO has used this option and supplemented the harmonised questions with the set of additional questions having predictive potential. Both sets of questions, harmonised and non-harmonised ones, were used in our analysis for construction of the alternative models to test their ability to forecast/predict the GVA development.

As regards surveys, CZSO conducts four surveys on a monthly basis in the following areas: manufacturing industry, construction, retail trade and services including financial services. All the questionnaires include additional questions that are asked on a quarterly basis. In addition, an investment survey of the manufacturing sector, which gathers information on companies' investment plans, is conducted twice a year.

Answers obtained from the surveys are aggregated in the form of "balances". Balances are constructed as a difference between the percentages of respondents giving positive and negative replies.

The balance series are then used to build composite indicators. The composite indicators for all surveyed sectors (manufacturing industry, construction, retail trade, services and consumers) are calculated as the simple arithmetic mean of the selected questions (seasonally adjusted balances). The questions included in the calculation (see Table 1, questions in bold) have been determined by the DG ECFIN. They were chosen with the aim of achieving an as highly as possible coincident correlation of the individual confidence indicators with a reference series (e.g. industrial production for the industrial confidence indicator). These indicators thus provide information on economic developments in different sectors.

The results for the individual business confidence indicators are consequently aggregated through the weighted arithmetic mean into the Business Climate Indicator (hereafter referred to as BCI). Economic Sentiment Indicator (hereafter referred to as ESI), whose purpose is to track GDP/GVA growth is then weighted arithmetic mean of the BCI and the Consumer Confidence Indicator (hereafter referred to as CCI). The weights used to calculate composite indicators are as follows:

- Manufacturing Industry: 40%,
- Services: 30%,
- Consumers: 20%,
- Construction: 5%,
- Retail Trade: 5%.

The weights have been set according to two criteria, namely "representativeness" of the sector in question and tracking performance vis-a-vis the reference variable.

### 1.2 Business and Consumer Surveys and their relationship to the Business Cycle

Business cycles are an important feature of the economies of market-oriented industrialised countries. The statistical series derived from Business Tendency and Consumer Opinion Surveys are particularly suitable for monitoring and forecasting business cycles. Data are available rapidly and survey information focuses on assessments and expectations of the economic situation by actors on the market. The cyclical profiles of the series are in many cases easy to detect because they contain no trend. The series are/should be seasonally adjusted, at least to some extent, already by the respondents. All these and the fact that they usually do not need revisions facilitate their use in forecasting and, in particular, in predicting turning points in the business cycle. For example, Zeman (2013) uses the Czech BCS data (together with other indicators having forecasting potential in relation to the business cycle) for construction of a leading composite indicator aiming at the forecasting of q-o-q changes of GDP using VAR models, Granger causality and co-integration analysis for testing the presence of long-term statistically significant relations.

**Table 1** The questions harmonized by DG ECFIN through the BCS programme

| Statement | Question | Rank of Question in the Statement |
|---|---|---|
| BTS in Manufacturing Industry | **Assessment of Current Overall Demand for Production** | **2** |
| | Assessment of Foreign Demand | 3 |
| | Development of Production Activity in the Past 3 Months | 5 |
| | **Assessment of Current Stocks of Finished Products** | **6** |
| | **Expected Development of Production Activity in the Next 3 Months** | **10** |
| | Expected Development of Number of Employees in the Next 3 Months | 11 |
| | Expected Development of Selling Prices in the Next 3 Months | 12 |
| BTS in Construction | Development of Construction Activity in the Past 3 Months | 2 |
| | **Assessment of Current Overall Demand for Production** | **3** |
| | **Expected Development of Employment** | **10** |
| | Expected Selling Prices Development in the Next 3 Months | 11 |
| BTS in Retail Trade | **Sales Development in the Past 3 Months** | **2** |
| | **Expected Sales Development in the Next 3 Months** | **3** |
| | Expected Development of Employment in the Next 3 Months | 4 |
| | Expected Selling Prices Development in the Next 3 Months | 5 |
| | **Assessment of Current Stocks** | **6** |
| | Expected Development of Requirements on Suppliers in the Next 3 Months | 7 |
| BTS in Selected Services | **Assessment of Current Overall Business Situation** | **1** |
| | **Assessment of Demand in the Past 3 Months** | **2** |
| | **Expected Development of Demand in the Next 3 Months** | **3** |
| | Number of Employees in the Past 3 Months | 4 |
| | Expected Development of Employment in the Next 3 Months | 5 |
| | Expected Price Development in the Next 3 Months | 6 |
| Consumer Tendency Survey | **Financial Situation of the Consumer Expected** | **x** |
| | **Expected general economic situation in the country** | **x** |
| | **Total Unemployment Expected** | **x** |
| | **Expected Savings of the Consumer in the Next 12 Months** | **x** |

**Note:** 1) Consumer Tendency Survey is performed by GFK Organisation.
2) The questions in bold enter the calculation of the composite indicators, i.e. the industrial confidence indicator, the construction confidence indicator, the retail trade confidence indicator, the services confidence indicator and the consumer confidence indicator.
**Source:** Czech Statistical Office, own construction

Fischer (2004) uses besides other things Czech BCS data for the construction of the model forecasting year-on-year quarterly GDP data development. For construction of models he uses regression analysis with the y-o-y changes of quarterly GDP at 1995 constant prices as dependent variable and confidence indicators as explanatory variables. The most successful model employs the retail trade confidence indicator as one of the explanatory variables. The forecast is carried out 40 days prior to the official data publication.

A similar use of Business Tendency and Consumer Opinion Survey data can be found abroad. For example, Abberger (2007) uses regression based on principal components and autoregressive time series models to predict the quarterly changes of German GDP.

KOF Swiss Economic Institute publishes one of the most observed leading indicators of economic activity so-called KOF Economic Barometer. Its predictive ability in forecasting y-o-y changes in real quarterly GDP growth in a relatively short period of time (16 quarters) is elaborated in the work of Silivestrovs (2010). In his tests he uses univariate autoregressive model. The important findings are that KOF Economic Barometer Granger-causes GDP and that a relatively high-quality predictions were achieved. The model enables to predict GDP up to seven months before the publication of the official estimate.

