FORECASTING ECONOMIC GROWTH IN THE CONDITIONS OF GLOBAL TRANSFORMATIONS

Olena Vilchynska[1]

DOI: https://doi.org/10.30525/978-9934-26-673-7-11

Abstract. The section of the monograph is devoted to a comprehensive study of theoretical and methodological foundations, modern methods and software for forecasting economic growth in the conditions of global transformations, strengthening integration processes and digitization of the economy. The focus is on the need to adapt traditional forecasting methods to the new operating conditions of economic systems characterized by a high level of uncertainty, rapid technological changes, and a growing amount of data.

The subject of the research is the theoretical, methodological and applied aspects of forecasting economic growth using modern digital tools and software. The purpose of the study is to generalize scientific approaches to forecasting economic growth, systematize modern methods and models, as well as to substantiate directions for increasing the effectiveness of forecasting calculations in the conditions of digital transformation of the economy. The methodological basis is general scientific and special research methods, in particular, a systematic approach, economic and statistical analysis, econometric modeling, comparison and generalization methods, scenario analysis, as well as machine learning and big data analysis tools that allow taking into account complex nonlinear dependencies between economic indicators.

The work reveals the economic essence of forecasting as an important tool of state regulation and strategic management of the development of the national economy. The evolution of theories of economic growth and their influence on the formation of modern approaches to forecasting are

[1] Candidate of Economic Sciences,
Associate Professor of the Department of Law and Humanitarian Disciplines,
Vinnytsia Educational and Scientific Institute of Economics
West Ukrainian National University
ORCID: https://orcid.org/0000-0001-8443-7397

analyzed. Methodological approaches and principles of building predictive models, in particular econometric, macroeconomic, scenario and simulation models, are summarized, with the definition of their functional capabilities and areas of application.

Particular attention is paid to modern forecasting methods, including regression models, time series models, structural macroeconomic models, cross-industry and simulation models, as well as machine learning and big data analysis tools. Their key advantages are identified, including increased forecast accuracy, the ability to process large amounts of information and detect hidden patterns, and limitations related to the complexity of interpreting results and the dependence on the quality of input data are outlined. It was established that the choice of a specific method depends on the purpose of the research, the availability of data, the horizon of forecasting and the level of complexity of the economic system under analysis.

Special emphasis is placed on researching the role of software and digital platforms in increasing the effectiveness of forecasting economic growth. Modern analytical systems, data processing tools, and cloud technologies are characterized, which provide automation of analytical processes, integration of disparate sources of information, and increase in efficiency of management decision-making.

As a result of the study, theoretical and methodological provisions and practical recommendations were developed for improving the economic growth forecasting system, taking into account modern global challenges, digitalization and the need to increase the competitiveness of the economy. The main conclusion is that the effective combination of classical econometric approaches with modern digital technologies, in particular artificial intelligence tools and big data analysis, creates prerequisites for forming more accurate, adaptive and reliable forecasts, which is a key factor in ensuring sustainable economic development.

Introduction

The current stage of development of the world economy is characterized by a high level of uncertainty, dynamic changes and the deepening of globalization processes. In such conditions, the problem of ensuring stable economic growth, which is a key prerequisite for improving the welfare of the population and the competitiveness of national economies, becomes

particularly important. At the same time, effective management of economic development is impossible without scientifically based forecasting of its trends and results.

The relevance of the research topic is due to the need to improve theoretical and methodological approaches to forecasting economic growth in the conditions of digital transformation, as well as the need to introduce modern analysis and modeling tools. This issue is of particular importance for Ukraine, whose economy functions under the influence of both internal structural imbalances and external challenges, including global economic crises, technological changes, and geopolitical factors.

The degree of scientific development of the problem indicates a significant interest in the issues of economic growth and its forecasting on the part of foreign and domestic scientists.

Economists, including Adam Smith, John Maynard Keynes, Robert Solow, Milton Friedman, Robert Barro, John Lee, Robert Caselli, Rudiger Dornbusch, Stanley Fisher, David Romer, and others, were engaged in theoretical and applied studies of economic growth. Their theoretical and applied studies laid the foundation for the formation of models that allow predicting the dynamics of economic development.

Studies in the field of econometric modeling carried out by such scientists as Simon Kuznets, William Easterly, Robert Lucas, Thorsten Beck, Ross Levin, Norman Loiza, Prabin Upreti are of special importance for the development of forecasting methods. A significant contribution to the development of the theory and practical application of mathematical methods in the study of economic systems was made by domestic scientists, in particular Viktor Glushkov, Valery Vitlinskyi, Vasyl Vovk, Anatoly Bomba, Oleksandr Nakonechnyi, Oleksandr Yastremskyi, Iryna Lukyanenko, Natalia Kostina, Oleksandr Rotshtein, as well as leading Ukrainian economists Valery Geits, Anatoly Galchynskyi, and Yaroslav Zhalilo. Thanks to their research, it became possible not only to better understand the patterns of economic growth, but also to create modern mathematical models used to forecast GDP dynamics and assess the impact of key macroeconomic factors on the future development of the economy.

However, despite significant progress in this area, the issues of integration of modern software, big data processing tools and artificial intelligence

technologies in economic forecasting processes remain insufficiently researched.

The purpose of the monograph is to deepen the theoretical and methodological foundations of forecasting economic growth and to substantiate practical approaches to the use of modern software and digital platforms to increase the accuracy of forecasts and the effectiveness of management decisions.

To achieve the goal, the following tasks have been defined:

1) research the theoretical foundations of forecasting economic growth;

2) analyze modern methods and models of economic forecasting;

3) characterize the capabilities of software and digital tools in the forecasting process;

4) to determine directions for improving the practice of forecasting economic growth.

The object of research is the processes of economic growth at the national and global levels. The subject of the research is theoretical, methodical and applied aspects of forecasting economic growth using modern software.

The methodological basis of the research is general scientific and special methods of cognition, including system analysis, economic-mathematical modeling, econometric methods, methods of comparative analysis, as well as modern digital data processing tools.

