



ANALYSIS OF THE RELATIONSHIP BETWEEN MACROECONOMIC INDICATORS BASED ON THE VAR (VECTOR AUTOREGRESSION) MODEL

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“Mutaxassislik, ijtimoiy-gumanitar va aniq fanlar”

kafedراسи katta o’qituvchi

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«Iqtisodiyot» ta’lim yo’nalishi 2-bosqich talabasi

Annotation:

This article explores the application of the VAR (Vector Autoregression) model in analyzing the interrelationships among macroeconomic indicators. The VAR model is one of the modern econometric analysis methods that allows identifying dynamic relationships between multiple variables and studying their mutual influence in depth. Examining the interactions among macroeconomic indicators — such as Gross Domestic Product (GDP), inflation rate, interest rate, investment volume, and exchange rate — plays an important role in shaping economic policy, national planning, and ensuring financial stability.

The paper provides a detailed discussion of the mathematical foundations, structure, and practical use of the VAR model. A key feature of the model is its ability to identify causal relationships (Granger causality) among variables. The article also explains the process of preparing time series data, building the model, selecting the lag order (AIC, BIC), and applying analytical tools such as Impulse Response Function (IRF) and Variance Decomposition for deeper interpretation.

Using real data from the economy of Uzbekistan, the relationships between



GDP, inflation, and interest rate are analyzed through the VAR model. The results indicate a strong interconnection between these macroeconomic variables. The study highlights the importance of the VAR model in developing macroeconomic policies, supporting decision-making processes, and assessing economic stability.

This work will be useful for students of econometrics, researchers, and professionals involved in economic policy, serving as an effective methodological tool for understanding, forecasting, and analyzing macroeconomic processes.

Keywords:

VAR model, vector autoregression, macroeconomics, time series, Granger causality, impulse response function, economic analysis, forecasting, econometrics.

In the modern economy, correctly analyzing the interrelationships among macroeconomic indicators and deeply understanding their mechanisms of interaction are of great importance. In order to formulate economic policies, ensure financial stability, and maintain sustainable economic growth, countries need to thoroughly study the relationships among indicators such as Gross Domestic Product (GDP), inflation rate, interest rates, and investment volume. In performing such tasks, econometric models, particularly the VAR (Vector Autoregression) model, are widely used.

The VAR model is a mathematical approach that allows the simultaneous analysis of interactions among several economic variables. It examines how each indicator depends on its own past values as well as on the past values of other variables. In other words, the VAR model considers many economic processes as an interconnected system. Using this model, it is possible to analyze how changes in inflation affect GDP growth or how changes in interest rates influence investment volume.



Time series data refer to sequences of economic indicators collected over a specific period of time, reflecting the dynamics of economic processes. For example, Uzbekistan's quarterly GDP indicators, monthly inflation rates, or interest rates are all examples of time series data. Such data help identify past trends, examine changes, and forecast future economic conditions based on historical patterns.

However, economic time series data are often non-stationary, meaning that their mean, variance, or covariance changes over time. In such cases, the results of the analysis may become unreliable. Therefore, the data used in VAR models are usually transformed into a stationary form. By making the data stationary, it becomes easier to identify the true relationships among economic variables.

This approach is particularly important for the economy of Uzbekistan, where macroeconomic indicators strongly influence one another. For instance, rising inflation directly affects the purchasing power of the population, the volume of investments, and the pace of economic growth. Therefore, identifying and analyzing the relationships among these indicators through the VAR model helps improve the effectiveness of economic policy planning.

This article discusses the theoretical foundations of the VAR model, the stages of time series analysis, the process of selecting model parameters, and an empirical analysis of the relationship between GDP and inflation in the case of Uzbekistan's economy. The purpose is to demonstrate the importance of the VAR model in macroeconomic analysis, explain cause-and-effect relationships among economic indicators using this model, and present the topic in a simple and understandable way for students studying econometrics.

In time series analysis, multiple economic variables are often interrelated. In such situations, the VAR (Vector Autoregression) model serves as a powerful tool for representing the dynamic relationships among several time series variables



through their lagged values. Each equation in a VAR model is estimated using the OLS (Ordinary Least Squares) method, where each variable is explained by its own previous values as well as by the lagged values of other variables within the system.

One of the main advantages of the VAR model is that it does not impose predetermined cause-and-effect relationships. Instead, the model allows statistical relationships, such as Granger causality among variables, to be identified directly from the data. This is particularly important in macroeconomic policy analysis because it enables researchers to empirically determine whether changes in GDP affect inflation or vice versa.

