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SHORT-TERM FORECASTING OF GROSS DOMESTIC PRODUCT

Abstract. *In the article, a set of appropriate model tools was developed and presented, which allows to assess the relationship between the economic confidence index and GDP, calculated on the main types of economic activity, and to make a short-term forecast on GDP. The research examines the main hypothesis about the cyclical sensitivity of the composite indices, especially the economic confidence index in relation to the dynamics of the physical volume of GDP. The authors calculate a composite index of aggregate economic confidence and, based on a consistent analysis of the relationship between the index of the physical volume of GDP and the index of economic confidence, have determined aggregate empirical regularities and characteristics of its cyclical development. The nature of the Economic Confidence Index calculated in the work was determined, and its forecasting capabilities for monthly and annual real growth rates of GDP were studied using autoregression and seasonal filters. The authors used the DEMETRA+ statistical package.*

Keywords: *Economic Confidence Index, Gross Domestic Product (GDP), economic shocks, economic indicators, Business Activity Index of Real Sector, Monitoring.*

INTRODUCTION

Despite the increase in the number of tools stimulating the economic activity of market participants, the problem of confidence has not only lost its actuality but has also begun to have an increasing impact on economic development.

Researches are conducted to evaluate economic activity in the world. The whole activity of most research institutes is to study changes in the economy through various indices.

Azerbaijan's economy has not yet been studied in terms of confidence, and index estimates are still in their infancy.

One of the main tasks of the analysis and forecasting of economic activity is the development of systems for the early detection of changes in the phases of economic periods based on specially developed economic indicators. Leading economic indicators are used to obtain early information about phase changes and to estimate the moments of phase change called crucial points within these systems.

Assumed that the turning points of the forecast indicators are ahead of the turning points of some key economic indicators (for example, real GDP) that characterize the economic situation as a whole.

Currently, there exist two main methodological centers for the development of such indicators [1–3]:

- US National Bureau of Economic Research (NBER);

- Statistical Department of The Organization for Economic Co-operation and Development (OECD).

EU countries and a number of other countries (more than 30 countries) are currently using an adapted methodology to build leading indicators based on a survey prepared by the OECD Statistics Department and the European Commission (now OECD-EU methodology).

The Economic Confidence Index (ECI) is one of the most important indicators of macroeconomics. This indicator is similar to the business activity index. The difference is that economic confidence is most often associated with business expectations in the near future. ECI has powerful forecasting properties. Allows the Economic Confidence Index (ECI) to be called a reliable and important tool for analysis and forecasting.

In the presented research, we evaluate the turning points of the business period of the country's economy and identify the leading nature of the proposed economic confidence index. Forecasting possibilities of the economic confidence index are determined in the autoregression and error correction models for the monthly and annual growth rates of the country's real GDP.

METHODOLOGY

The methodology of the article was tested on the example of data provided by the State Statistical Committee of the Azerbaijan Republic and the Central Bank of the Azerbaijan Republic (CBAR).

The data analysis is based on tracking monthly GDP growth rates for the period from January 2015 to March 2021 and statistical data on economic activity in the real sector presented on surveys and published monthly by the CBAR.

All our surveys reflecting the entrepreneurs' sentiments in the context of business confidence are based on the results of surveys conducted by the State Statistics Committee of Azerbaijan in thirty-five regions of Azerbaijan in six basic sectors of the economy over the period 2015–2021.

The stratified sampling set of all quarterly surveys covers about 13 thousand units of observation: 700 manufacturing and 150 extractive industries, 1500 construction organizations, 2000 retail and 2000 wholesale firms, 2000 organizations in the service sector, and 4000 individual entrepreneurs. Business and consumer surveys contain qualitative assessments and expectations of respondents and actual and expected changes in the activities of organizations. The responses are aggregated as percentage balances of scores. Balances are built on the basis of the difference between the shares of positive and negative answers, that is, they determine the ratio between the increase and decrease in the indicator compared to the previous period or levels above and below normal for each indicator in the surveyed period. Time series of balances are used to build various composite indicators, harmonized to the extent possible with the OECD recommendations for comparative analysis [10; 11].

