The paper develops and presents an appropriate model toolkit that allows assessing the relationship between the calculated indices of economic sentiment and confidence for the main types of economic activity. The aim of the study is to experimentally substantiate the relevance of data on the opinions of technological economic agents and assess the value of this information for the statistical description and analysis of macroeconomic trends, including economic cycles and unforeseen and prolonged crises. The main hypothesis about the cyclical sensitivity of composite indices, in particular the index of economic sentiment in relation to the dynamics of the physical volume of GDP, is tested. The authors calculate a composite indicator of aggregate economic sentiment and, based on a consistent analysis of the relationship between the index of physical volume of GDP and the indicator of economic sentiment, identify aggregate empirical patterns and features of the cyclical development of technological enterprises. Accordingly, the turning points of the business cycle are discussed and the leading nature of the proposed index of economic sentiment is affirmed. The importance of the composite indicators in the economic analysis of entrepreneurial behavior in the implementation of technological innovations is shown.

The nature of the calculated Economic Sentiment Index was established, and its predictive capabilities for monthly and annual real GDP growth rates using autoregression and error correction models were investigated. The stages of calculating and setting indices with the application of the DEMETRA+ statistical package were implemented

Keywords: Economic Sentiment Index, confidence indices, short-term cyclicality, technology industry, critical points, econometric models

UDC 004, 004.22, 004.62
DOI: 10.15587/1729-4061.2022.265656

INVESTIGATION OF THE RELATIONSHIP BETWEEN THE DYNAMICS OF GDP AND ECONOMIC SENTIMENT INDEX

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Received date 05.08.2022
Accepted date 07.10.2022
Published date 26.10.2022

How to Cite: *Huseynova, A., Aliyeva, T., Rzayeva, U. (2022). Investigation of the relationship between the dynamics of GDP and economic sentiment index. Eastern-European Journal of Enterprise Technologies, 5 (13 (119)), 60–72. doi: https://doi.org/10.15587/1729-4061.2022.265656*

1. Introduction

One of the key tasks in analyzing and forecasting economic activity is the development of systems for the early detection of changes in the economic cycle phases based on specially elaborated economic indicators. For this purpose, the so-called Composite Economic Indicators within the framework of these systems are used to receive early signals on changes in phases and to estimate the moments of these changes, called critical points [1]. It is assumed that the critical points of composite indicators precede the turning points of some basic economic indicator (for example, real GDP), which characterizes the state of the economy as a whole.

It is even more important to understand the real impact of economic sentiment on innovation activity since innovation is necessary for economic growth. Endogenous growth models emphasize that the economic growth rate is determined by technological progress driven by innovation [2, 3].

Another potential advantage of the Economic Sentiment Index is that it can capture young and/or small innovation firms that, due to their nature, are more likely to have time-varying investment opportunities.

The study [4] shows that firms with financial constraints invest more in R&D when the performance of this composite index is high. The positive relationship between economic sentiment and innovation spending may also be managers' high optimism about their firms' future earnings and higher risk tolerance [5].

Within the approach proposed by the USA National Bureau of Economic Research (NBER) in periods of business cycle changes, a sequential change of two phases of economic activity – periods of "growth" and "recession" are assumed. In doing so, critical points correspond to the "peak" (maximum point of growth) and "bottom" (minimum point of decline) of the economic cycle. Within the framework of another concept suggested by the Organization for Economic Cooperation and Development (OECD), the business activity of technological enterprises is assessed by greater detail of the main phases in the cycles relative to the long-term trend, highlighting periods of "growth" and "slowdown" (above the trend line), as well as "recession" and "recovery" (below the trend line) [6]. The critical points, in this case, are fully in line with the moments of the beginning of the slowdown in growth and the beginning of recovery after the recession.

The OECD Statistics Department and the European Commission have developed a harmonized methodology (hereinafter referred to as the OECD-EC methodology) for constructing leading indicators based on survey data, which is currently being successfully used in the countries of the European Union and a number of other countries for forecasting macroeconomic indicators [7]. In the context of OECD-EC methodology, these indicators correspond to the Economic Sentiment Index (ESI) – a widely used composite indicator that aggregates primary sectoral indices of business and consumer confidence.

The composite indicators, calculated according to the OECD-EC methodology, are related to the class of correlated, mixed, multi-component rates of economic activity since there is an almost simultaneous change in relation to amendments in GDP indicators. ESI is a summary of the analysis of the business activity of enterprises and organizations and consumer expectations conducted by statistical committees of different countries.

Along with this, composite indicators' values can be presented earlier than traditional statistical evidence, since their calculation involves obtaining information from simpler questionnaires (which implies a shorter data processing process). Accordingly, the interested audience can receive signals about changes in business activity sooner.

The relevance of the development of this toolkit lies in the fact that by using composite indices it is possible to analyze the current phase of the economic business cycle in real time and determine the direction of changes in GDP growth rates in the current period and in the near future. In general, the composite index of leading indicators demonstrates consistently high predictive properties (for example, it predicts all the peaks and falls of the cyclical component of GDP). On average, the leading dynamics of this index relative to the cyclical component of GDP is 3 months. Thus, this index corresponds to the characteristics required for such indicators and can be actively used in economic analysis and short-term economic forecasting.

2. Literature review and problem statement

In world practice, composite indicators, calculated on the basis of research results on business proposals and consumer demand (for example, country-specific or harmonized confidence indicators) are widely used for the aggregation and subsequent analysis of entrepreneurial opinions and expectations. In [8], only the results of calculating Harmonized Confidence Indicators (HCI) based on enterprise surveys without a computational basis are given and the differences between national indicators and HCI calculated by the European Commission are presented. The work [9] studies the main characteristics of Composite Leading Indicators (CLI) for analyzing changes in business cycles and post-factum evaluates the effectiveness of CLI during the Great Recession. Based on the results, timely analysis of the CLI could predict the onset of the Great Recession in the G7 countries for several months ahead. The work [10] considers the relationship between the Business Climate Index (BCI) and the country's GDP, presents a simultaneous correlation of annual and quarterly rates of change in GDP and this index, and also indicates the good predictive properties of BCI using statistical and econometric methods. However, as the authors themselves point out, the aggregation methods presented in the paper are not devoid of certain practical shortcomings.

The work [11] considers the use of composite indicators (CI) to assess the company's performance by decision-makers, but, as the authors summarize, CI at the macro level is not suitable for implementation at the company level. The paper [12] presents a composite leading indicator for the Swiss business cycle, as a result of the analysis of the KOF economic barometer. The study is conducted in pseudo-real time, comparing the characteristics of the new KOF barometer with previous versions and other alternatives.