However, BCS data do not have to serve only to the GDP forecast and the economic cycle as such, but they can be used to predict the development of other economic indicators. Hansson et al. (2003) proved using the standard VAR models that the BCS can be useful as well for forecasting of other indicators such as unemployment, inflation or the exchange rate.

## 2 DATA AND METHODOLOGY

As already outlined in the previous chapter, we decided to apply one of the possible approaches to evaluate the ability of the BCS to predict the development of GVA, namely Granger causality with associated analysis by using standard VAR models. Eventual verification of co-integration relationships between examined time series is also a part of the analysis due to the possibility of the potential presence of statistically significant long-term relationship under certain conditions (Arlt, 1997).

### 2.1 Granger causality test and vector autoregressive models as tools for analysis of the relationships

Granger causality in connection with VAR models and co-integration analysis represent relatively popular methods for analysing the relationships among time series. There are several possible approaches to the analysis of time series. Given that we try to find the best possible prediction model, we decided to use standard VAR models in which both analysed variables are considered endogenous. This allows for a deeper analysis and revealing actual relationships between considered variables. The concept of the VAR model is generally considered useful for describing the dynamic behaviour of economic and financial time series and predictions.

In our paper, we decided to investigate the relationship among GVA and indicators from BCS. For our analysis we used software EViews 8 representing relatively widely used tool for studying time series and creation of econometric models.

In time series analysis we often wish to know whether changes of one variable have an impact on the changes of some other variable. The Granger causality test copes with this question. It can be used as a test for whether one of the variables is exogenous and therefore is not systematically affected by changes in another variable or a group of the other variables in the model. The concept of the causality that is fairly easy to deal with in the context of VAR models was for the first time defined by Granger (1969).

Granger causality can be described, using the interpretation provided by Arlt and Arltová (2009) or similarly by Lütkepohl and Krätzig (2004), as follows: if the variable *X* Granger causes the variable *Y*, the latter one can be predicted more accurately using the information supplied by the former variable, i.e. if for the following mean squared errors applies:

$$MSE\left[Y_t\left(h\middle|\Omega_t\right)\right] < MSE\left[Y_t\left(h\middle|\Omega_t \setminus \left\{X_{t-s}, s \geq 0\right\}\right)\right], \tag{1}$$

for at least one of the horizons h = 1, 2, …, where $\Omega_t$ is the set of all the past and present information existing at time $t$ and $\Omega_t \setminus \left\{X_{t-s},\ s \geq 0\right\}$ is the set of all the information except the past and present information of the $X_t$ process.

One should notice that Granger causality is not real causality in a deep sense of the word but only a statistical concept of causality based on prediction.

Foresti (2007) lists three different types of situations where Granger causality can be applied:

a) In a simple Granger causality test with two variables (with no model framework),
b) In Granger causality test with more than two variables (it is supposed that more than one variable can influence the results, two groups of variables are tested),
c) Within VAR models (test for the simultaneity of all included variables).

Our work deals with the latter approach to the Granger causality testing.

We considered matrix representation (2) describing the dependence of the process $Y_{1,t}$ on its lagged values and lagged values of the process $Y_{2,t}$ and furthermore, describing the dependence of the process $Y_{2,t}$ on the lagged values of the process $Y_{1,t}$ and on its own lagged values:

$$\begin{bmatrix} y_{1,t} \\ y_{2,t} \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} + \begin{bmatrix} a^1_{1,1} & a^1_{1,2} \\ a^1_{2,1} & a^1_{2,2} \end{bmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \end{bmatrix} + \ldots + \begin{bmatrix} a^p_{1,1} & a^p_{1,2} \\ a^p_{2,1} & a^p_{2,2} \end{bmatrix} \begin{bmatrix} y_{1,t-p} \\ y_{2,t-p} \end{bmatrix} + \begin{bmatrix} e_{1,t} \\ e_{2,t} \end{bmatrix}, \tag{2}$$

where $p$ stands for the length of lag per time point $t$, $a_{1,1}$, $a_{1,2}$, $a_{2,1}$ and $a_{2,2}$ stand for the regression coefficients for the corresponding lagged variables, $c_1$, $c_2$ stand for the constants and $e_1$, $e_2$ stand for random components of the models.

In this contribution we tried to identify the existence of such relationships so that we can say that the development of a single series is the cause of the development of the other series on one hand and the direction of the relationship to confirm the presence of the direction desired – whether base indices' past values ($t$–$s$) of ESI (and other tested indicators or past values of GVA) satisfactorily explain the development of GVA at time $t$ – on the other hand.

Also a situation may occur when bidirectional dependencies are identified. In this case it is necessary to decide on the basis of relevant criteria.

Considering the fact that the construction of VAR model is based largely on the regression analysis there may be common misconception that the model obtained is appropriate and desirable.

Generally known and frequently used criterion for evaluating the quality of the regressive model is determination index. However, the latter should not be used as quality criterion for the time series containing trend (Hebák et al., 2013). Not only due to this fact it is necessary to work with time-effect adjusted (stationary) time series. For testing stationarity we used the augmented Dickey-Fuller (hereafter referred to as ADF) test and significance level of 5%. If the test shows that time series tested is not stationary, it is necessary to stationarize it. Since the stochastic trend is present in the time series that is subject of analysis, differencing is sufficient for its stationarization and we call it difference-stationary.

For finding the most appropriate model performing better than the others (in the case of several comparable models) there is a related question of the order of model chosen. Order of VAR model represents the number of lags of individual variables occurring in the model. Arlt and Arltová (2009) recommend Akaike Information Criterion (hereafter referred to as AIC) as one of the criteria for order selection that should be minimized. In connection with this fact, Vrieze (2012) recommends to take into account AIC as more efficient in cases when the true model is not in the candidate model set. This is common for exploratory analyses and the case of our paper. Other frequently used criteria describe e.g. Lütkepohl and Krätzig (2004). For VAR model of order $p$, i.e. VAR($p$) with a constant, AIC can be expressed as follows:

$$AIC(p) = \ln\left|\hat{\Sigma}_a\right| + \frac{2l(pl+1)}{T}, \tag{3}$$

where $\hat{\Sigma}_a$ stands for estimated residual covariance matrix based on the corresponding VAR model, $p$ stands for model order, $l$ stands for process dimension (number of variables in the system) and $T$ stands for the number of periods (in given time series according to the corresponding VAR model).