The Economic Sentiment Index (ESI) is calculated as a composite index of confidence in the industry, construction, retail trade, and services, as well as the Consumer Confidence Index. The methodology of the article as a whole is based on generally accepted international methodological provisions presented in the basic User Guide for the EU Harmonized Business and Consumer Surveys Program jointly developed by the OECD and the European Commission [1; 2; 11; 12]. According to these guidelines, the possibility of quantifying the opinions of respondents, their aggregation in accordance with various qualitative characteristics, comparability over time, replenishment of missing data, out-of-sample predictive assessment, creating user-friendly graphical and tabular visualization formats, distribution on online platforms, etc. constitute the necessary criteria for measuring short-term trends of a cyclic nature in the country.

Preliminary data on the calculation of the ESI imply the preparation and distribution of questionnaires by types of business activity and the construction of time series; calculation of the composite index of economic confidence by types of business activity; detection of long-term correla-

tion of real GDP and Economic Sentiment Index and their comparative analysis.

It is known that monthly and quarterly indicators are highly dependent on seasonal fluctuations. Finding a trend that cleans the time series of seasonal fluctuations and eliminates seasonal and calendar deviations from the time series of the seasonally adjusted indicator has long been a serious problem in short-term macroeconomic forecasting. The current practice of clearing time series from seasonal fluctuations allows for overcoming the above-mentioned problems. The current practice involves the use of methods such as X-12-ARIMA and TRAMO-SEATS. These methods have been successfully applied in European countries on the basis of special DEMETRA + software developed by Eurostat. The software allows for the implementation of both methods X-12-ARIMA and TRAMO-SEATS and takes into account the effects of the calendar on the basis of regression (work, holidays, short and long years) automatic selection of parameters, model selection, and assessment of model adequacy. The empirical calculations carried out are based on the OECD recommendations [11]. According to studies, when decomposing the dynamics of the ESI and GDP growth, a double pass of the Hodrick-Prescott filter is used in case of accumulation in certain time intervals of such scales of pessimism or optimism that violate the stationarity inherent in the analyzed time series. To estimate the forecast values of GDP, a two-dimensional Vector Autoregression Model (VAR) was used, on the basis of which the effectiveness, strength, and direction of the non-linear impact of the ESI on GDP growth are confirmed.

As a result, the seasonal component (seasonal fluctuations, including unstable calendar effects during the year, such as a number of working days, holidays with variable dates, a sign of the leap year), trend-cyclic component (long-term changes, longer than seasonal), irregular component (noise and random deviations due to their nature) are decomposed in an additive or multiplicative form, the time sequence is visualized and can be transferred to other programs for use.

In the presented work, we focus on the results of foreign studies and national indicators of business activity, which are carried out by state financial regulators quite systematically and on a large scale.

In light of all the above, we may state with confidence that it is advisable to conduct a study of the ESI index, which separates the zones of optimistic and depressive economic sentiment, and its relationship with GDP growth. In fact, this is a comprehensive study of the economic sentiments of business entities for the period 2015–2021, when

business representatives themselves evaluate the economic situation, the position of their enterprises, changes in production volumes, demand, and subsequent sales of manufactured products. This research combines pre-calculated confident indicators' values based on the developed toolkit into a composite indicator. An analysis of the impact of such an indicator on the physical volume of GDP demonstrates the relationship between the dynamics of aggregated indicators in the basic sectors of the economy and economic growth in the country in real-time.

The composite ESI Index itself is a timely and reliable tool for tracking GDP, and can also improve the accuracy of preliminary statistical estimates of real GDP in countries. This article reveals the important advantages of sentiment indicators in terms of early warning of changes in the intensity of economic growth, such as real-time availability and the absence of subsequent revisions. Macroeconomic variables, in contrast, are usually released with a delay and are often subject to significant revisions after initial release [12].

CONFIDENCE INDEX AND CALCULATION METHODS OF COMPOSITE ECONOMIC CONFIDENCE INDEX

Direct or indirect calculation methods can be used to calculate the ECI.

The indirect method in the calculation of ECI. Via the indirect method, the confidence indices are calculated for seasonally adjusted time group series of response balances in the form of geometric averages for each economic activity. In this case, the calculation of the ECI index assumes the following [11]:

- Calculation of a composite index for all seasonal adjustments and standardized time series of balanced weighted average response balances

equal to the specific weights of economic activities in GDP for surveys related to relevant economic activity;

- Standardization and measurement of the resulting composite index so that the long-term average is 100 and the standard deviation is 10.