These composite indicators reflect the perception of reality by a business or consumer expectations and are applied to assess multidimensional phenomena that are not covered by traditional statistics. State statistical committees increasingly use sentiment indicators in various areas of the economy to analyze the current situation with subsequent short-term forecasting. The results obtained cover business cycles, changes in the welfare and sentiment of businesses, households, consumers, enterprises, technology companies, innovative firms, and their confidence and expectations, and are used in international comparisons.

The study [13] is devoted to a detailed review of the literature on the use of quantitative and qualitative indicators in the practice of economic analysis, methods of their calculation, as well as assessments of the phenomena of economic life. As the authors rightly point out, the main limitation of the study is the use of only qualitative indicators based on the results of surveys, although the forecasting efficiency could be improved if quantitative economic variables were included in the model.

The paper [14] provides a detailed assessment of the linear relationship between real GDP and OECD-EC confidence indicators, considers their cyclical behavior, and confirms an important conclusion about their role in assessing economic growth and recession. In the work, improvements using the presented model are based on time-varying parameters, which can be interpreted as a rather strong limitation.

The study [15] analyzes the results of the business and consumer survey, covers a wide range of variables, uses them to monitor the current state of the economy, and provides a short-term forecast of economic changes. The results are limited to an analysis of spillovers during and after the last EU recession.

The paper [16] examines the role of technological business and household sentiment indicators as predictors of changes in the US economy. In the work, sentiment variables were combined with general factors based on a large set of macroeconomic and financial variables, implying the difficulty of data accessibility for applying the model in other countries.

The study [17] provides an empirical analysis of the industry confidence indicators' impact on real GDP growth during EU and US recessions and growth and concludes that sentiment indicators are statistically significant for economic growth in both good times and bad. The paper summarizes the statement about the absolute correlation of only the Purchasing Managers' Index with GDP data.

Changes in business sentiment and other composite indices, which characterize the conjuncture of the world economy, show an increasingly higher correlation with annual GDP growth in recent years. The results of the study [18] confirm the significant leading capabilities of composite indicators in the analysis of the current economic situation.

The paper states the existence of conflicting signals about the strength of the correlation of indicators, which led some analysts to question the relationship between hard and soft indicators and express doubts about the usefulness of survey data for forecasting economic growth. Unfortunately, clear reasons for this discrepancy are not presented. The paper also confirms the cyclic nature of turning points.

The study [19] ex post facto proves that economic sentiment and consumer expectations act as factors in forming uncertainty in economic systems and significantly impact European economic activity during the financial crisis and the Great Recession of 2008.

In the existing literature, the methodological justification for the practical value of the generalized results' applicability obtained through the survey of technological enterprises, taking into account macroeconomic information, is not sufficiently considered. After all, in addition to numerous external and internal shocks and economic policy measures that prevent them, the rates of cyclical economic growth in the short term are also influenced by the response signals of the business environment (especially in innovative business), affecting fluctuations in micro and macro indicators of the original economic system. There is also no sufficiently complete methodological framework to substantiate a causal relationship between changes in economic activity in the implementation of activities and the realization of entrepreneurs' expectations in the real sector of the economy.

It is also the case that the importance of using composite indicators and composite leading indices increases significantly during economic crises. Under these conditions, the inconsistency of economic policy measures with the real situation can boost the depth of the cyclical downturn and "delay" the economic recovery from the crisis.

3. The aim and objectives of the study

The study aims to substantiate the empirical value of data on the opinions of technological economic entities, use this information for statistical analysis, and assess its role in the macroeconomic review and business cycles.

To achieve this aim, the following objectives are accomplished:

– to carefully select the optimal algorithms for statistical analysis when processing time series and determine the conditions for their applicability, including seasonal smoothing, selection of periods, and algorithms for calculating the composite leading index;

– to process available economic indicators using program methods, including data on the main economic indicator, as well as to identify the predictive nature of the calculated index of economic confidence (sentiment) and determine the critical moments of economic activity in the business cycle of Azerbaijan;

– to determine the existence of the dependence of GDP change on the Economic Sentiment Index, to determine the warning nature of the ESI, and to build a model of critical moments of business cycles based on the presented modeling tools.

4. Materials and methods

The methodology of the paper 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 time period 2015–2021.

The stratified sampling set of all quarterly surveys covers about 13 thousand units of observation: 700 manufacturing and 150 extractive industries, 1,500 construction organizations, 2,000 retail and 2,000 wholesale firms, 2,000 organizations in the service sector, and 4,000 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.

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 paper 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 [20]. 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 correlation 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 X-12-ARIMA and TRAMO-SEATS methods and takes into account the effects of the calendar on the basis of regression (work, holi-

days, 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 [21]. 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 the 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 can 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 paper 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.

5. Results of research determining the relationship between the dynamics of GDP and the Economic Sentiment Index

5. 1. Choosing the optimal algorithm for calculating the Composite Leading Index

The Economic Sentiment Indicator characterizes the confidence of entrepreneurs in certain areas of the economy and assesses their market expectations regarding the easiness of doing business and the convenience of their business in the future [22].

Simply put, the Economic Sentiment Index measures companies' confidence, and the overall health of the business environment, and analyzes levels of technology production, inventories, supplies, and employment. This index is highly correlated with the performance of the business sector. Thus, when the economic sentiment index is high, businesses are more likely to take action to expand and use industry agents [23].

Various factors influence the business environment of innovative enterprises. More recent studies have recognized the importance and impact of both consumer and business economic sentiment in this regard [24]. The Economic Sentiment Index, in particular, has generated a lot of interest in the structure of the investment and business cycle, primarily due to the recognition of the role of expectations in economic activity and for predicting the development of enterprises and thus business activity [25].

[26] emphasizes that economic sentiment is especially revealing in "abnormal" periods because business spending depends not only on "ability" but also on "willingness" to buy. Thus, production settings cannot be explained only by their response to changes in economic variables, but are also influenced by qualitative factors such as pandemics, crises, or wars that directly affect the psychological mood of the consumer [27]. Some empirical research supports the hypothesis put forward in [27] for the US during the Gulf War [28], while the paper [29] points out that including the economic sentiment index in the consumption function would have helped predict the US recession in 1991.

The practical significance of the ESI is determined by the computational speed and simplicity and the reflection of aggregated primary industry indicators, taking into account the time factor. This kind of efficiency, combined with the high statistical significance of this index, is in mutual influence with the dynamics of the growth rates in sectoral indicators reflecting the physical volume of gross value added by industry and gross domestic product. As a basic economic indicator in the analysis of economic cycles, it is advisable to use real GDP, which is traditionally preferred in many countries, as the most widely reflecting economic activity, both on the supply and the demand side of the economy. In this study, the task of estimation and short-term forecasting provides for the construction of business cycle phases based on their monthly values.