The scientific novelty of the obtained results lies in the development of approaches to forecasting economic growth based on the integration of classical economic models with modern mathematical modeling methods and software.

The practical significance of the obtained results lies in the possibility of using them to increase the effectiveness of forecasting and strategic planning of economic development.

1. Theoretical and Methodological Foundations of Forecasting Economic Growth in Modern Economic Science

Forecasting economic growth is an important component of economic science and the practice of public administration, as it allows you to determine future trends in the development of economic systems and form an effective economic policy strategy. Forecasting is a tool for scientific prediction of future changes in the economic system based on the analysis

of the patterns of its development. The theoretical foundations of economic forecasting were formed within the framework of the development of macroeconomic theory, statistics, econometrics and system analysis.

Forecasting becomes especially important in conditions of instability and high uncertainty, which is typical for the economy of Ukraine in the period of transformational processes and the influence of external shocks.

The methodology of forecasting economic growth is based on a systemic approach, which involves considering the economy as a complex, multi-level and dynamic system, the elements of which are in constant interaction and mutual influence. In this context, it is important to take into account not only individual macroeconomic indicators, but also the interrelationships between them, as well as the influence of external and internal factors.

The key principle is systemicity, which means a holistic perception of the economy as a single organism, where changes in one sector can have significant consequences for others. Complexity involves taking into account a wide range of factors - economic, social, political, technological and foreign economic - that affect the process of economic growth. Scientific validity is provided by the use of proven theoretical approaches, economic laws, as well as modern economic-mathematical and econometric methods of analysis and forecasting.

An important principle is variability, which consists in the development of several possible options for the development of events depending on the change of key factors and conditions, which allows you to prepare for different economic situations. Adaptability to changes in the external environment implies the ability of the forecasting system to respond in a timely manner to new challenges, risks and uncertainties, in particular by regularly updating data, revising assumptions and adjusting forecasts.

Economic growth is one of the key categories of macroeconomics, which reflects the dynamics of the development of the national economy and determines the level of welfare of society. In a general sense, as stated in [1], economic growth is interpreted as a long-term increase in the real volume of production of goods and services, which is most often measured through the indicator of gross domestic product (GDP).

The theoretical foundations of forecasting economic growth were formed within the framework of the development of economic theory. Classical economists such as A. Smith and D. Ricardo viewed economic growth

through the lens of capital accumulation and resource efficiency. Neoclassical models were further developed, in particular the model of R. Solow, which proves the determining role of technological progress as an exogenous factor. The theories of endogenous growth by P. Romer and R. Lucas shifted the emphasis to internal factors of development – innovations, human capital, knowledge [2]. This became an important basis for modern approaches to forecasting, which take into account the intellectualization of the economy.

The methodological base for forecasting economic growth is based on a combination of general scientific and special research methods. General scientific methods include analysis and synthesis, induction and deduction, and a systematic approach. At the same time, specialized forecasting approaches include economic-mathematical modeling, econometric analysis, time series research methods, scenario forecasting, as well as simulation modeling, machine learning methods that provide a more comprehensive and well-founded prediction of future trends, allow taking into account the influence of various factors, analyze the dynamics of indicators over time, and form alternative options for the development of events depending on changes in external and internal conditions.

In modern economic science, forecasting is considered as a complex process that includes several main stages of implementation. At the first stage, the goal of forecasting is formulated. The goals of the forecast are determined (for example, the assessment of GDP rates, inflation, unemployment, etc.). The forecasting horizon is selected (short-term, medium-term or long-term forecast).

At the second stage, the collection and analysis of initial data is carried out. Internal factors are evaluated, macroeconomic indicators are analyzed (GDP, inflation, unemployment rate, investments, public debt, fiscal and monetary policy, consumption and investment levels), external factors are studied (world economic situation, resource prices, international trade). We note that for the successful construction of forecasts, it is necessary to ensure the accuracy of the input statistical information, which is a guarantee to a certain extent of the accuracy of the results of the quantitative analysis of GDP. Also, taking into account the fact that economic processes are dynamic, characterized by the variability of parameters and structural relationships, it is necessary to have a steady flow of new data to adjust the forecast.

The third stage involves choosing a forecasting method. Modern economic science uses a wide range of forecasting methods, which differ in approaches, tools and scope of application. One of the most important groups is econometric methods, which include regression analysis, time series models (in particular ARIMA and VAR), and panel models. They make it possible to quantitatively assess the impact of various factors on economic growth, establish statistical dependencies between variables, and make short- and medium-term forecasts based on historical data.

An important place is occupied by macroeconomic models, among which DSGE-models (dynamic stochastic general equilibrium models), CGE-models (general equilibrium models), as well as inter-industry balance models are distinguished. These models allow analyzing the structure of the economy, interrelationships between its sectors, and assessing the impact of economic policy on macroeconomic indicators.

In addition to formalized models, expert forecasting methods based on the experience and knowledge of specialists play a significant role. These include the Delphi method, analytical assessments and scenario forecasting. These approaches are particularly useful under conditions of high uncertainty or insufficient statistical data, where quantitative methods are of limited application.

Recently, modern digital methods of forecasting, based on the use of machine learning, neural networks and big data analysis, have become increasingly popular. They make it possible to process large amounts of information, reveal hidden patterns and increase the accuracy of forecasts, especially in conditions of complex and rapidly changing economic processes. The combination of traditional and modern approaches provides more complete and flexible forecasting of economic growth.

It is worth noting that modern economic processes are characterized by a high level of uncertainty, which is due to the influence of a number of interrelated factors. First of all, these are globalization processes that increase the interdependence of national economies and make them more sensitive to external shocks. An important factor is also financial crises, which can quickly spread between countries and cause significant fluctuations in macroeconomic indicators. An equally important role is played by geopolitical factors, in particular conflicts, changes in international relations and trade restrictions, which affect the stability of economic development.