In the used measurement versions, the values of ECI vary mainly in the range from 90 to 110.

We assume that the significance of the ECI at the level of 100 units is consistent with the long-term trend. Exceeding this level, ie a positive deviation from the long-term trend is interpreted as economic growth, and a value below 100 indicates a negative deviation from the trend and a deterioration of the economic situation. An **indirect method** was used to calculate the composite ECI for Azerbaijan [9].

Before assessment of the Economic Confidence Index, first, we should observe the dynamics of GDP from 2015 to the current period, as well as the dynamics of the industry, construction, retail, service confidence indices provided by the Central Bank of the Republic of Azerbaijan (**Figure 1**).

As seen from **Figure 1**, the dynamics of GDP (*Gross Domestic Product*) by months are positive, excluding local increases and decreases. However, in the period when the Covid-19 pandemic began to spread in the Azerbaijan, business activity decreased due to the restrictive measures applied by the Operational Headquarters under the Cabinet of Ministers in the country, which manifested itself in monthly reductions in GDP.

However, the need to ease social restrictions is already accelerating the recovery process in the economy.

Figure 2 shows the confidence indices prepared on the basis of the Central Bank's survey on business activity in the real sector of the economy.

Figure 3 shows the diagram of the initial ECI time series and the seasonal adjusted ECI time

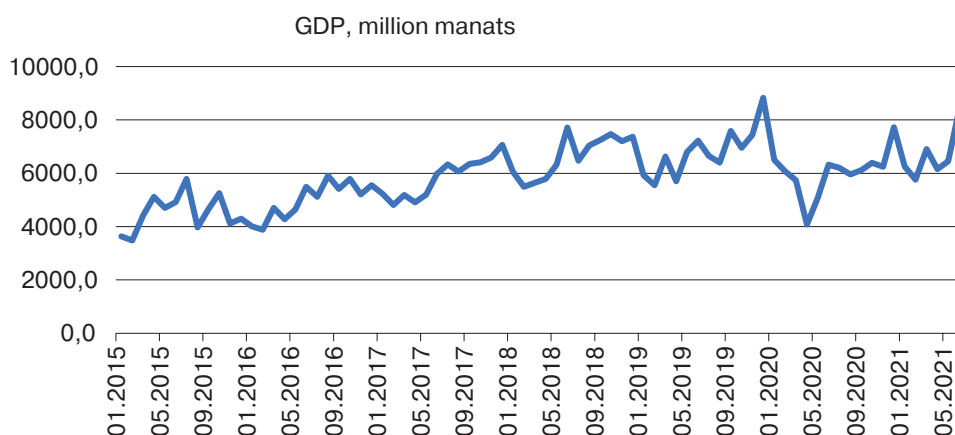


Figure 1. Dynamics of gross domestic product

Source: the State Statistics Committee (SSC).

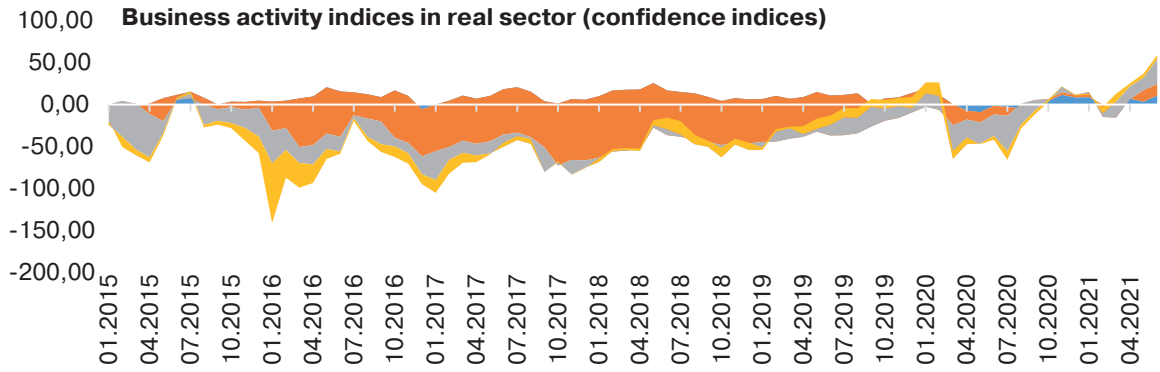


Figure 2. Business activity indices in real sector

Source: Central Bank of the Republic of Azerbaijan.