There is, of course, an important caveat to mention in regard to measuring confidence. Technology enterprise sentiment is a personal and subjective assessment of the environment (current and future) in which agents make economic decisions. In addition, consumer sentiment indices can be subject to measurement errors because survey questions are often too ambiguous for the respondent and difficult to quantify.

One obvious advantage of the Confidence Index is its timeliness. In addition, a key issue concerns its ability to predict future changes in the actual consumption spending of households and technology enterprises. Because they are based on forward-looking questions, the confidence indicator may include some information not found in any other economic indicator [30].

The Economic Sentiment Index is calculated on the basis of 18 industry indicators that promptly respond to the needs of businesses, households, and consumers under emerging market changes:

– in the mining, raw materials, and manufacturing industries, data on the level of demand for the technological products provided, the expected fluctuations in the output of products, and the level of stocks of finished products stored in warehouses and shipping areas are considered;

– in the construction industry, data on the level of utilization of the organizations' production capacities, their share in

the market of relevant goods and services, and expected trends in changes in employment by types are taken into account;

– in retail trade, data on current changes in demand for services and the economic situation of organizations, and expected changes in demand and the volume of finished products in warehouses are examined;

– in the service sector, data on current changes in demand for services and the economic situation of organizations, and expected changes in demand are also dealt with.

The ESI, as well as the business and confidence indices, are calculated based on the analysis of the corresponding time series, however, the methods for describing and interpreting the resulting data have a number of peculiarities. As a rule, confidence indices for each sector are calculated as arithmetic averages of partial indices, reflecting the cumulative consumer expectations of the population, while the calculation of the ESI uses the procedure for aggregating selected variables in the regarded economic areas using statistical methods of data processing, as standardization of seasonally adjusted time series to bring the indicators under consideration into a comparable form in terms of deviations from the average level and relative indicators of variation, as well as compliance with the sectoral weights of all standardized values.

The algorithm for constructing a composite ESI as a weighted average index is standard and includes the following iterations: seasonal adjustment and standardization of constituent components, their weighting in accordance with sectoral shares in GDP, summing of the components, and normalizing the result with an average value of 100 and a standard deviation of 10.

When calculating the ESI, the individual components are standardized to achieve their comparability in terms of average level and variation (in this study, we use a sample for the period 2015–2021, or 28 quarters) for standardization:

$$Y_{1,t}=\frac{X_{1,t}-\overline{X_1}}{S_1}, \tag{1}$$

where $S_1=\sqrt{\frac{1}{27}\sum_{t-1}^{28}\left(X_{1,t}-\overline{X_1}\right)^2}$, $\overline{X_1}=\sum_{t-1}^{28}X_{1,t}$, $Y_{1,t}$ – standardized value of each component, $X_{1,t}$ – initial value of each component.

In the second iteration, all standardized series are weighted according to their sectoral weights. The sum of weights for each component $j=1{,}18$ (of the 18 components named in Table 1) is determined at every moment t; weights are the shares of each sector in GDP for each quarter of all years:

$$\left(\sum_j \omega_j\right)_t, \tag{2}$$

where ω – weight assigned to each component.

The weighted sum is divided by the sum of the assigned weights:

$$Z(t)=\frac{\sum_j \omega_j \cdot Y_{j,t}}{\left(\sum_j \omega_j\right)_t}. \tag{3}$$

As a result, a time series $Z(t)$ is determined.

In the third iteration, the computed weighted averages are scaled to give a long-term average of 100 and a standard deviation of 10:

$$\overline{Z}=\frac{1}{27}\sum_{t-1}^{28}Z_1, \tag{4}$$

$$S_z=\sqrt{\frac{1}{27}\sum_{t-1}^{28}\left(Z_t-\overline{Z}\right)^2}, \tag{5}$$

$$ESI_t=\left(\frac{Z_t-Z}{S_z}\right)\cdot 10+100, \tag{6}$$

where $\overline{Z}$ – period average, S_z – standard deviation, ESI_t – ESI value at the moment t.

The scaling of the average weights of the addressed indicators is carried out with the condition that in the long run the average value and the standard deviation are equal to 100 and 10, respectively. Taking into account the condition of normality, it was determined that the distributions of ESI in most cases vary from 90 to 110. While the average values of ESI vary in the range of about 100, this indicates normal sentiment in the business environment; values much higher than 100 confirm the existence of the most favorable business environment; values markedly below 100 portend depression, recession, and crisis.

The ESI indicator for Azerbaijan is the result of combining the opinions of various representatives of the general population from the considered sectors of the economy. As mentioned above, our calculations are based on data from eighteen primary indicators that reflect short-term fluctuations in business activity for 2015–2021, presented by the State Statistical Committee of the Republic of Azerbaijan (Table 1).

The ESI can be calculated using direct or indirect calculation methods.

Table 1

ESI Components – Results of Quarterly Business Surveys

Economic field	Period	Indicator
Industry	Next 3 months	Product production
		Orders accepted for execution
		Finished product stock
		Production expectations
		Price expectations
Construction	Last 3 months	The volume of construction works
		Orders accepted for execution
	Next 3 months	Change in the number of employees
		Price expectations
	Monthly	Orders' execution period
Retail Trade	Last 3 months	Actual sales
		Changes in inventories
	Next 3 months	Sales expectations
		Price expectations
Service	Last 3 months	Business conditions
		Actual demand
	Next 3 months	Demand expectation
		Price expectations

The indirect method in the calculation of the ESI. To calculate the confidence index indirectly, data are evaluated for time series with a seasonally adjusted balance of responses. In this case, the calculation of the ESI index involves the following actions:

1) calculating a composite index with the identification and leveling of the seasonal factor influence and standard-

ized time series of weighted average response estimates, using specific weights for individual classification groups of economic activity in GDP;

2) standardizing and ordering the set of values of the composite index, formed by taking into account the equality of the mean 100, and the standard deviation 10.

The direct method of calculating the ESI does not consider the factor seasonality when using standardized time series. In this case, the ESI composite index is calculated at all levels of aggregation.