In addition, uncertainty is exacerbated by technological changes, which, on the one hand, create new opportunities for growth, and on the other hand, create new risks and challenges for economic systems. In such conditions, the consideration of risks in the process of forecasting economic development becomes especially important. For this purpose, scenario analysis is widely used, which involves the development of alternative options for the development of events; stress testing, which allows you to assess the resilience of the economic system to negative shocks; as well as simulation modeling, which makes it possible to reproduce the behavior of economic processes in different conditions and evaluate the possible consequences of the decisions made. The use of these approaches helps to increase the reliability of forecasts and provides more reasonable management decisions in conditions of uncertainty.

The fourth stage is the development of a predictive model, determination of variables and parameters of the model, calibration of the model based on retrospective data, verification of model adequacy. The current stage of the development of economic science is characterized by the active integration of software into forecasting methodology, which significantly expands the possibilities of analysis and increases the quality of forecast estimates. Statistical packages such as R, Stata and SPSS, as well as programming languages, in particular Python, are widely used in research practice. In addition, modern data analysis and visualization platforms, such as Power BI and Tableau [3], have become widely used. The use of these tools allows you to automate the processing of large data sets, increase the accuracy of the forecast, reduce the time of calculations and provide a visual visualization of the research results. In combination with modern methods of analysis, this helps to increase the effectiveness of forecasting economic growth and the validity of management decisions.

The fifth stage involves an in-depth analysis of the obtained results and interpretation of the forecast. At this stage, the probability of realization of each of the formed scenarios (basic, optimistic and pessimistic) is assessed, key risks and sources of uncertainty are determined, which may affect the deviation of actual indicators from forecast ones. Special attention is paid to the analysis of the sensitivity of the model to changes in individual factors, as well as to the assessment of the impact of economic policy tools (fiscal, monetary) on the expected dynamics of GDP and other macroeconomic

indicators. This allows not only to check the reliability of the forecast, but also to identify the most critical factors of economic development.

At the sixth stage, the forecast is adjusted and practical recommendations are formed. Forecast values are refined taking into account new statistical data, changes in the external and internal environment, as well as the results of additional analysis. Based on the updated forecast, recommendations are being developed for state administration bodies, business and other interested parties regarding the optimization of economic policy, increasing the stability of the economy and minimizing risks. In addition, the forecast is used as a tool to support strategic decision-making, in particular in the field of investment planning, budget forecasting and long-term development.

In general, the given stages of the forecasting process form a coherent methodological basis for a comprehensive analysis of economic growth. Their consistent application ensures an increase in the accuracy of forecasts, the validity of management decisions and the adaptability of economic policy to changes in a dynamic environment, which is especially important in the conditions of modern global challenges and instability.

So, the theoretical and methodological foundations of forecasting economic growth are a multi-component system of knowledge that includes classical economic theories, modern economic and mathematical methods, and the latest digital technologies. Their development determines the improvement of the quality of forecasting and the efficiency of management decision-making.

2. Modern Methods and Models of Forecasting Economic Growth

In today's conditions of transformation of economic systems, digitization and global instability, economic growth forecasting acquires new features associated with the use of innovative methods of data analysis and processing. Traditional approaches are gradually supplemented by tools based on computing technologies, big data and artificial intelligence.

Modern models used for forecasting economic development can be conventionally divided into classical econometric, macroeconomic structural models, simulation and scenario models, models based on machine learning.

Econometric models remain the basic tool for forecasting economic growth. They allow establishing quantitative dependencies between

macroeconomic indicators. The most common include regression models, autoregressive models (AR, VAR, VECM), time series models (ARIMA, SARIMA).

In the context of the use of regression models of economic growth, the theoretical work of leading economists, who identified key factors influencing the dynamics of macroeconomic indicators, is of great importance. In particular, Robert Solow's neoclassical model serves as a theoretical basis for constructing regression relationships, in which capitalization, population growth rates, and technological progress are used as explanatory variables. This allows us to quantify the contribution of each factor to the change in GDP and confirms that in the long term technological development plays a decisive role [1].

These approaches were further developed in models of endogenous growth, in particular in the works of Paul Romer, where such variables as the level of human capital, innovative activity and openness of the economy to international trade are included in the regression models. This makes it possible to more accurately reflect the impact of knowledge and technology on economic growth. In turn, Robert Lucas' model emphasizes human capital as a key variable, which is also widely used in empirical regression studies [2].

An important contribution to the formation of modern approaches to the regression analysis of economic growth was also made by Jean Grossman and Elhanan Helpman, who emphasized the role of innovation, knowledge accumulation, and investment in scientific research. In the regression models, these factors are reflected through the level of education and innovative activity.

Thus, regression models of economic growth make it possible to establish quantitative relationships between macroeconomic indicators, based on the theoretical concepts of various schools of economic thought, and provide the possibility of empirical verification of the influence of key factors on GDP dynamics.

Time series models, in particular ARIMA, VAR and GARCH, are widely used to analyze the dynamics of GDP in the time dimension, which makes it possible to identify long-term trends, seasonal fluctuations and cyclical changes in economic activity. The use of these models allows not only to describe the behavior of macroeconomic indicators, but also to form reasonable short- and medium-term forecasts of their development.

Studies have confirmed that the use of time series models is an effective tool for forecasting the real GDP of Ukraine [4]. In particular, such models make it possible to take into account the influence of key macroeconomic factors, including the consumer price index, the unemployment rate, the volume of exports of goods and services, capital investments, as well as the exchange rate of the hryvnia against the US dollar. Analysis of the dynamics of these indicators over time allows establishing their interrelationships and assessing the power of influence on the change in GDP.

In addition, the use of ARIMA models provides efficient forecasting based on the internal structure of the time series itself, while VAR models allow for the consideration of the mutual influence of several economic variables. In turn, GARCH models are useful for analyzing and forecasting the variability of economic indicators, which is especially relevant in conditions of instability and crisis phenomena. The combination of these approaches contributes to increasing the accuracy of forecasts and forming a deeper understanding of the dynamics of economic growth.