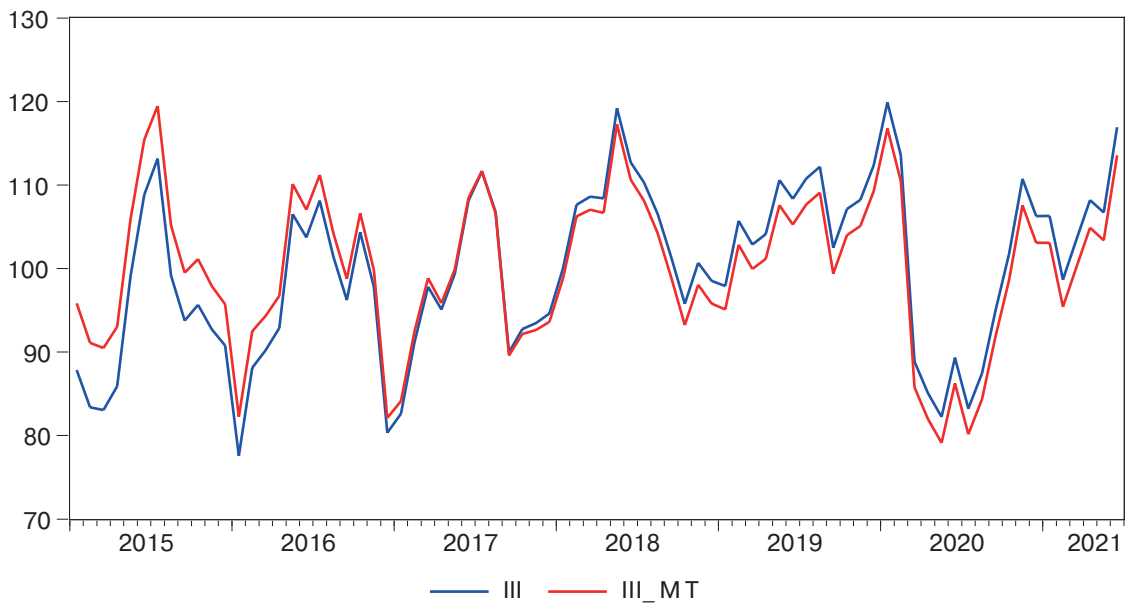


Figure 3. ECI time series and the seasonal adjusted ECI time series

series for the period from January 2015 to June 2021 for comparison.

The seasonal adjustment was performed using the Hodrick-Prescott (HP) statistical filter.

METHODS FOR OBTAINING THE CYCLIC COMPONENT OF ECI

When using the indirect method to construct the ECI, the use of two methods for the subsequent statistical processing of the time series of the ECI is recommended to obtain its cyclic component:

1) Double use of the Hodrick-Prescott filter with parameter values $\lambda = 42131.155$ for the first stage and $\lambda = 13.93$ for the second stage, analogous to the key economic indicator;

2) Single application of Hodrick-Prescott filter with parameter value $\lambda = 13.93$.

The first method assumes the ECI has a long-term trend over time. The second method is based

on the assumption that the ECI series (in economic terms) is stationary.

Therefore, the problem of choosing the processing method can be selected depending on the type of probable model.

If the time sequence of the ECI is determined, there is no need to eliminate the trend, and it is sufficient to eliminate the high-frequency “noise component” using the Hodrick-Prescott filter with the λ parameter value, $\lambda = 13.93$.

This key economic indicator allows a smoother and more convenient cycle component to identify important components that can be used in the analysis cooperatively with a sound business cycle. Otherwise, the use of a two-stage isolation procedure is recommended.

Also, known that structural changes and short time series make it difficult to determine the type of time series model using statistical tests known

as “single root” tests. In such a situation, the test results should be analyzed economically to substantiate and interpret the moments of structural change.

The non-stationary timing of the ECI may be due to structural changes due to shocks in the economy, as well as the inability of respondents to distinguish between market fluctuations and structural changes.