Thus, according to the OECD-EC methodology, the calculation of the ESI consists of three stages:

1. Standardizing time series of response balances:

$$\tilde{B}_{lt} = \frac{B_{it} - \tilde{B}_l}{S_i}, \quad (7)$$

$$\tilde{B}_{lt} = \frac{1}{T}\sum_{i=1}^{T} B_{it},, \quad (8)$$

$$S_i = \sqrt{\frac{1}{T-1}\sum_{i=1}^{T}\left(B_{it} - \bar{B}_i\right)^2}. \quad (9)$$

2. Calculating the weighted average of the standard response balances:

$$Z_t = \sum_{i=1}^{n} \omega_i \tilde{B}_{it}. \quad (10)$$

Here ω_i is the weighted coefficients of the answers to the survey questions. It is assumed that these coefficients are equal to the total unit. Weight ratios (ω_i) are calculated based on statistics for the period under review. According to the methodology, it is recommended to use the share of key sectors of GDP to calculate weights [31].

3. Standardizing and calculating the scale of ESI:

$$ESI = \frac{Z_t - \bar{Z}}{S_z} * 10 + 100, \quad (11)$$

$$\bar{Z} = \frac{1}{T}\sum_{i=1}^{T} Z_t, \quad (12)$$

$$S_z = \sqrt{\frac{1}{T-1}\sum_{i=1}^{T}\left(Z_t - \bar{Z}\right)^2}. \quad (13)$$

The indirect method is used to calculate the composite ESI for Azerbaijan. In the measurement variant used, the values of the ESI mainly vary from 90 to 110.

It is assumed that the significance of the ESI at the level of 100 units is consistent with the long-term trend. Exceeding this level, i.e., a positive deviation from the long-term trend is interpreted as economic growth, and a value below 100 indicates a negative trend reversal and deterioration of the economic situation.

5. 2. Processing economic indicators by software methods

Before moving on to the assessment of the Economic Sentiment Index, it is necessary to observe the dynamics of GDP from 2015 to the current period, as well as the dynamics of the industrial, construction, retail trade, and service confidence indices provided by CBAR (Fig. 1).

As can be seen from Fig. 1, the dynamics of GDP by months are positive, excluding local increases and decreases. However, during the period when the COVID-19 pandemic began to spread in the country, business activity decreased due to the restrictive measures applied by the Operational Headquarters under the Cabinet of Ministers, which was reflected in the monthly decline in GDP. However, it is already accelerating the recovery process in the economy by encouraging the need to ease social restrictive measures.

Fig. 2 shows the confidence indices prepared based on the results of a survey conducted by the Central Bank on business activity in the real sector of the economy.

Overall economic confidence was higher than average in all sectors considered during this period. In February, confidence levels were low in all sectors except the service sector. In March, confidence in construction, services and retail trade increased, but the industry was still below average.

Periods were determined by applying seasonal smoothing to the Industrial Production Index and the Industrial Confidence Index (Fig. 3).

Compared to February-March of the current year, the physical volume index of GDP has increased. During this period, the increase in confidence indices by sector also led to an increase in the Economic Confidence Index by 3.5 %. In general, the significant easing of the special quarantine regime in connection with the pandemic, the growing popularity of the vaccination process in the country have led to the revival of economic life.

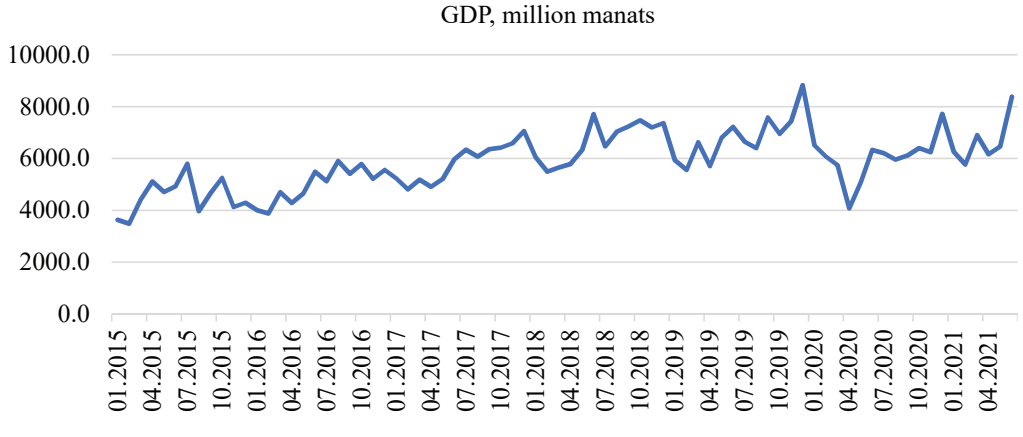


Fig. 1. Dynamics of gross domestic product

Source: The State Statistical Committee of the Republic of Azerbaijan

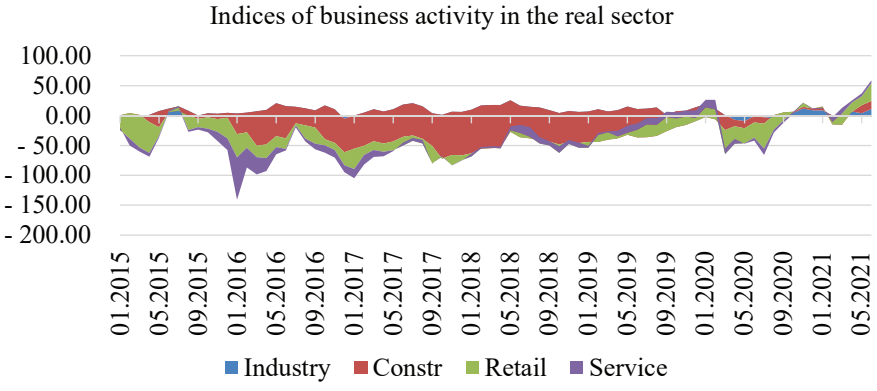


Fig. 2. Indices of business activity in the real sector
Source: Central Bank of the Republic of Azerbaijan

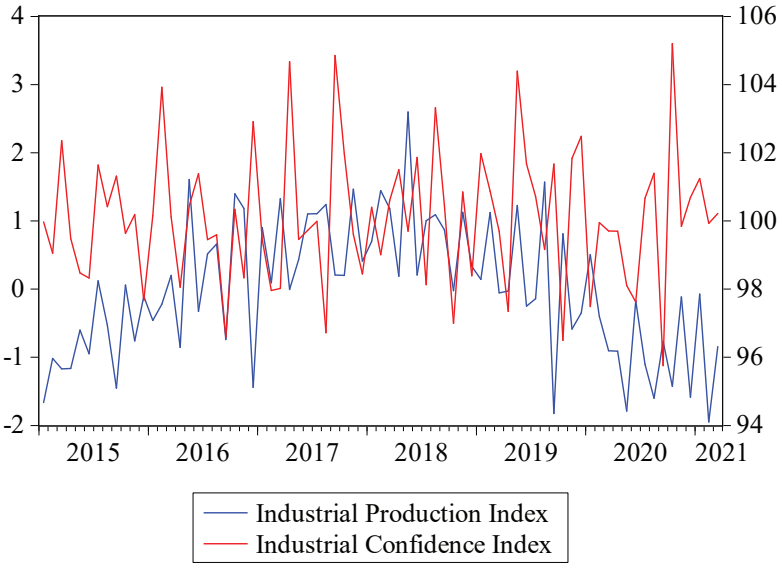


Fig. 3. Industrial Production Index and Industrial Confidence Index

Although the volume of industrial output increased by 12.2 % in nominal terms or 425.6 million manats in March compared to February of the current year, in 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 and amounted to 1,007.1 million manats. In the same period, retail trade turnover decreased by 1.1 %.