A substantial criterion is then the compliance of the estimated values by selected VAR model with the observed values of the response variable. The aim of our contribution was directly related to this as we assumed that the response variable should be represented by the q-o-q GVA change or its absolute changes in the case the differencing of series is necessary. Additionally, we strived to demonstrate the desired direction of the relationship between time series tested.

### 2.2 Co-integration analysis

In econometric analysis and their modelling short-term and long-term relationships are usually distinguished. Short-term relationships exist only in a relatively short time period and after a certain time they disappear. On the contrary, long-term relationships are long lasting and do not disappear. When the diversion of the trends is only short-term, disappears over time and there is a boundary that cannot be exceeded, we talk about co-integration of time series (Arlt, 1997) and it applies:

$$\{X_t\} \sim I(1) \text{ and } \{Y_t\} \sim I(1), \text{ then } \{aX_t + bY_t\} \sim I(0), \tag{4}$$

where $\{X_t\}$ and $\{Y_t\}$ are processes integrated of order 1, therefore non-stationary and their linear combination with constants $a$ and $b$ is integrated of order 0, therefore stationary. This thesis can be generalized and we can say that co-integration occurs when certain linear combination of the variables in vector process is integrated of lower order than the process itself (Juselius, 2006).

The presence of co-integration implies the presence of short-term and long-term relationships that can be captured and separated by the Error Correction model (EC model) according to the formula (5):

$$\Delta Y_t = \alpha(1-p) + \beta \Delta X_t + (p-1)[Y_{t-1} - \beta X_{t-1}] + a_t, \tag{5}$$

where $\alpha$ and $\beta$ are the estimated model parameters, $a_t$ is white noise process and $(p-1)$ term is the loading parameter expressing how strongly the long-term relationship between time series is promoted. The inclusion of co-integrated variables into VAR model would mean an incorrect specification.

There is a variety of tests for verification the presence of co-integration. The best known ones include e.g. Engel and Granger two-stage test based in the first stage on the estimation of co-integration vector by static regression using least squares method and in the second stage the resulting residues from this static regression model are applied to the EC model. Another frequently used test, suitable especially if the presence of more co-integration relationships is expected, is Johansen co-integration test based on the rank identification in the matrix of long-term relationships. To determine the number of co-integration vectors the maximum likelihood method is used. For more information see Arlt and Arltová (2009).

### 2.3 Data adjustment

All the analyses referred to the exploration of relationships between q-o-q GVA changes at 2010 constant prices and the series of base indices of the confidence indicators based on balances computed as arithmetic mean for selected seasonally adjusted questions. We chose the period from the first quarter of 2003 to the third quarter of 2014 as there are all indicators recalculated according to the current classification CZ-NACE since 2003.

Series of q-o-q GVA changes was not further modified due to the fact that after conversion to base indices the course of series and results are almost identical. Likewise, there are no different results if we include only the cyclical component of GVA into the analysis (tested by using Hodrick-Prescott filter).

ESI is generally calculated as weighted arithmetic mean of seasonally adjusted confidence indicators in manufacturing industry, construction, retail trade, selected services and CCI. The calculation of confidence indicators in the individual sectors and CCI is briefly described in the chapter 1.1, for more detailed information see the relevant methodology of the Czech Statistical Office.

Base indices of ESI and other confidence indicators respectively which are based on the average value of 2010 were calculated according to the following formula:

$$B = 100\frac{X}{\overline{X}}, \tag{6}$$

where $B$ stands for confidence indicator's base index, $X$ stands for averaged business cycle balance in a given sector + 100 and $\overline{X}$ stands for the average value of $X$ in 2010.

The average balance in the denominator (base period) was calculated for 2010 and not for 2005 as in the data published by the Czech Statistical Office for reasons of consistency with GVA valued at constant prices of 2010 published since September 2014 by implementation of the new European standard of national accounts ESA 2010 which brought several significant changes in comparison to the former ESA 1995 (Sixta et al., 2016). The advantage of such base indices is the fact that we avoid negative values in analysis. Further, the monthly series of indices was aggregated to quarterly series by ordinary arithmetic mean to be consistent with GVA series.

In order to be able to perform the analysis and get relevant and unbiased results, it was necessary to seasonally adjust all the series though the usual practice is that respondents of BCS are requested for seasonally adjusted data. We chose TRAMO/SEATS method for seasonal adjustment as there is no problem with negative values occurring in series of balances. It is one of the methods along with X-12 ARIMA suggested by official OECD manual (2003).

The initial state at the beginning of the analysis was therefore seasonally adjusted time series of q-o-q GVA changes at 2010 constant prices and seasonally adjusted quarterly series of ESI base indices consisting of sectors' confidence indicators and CCI that were based on the balances of the questions stipulated by the BCS programme.

### 2.4 Procedure specification

We divided the analysis into the two steps. In the first step we tested the initial state, i.e. we assessed the nature of the relationship between the time series of q-o-q indices of GVA and base indices of ESI.

Subsequently, we experimented with the questions surveyed within the Czech BCS and weights used for the calculation of ESI in order to find such an alternative ESI that would be able to better predict the GVA development. As for the questions, we started with the tests of predictive ability of the harmonized questions – the questions included in the questionnaires in conformity with the BCS programme (see Table 1). Then, we proceeded to test the predictive ability of the other surveyed (non-harmonized) questions (see Table 3 of the Annex). We tested only those questions for which we could calculate balances (i.e. the difference between the percentages of respondents giving positive and negative replies) and tests were performed for each question separately.

On the basis of the results we divided those questions for which it was confirmed a statistically significant relationship with the development of q-o-q changes of GVA into two groups. In the first group we included all the questions for which it was confirmed statistically significant relationship with the development of q-o-q changes of GVA, in the second one only those for which it was confirmed a statistically significant relationship with a certain quality of the regression model measured by the modified index of determination. The boundaries of the modified index of determination were set subjectively, on empirical basis and separately for each sector.