Therefore, the structural fluctuations in the economy through the responses of the respondents are reflected in the time series of the ECI [12].

In other words, at certain stages, the ECI may contain a trend component and may not be stationary.

Figure 4 shows the comparative results of the time series of the normalized ECI with the above values of the filter parameter. ECI-1 is a cyclic component of the ECI after two staged applications of the Hodrick-Prescott (HP) filter, and ECI-2 is an ECI regulated by a single application of the Hodrick-Prescott filter.

Figure 4 shows that the dynamic characteristics of the time series ECI-1 and ECI-2 are different.

The application of a two-staged HP filter has significantly smoothed the ECI-1 index, bringing it to an almost stable straight line after 2018.

Figure 5 shows the two-staged application of the Hodrick-Prescott filter for GDP and ECI-1, and the single ($\lambda = 13.93$) application for ECI-2.

This year the physical volume index of GDP has increased compared to February-March. The increase of confidence indices in these sectors during this period led to an increase in the Economic Confidence Index by 3,5 %. In general, the significant easing of the special quarantine regime connected with the pandemic, the growing popularity of the vaccination process in the country has led to the revival of economic life.

Although the volume of industrial productions increased by 12,2 % in nominal terms in March compared to February of the current year, in

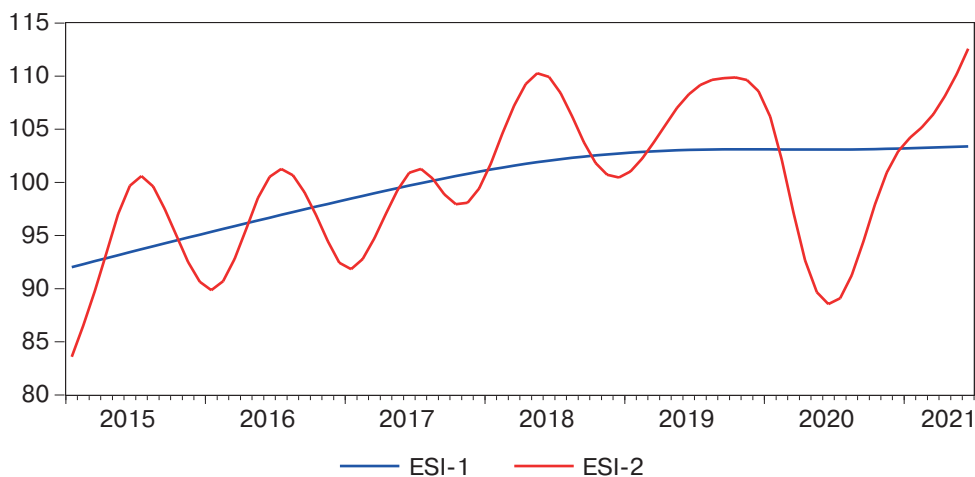


Figure 4. The effect of a trend reversal on the dynamics of the ECI

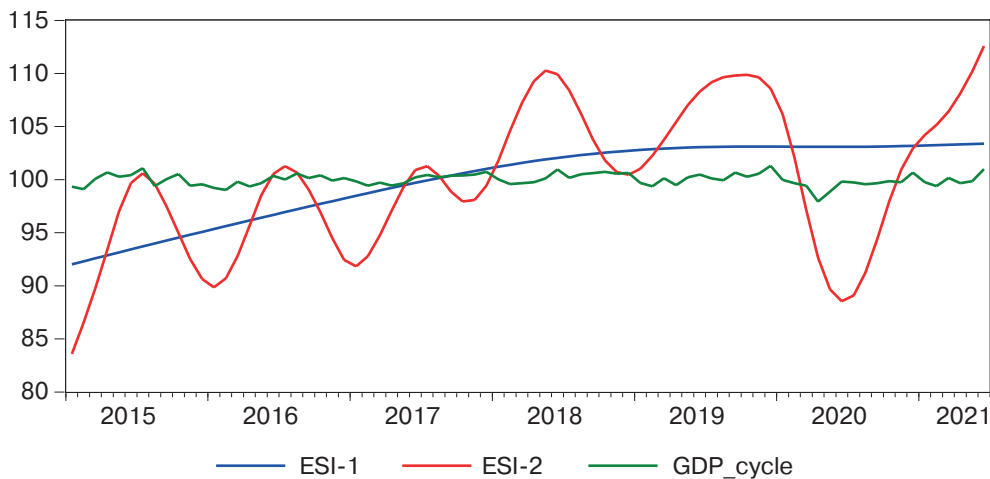


Figure 5. Time series obtained by the two-staged method for GDP and ECI cycles

January-March it decreased by 4,6 % in real terms compared to the same period of the previous year.