The decomposition of the dynamics of the aggregate survey index and quantitative macroaggregate is based on the statistical two-way linear Hodrick-Prescott filter, which is used in our studies according to the recommendations and relevant experience of the OECD. The HP filter calculates a smoothed time series by minimizing the variance of the elements s_t around y_t in a general form:

$$\sum_{t=1}^{T}\left(y_t - s_t\right)^2 + \lambda\sum_{t=2}^{T-1}\left(\left(s_{t+1} - s_t\right)^2 - \left(s_t - s_{t-1}\right)\right)^2 \to \min, \qquad (14)$$

where s_t is smoothed time series. The smoothing parameter is calculated as

$$\lambda = \left(2\cdot\left(\frac{\pi}{l}\right)\right)^{-4}, \qquad (15)$$

where the parameter l defines the smoothing period.

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

1. Double use of the Hodrick-Prescott filter analogous to the main economic indicator with parameter values λ=42131.155 for the first stage and λ=13.93 for the second stage.

2. Single application of the Hodrik-Prescot filter with a parameter value λ=13.93.

The first method assumes that the ESI has a long-term trend over time. The second method is based on the assumption that row ESI (in economic terms) is stationary. Therefore, the problem of choosing a processing method will depend on the type of probable model. If the time sequence of the ESI series 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 a parameter value of λ=13.93. This key economic indicator allows for identifying important components for a smoother and more convenient cycle component that can be used in the analysis in conjunction with a well-grounded business cycle. Otherwise, it is recommended to apply a two-stage cycle isolation procedure. At the same time, it is known that structural changes 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 economically analyzed to substantiate and interpret the moments of structural change. The non-stationarity of ESI's time series may be due to structural changes and shocks in the economy, as well as the inability of respondents to distinguish between market fluctuations and structural changes. Therefore, through the respondents' responses, the structural fluctuations in the economy manifest themselves in the time series of the ESI. In other words, at certain stages, the ESI may contain a trend component and may not be stationary.

Fig. 4 shows the comparative results of the time series of the normalized ESI with the above-mentioned values of the filter parameter. ESI-1 is a cyclic component of ESI after the two-stage application of the Hodrick-Prescot filter, ESI-2 is ESI with a single application of the Hodrick-Prescot filter.

Fig. 5 shows the plots of the initial ESI's time series and the time series of the seasonally adjusted ESI for the period under review from January 2015 to June 2021. The seasonal adjustment was performed using the Hodrick-Prescot statistical filter.

Also, Fig. 5 shows the differences in the dynamic characteristics of the ESI-1 and ESI-2 time series. The application of the 2-stage Hodrick-Prescott filter has significantly smoothed the ESI-1 index, bringing it to an almost stable straight line after 2018.

Fig. 6 shows the two-stage application of the Hodrick-Prescott filter for GDP and ESI-1 and a single (λ=13.93) application for ESI-2.