Subsequently, separately for the two groups of questions, we tested individual sector confidence indicators aggregating them afterwards to the BCI. This is how we calculated the two types of the BCIs – the first one was calculated on the basis of the questions which showed a statistically significant relationship with the development of q-o-q changes of GVA, the other is calculated on the basis of the questions which showed a statistically significant relationship with the development of q-o-q changes of GVA having the certain quality of the regression model (see chapter 3).

As regards weighting the sector confidence indicators when computing the BCI, we tested two sets of weights. The first set was derived from the share of GVA of individual sectors (manufacturing industry, construction, retail trade, services) in total 2010 GVA. As the population of the business part of the BCS includes only the enterprises classified in the sectors of non-financial corporations, financial corporations, employers and own-account workers of the institutional sectors classification of the National Accounts (i.e. S.11, S.12, S.141 and S.142) and the sample includes in fact almost exclusively only enterprises classified in the sectors S.11 and S.12, the second set of weights was derived from the shares of the individual sectors/industries in combination with the institutional sectors S.11 and S.12 in total 2010 GVA for institutional sectors in question.

In the same way as in the case of BCI we were looking for a better model for CCI. Having two versions of BCI and CCI, we could derive the two versions of ESI. As it is presented in the next chapter both models show better predictive characteristic comparing the model based on the BCS programme.

After assembling the models we supplement our analysis with out-of-sample forecasts of q-o-q GVA for the period from the fourth quarter of 2014 to the second quarter of 2016.

## 3 MAIN RESULTS

After the necessary data adjustment, we first analysed the initial state considering the nature of relationships between q-o-q GVA changes and ESI in the form of base indices related to the 2010 average (see Figure 1).

ADF test results for GVA and the key confidence indicators indicate that the null hypothesis of non-stationarity of q-o-q GVA changes time series is rejected. Regarding confidence indicators in levels, the null hypothesis was not rejected in all the cases. After its first differencing the null hypothesis is rejected, i.e. for all confidence indicators it was proved that only first difference is needed to stationarize them. All models are presented with statistically significant variables. Greek letter delta indicates that the specific series was differentiated to stationarize it. The number in the square brackets stands for the modified determination index obtained from the model. All models have undergone diagnostic tests for residuals (no autocorrelation, constant variance and normal distribution of residuals). Response variables in the following models are estimates.

In the case of initial state, we came to the system of models:

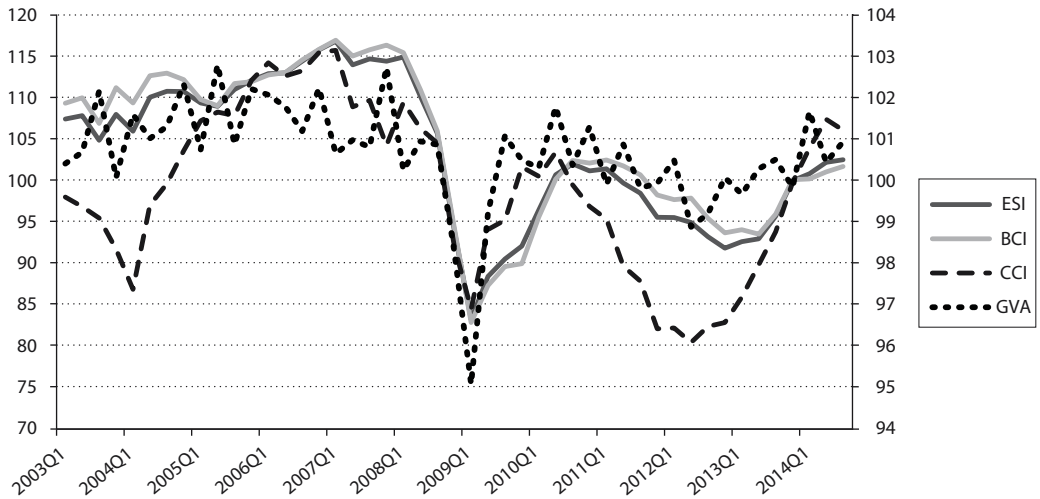
$$\begin{aligned} \hat{GVA}_t &= 49.949 + 0.193\, GVA_{t-2} + 0.453\, GVA_{t-3} + 0.321\, \Delta ESI_{t-1} && [0.502] \\ \Delta \hat{ESI}_t &= 115.587 - 1.138\, GVA_{t-2} + 0.692\, GVA_{t-3} + 0.547\, \Delta ESI_{t-1} && [0.257] \end{aligned} \tag{7}$$

Upon closer examination we conclude that there is statistically significant short-term relationship between the time series but it cannot be characterized as too tight. Q-o-q GVA changes are influenced both by its lagged value of two and three quarters and one quarter lagged value of the ESI change. A similar conclusion was reached in case of BCI assessment. However, in this case the q-o-q GVA changes are influenced by only its lagged value of three quarters and one quarter lagged value of the BCI change,

$$\begin{aligned} \hat{GVA}_t &= 0.469\, GVA_{t-3} + 0.311\, \Delta BCI_{t-1} && [0.431] \\ \Delta \hat{BCI}_t &= 1.241\, GVA_{t-3} + 0.706\, \Delta BCI_{t-1} && [0.353] \end{aligned} \tag{8}$$

In both above mentioned cases it was proved that the series of changes in the corresponding confidence indicator Granger causes the series of q-o-q GVA. This and the following results of Granger causality tests are presented in Table 4 of the Annex.

**Figure 1** Seasonally adjusted series of q-o-q GVA changes in % (right axis) and base indices of ESI, BCI and CCI in % (average of 2010 = 100, left axis)




**Source:** Own construction

Since we rejected the null hypothesis that the series of q-o-q GVA changes contains unit root within ADF test, we conclude that there cannot be long-term statistically significant relationships and therefore we leave co-integration analysis aside.

In the next step we searched for ways to ensure the improvement of the relationship's nature between confidence indicators and GVA. First, we tested in a similar way, besides the harmonised questions (see Table 1), other (non-harmonised) questions listed in Table 3 of the Annex. Numbers in the next part indicate the rank of the question in the statement in question.

In manufacturing industry, we proved the relationship for questions 1, 2, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16 and 18. According to the results, boundary of determination index (see chapter 2.4) was set to 0.4, which is met for questions 1, 10, 14 and 15.