Macroeconomic structural models, which reflect the structure of the economy and the relationships between its sectors, occupy an important place among modern forecasting tools. Macroeconomic models of general equilibrium are used to analyze structural changes in GDP, employment dynamics, population incomes, tax revenues and the state of the state budget, as well as to assess the levels of consumption and investment activity. Studies confirm that general equilibrium models are an effective tool for evaluating and forecasting the consequences of economic policies, as they reproduce a complex system of interaction between all economic agents [5]. In particular, such models take into account the behavioral characteristics of households, enterprises and the state, which ensures consistency between aggregate demand and supply. This, in turn, makes it possible to quantitatively assess the impact of various management decisions and to form more reasonable forecasts of the development of the economy.

One of the key tools for forecasting economic development are DSGE models (dynamic stochastic general equilibrium models), which are a system of interrelated equations describing the behavior of the economy at the micro and macro levels [6]. As stated in [7, 8], these models make it possible to formalize the decisions of the main economic agents, namely households, enterprises and the state, and to reflect a complex system of

interrelationships between indicators such as GDP, inflation, employment, investment and consumption. With their help, it is possible to analyze the economy's reaction to various internal and external shocks, such as changes in interest rates, fluctuations in resource prices or external economic shocks, as well as to simulate alternative scenarios of the development of events.

The development of DSGE models is quite complex and multi-stage, as it requires an accurate definition of economic dependencies, calibration or estimation of parameters based on real data, application of log-linear approximation, as well as bringing the model to a steady state to ensure the correctness of calculations. Despite this, such models have become widely used in the practice of macroeconomic analysis and forecasting, which indicates their high analytical value.

At the same time, it is important to consider that due to the presence of stochastic components and the influence of numerous uncertainties, these models have certain limitations, in particular, regarding the accuracy of long-term forecasts. That is why they are most effectively used in medium-term forecasting, where they provide a balance between theoretical validity and practical relevance of the results.

It is worth noting that models of the inter-industry balance of the "expenditure-output" type, initiated by Vasyl Leontiev, are an important tool for analyzing and forecasting economic growth, especially in the context of structural changes between industries. In work [9], the emphasis is on the dynamics of inter-industry relations, which is critically important for the long-term development of the economy. The authors emphasize that the classic static model has certain limitations, therefore, in modern research, dynamic cross-industry models are increasingly used, taking into account the time factor.

The input-output model describes how the output of one industry is used as a resource in others, which makes it possible to estimate the multiplier effect of changes in demand, to identify key industries that stimulate economic growth, and to model the consequences of investments or various shocks, in particular energy or military. This means that an increase in demand in one industry can cause a chain reaction of expanding production in other sectors of the economy. This opens up possibilities for forecasting changes in the structure of the gross domestic product, the reallocation of resources between industries, and the emergence of new sectors such as

information technology or green energy. The model also provides a deeper understanding of the relationship between inter-industry proportions and economic growth, allowing to assess the contribution of each industry to the formation of GDP, determine the efficiency of investments and find out the level of import dependence of the economy, which is especially relevant for Ukraine.

At the same time, these models are not without shortcomings, among which it is worth noting the assumption about the linearity of inter-industry relations, the difficulty of timely updating of statistical data, as well as the limited consideration of innovation processes and behavioral factors of economic agents. But, despite certain limitations, input-output models remain a powerful analytical tool for research and forecasting of economic growth.

Agent-oriented modeling as a method of forecasting economic growth is a modern tool for analyzing complex dynamic systems that complements traditional econometric and macroeconomic approaches. Its feature is the possibility of modeling the behavior of individual economic agents (enterprises, households, financial institutions) taking into account their heterogeneity, adaptability and interaction among themselves [10].

Unlike classical models, which are mostly based on aggregated indicators, agent-oriented models make it possible to make forecasts based on micro-level interactions that collectively form macroeconomic dynamics. The theoretical basis of this approach includes the use of decision-making models, elements of game theory, optimization methods and other tools of economic behavior analysis, which makes it possible to determine the rules of interaction of agents and predict various scenarios of the development of the economic system.

In a practical aspect, agent-oriented modeling is implemented through the creation of computer simulations that reproduce the functioning of the economy in conditions of a changing environment. Such models allow conducting experiments, evaluating the influence of various factors on market processes, testing alternative scenarios and determining effective management strategies. The use of real or simulated data provides verification of the adequacy of models and increases the reliability of forecasts.

In conditions of high uncertainty caused by global economic, political and technological changes, scenario modeling is becoming more and

more widespread. Its essence lies in the formation of several alternative options for the development of the economy depending on possible changes in key factors affecting macroeconomic dynamics. Usually, a basic scenario is selected, which reflects the most likely course of events under stable conditions; optimistic, predicting a favorable economic situation, investment growth and acceleration of economic development; as well as pessimistic, which takes into account possible risks, crisis phenomena and negative external influences.

Such an approach allows not only to increase the flexibility of forecasting, but also to prepare for various options for the development of events, which is especially important for making strategic management decisions. Scenario analysis is often combined with the use of simulation models, which make it possible to reproduce the behavior of the economic system in different conditions and to study its reaction to changes in individual parameters.

According to modern Ukrainian research, scenario modeling is a key tool in the period of war and post-war reconstruction of the Ukrainian economy [11].

In recent years, forecasting methods based on the use of machine learning and artificial intelligence, which are increasingly used in the analysis of economic growth, have gained rapid development. Such methods include decision trees, random forests (Random Forest), gradient boosting, as well as neural networks, in particular artificial neural networks (ANN) and recurrent neural networks of the LSTM type. Their application opens up new opportunities for processing complex economic data and building more accurate forecasts.

Unlike traditional approaches, machine learning methods allow taking into account complex nonlinear dependencies between variables, which are often characteristic of modern economic systems. They also work effectively with large data sets, including unstructured information, which significantly expands the analytical capabilities of researchers. Ukrainian scientists, in particular in the study [12], emphasize that the use of such approaches helps to increase the accuracy of forecasts, especially in the short term, where the speed of data processing and the ability to adapt to new trends play a key role.