In the first quarter of 2021, the volume of work and services in the construction sector increased by 4,8 % compared to the same period in 2020. In the same period, retail trade turnover decreased by 1,1 %.

Due to the short duration of surveys conducted by the Institute for Scientific Research on Economic Reforms (surveys started in the first quarter of 2020) and the small number of respondents, the Economic Confidence Index was calculated based on the European Union methodology based on monthly confidence indices calculated by the Central Bank of Azerbaijan since 2015.

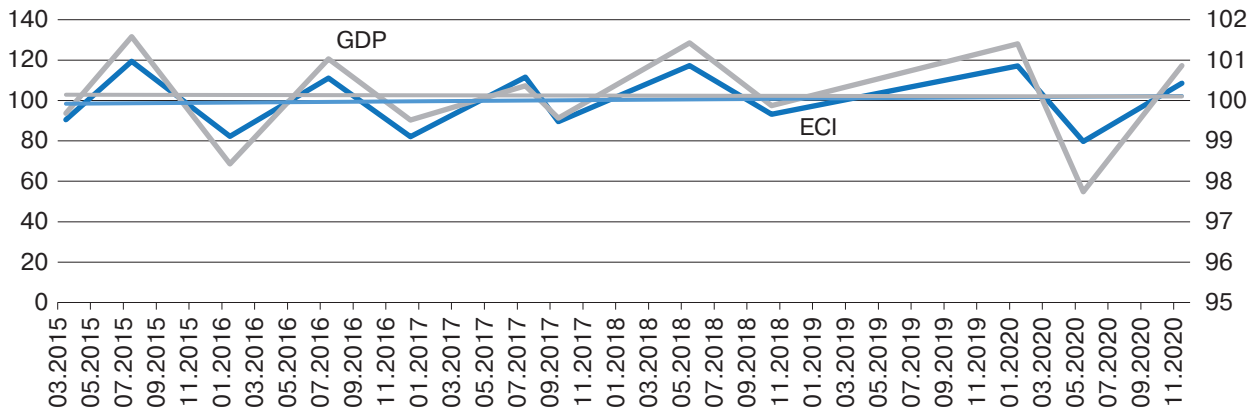


Figure 6. ECI and GDP turning points

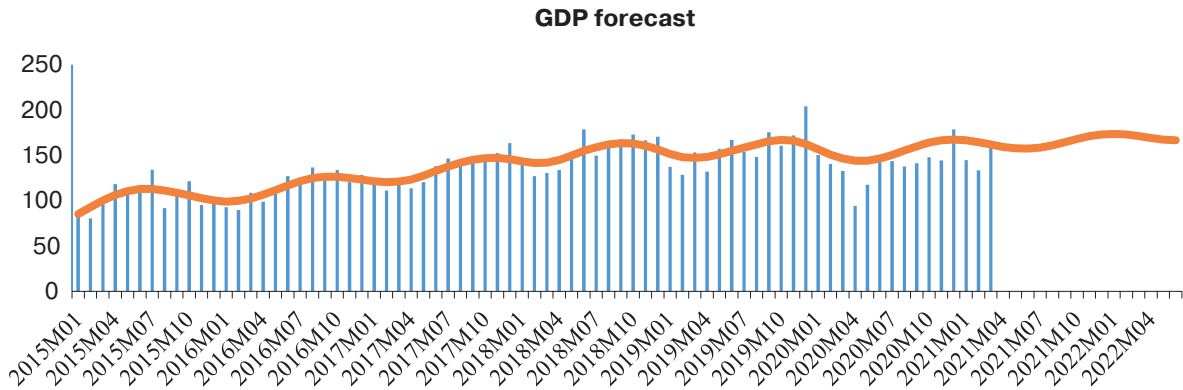


Figure 7. Gross Domestic Product forecast

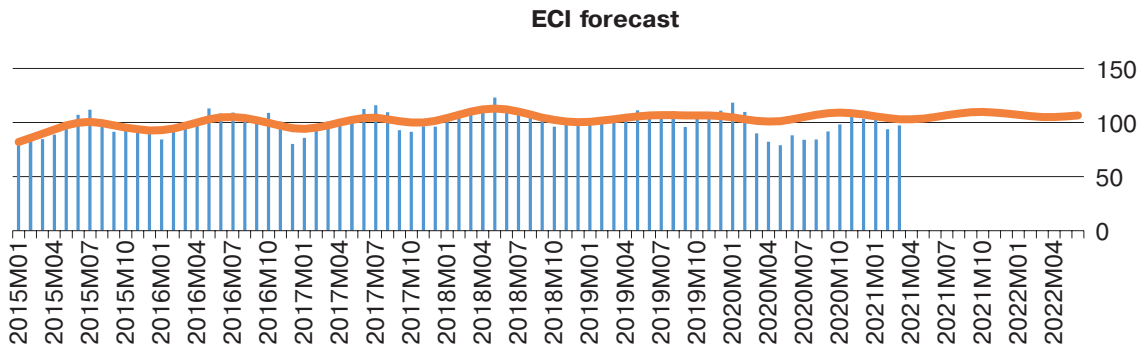


Figure 8. Economic Confidence Index Forecast

VAR Model:

$$GDP_t = 0,37 \times ECI_{t-1} - 0,91 \times ECI_{t-2} + 0,91 \times ECI_{t-3} - 0,37 \times ECI_{t-4} + 2,79 \times GDP_{t-1} - 2,95 \times GDP_{t-2} + 1,30 \times GDP_{t-3} - 0,14 \times GDP_{t-4} + 0,87$$

$$ECI_t = 3,07 \times ECI_{t-1} - 3,76 \times ECI_{t-2} + 2,13 \times ECI_{t-3} - 0,46 \times ECI_{t-4} + 0,15 \times GDP_{t-1} - 0,38 \times GDP_{t-2} + 0,356 \times GDP_{t-3} - 0,12 \times GDP_{t-4} + 1,50$$

Periods were determined by conducting seasonal leveling on GDP and Economic Confidence Index. ECI peak points ahead of GDP growth about 2–4 months, bottom points 1–4 months ahead.

Periods are determined by applying seasonal smoothing to the Industrial Production Index and the Industrial Confidence Index.

The diagram shows an improvement in the decentralization rate. From a sectoral perspective, confidence in construction and industry increased in January 2021. Overall, economic confidence was above average in all sectors during this period. In February, confidence levels were low in all sectors except the service sector. In March, confidence remained below average in the industry, although confidence increased in construction, services, and retail trade [11; 12].

ECONOMIC CONFIDENCE INDEX AND GDP FORECASTING

The following diagrams show the ECI and GDP forecasts for June 2022 based on the vector autoregression (VAR) model [11].

CONCLUSION

1. A choice of an algorithm for calculating the composite ESI index, processing time series of the annual GDP growth rate and ESI, and confirmation the leading nature of the economic sentiment indicator was undertaken, and the interpretation of the detected dependencies was carried out. As a primary statistical base for the study, the database “Business Activity Indices in the Real Sector” was formed on the basis of surveys conducted using the Economic Survey for the observation period of the CBAR. According to the presented forecast for the last quarter of 2022, the Economic Sentiment Index is confidently holding its average level of 100, which defines the border between the zones of a favorable and unfavorable business climate. In quarter IV of 2021, the growth driver of the ESI was the positive dynamics of its “production” components, which characterize the mood of managers in the mining and manufacturing industries, as well as in the construction industry. The short-term expectations of entrepreneurs improved especially noticeably. Quantitative quarterly variables of the real and financial sectors are used in this paper to build the turning points of the business cycle. The results of the monitoring are combined into an economic sentiment index, the calculation algorithm of which is based on generally accepted international methodology and updated taking into account the peculiarities of the Azerbaijani economy.