In construction sector we identified statistically significant relationship for questions 3, 6 and 11. For last two questions the determination index reaches at least 0.15.

In retail trade sector relationship was proved for questions 2, 3, 7, 9 and 10. Questions 2, 9 and 10 reach determination index of at least 0.19.

In the sector of services there is only one question with relationship to GVA, namely Expected Development of Overall Business Situation in the Next 3 Months (number 7 in the statement) with determination index of 0.18.

Finally, we tested questions from the consumer survey with statistically significant relationship for Expected general economic situation in the country and Expected Total Unemployment both reaching determination index above 0.16.

The results for the individual confidence indicators obtained from questions with proved short-term relationship (marked by *a*) and from questions reaching the threshold of modified determination index (marked by *b*) are as follows:

*Manufacturing Industry*

$$\begin{aligned} a)\ \hat{GVA}_t &= 0.457\ GVA_{t-3} + 0.321\ \Delta CI_{t-1} && [0.481] \\ \Delta\hat{CI}_t &= 0.993\ GVA_{t-3} + 0.653\ \Delta CI_{t-1} && [0.335] \end{aligned} \qquad (9)$$

*b*) $\hat{GVA}_t = 55.372 + 0.334\ GVA_{t-3} + 0.174\ \Delta CI_{t-1}$ [0.504]
$\Delta\hat{CI}_t = 203.837 + 0.927\ GVA_{t-3} + 0.390\ \Delta CI_{t-1}$ [0.150] (10)

*Construction*

*a*) $\hat{GVA}_t = 53.993 + 0.463\ GVA_{t-1}$ [0.120]
$\Delta\hat{CI}_t = -203.809 + 2.014\ GVA_{t-1}$ [0.096] (11)

*b*) $\hat{GVA}_t = 44.444 + 0.558\ GVA_{t-1}$ [0.167]
$\Delta\hat{CI}_t = -173.378 + 1.714\ GVA_{t-1}$ [0.049] (12)

*Retail Trade*

*a*) $\hat{GVA}_t = 67.454 + 0.330\ GVA_{t-1} + 0.082\ \Delta CI_{t-1}$ [0.195]
$\Delta\hat{CI}_t = -38.516 + 0.379\ GVA_{t-1} - 0.298\ \Delta CI_{t-1}$ [0.044] (13)

*b*) $\hat{GVA}_t = 71.604 + 0.289\ GVA_{t-1} + 0.147\ \Delta CI_{t-1}$ [0.302]
$\Delta\hat{CI}_t = -59.695 + 0.590\ GVA_{t-1} - 0.107\ \Delta CI_{t-1}$ [–0.005] (14)

*Services*

*a*) $\hat{GVA}_t = 77.565 + 0.105\ \Delta CI_{t-1}$ [0.184]
$\Delta\hat{CI}_t = -98.190 - 0.146\ \Delta CI_{t-1}$ [0.038] (15)

*b*) the same as *a*)

*Consumers*

*a*) $\hat{GVA}_t = 39.159 + 0.492\ GVA_{t-3} + 0.145\ \Delta CI_{t-1} - 0.057\ \Delta CI_{t-3}$ [0.477]
$\Delta\hat{CI}_t = 241.049 + 1.567\ GVA_{t-3} + 0.351\ \Delta CI_{t-1} - 0.029\ \Delta CI_{t-3}$ [0.225] (16)

*b*) the same as *a*)

Generally, the better results were obtained if the balances of questions with statistically significant proved relationship and determination index exceeding certain chosen limit are used for construction of partial confidence indicators.

Subsequently, we approached to the construction of BCI and ESI. Again, they are based on questions identified by the existence of relationship (models 17 and 19) and questions identified by the boundary of determination index (models 18 and 20). In order to construct BCI it was necessary to find a clue how to weigh partial confidence indicators. Therefore, we decided to use weights specified by given sector's GVA share on the total GVA in 2010 from data supplied by National Accounts. Weighting scheme has the following form:

- Manufacturing Industry: 30.39%,
- Services: 43.66%,
- Construction: 6.98%,
- Retail Trade: 18.97%.

When designing ESI, the weight of consumers was set to 20%. Therefore, the weights of individual sectors were multiplied by the value of 0.8.

*Business Climate Indicator*

$$\begin{aligned} a)\ & \hat{GVA}_t = 89.497 + 0.217\ \Delta BCI_{t-1} && [0.314] \\ & \Delta \hat{BCI}_t = -18.315 + 0.188\ \Delta BCI_{t-1} && [0.010] \end{aligned} \tag{17}$$

$$b)\ \hat{GVA}_t = 0.475\ GVA_{t-3} + 0.371\ GVA_{t-4} + 0.313\ \Delta BCI_{t-1} + 0.148\ \Delta BCI_{t-2} - 0.149\ \Delta BCI_{t-4} \quad [0.468]$$

$$\Delta \hat{BCI}_t = 0.834\ GVA_{t-3} + 0.313\ GVA_{t-4} + 0.375\ \Delta BCI_{t-1} + 0.536\ \Delta BCI_{t-2} - 0.507\ \Delta BCI_{t-4} \quad [0.168] \tag{18}$$

*Economic Sentiment Indicator*

$$a)\ \hat{GVA}_t = 53.892 + 0.458\ GVA_{t-3} + 0.331\ GVA_{t-4} + 0.318\ \Delta ESI_{t-1} + 0.159\ \Delta ESI_{t-2} \quad [0.488]$$

$$\Delta \hat{ESI}_t = 62.065 + 0.873\ GVA_{t-3} + 0.080\ GVA_{t-4} + 0.479\ \Delta ESI_{t-1} + 0.450\ \Delta ESI_{t-2} \quad [0.143] \tag{19}$$

$$\begin{aligned} b)\ & \hat{GVA}_t = 50.459 - 0.442\ GVA_{t-1} + 0.544\ GVA_{t-3} + 0.386\ GVA_{t-4} + \\ & + 0.287\ \Delta ESI_{t-1} + 0.153\ \Delta ESI_{t-2} - 0.100\ \Delta ESI_{t-4} && [0.563] \\ & \Delta \hat{ESI}_t = 99.160 - 1.288\ GVA_{t-1} + 1.285\ GVA_{t-3} + 0.345\ GVA_{t-4} + \\ & + 0.538\ \Delta ESI_{t-1} + 0.476\ \Delta ESI_{t-2} - 0.436\ \Delta ESI_{t-4} && [0.257] \end{aligned} \tag{20}$$

At this stage we reached a slight improvement in BCI and ESI model due to higher number of statistically significant variables in models.