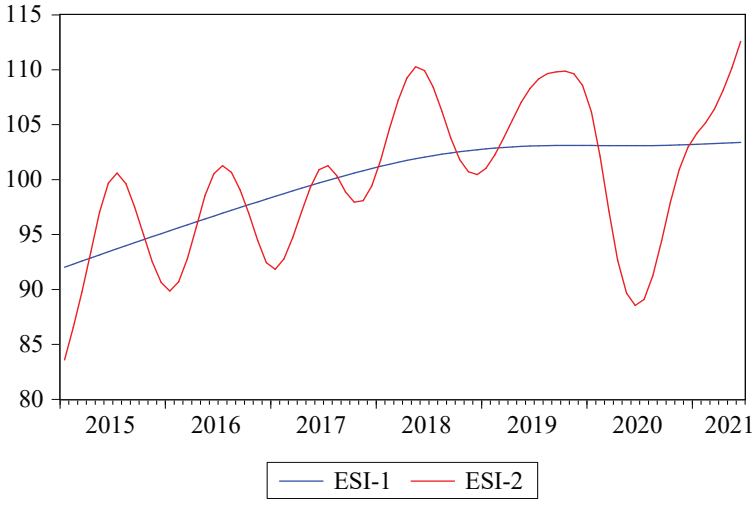


Fig. 4. Impact of trend reversal on the dynamics of the ESI indicator

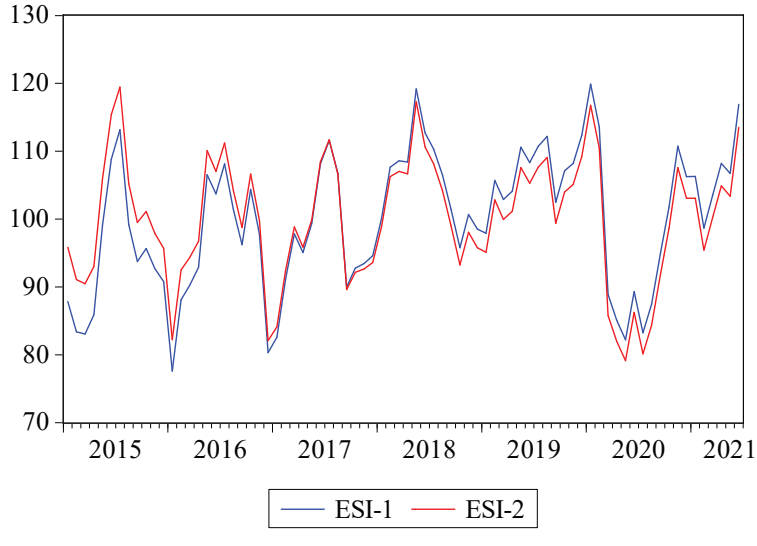


Fig. 5. ESI's time series and season-adjusted ESI series indicator

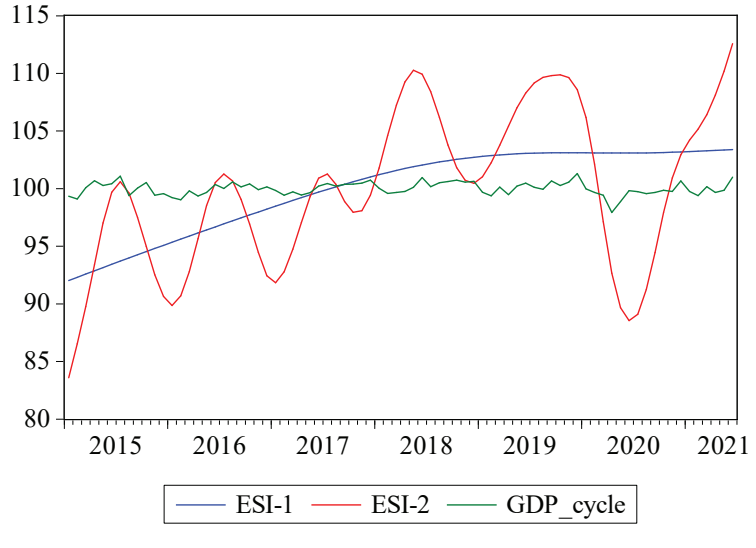


Fig. 6. Time series obtained by the two-stage method for GDP and ESI cycles

The share of the above-mentioned sectors in the calculation of the economic confidence index is 45 % in industry, 25 % in services, 16 % in construction, and 14 % in retail trade. During the calculations, the rows were normalized to an average of 100 and a standard deviation of 10.

According to the results, the periods when the peak and bottom points of ESI and GDP meet are shown in Table 2.

Table 2

Critical Points of ESI and GDP

Turning points of cycles	ESI		GDP	
bottom	2015M1	93.45606	2015M1	97.35299
peak	2016M3	98.11717	2016M5	117.7574
bottom	2018M5	103.1198	2018M9	146.6464
peak	2020M6	99.66686	2020M5	151.9646
bottom	2021M1	97.70158	2021M1	152.234

Source: Authors' calculations

The synchronous correlation coefficient between the periods of the ESI and the physical volume index of GDP (smoothed) is 0.89.

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

Periods were determined by the seasonal leveling of the ESI and GDP. According to Table 2, the replacement of the "bottom" and "peak" phases covers a period of 6–9 months in GDP and 6–7 months in ESI. The "peak" points of the ESI are 2–4 months ahead of the GDP growth rate, and the "bottom" points are 1–4 months ahead.

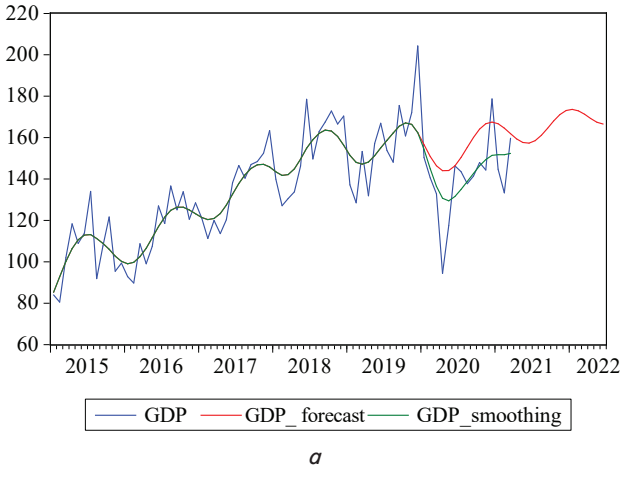
5. 3. Determining the dependence of GDP change on ESI, building a model of critical moments of business cycles

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

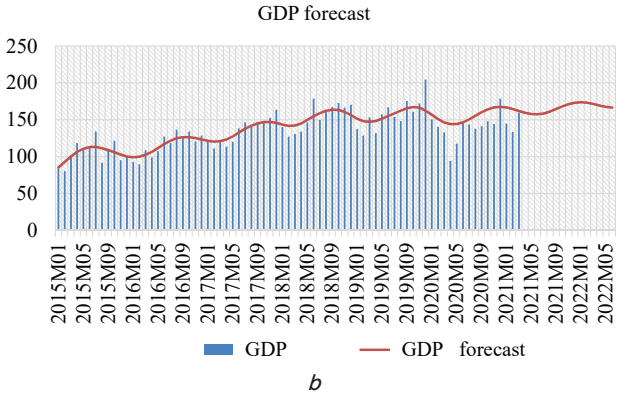
The following graphs provide forecasts of ESI and GDP until June 2022 based on the vector autoregression (VAR) model [32] (Fig. 7, 8).

The model proposed in this paper describes the relationship between the main macroeconomic indicator and economic sentiments. The use of the VAR method for a set of parameters selected for further processing in DEMETRA makes it possible to reduce the bias of the estimated coefficients and build a confidence interval for the parameters. We evaluate the model with the chosen optimal value of the parameter λ. We will further use this set of parameters when estimating the model with a constraint on long-term growth rates. Note that the model allows for any restrictions on long-term growth rates. Next, we will test the

formulated hypothesis that the short-term growth rates of GDP and the economic sentiment index are equal, that is, that these indicators change at the same tempo.



a



b

Fig. 7. Gross Domestic Product forecast:
a — Periods determined by applying GDP seasonal smoothing;
b — A forecast of the future change of GDP

The aggregate economic sentiment of Azerbaijani entrepreneurs and the population collapsed almost vertically in the third quarters of 2015 and 2016, associated with the devaluation of the national currency, as well as in the first quarter of 2020 under the influence of coronavirus shocks. Then, after the adaptation of economic agents to the new economic conditions, ESI won back most of the losses. Subsequent fluctuations in economic sentiment in 2020–2021 were mainly due to the alternation of new waves of COVID-19 and periods of stabilization of the pandemic situation. Studies have revealed and Fig. 7, 8 confirm the close correlation of the ESI with the index of physical volume of GDP.

The ESI responds more quickly to the ups and downs of the periodic economic development and reflects the impending economic events, and thus becomes a harbinger of them. The Economic Sentiment Index, by its very nature, already has the potential to be predictive, as the speed with which relevant data collected allows it to be published before economic growth.

The Economic Confidence Index and the turning points of GDP coincide with a small deviation (the deviation arises from the calculation of the sectoral weight of the Economic Confidence Index in relation to 2020, not by sectoral shares for each year).