Recurrent neural networks of the LSTM (Long Short-Term Memory) type, which are specially designed to work with time series, deserve special

attention. They are able to take into account long-term dependencies in the data, which makes them extremely effective for forecasting macroeconomic indicators such as GDP, inflation or the exchange rate. Due to the ability to "remember" the previous states of the system, as stated in [13], LSTM models provide a more accurate reproduction of the dynamics of economic processes.

At the same time, the effectiveness of machine learning and artificial intelligence methods largely depends on the quality of the input data, the correct choice of the model and the setting of its parameters. Therefore, in practice, they are often combined with classical approaches, which makes it possible to obtain more reliable, stable and interpretable results of forecasting economic development.

It is also worth noting that the current stage of economic development is characterized by the active use of big data, which significantly transforms approaches to the analysis and forecasting of economic processes. In Ukraine, the implementation of Big Data technologies in the field of economic forecasting is only gaining momentum, but it already shows significant potential. The use of big data opens up new opportunities for improving the quality of analytics, in particular thanks to the integration of disparate sources of information and the use of modern digital tools [14].

Among the key advantages of Big Data, it is worth highlighting the efficiency of obtaining information, which allows you to significantly reduce the time lag between data collection and their analysis; high detail, which makes it possible to study economic processes at the level of individual regions, industries or even enterprises; as well as the ability to perform real-time analysis, which is critical for rapid response to economic changes. In addition, big data helps reveal hidden patterns, improve the quality of predictive models, and increase the accuracy of managerial decision-making.

The combination of Big Data with methods of machine learning, econometrics and simulation modeling forms a new paradigm of economic forecasting, which is based on flexibility, adaptability and high speed of information processing. This is especially relevant in conditions of instability and rapid changes in the economic environment, where traditional approaches no longer always provide sufficient accuracy and timeliness of forecasts.

Below is a comparative table of the main models used in the process of forecasting economic development (Table 1).

Table 1

Comparative Characteristics of Forecasting Methods

Method Group	Main Tools / Models	Advantages	Disadvantages	Scope of Application
Econometric Models	Regression models, ARIMA, VAR, GARCH	Quantitative assessment of factor influence; high interpretability; hypothesis testing	Limited ability to capture nonlinearities; dependence on data quality	Short- and medium-term forecasting of GDP, inflation, unemployment
Macro-economic General Equilibrium Models	DSGE, CGE, input-output models	Comprehensive consideration of the economic system; policy analysis	Complexity of construction; significant data and assumption requirements	Policy analysis, medium- and long-term forecasting
Agent-Based Modeling	Agent-based simulation models	Consideration of individual agents' behavior; modeling complex systems	High computational complexity; difficulty of validation	Analysis of market processes, behavioral effects
Scenario Approach	Scenarios (baseline, optimistic, pessimistic)	Flexibility; accounting for uncertainty; support for strategic decisions	Subjectivity of assessments; dependence on assumptions	Strategic planning, risk assessment
Machine Learning Methods	Random Forest, Gradient Boosting, ANN, LSTM	High accuracy; ability to capture nonlinearities; handling large datasets	Low interpretability; need for large datasets	Short-term forecasting, analysis of complex relationships
Big Data Approaches	Big data analytics, data mining	Timeliness; high level of detail; real-time analysis	Need for infrastructure; data quality issues	Economic monitoring, real-time forecasting

Source: compiled by the author based on the reviewed forecasting models of economic growth

This table allows you to note that none of the approaches is universal. The best results are achieved by combining different models depending on the research objectives, data availability and forecasting horizon.

So, despite the rapid development of modern methods of forecasting economic development, their practical application is accompanied by a number of significant problems and limitations. This is primarily due to the high level of uncertainty of the economic environment caused by globalization processes, geopolitical risks, financial crises and rapid technological changes. Such factors significantly complicate the formation of stable and long-term reliable forecasts, since even minor external shocks can lead to significant deviations from expected trends.

An important problem is also the limitation of qualitative statistical data. In many cases, economic information is incomplete, untimely or insufficiently detailed, which reduces the accuracy of models and complicates their calibration.

Another significant limitation is the complexity of modeling behavioral factors. Economic agents (households, enterprises, investors) often make decisions under the influence of expectations, psychological factors and information asymmetry, which are difficult to formalize in the form of clear mathematical dependencies. This reduces the ability of models to adequately reflect real economic processes, especially in conditions of instability.

Additional limitations are the high complexity of modern models, the need for significant computing resources, as well as the dependence of results on initial assumptions and parameters. Taken together, this shows that no forecasting method is universal, and the most effective approach is to combine different models and methods, taking into account their strengths and weaknesses, which integrate economic theory, economic-mathematical methods and artificial intelligence tools. This makes it possible to increase the reliability of forecasts and ensure more reasonable economic decision-making.

3. Software and Digital Platforms for Forecasting Economic Growth

In the 21st century, digitalization has become a key factor in the transformation of economic science and practice. The use of software and digital platforms in forecasting economic growth allows to significantly

increase the accuracy, speed and adaptability of analytical processes.

Modern research in Ukraine emphasizes that digital technologies form a new paradigm of economic analysis, based on the processing of large data sets, the automation of calculations and the use of artificial intelligence algorithms [3; 15; 16; 17; 18]. Digitization of forecasting involves the automation of data collection and processing, the use of cloud technologies, the integration of various sources of information, and the use of analytical platforms in real time.

Based on the analyzed studies, software for forecasting economic growth will be divided by functional purpose into statistical and econometric packages, programming languages and data analysis environments, BI systems, cloud platforms and data processing services, as well as artificial intelligence and machine learning tools. Statistical and econometric software packages play a key role in building economic models, analyzing data and forecasting socio-economic processes. Among the most common tools, it is worth highlighting the EViews package, which is primarily focused on building ARIMA models, VAR analysis, and testing hypotheses regarding macroeconomic data. In addition, the program has a convenient interface, easy to manage and interpret the results, which makes it more flexible to use. In turn, the STATGRAPHICS package is focused on statistical analysis and data visualization, easy to use thanks to a clear interface and a wide range of basic statistical procedures, used for regression analysis, variance analysis, hypothesis testing. Equally important is the specialized package for conducting econometric research, Stata, which is distinguished by the convenience of working with panel data, time series and micro data, and is also widely used in applied economic research.