There are 7 common questions in retail trade and services sectors. We decided to merge these questions to increase their predictive potential and test the character of relationships for each merged question separately, then for confidence indicator of retail trade + services and in the final phase for BCI and ESI.

Based on the results we conclude that statistically significant short-term relationship was found for the following questions: Assessment of Current Overall Business Situation, Expected Development of Overall Business Situation in the Next 3 Months and Expected Development of Overall Business Situation in the Next 6 Months. All with modified determination index above 0.18. We constructed confidence indicator according to these questions with weight of retail trade 12.5% and services 87.5%. These weights were derived from the scheme shown below (services with weight of 40.41% and retail trade with weight of 5.77% are in the ratio of 87.5% and 12.5%). Even in this case we proved that confidence indicator of these two linked sectors Granger causes q-o-q GVA changes.

The system of models is as follows:

$$\begin{aligned} & \hat{GVA}_t = 84.236 + 0.178\ \Delta CI_{t-1} && [0.236] \\ & \Delta \hat{CI}_t = -42.160 + 0.120\ \Delta CI_{t-1} && [0.027] \end{aligned} \tag{21}$$

At the same time, we tried to find a different weighting scheme that would better reflect the structure of the business tendency surveys samples. This scheme is again represented by the share of GVA for given sector on the total GVA in 2010. However, at this point we took into account only institutional sectors of non-financial corporations and financial corporations (see also the chapter 2.4). In this case:

- Manufacturing Industry: 46.27%,
- Services: 40.41%,
- Construction: 7.55%,
- Retail Trade: 5.77%.

Using merged retail trade and services confidence indicator and adjusted weighting scheme the following systems were derived:

For Business Climate Indicator:

$$a)\quad \begin{aligned} \hat{GVA}_t &= 0.548\, GVA_{t-3} + 0.380\, GVA_{t-4} + 0.385\, \Delta BCI_{t-1} - 0.162\, \Delta BCI_{t-4} \quad [0.483] \\ \Delta \hat{BCI}_t &= 0.910\, GVA_{t-3} + 0.223\, GVA_{t-4} + 0.630\, \Delta BCI_{t-1} - 0.441\, \Delta BCI_{t-4} \quad [0.263] \end{aligned} \tag{22}$$

$$b)\quad \begin{aligned} \hat{GVA}_t &= 0.506\, GVA_{t-3} + 0.354\, GVA_{t-4} + 0.300\, \Delta BCI_{t-1} - 0.146\, \Delta BCI_{t-4} \quad [0.498] \\ \Delta \hat{BCI}_t &= 1.007\, GVA_{t-3} + 0.185\, GVA_{t-4} + 0.453\, \Delta BCI_{t-1} - 0.451\, \Delta BCI_{t-4} \quad [0.203] \end{aligned} \tag{23}$$

For Economic Sentiment Indicator:

$$a)\quad \begin{aligned} \hat{GVA}_t &= 44.983 - 0.489\, GVA_{t-1} + 0.596\, GVA_{t-3} + 0.400\, GVA_{t-4} + 0.366\, \Delta ESI_{t-1} + 0.165\, \Delta ESI_{t-2} \\ &\quad [0.562] \\ \Delta \hat{ESI}_t &= 70.722 - 1.156\, GVA_{t-1} + 1.185\, GVA_{t-3} + 0.206\, GVA_{t-4} + 0.683\, \Delta ESI_{t-1} + 0.386\, \Delta ESI_{t-2} \\ &\quad [0.319] \end{aligned} \tag{24}$$

$$b)\quad \begin{aligned} \hat{GVA}_t &= 47.221 - 0.419\, GVA_{t-1} + 0.546\, GVA_{t-3} + 0.379\, GVA_{t-4} + \\ &\quad + 0.297\, \Delta ESI_{t-1} + 0.149\, \Delta ESI_{t-2} - 0.114 * \Delta ESI_{t-4} \quad [0.557] \\ \Delta \hat{ESI}_t &= 95.584 - 1.182\, GVA_{t-1} + 1.260\, GVA_{t-3} + 0.221\, GVA_{t-4} + \\ &\quad + 0.534\, \Delta ESI_{t-1} + 0.446\, \Delta ESI_{t-2} - 0.427\, \Delta ESI_{t-4} \quad [0.259] \end{aligned} \tag{25}$$

When comparing the results of the initial state with the results after the above described adjustments of the confidence indicators' composition and weighting scheme, we can conclude, at least on the basis of the number of statistically significant variables and the modified indices of determination that the adjustment led to certain improvements of the predictive capability of the models.

In order to practically prove that the adjustments helped to improve the predictive capability of the models, we proceeded to construct out-of-sample forecasts of GVA for the period from the fourth quarter of 2014 to the second quarter of 2016. Evaluation was carried out for VAR models containing the BSI and ESI variables, as they are the core of our analysis, by using root mean squared error (RMSE) as a measure of differences between values predicted by model ($\hat{y}_t$) and values actually observed ($y_t$).

$$RMSE = \sqrt{\frac{\sum_{t=1}^{n} (\hat{y}_t - y_t)^2}{n}} \tag{26}$$

Results are listed in Table 2.