For additional visualization of the formation of cyclic structures of the ESI, a tracer of short-term cyclic profiles in dynamics is formed (Fig. 9). Using the Hodrick-Prescott filter, irrelevant changes in the original time series are leveled. The y-axis in such a graphical representation characterizes the level values of the indicator's time series corresponding to growth rates, and the x-axis characterizes their quarterly changes (absolute growth). Thus, the tracer simultaneously displays the level and change in the dynamics of the ESI's short-term cycle, visualizing the four quadrants of the trajectory of its movement, corresponding to the following four phases of the cycle:

– the upper right quadrant I (growth acceleration phase, expansion) corresponds to the intensive growth of the indicator with a level above the average (for the ESI it characterizes the optimism boom phase);

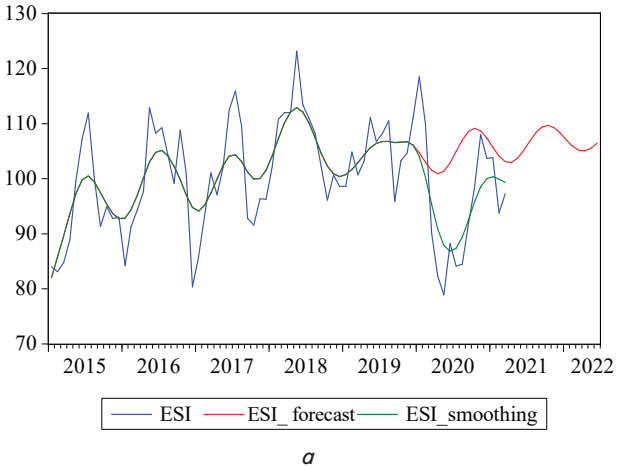
– the upper left quadrant II (growth slowdown phase) corresponds to slower growth of the indicator with an above-average level (for ESI – the phase of increasing pessimism);

– the lower left quadrant III (phase of decline, recession) corresponds to a decrease in the indicator with a level below the average (for ESI – the phase of crisis moods);

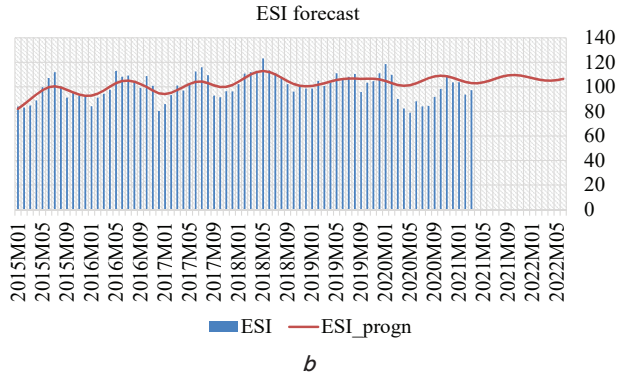
– the lower right quadrant IV (deceleration phase) corresponds to the growth of the indicator with a level below the average (for ESI – the phase of increasing optimism).

The four quadrants corresponding to the four phases of the cycle intersect counterclockwise as the tracer moves. Cyclical maximums (peaks, overheating of the economy) are in the upper central area of the chart, and cyclical minimums (depressions, crises) are in the lower central area.

As can be seen from Fig. 9, the circular peaks are located in the upper center of the graph, and the depressions in the lower center.



a



b

Fig. 8. Economic Sentiment Index forecast:
a — Periods determined by applying ESI seasonal smoothing;
b — A forecast of the future change of ESI

As shown in Fig. 9, the tracer of short-term cycles of the ESI almost synchronously captures all critical points of maximum gaps between potential aggregate economic activity and its nominal level (in terms of the output gap theory), repeating, in particular, all phase features of short-term cycles of GDP, all four peaks and four troughs. The visualization of the movement of the tracer, which describes the short-term cycles of ESI and GDP, quite clearly reflects the development of macroeconomic trends, focusing on all the phase nuances of the business environment in a particular period of the functioning of organizations.

After a clear peak at the beginning of 2015, the ESI in its cyclic movement crossed the border of the expansion area and was in the phase of a turn to decline, demonstrating a steady slowdown of growth with the same intensity. The latest values of the indicator are in the phase of cyclic contraction, indicating that pessimistic economic sentiment remains in the business environment. However, in the first quarter of 2019, the ESI approached the border of the cyclical upswing phase, which indicates a possible increase in the optimism of entrepreneurs in 2021.

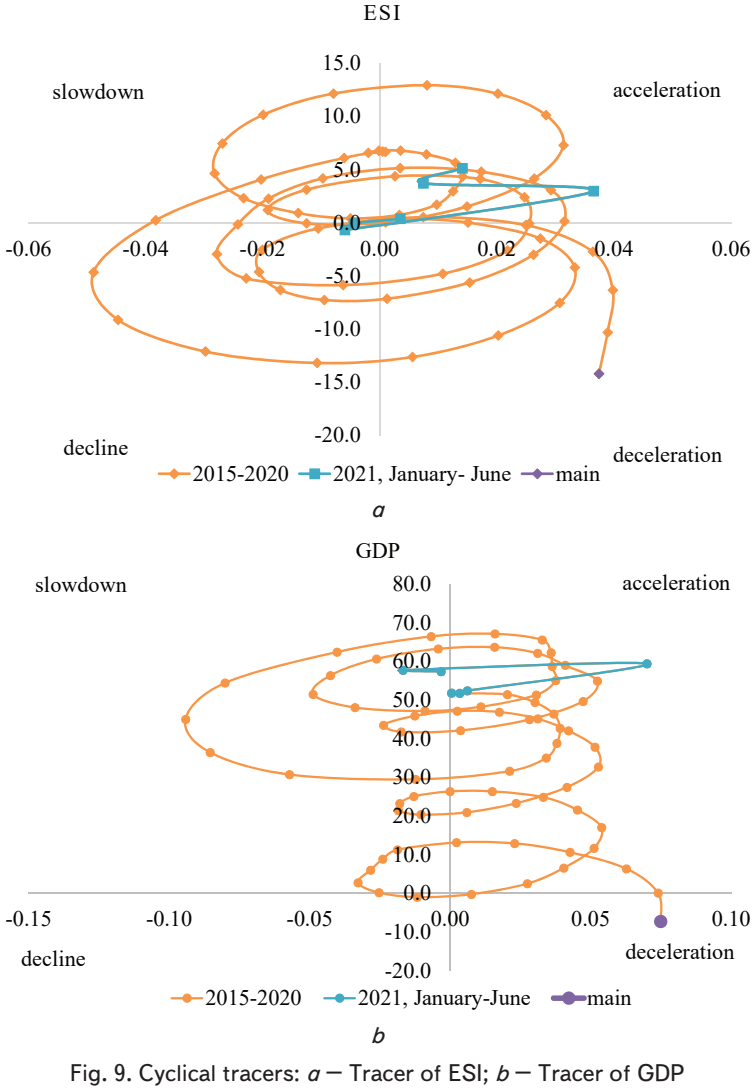


Fig. 9. Cyclical tracers: *a* — Tracer of ESI; *b* — Tracer of GDP

With the help of a tracer based on its phase-by-phase movement, new possibilities of visualization and analytical representation of the cyclic profile in the dynamics of ESI and GDP indicators are demonstrated. The movement of the tracer in the four quadrants of the diagram (counterclockwise) allows tracking the passage of the indicator through the four phases of the economic cycle; while the cyclic peaks are located in the upper central region of the diagram, and the cyclic troughs are located in the lower central part.