Modern economic research increasingly relies on the use of programming languages and specialized data analysis environments, which allows to increase the accuracy of calculations, automate the processing of large amounts of information, and apply complex forecasting models. One of the most popular languages in this field is Python, which, thanks to its versatility and large number of libraries, has become the standard in big data analysis and econometrics. In particular, Pandas and NumPy libraries are used for data processing and analysis, statsmodels – for building econometric models, and Scikit-learn and TensorFlow – for applying machine learning methods and neural networks in forecasting economic processes. Python

also integrates well with databases and cloud services, making it an effective tool for working with big data.

An important place among modern tools is occupied by Julia, which was developed specifically for high-performance numerical calculations. It combines the speed of execution typical of compiled languages with the convenience of syntax. This makes Julia particularly attractive for complex economic modeling, optimization problems, analysis of large systems of equations and dynamic models, where computational speed is important. In economics, it is used to simulate macroeconomic dynamics, financial markets, and agent-oriented models.

A key tool for developing predictive analytics is the R programming language. In forecasting, R is used to analyze trends, seasonality, and build models such as ARIMA, exponential smoothing.

An equally significant tool for mathematical modeling is MATLAB, which is widely used in financial analysis, macroeconomic forecasting, and engineering and economic research. MATLAB has a developed set of built-in functions and specialized packages that allow you to implement complex algorithms, work with matrices, optimization problems, and time series. It is especially useful in cases where it is necessary to quickly create a prototype model or conduct a numerical experiment.

Business intelligence platforms (BI systems) play an important role in modern economic research and management, as they provide effective visualization, analysis and interpretation of large volumes of data. They allow you to transform complex arrays of information into clear analytical reports, interactive dashboards and graphic models, which greatly facilitates the process of making management decisions. One of the most common platforms is Power BI, which integrates with the Microsoft ecosystem and provides extensive opportunities for connecting to various data sources, processing them, modeling and creating interactive reports. Power BI is actively used both in business and in the public sector, in particular for monitoring economic indicators, financial analysis and performance evaluation.

Another popular platform is Tableau, which specializes in creating high-quality visualizations and allows users to quickly analyze data without deep programming knowledge. Tableau is characterized by a convenient interface, flexibility in working with various data formats, and the ability

to create interactive dashboards that are widely used in financial analysis, marketing, and strategic planning.

An important place among BI systems is occupied by Qlik Sense, which uses an associative data model, which allows users to explore information more flexibly and discover hidden relationships between indicators. This platform supports independent data analysis, which enables users without special technical training to create their own reports and analytical dashboards.

Modern BI systems not only provide data visualization, but also integrate with other analytical tools, such as Python or R, which expands their capabilities through the use of machine learning, predictive analytics, and big data processin*g. In addition, many platforms support cloud technologies, which allows working with real-time data, provides shared access to analytics and improves the effectiveness of forecasts.

Cloud platforms and data processing services play an increasingly important role in modern economic research and business analytics, as they provide access to powerful computing resources without the need to create your own IT infrastructure. Leading solutions in this area include Google Cloud Platform, Amazon Web Services and Microsoft Azure. Each of these platforms offers a wide range of tools for storing, processing, analyzing and visualizing data, which allows you to effectively implement complex economic and analytical projects.

The use of cloud technologies opens up new opportunities for scaling computing, as users can flexibly increase or decrease computing resources based on needs. This is especially important for processing large data sets, conducting complex econometric calculations, and building predictive models. Cloud platforms also provide access to modern machine learning and artificial intelligence tools that allow for automating data analysis, identifying patterns, and increasing the accuracy of economic development forecasts. As a result, cloud technologies are becoming an integral part of the modern digital economy, helping to increase the efficiency of research, speed up information processing, and make informed management decisions based on data.

We should also note that modern digital platforms actively integrate machine learning algorithms to analyze large data sets, automatically identify patterns and build predictive models, which is especially relevant

in conditions of instability and rapid structural changes in the economy. Among the main tools, it is worth highlighting neural networks, in particular artificial neural networks (ANN) and recurrent neural networks of the LSTM type, which are effectively used to analyze time series and forecast macroeconomic indicators, such as GDP, inflation, or the unemployment rate [13]. Due to their ability to account for prior values and complex dependencies, these models often demonstrate superior accuracy compared to traditional econometric approaches, especially in cases of unstable or incomplete data.

Therefore, the integration of artificial intelligence and machine learning in economic research contributes to the improvement of the quality of analytics, the accuracy of forecasts and the effectiveness of management decisions. These technologies make it possible not only to forecast economic growth, but also to identify hidden trends, assess risks, and formulate more informed economic policies in conditions of global uncertainty.

Note that the use of modern software in economic research and forecasting has both significant advantages and certain limitations that must be taken into account when implementing it. The main advantages include, above all, the high accuracy of forecasts, which is achieved thanks to the use of complex mathematical models, econometric methods and machine learning algorithms. The speed of data processing is also an important advantage, because modern computer systems are able to analyze huge amounts of information in a short time, which is critically important in a dynamic economic environment.

Another important aspect is the automation of processes, which allows you to minimize the human factor, reduce the probability of errors and increase the efficiency of analysts' work. For example, modern analytical platforms can automatically update data, build reports and generate forecasts without constant human intervention.

At the same time, there are significant drawbacks. One of the key ones is the need for highly qualified specialists, since the effective use of such tools requires knowledge in the field of programming, statistics, econometrics and data analysis. This creates additional costs for personnel training and limits access to modern technologies for certain organizations. Another important problem is the dependence of the results on the quality of the input data. If the data is incomplete, inaccurate or biased, it can lead to

wrong conclusions and ineffective management decisions. A separate problem is the difficulty of interpreting the results, especially in the case of using artificial intelligence and machine learning models, such as neural networks, which often function as a "black box". This makes interpretation of the results difficult and may reduce the level of trust in them by users or decision makers.