From the results for Economic Sentiment Indicator in Table 2 we can conclude that by comparing the initial state of ESI with the modification based on the adjustment of the weighting scheme (share of GVA of particular industry on the total GVA in 2010) we obtain worse results with inclusion of all the questions with statistically significant short-term relationship with GVA. Conversely, there is a significant improvement in results if only the questions exceeding aforementioned boundaries of modified determination index are included into the confidence indicators with RMSE of 0.469. If we consider the same weights given by share of GVA on the total GVA in 2010 but considering only non-financial and financial corporations and merging questions in retail trade and services industries, there is also

**Table 2** Root Mean Square Errors for Out-of-Sample Forecasts 2014Q4–2016Q2

| System of Equations | Response Variable | RMSE (AIC) |
|---|---|---|
| 7 | $G\hat{V}A_t$ | 0.525 |
| | $\Delta E\hat{S}I_t$ | 1.456 |
| 8 | $G\hat{V}A_t$ | 0.484 |
| | $\Delta B\hat{C}I_t$ | 1.617 |
| 17 | $G\hat{V}A_t$ | 0.406 |
| | $\Delta B\hat{C}I_t$ | 1.279 |
| 18 | $G\hat{V}A_t$ | 0.446 |
| | $\Delta B\hat{C}I_t$ | 1.829 |
| 19 | $G\hat{V}A_t$ | 0.604 |
| | $\Delta E\hat{S}I_t$ | 2.732 |
| 20 | $G\hat{V}A_t$ | 0.469 |
| | $\Delta E\hat{S}I_t$ | 2.589 |
| 22 | $G\hat{V}A_t$ | 0.470 |
| | $\Delta B\hat{C}I_t$ | 1.319 |
| 23 | $G\hat{V}A_t$ | 0.433 |
| | $\Delta B\hat{C}I_t$ | 1.934 |
| 24 | $G\hat{V}A_t$ | 0.488 |
| | $\Delta E\hat{S}I_t$ | 1.898 |
| 25 | $G\hat{V}A_t$ | 0.373 |
| | $\Delta E\hat{S}I_t$ | 2.014 |

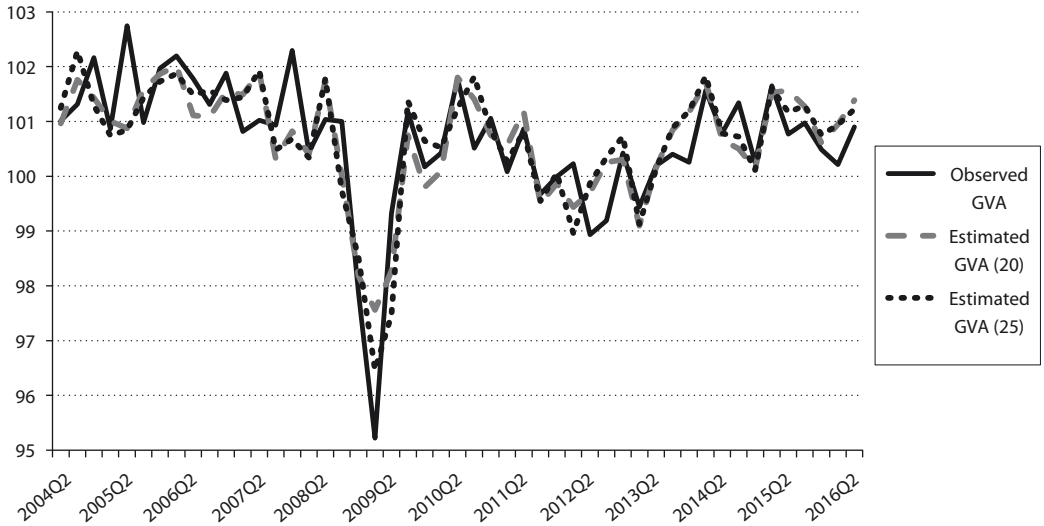
**Source:** Own calculation

an improvement over the initial state in both cases. However, overall the greatest conformity with the evolution of GVA is achieved in system (25). The course of actual and estimated values of q-o-q GVA according to the aforementioned system (25) and the second best system (20) is depicted in Figure 2.

Regarding Business Climate Indicator, in comparison to the initial state there is an improvement when using the weighting scheme of the GVA share on the total GVA in 2010 (RMSE decreases from 0.484 to 0.406). If we consider the weighting scheme with the inclusion of only non-financial and financial corporations and merging the common questions in retail trade and services industries, we obtain slightly better results when RMSE decreases to 0.470 (statistically significant short-term relationship between given questions and GVA) and to 0.433 (questions exceeding given boundary of determination index).

For models with BCI and ESI occurring as response variables there are values of RMSE relatively high and therefore the predictive ability of such models is poor. Overall, we can conclude that neither differences of ESI nor BCI tend to be explained well by development in q-o-q GVA, whereas relatively low levels of RMSE are achieved by models where q-o-q GVA is explained by differences of BCI and ESI. Although there is a leeway for improvement of the results, the results confirm to some extent the leading character of BCS indicators.

**Figure 2** Observed and estimated values of q-o-q GVA changes in % based on system (20) and (25)




**Source:** Own construction

## CONCLUSION

The aim of this paper was to assess the ability of ESI to predict the development of GVA expressed in the form of q-o-q changes. Initial state with parameters set as they are currently used officially in conformity with the methodology determined by the European Commission was analysed. Furthermore, the predictive ability of individual questions surveyed within as well as beyond the BCS programme was analysed and alternative models of BCI, CCI and ESI were suggested.

The results of the models of those questions currently used to construct sectors' confidence indicators show that except for the manufacturing industry (2 out of 3 questions with significant short-term relationship) they do not evince predictive ability towards q-o-q GVA changes.

Generally, the worst situation seems to be in services sector where no question currently used shows any relationship with q-o-q GVA changes. Just a little better situation was detected in construction and retail trade sector with short-term relationship proved for 1 out of 2 questions in construction and 1 out of 3 questions in retail trade. As regards consumers a relationship was identified for only 2 out of 4 questions entering the calculation of CCI.

Experimenting with the alternative questions surveyed within the BCS and weights of sectors in question derived from National Accounts statistics we managed to find the alternative models showing some improvements in the predictive ability of the ESI towards GVA development.

Considering all the obtained results we can conclude that the predictive ability of BCS could be considerably improved. When speaking about improvements there are several factors that should be taken into account. Questions entering BCS are largely harmonized across the European Union countries and therefore proper understanding and their accurate translation is crucial.

Analysis made by the CZSO showed that the answers reported by the units under survey do not always correspond to the results later reported by the same units within the conventional statistics. The CZSO in cooperation with the University of Economics, Prague, plans in this regard to realize a "survey on survey" project which aims to more detailed analysis of BCS with respect to the evaluation of respondents' answers quality, how far they provide the relevant information with respect to other business statistics and what are the reasons for inconsistencies.