The first step in constructing a VAR model is preparing the data and testing for stationarity. VAR models generally operate with stationary data; therefore, if the variables are non-stationary, they must be transformed into stationary form through first differencing or, if necessary, higher-order differencing. However, many macroeconomic indicators may share a long-run equilibrium relationship, known as cointegration. If the variables are cointegrated, instead of using a simple differenced VAR model, a VECM (Vector Error Correction Model) should be applied, as it captures both short-run dynamics and long-run equilibrium simultaneously. The Johansen test is widely used to detect cointegration, while the Augmented Dickey–Fuller (ADF) test is commonly employed to examine stationarity. The next stage is selecting the lag order. Criteria such as AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion) are commonly used in determining the optimal number of lags, as they balance model fit and complexity. If the lag length is chosen incorrectly, the model may become unstable, or forecasting accuracy may decline due to an excessive number of parameters. After selecting the lag order, the VAR equations are estimated separately using the OLS method, and the stability of the model is checked. In particular, the moduli of the roots of the companion matrix must be less than one.



One of the important tools in VAR model analysis is the Impulse Response Function (IRF). The IRF allows researchers to observe how a structural shock applied to one variable — for example, an unexpected increase in inflation — affects other variables and how long these effects persist. For instance, the IRF can illustrate how a positive shock to GDP influences inflation and over how many quarters the impact remains significant. Another important tool is Forecast Error Variance Decomposition (FEVD), also known as variance decomposition, which shows the proportion of the forecast error variance of each variable explained by different factors. Through this method, policymakers can identify which variables have the greatest influence on economic fluctuations and therefore require closer policy attention.

From a practical perspective, the process of analyzing GDP and inflation indicators in the case of Uzbekistan using the VAR model can be described as follows. First, data are collected from official statistical sources such as the State Statistics Agency and the Central Bank, including quarterly GDP data and monthly or quarterly inflation data. Next, stationarity is tested using the Augmented Dickey–Fuller (ADF) test; if necessary, differencing is applied or the Johansen test is conducted to determine the existence of cointegration. The following step involves selecting the optimal lag length using AIC or BIC criteria and estimating the VAR model. Once the model is established, IRF and FEVD analyses are performed to identify the short-run and long-run mechanisms of interaction between GDP and inflation. For example, IRF results may indicate that fluctuations in inflation negatively affect GDP growth in the short run, while the effect gradually diminishes in the long run as the economy adjusts. Similarly, FEVD helps evaluate the contribution of GDP to inflation forecast errors.

To evaluate the model, forecasting performance indicators such as RMSE (Root Mean Square Error) and MAE (Mean Absolute Error) are calculated. In



addition, residual analysis is conducted to examine autocorrelation using the Ljung–Box test, as well as normality and heteroskedasticity. If problems are detected in the residuals, the model may need to be re-specified by changing the lag structure or including additional variables.

The strengths of the VAR model include its ability to analyze multivariable systems simultaneously, reveal dynamic effects through IRF and FEVD analyses, and identify Granger causality relationships. However, the model also has certain limitations. When the number of parameters becomes large, a substantial amount of data is required. Moreover, structural interpretation often demands additional identification assumptions, and if cointegration exists, a separate approach such as the VECM model becomes necessary. In addition, the standard VAR model does not automatically identify structural causality; therefore, extensions such as the Structural VAR (SVAR) model may be required.

For this reason, when applying the VAR model, it is important to consider its limitations, account for cointegration and structural factors, and interpret the results within the broader policy context. In the case of Uzbekistan, VAR analysis of GDP and inflation can assist policymakers in providing more accurate recommendations regarding the balance between price stability and economic growth.

This article comprehensively examined the theoretical and practical aspects of analyzing the interrelationships among macroeconomic indicators using the VAR (Vector Autoregression) model. In particular, the interactions among key economic indicators such as Gross Domestic Product (GDP), inflation rates, interest rates, and unemployment were effectively analyzed through the VAR framework. The model made it possible to evaluate how economic variables respond over time and to forecast their future behavior. Transforming the data into a stationary form,



determining the optimal lag length, and evaluating the model results played an important role in improving the accuracy of economic analysis.

It should be emphasized that macroeconomic processes constitute a complex and multifactor system. Therefore, although the VAR model is an important tool for explaining economic relationships, it cannot fully capture every aspect of economic reality. Nevertheless, the model remains highly valuable for deeply analyzing the interactions among economic indicators, identifying economic problems, and supporting effective economic policymaking. In particular, for students and economic researchers, mastering the practical application of the VAR model provides a significant opportunity to develop econometric analysis skills.

Within the scope of this article, the advantages and limitations of the VAR model, as well as its application prospects in the economy of Uzbekistan, were discussed. The study demonstrated that the model allows the evaluation of both short-run and long-run effects of economic changes. At the same time, it was emphasized that integrating the VAR model with other econometric methods and modern artificial intelligence technologies could lead to more accurate and efficient forecasting results.

In conclusion, modern econometric models play an essential role in the analysis and forecasting of relationships among macroeconomic indicators. The VAR model, in particular, is considered one of the most effective tools for identifying dynamic interactions among economic variables. Therefore, studying this model in depth and applying it in practice is highly important for ensuring economic stability, making well-grounded economic decisions, and supporting national economic development.

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