We will describe the advantages and disadvantages of using this software in the process of forecasting economic growth in the following table (Table 2).

Table 2

Classification of software tools for forecasting economic growth and their characteristics

Tool Category	Software	Main Purpose	Advantages	Disadvantages
Statistical and Econometric Packages	R, Stata, EViews, SPSS	Statistical analysis, econometric modeling, time series analysis	High accuracy, well-established methods	Requires specialized knowledge
Programming Languages and Environments	Python, Julia, MATLAB	Data processing, machine learning, modeling	Flexibility, scalability	Complexity of learning
BI Systems	Power BI, Tableau, Qlik Sense	Data visualization, dashboard creation	Interactivity, clarity	Limited analytical capabilities without integrations
Cloud Platforms	Google Cloud Platform, Amazon Web Services, Microsoft Azure	Storage and processing of big data, cloud computing	Scalability, accessibility	Security risks, dependence on internet
AI and ML Tools	Neural networks, Random Forest, XGBoost	Forecasting, pattern detection	High accuracy, handling nonlinear data	Complexity of interpretation
Big Data Technologies	Apache Hadoop, Apache Spark	Processing large datasets	Big Data handling, high speed	High resource requirements

Source: built by the author based on the forecasting process software in question

Therefore, despite significant advantages, the use of software in economic forecasting requires a balanced approach, combining technical capabilities with professional expertise and taking into account potential risks. Only under such conditions can modern digital tools be used as efficiently as possible to improve the quality of forecasting and make informed economic decisions. It is also worth noting that the integrated use of various types of software allows you to significantly improve the quality of forecasting economic growth. The most effective approach is a combination of econometric models, programming languages, BI systems, cloud technologies and artificial intelligence tools, which provides a deep, flexible and accurate analysis of economic processes.

The prospects for the development of digital platforms for forecasting economic growth are directly related to the further evolution of data processing technologies, the increase in computing power and the expansion of the capabilities of analytical systems. First of all, the key direction is the development of artificial intelligence, which makes it possible to create more accurate and adaptive forecasting models capable of taking into account non-linear relationships between economic indicators, quickly learning from new data and revealing hidden patterns in economic processes. Combined with machine learning technologies, this forms the basis for the transition from classical econometric models to hybrid intelligent systems.

Automation of analytical processes is also an important direction, which involves minimizing manual intervention, automatically updating models, building forecasts in real time and using decision support systems.

Thus, the development of digital forecasting platforms in the future will be determined by the synergy of artificial intelligence, big data and automated analysis systems, which will significantly increase the accuracy of economic forecasts and the effectiveness of management decisions at both the national and global levels.

Conclusions

As a result of the conducted study of theoretical and methodological principles, modern methods and software for forecasting economic growth, it was established that in the conditions of global transformations and digitalization of the economy, forecasting is a key tool for ensuring effective management of socio-economic development.

The study showed that the theoretical basis of forecasting economic growth is formed on the basis of classical and modern economic theories, in particular, neoclassical and endogenous growth models. At the same time, the modern stage of the development of economic science is characterized by a reorientation towards complex approaches combining economic theory, economic-mathematical methods and digital technologies.

It has been established that modern methods of forecasting economic growth cover a wide range of tools – from traditional econometric models to complex macroeconomic systems and machine learning methods. The most effective are hybrid approaches that allow taking into account both the structural features of the economy and the non-linear nature of economic processes.

It is substantiated that the use of software and digital platforms plays an important role in improving the quality of forecasting. Modern tools, such as statistical packages, programming languages, cloud services, and business intelligence systems, provide automation of data processing, increased accuracy of models, and promptness of decision-making. The integration of artificial intelligence and big data technologies is of particular importance, which opens up new opportunities for forecasting economic dynamics.

At the same time, it was determined that the forecasting process is accompanied by a number of problems, in particular, a high level of uncertainty, limited quality data, the complexity of modeling behavioral factors, and risks associated with the use of complex digital models. This necessitates the use of a complex and adaptive approach to forecasting.

For Ukraine, the development of the national system of economic forecasting, which must take into account the specifics of the economy, the impact of external shocks, the processes of European integration and post-crisis recovery, is of particular importance. An important direction is the implementation of modern digital technologies, the development of analytical infrastructure, and the training of highly qualified specialists capable of working at the interface of the economy and information technologies.

In general, increasing the effectiveness of forecasting economic growth requires a combination of scientifically based methods, modern software and a strategic vision of economic development. The implementation of these approaches will contribute to the formation of an effective economic policy and ensure the sustainable development of Ukraine in the long term.

References:

1. Vilchynska O. M., Rumiantseva K. Ye. (2025). Doslidzhennia faktoriv vplyvu na ekonomichne zrostannia za dopomohoiu ekonometrychnoho modeliuvannia [Study of factors influencing economic growth using econometric modeling]. *Ekonomika ta suspilstvo*, no. 71. DOI: https://doi.org/10.32782/2524-0072/2025-71-6 (in Ukrainian)

2. Rudievska V. I. (2021). Evoliutsiia teorii ekonomichnoho zrostannia ta chynnyky yoho otsiniuvannia [Evolution of economic growth theories and factors of its assessment]. *Problemy i perspektyvy ekonomiky ta upravlinnia*, no. 2(22), pp. 18–30. DOI: https://doi.org/10.25140/2411-5215-2020-2(22)-18-30 (in Ukrainian)

3. Vilchynska O. M. (2025). Metodychni pidkhody do vykorystannia prohramnoho zabezpechennia u protsesi vyvchennia ekonomiko-matematychnykh dystsyplin [Methodological approaches to the use of software in teaching economic and mathematical disciplines]. *Aktualni pytannia rozvytku nauky, ekonomiky ta sotsiumu v umovakh viiny ta povoiennoho vidnovlennia*: zbirnyk materialiv Vseukrainskoi naukovo-praktychnoi konferentsii (Vinnytsia, October 16–17, 2025), vol. 1, part 2, pp. 167–170. Ternopil: Krok. (in Ukrainian)