One of the reasons affecting the relevance of the results might be the issue of to what extent are the people responding to the questionnaire informed about the current economic situation of the enterprise in question, its investment plans, factors influencing investments and about other information necessary for the correct completion of the questionnaire. The questionnaire is designated for people familiar with the current economic situation and plans of the respective enterprise, ideally for managers. However, answering the questionnaire is often delegated to subordinates who may not have the information required. This is closely connected with the fact that people who do not have the access to the relevant information might be easily influenced by the past and particularly by the presence in their prospects for future. This subsequently causes the leading character of survey's results disappear.

Last but not least, it is necessary to stress that the test results of the predictive ability of the BCS towards the development of the reference indicators might be influenced by the methodology selected. We are aware of the fact that the methodology chosen for our tests is just one of many other possible ways and alternative methodologies may give better results. Therefore, we plan to continue analysing the issue with the aim to suggest an alternative construction of ESI better reflecting the specificities of the Czech economy having strong relationship with the GVA development. We have already started the testing of alternative weights derived from the structural business statistics with promising results. Moreover, besides VAR models, we consider to employ alternative ways of assessing the relationships between time series. One of the possible alternatives could be so called bridge equations models based on the linking high and low frequency variable.

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# ANNEX

**Table 3** The questions included in the Czech BCS, beyond the harmonized questions, used in the analysis

| Statement | Question | Rank of Question in the Statement |
|---|---|---|
| BTS in Manufacturing Industry | Assessment of Current Overall Business Situation | 1 |
| | Assessment of Total Demand in the Past 3 Months | 4 |
| | Assessment of Current Insolvency | 7 |
| | Expected Development of Overall Business Situation in the Next 3 Months | 8 |
| | Expected Development of Overall Business Situation in the Next 6 Months | 9 |
| | Expected Development of Total Demand in the Next 3 Months | 13 |
| | Expected Development of Total Export in the Next 3 Months | 14 |
| | Expected Development of Total Import in the Next 3 Months | 15 |
| | Expected Ability to Meet Liabilities in Time in the Next 3 Months | 16 |
| | Expected Development of Production Capacity in the Next 3 Months | 18 |
| | Expected Development of Stocks of Raw Materials and Supplies in the Next 3 Months | 20 |
| BTS in Construction | Assessment of Current Overall Business Situation | 1 |
| | Assessment Current Insolvency (Liabilities in Time) | 5 |
| | Expected Development of the Overall Business Situation in the Next 3 Months | 6 |
| | Expected Development of the Overall Demand for Construction Work in the Next 3 Months | 8 |
| | Expected Development of Construction Activity in the Next 3 Months | 9 |
| BTS in Retail Trade | Assessment of Current Overall Business Situation | 1 |
| | Assessment of Overall Business Situation in the Past 3 Months | 8 |
| | Expected Development of Overall Business Situation in the Next 3 Months | 9 |
| | Expected Development of Overall Business Situation in the Next 6 Months | 10 |
| BTS in Selected Services | Expected Development of Overall Business Situation in the Next 3 Months | 7 |
| | Expected Development of Overall Business Situation in the Next 6 Months | 8 |

**Source:** Czech Statistical Office, own construction

**Table 4** Granger Causality Test in VAR Models

| System of Equations | Response Variable | P-value | Does Explanatory Variable Granger Cause Response Variable? |
|---|---|---|---|
| 7 | $G\hat{V}A_t$ | 0.000 | Yes |
| | $\Delta E\hat{S}I_t$ | 0.022 | Yes |
| 8 | $G\hat{V}A_t$ | 0.000 | Yes |
| | $\Delta B\hat{C}I_t$ | 0.011 | Yes |
| 9 | $G\hat{V}A_t$ | 0.000 | Yes |
| | $\Delta\hat{C}I_t$ | 0.013 | Yes |
| 10 | $G\hat{V}A_t$ | 0.000 | Yes |
| | $\Delta\hat{C}I_t$ | 0.045 | Yes |
| 11 | $G\hat{V}A_t$ | 0.366 | No |
| | $\Delta\hat{C}I_t$ | 0.010 | Yes |
| 12 | $G\hat{V}A_t$ | 0.073 | No |
| | $\Delta\hat{C}I_t$ | 0.039 | Yes |
| 13 | $G\hat{V}A_t$ | 0.029 | Yes |
| | $\Delta\hat{C}I_t$ | 0.494 | No |
| 14 | $G\hat{V}A_t$ | 0.001 | Yes |
| | $\Delta\hat{C}I_t$ | 0.210 | No |
| 15 | $G\hat{V}A_t$ | 0.041 | Yes |
| | $\Delta\hat{C}I_t$ | 0.054 | No |
| 16 | $G\hat{V}A_t$ | 0.000 | Yes |
| | $\Delta\hat{C}I_t$ | 0.012 | Yes |
| 17 | $G\hat{V}A_t$ | 0.000 | Yes |
| | $\Delta B\hat{C}I_t$ | 0.669 | No |
| 18 | $G\hat{V}A_t$ | 0.000 | Yes |
| | $\Delta B\hat{C}I_t$ | 0.209 | No |
| 19 | $G\hat{V}A_t$ | 0.000 | Yes |
| | $\Delta E\hat{S}I_t$ | 0.286 | No |
| 20 | $G\hat{V}A_t$ | 0.000 | Yes |
| | $\Delta E\hat{S}I_t$ | 0.043 | Yes |
| 21 | $G\hat{V}A_t$ | 0.007 | Yes |
| | $\Delta\hat{C}I_t$ | 0.296 | No |
| 22 | $G\hat{V}A_t$ | 0.000 | Yes |
| | $\Delta B\hat{C}I_t$ | 0.110 | No |
| 23 | $G\hat{V}A_t$ | 0.000 | Yes |
| | $\Delta B\hat{C}I_t$ | 0.093 | No |
| 24 | $G\hat{V}A_t$ | 0.000 | Yes |
| | $\Delta E\hat{S}I_t$ | 0.033 | Yes |
| 25 | $G\hat{V}A_t$ | 0.000 | Yes |
| | $\Delta E\hat{S}I_t$ | 0.040 | Yes |

**Note:** Tests evaluated at the 5% significance level.
**Source:** Own calculation