2. The presented data were processed by the statistical software package DEMETRA+, business cycle turning points are examined using a Hodrick-

Presscott filter and a vector autoregression model is proposed to predict real GDP growth rates. In order to visualize cyclic possibilities, its tracer is built. According to the EU methodology, the Hodrick-Presscott filter is used to smooth out fluctuations in the original time series that are insignificant from the point of view of visualizing growth cycles. In the course of the conducted studies, the outrunning nature of the ESI in relation to real GDP was established, i.e., it is shown that the moments of the cycle phase change (turning points) of the ESI precede the moments of the real GDP cycle phase change by an average of 4 months. According to the results of joint graphical visualization and cross-correlation analysis of the smoothed cyclical dynamics of the economic sentiment index and GDP growth, a stable synchronous relationship of short-term growth cycles in the time series of two such indicators is confirmed.

3. The preventive nature of the ESI was determined and a model of business cycles’ turning points based on the presented modeling tools was built. It was found that the turning points of the ESI and real GDP cycles correspond to each other. It can be concluded that the economic confidence index is used to prepare short-term forecasts of economic growth rates. The dependence of real GDP growth rates on the ESI is evaluated econometrically and analysis models of turning points of business cycles are built, forecasts are made based on the VAR (vector autoregression) model; the preventive nature of the calculated ESI is determined and the turning points of the business cycles of the Azerbaijani economy are assessed. Thus, a comparison of the time series of the ESI and GDP, as well as the construction of cyclic turning points, confirm the initial hypothesis of our study about the existence of almost simultaneous cyclic consistency in the analyzed series.

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КОРОТКОСТРОКОВЕ ПРОГНОЗУВАННЯ ВАЛОВОГО ВНУТРІШНЬОГО ПРОДУКТУ

Резюме. У статті розроблено та представлено набір відповідних модельних інструментів, які дають змогу оцінити зв'язок між індексом економічної впевненості та ВВП, розрахованим за основними видами економічної діяльності, а також зробити короткостроковий прогноз щодо ВВП. У дослідженні розглянуто основну гіпотезу про циклічну чутливість композитних індексів, особливо щодо індексу економічної впевненості та динаміки фізичного обсягу ВВП. Авторами розраховано зведений індекс сукупної економічної впевненості. Крім того, на засадах результатів послідовного аналізу зв'язку між індексом фізичного обсягу ВВП та індексом економічної впевненості було визначено сукупні емпіричні закономірності та характеристики його циклічного розвитку. Визначено характер розрахованого в роботі індексу економічної впевненості та досліджено його можливості прогнозування місячних і річних темпів реального зростання ВВП за допомогою авторегресії та сезонних фільтрів. Автори використовували статистичний пакет DEMETRA+.

Ключові слова: індекс економічної впевненості, валовий внутрішній продукт (ВВП), економічні потрясіння, економічні показники, індекс ділової активності реального сектору, моніторинг.

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АНАЛІЗ РОБОТИ ПАЛИВНО-ЕНЕРГЕТИЧНОГО КОМПЛЕКСУ УКРАЇНИ В УМОВАХ ВІЙСЬКОВОЇ АГРЕСІЇ ТА ВИЗНАЧЕННЯ ПЕРСПЕКТИВНИХ НАПРЯМІВ РОЗВИТКУ

Резюме. У дослідженні опрацьовано сучасний стан і напрями розвитку паливно-енергетичного комплексу України. Проаналізовано стан енергетичного комплексу, зокрема вплив широкомасштабної військової агресії на виробництво та споживання паливно-енергетичних ресурсів економікою України. Розглянуто стан електроенергетичного комплексу. Здійснено аналіз пошкоджень енергетичних об'єктів та інфраструктури за секторами: атомної енергетики, теплової енергетики, великої гідроенергетики, відновлюваних видів (сонячна та вітрова енергетика). Також проаналізовано рівень пошкоджень та їхніх наслідків енергетичної інфраструктури — високовольтних підстанцій. Опрацьовано стан нафтогазового комплексу. Підтверджено, що нафтова промисловість внаслідок широкомасштабної агресії не функціонує. Газовидобувна промисловість зменшила обсяги видобутку. Розглянуто економічні умови, у яких опинилась Україна внаслідок воєнних дій. Запропоновано напрями розвитку енергетичного сектору України на довгострокову перспективу.

Ключові слова: енергетичний сектор, паливно-енергетичні ресурси, виробництво електроенергії, споживання електроенергії, традиційні та відновлювані джерела енергії.