4. Zomchak L. M., Lapinkova A. O. (2022). Oblikova stavka yak instrument monetarnoi polityky: prohnozuvannia metodamy ekonometrychnoho analizu [Interest rate as a monetary policy tool: forecasting by econometric methods]. *Tsyfrova ekonomika ta ekonomichna bezpeka,* issue 2, pp. 39–45. DOI: https://doi.org/10.32782/dees.2-7 (in Ukrainian)

5. Bilousova T. P. (2024). Modeli zahalnoi ekonomichnoi rivnovahy [General equilibrium models]. *Tavriiskyi naukovyi visnyk. Seriia: Ekonomika*, no. 20, pp. 38–42. DOI: https://doi.org/10.32782/2708-0366/2024.20.4. (in Ukrainian)

6. Kyfiak V. I., Kobelia Z. I., Melnyk Ya. V. (2021). Pobudova dynamichnoi stokhastychnoi modeli zahalnoi rivnovahy natsionalnoi ekonomiky Ukrainy [Construction of a dynamic stochastic general equilibrium model of the national economy of Ukraine]. *Ekonomika ta derzhava*, no. 2, pp. 92–99. DOI: https://doi.org/10.32702/2306-6806.2021.2.92. (in Ukrainian)

7. Grui A., Vdovychenko A. (2019). Quarterly Projection Model for Ukraine. NBU Working Papers, no. 3. Kyiv: National Bank of Ukraine. Available at: https://bank.gov.ua/admin_uploads/article/WP_2019_03_Grui_Vdovychenko.pdf (in Ukrainian)

8. Lukianenko I. H., Semko R. B. (2015). Dynamichni stokhastychni modeli zahalnoi rivnovahy: teoriia pobudovy ta praktyka vykorystannia u finansovykh doslidzhenniakh [Dynamic stochastic general equilibrium models: theory and practice]. Kyiv: NaUKMA, 246 p. (in Ukrainian)

9. Kulyk V. V., Kudin H. I. (2018). Prohnozuvannia zmin mizhhaluzevykh zviazkiv u modeli «vytraty-vypusk» [Forecasting changes in intersectoral relations in the input-output model]. *Problemy ekonomiky*, no. 3(37), pp. 45–55. (in Ukrainian)

10. Stets O. V., Humeniuk B. Ye. (2020). Ahentno-oriientovane modeliuvannia ekonomiky [Agent-based modeling of the economy]. *Aktualni problemy ekonomiky*

i upravlinnia: zbirnyk naukovykh prats, issue 14. Kyiv: KPI im. Ihoria Sikorskoho. (in Ukrainian)

11. Artemenko A. V. (2025). Osoblyvosti stsenarnoho modeliuvannia rehionalnoho rozvytku klasternykh struktur [Features of scenario modeling of regional development of cluster structures]. *Visnyk Lvivskoho torhovelno-ekonomichnoho universytetu. Ekonomichni nauky*, no. 81, pp. 115–120. DOI: https://doi.org/10.32782/2522-1205-2025-81-16 (in Ukrainian)

12. Ostrovskyi O. O. (2025). Analiz naukovo-metodychnykh pidkhodiv do doslidzhennia vzaiemozviazkiv mizh didzhytalizatsiieiu, sotsialno-ekonomichnoiu sferoiu ta bezpekoiu [Analysis of scientific and methodological approaches to studying the relationship between digitalization, socio-economic sphere and security]. *Tsyfrova ekonomika ta ekonomichna bezpeka,* no. 1(16), pp. 376–382. DOI: https://doi.org/10.32782/dees.16-57 (in Ukrainian)

13. Shapovalova N. N., Dotsenko I. O., Trachuk A. A., Skrynnikov I. V. (2024). Zastosuvannia instrumentiv shtuchnoho intelektu dlia analizu chasovykh riadiv [Application of artificial intelligence tools for time series analysis]. *Visnyk Kryvorizkoho natsionalnoho universytetu*, no. 58(1), pp. 46–51. DOI: https://doi.org/10.31721/2306-5451-2024-1-58-46-52 (in Ukrainian)

14. Zelenyi D. (2025). Using big data for demand forecasting and dynamic pricing. *Economic Forum*, vol. 15, no. 2, pp. 45–55. DOI: https://doi.org/10.62763/ef/2.2025.45 (in Ukrainian)

15. Mazii N. H. (2025). Tsyfrovi innovatsii yak draiver optymizatsii biznes-protsesiv [Digital innovations as a driver of business process optimization]. *Modern Economics,* no. 53, pp. 182–187. DOI: https://doi.org/10.31521/modecon.V53(2025)-25 (in Ukrainian)

16. Roik M. V., Prysiazhniuk O. I., Denysiuk V. O. (2017). Ohliad prohramnykh zasobiv statystychnoho analizu danykh [Review of software tools for statistical data analysis]. *Efektyvna ekonomika*, no. 7. (in Ukrainian)

17. Zadorozhniuk N. O. (2021). Suchasne prohramne zabezpechennia dlia zdiisnennia biznes-analizu [Modern software for business analysis]. *Ekonomichnyi visnyk NTUU «Kyivskyi politekhnichnyi instytut»,* no. 19, pp. 156–159. (in Ukrainian)

18. Chupilko T. A., Ulianovska Yu. V., Mormul M. F., Lahoda A. E. (2021). Python dlia obrobky danykh i modeliuvannia finansovo-ekonomichnykh pokaznykiv [Python for data processing and modeling of financial and economic indicators]. *Informatsiini tekhnolohii ta kompiuterna inzheneriia*, no. 51(2), pp. 68–77. DOI: https://doi.org/10.31649/1999-9941-2021-51-2-68-77 (in Ukrainian)