In particular, of greatest interest is the cyclical development of indicators during periods of the brightest business cycles, covering the crisis and subsequent depression of 2015–2016, the pandemic period of 2019–2021, the subsequent post-crisis periods, and the entire course of the crisis-recovery scenario of 2015–2021. During the period of the highest business activity and the rapid functioning of the economy, which falls in pre-crisis 2014, the cyclic peaks of the tracer are located in the upper central area of the charts, demonstrating the maximum activation of entrepreneurial activity. The passage of the indicator into a decline phase, followed by a plunge into the most unfavorable zone of cyclic contraction, reflects the pre-crisis economic phenomena of the first half of 2015. As a result, from Q1 2016 to Q1 2017, the tracer was in a critical phase, indicating a sharp reduction in dynamics sector development. The ESI value in Q2 2016 dropped to 80. We see the same picture in 2020 – the ESI tracer value shows 76, setting an absolute record in the history of surveys. The subsequent movement of the tracer demonstrates the period of post-crisis recovery. Moving along the recession quadrant, already in Q3 2016 and Q2 2020, the cyclicity tracer overcame its boundaries, moving into the upswing phase. For the economy, this was perhaps one of the most unfavorable periods, when various strategic maneuvers were undertaken for compensatory recovery. However, given the ambiguity of the external economic environment, staying in this quadrant turned out to be short-lived. ESI in its cyclic development has overcome the decline phase and continued to develop in the expansion quadrant. The further cyclical development of ESI, which characterizes the state of the economy in post-crisis periods, can be characterized as moderately positive.

Based on the presented analysis of the results referred to the aggregate development of the economic activity, it can be assumed that its systemic feature at present is the transition to a lower trajectory in the analysis of growth, which is largely caused by a slight downward shift in the level of its potential values over the past six years since one of the deepest financial and economic crises in Azerbaijan of 2015.

6. Discussion of the results of the study of the relationship between the dynamics of GDP and Composite Leading Indicators

The paper considers the possibility of using composite market monitoring indicators to measure short-term economic dynamics cycles. Based on their statistically significant admissibility, the obtained results confirm the

market monitoring indicators' ability to be an integral part of the national corpus of short-term indicators with a cyclical nature, which was also scientifically substantiated by the literature presented in the paper.

To obtain additional information about the possible prospects for the country's economic development, as well as to improve the efficiency of statistical measurements in the new economic conditions, we considered it appropriate to pay closer attention to the collection and analysis of information from businesses and consumers based on regular large-scale surveys by the State Statistical Committee and Central Bank (Fig. 1, 2).

The "soft" qualitative statistics used in the work reflect the peculiarities of cognitive perception by economic agents of business trends and sectoral cyclical events in the "almost real-time" mode. Statistics Committee's primary data (respondents' answers to questionnaires) are structured in accordance with the direct indicators of each sample survey. As a result of data quantification, an information array is formed and presented mainly in ordinal and nominal measurement scales. Computational procedures for processing and aggregating the obtained categorical data make it possible to get the dynamics of composite (summary) indicators for all types of activities surveyed (Fig. 3).

The main results of the study are the identification of short-term trends in economic sentiment and the construction of the main development trajectories that have developed in the real economy in the period under review. The ESI time series is used as an indicator of phases and turning points of growth cycles in the dynamics of such an aggregate statistical macro-aggregate as the volume index of gross domestic product (Fig. 4, 5).

At present, early estimates of GDP are of particular practical importance in the context of the spread of crisis trends at the national level, caused not only by economic factors. This leads to the search for and wider use of alternative indicators that are relevant for measuring and forecasting economic growth in the face of sudden upheavals and shocks, in particular those generated by the spread of infections in the world. The empirical results of the study allow us to conclude that the aggregate index of economic sentiment is sensitive to GDP growth (Fig. 6); using the software product, their relevance for identifying phases and turning points in GDP dynamics is revealed, and cyclic profiles in macroeconomic dynamics are tested. The identification of short-term and smoothed cyclic profiles, as well as the dating of cyclic turning points in them, clearly reflected the presence of cyclic correspondence in the analyzed dynamics (Table 2). A number of theses were also formulated, which are illustrated in the paper on the example of the results of a visual comparison (tracers) of the ESI and GDP indicators (Fig. 9). In particular, in the analyzed period, the ESI in the phases of accelerating economic growth is one of those leading short-term indicators that portend cyclical reversals to a change in growth rates, especially from the moment when its values were steadily exceeding GDP growth rates. In the recession phase, the ESI can also be defined as an indicator that notifies in advance of the aggravation of crisis events. After each clear crisis period, there has been a significant gap and lag between strong GDP growth and a less pronounced improvement in economic sentiment.

It should also be noted that in Azerbaijan, the empirical measurement of economic growth is not an easy task due to the time constraints of the published statistical dynamics, especially taking into account the sectoral level. From this point of view, this paper seems to be useful for politicians and the expert community, especially during periods of the spread of crisis events.

However, the main limitation of the study is the paucity of data. In addition, conducting a questionnaire survey in enterprises and the fact that the questions relate to different areas of economic activity increases the risk of incorrect proportional distribution. Another limitation is time series. The longer the time, the more accurate the results. For example, the authors also calculate the consumer index as a result of consumer surveys, but due to lack of time, they cannot take it into account in the paper for the results to be more accurate.

The disadvantage of the study is its justification based on the data of the survey. When conducting a survey, the probability of correct answers to questions is low, and it depends on the correspondents themselves. The way to overcome this shortcoming is to receive information by processing it with text intellectual methods, and not to accept it from information sites. This will increase the amount of information, and allow for a more accurately assessing the situation and sentiments.

7. Conclusions

1. A choice of an algorithm for calculating the composite ESI index, processing the time series of the annual GDP growth rate and ESI, and confirming 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 the Hodrick-Prescott 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-Prescott filter is used to smooth out fluctuations

in the original time series that are insignificant in terms 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.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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