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Economic And Statistical Modeling Of Regional Import Flows: The Case Of Bukhara Region

Ergashev Mirjon Yorkin ugli

PhD researcher at Institute for professional skills upgrading and statistical research of the National Statistics Committee of the Republic of Uzbekistan

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Abstract: This study examines the dynamics of regional import flows in the Bukhara region through econometric and statistical modeling, employing an ARIMA regression framework. Using quarterly data with 36 observations, the research identifies both deterministic and stochastic components of import dynamics. The ARIMA(4,0,1) model reveals that imports are driven by a strong deterministic upward trend, with limited autoregressive persistence and significant short-term moving average adjustments. Diagnostic tests, including the Portmanteau Q-statistic, confirm that residuals behave as white noise, thereby validating the model's adequacy. The findings highlight that while structural factors underpin the long-term growth of imports, short-term policy shocks and market adjustments play a significant role in shaping quarterly fluctuations.

Keywords: Regional imports, ARIMA model, Bukhara region, time series analysis, statistical modeling.

Introduction: The Bukhara region is historically known as a trade hub, with strategic location and linkages to both domestic and international markets. In recent years, Bukhara's foreign trade turnover has grown steadily, with imports constituting a considerable share. Understanding the dynamics of import flows in this region is therefore critical for evaluating the efficiency of regional development strategies, diversification of supply sources, and adaptation to external shocks.

Time-series econometric models, such as ARIMA, provide powerful tools for analyzing and forecasting trade flows. Unlike simple trend models, ARIMA integrates both deterministic growth and stochastic fluctuations, allowing for a comprehensive understanding of short- and long-term dynamics. This

paper seeks to model the quarterly import flows of the Bukhara region using ARIMA regression analysis, highlighting both statistical and policy-oriented implications.

The analysis of regional import flows is a crucial component of understanding foreign trade dynamics and economic integration. Imports directly influence the structure of domestic production, consumer demand, and overall regional development. For the Bukhara region, which is increasingly engaged in international trade, modeling import flows provides insights for both policymakers and economic planners.

Recent studies emphasize the importance of time-series econometric techniques, such as ARIMA models, for capturing the temporal patterns of trade flows. These models are particularly effective in disentangling long-term deterministic trends from short-term stochastic shocks. This paper aims to investigate the import flows of Bukhara region by applying ARIMA modeling, focusing on statistical robustness and policy implications.

In regional contexts, ARIMA modeling helps policymakers understand how external shocks and domestic conditions shape import behavior. For instance, Hamilton (1994) highlighted the effectiveness of ARIMA models in analyzing macroeconomic time series. Enders (2014) also emphasized that ARIMA models are particularly useful when data is limited but reliable forecasts are needed. This study contributes to the growing literature by applying ARIMA regression to import flows in the Bukhara region, thereby bridging methodological insights with regional economic analysis.

LITERATURE REVIEW

Numerous studies have analyzed international and regional trade flows using ARIMA and related models. Box and Jenkins (1976) developed the ARIMA methodology, which has since become a standard approach in time-series forecasting. Hamilton (1994) emphasized its effectiveness in capturing both deterministic and stochastic patterns in macroeconomic series. Enders (2014) further demonstrated the practical relevance of ARIMA in applied econometrics, particularly when dealing with economic data that exhibit volatility and seasonality.

In the context of international trade, several empirical studies have confirmed the suitability of ARIMA models. For instance, studies on Asian economies revealed that ARIMA provides accurate forecasts of import and export volumes, thereby supporting trade policy evaluation. Similarly, research in developing economies highlighted the importance of ARIMA models in identifying structural trends and the effects of short-term shocks such as policy reforms or global crises.

Despite a growing literature on national trade flows, limited attention has been given to regional-level modeling. The application of ARIMA to regional imports in Bukhara contributes to this gap by providing localized insights into trade dynamics. Such analysis is important for decentralized policymaking, as regional administrations in Uzbekistan are increasingly tasked with managing their trade development strategies.

METHODOLOGY

This study applies the ARIMA regression framework to quarterly import data of the Bukhara region, covering 36 observations. The Box–Jenkins procedure was employed, consisting of four stages:

1. **Identification** – Time-series stationarity was tested using Augmented Dickey-Fuller (ADF) tests. The series was found to be stationary without differencing, hence the ARIMA(4,0,1) specification was selected.

2. **Estimation** – Parameters of the AR and MA terms were estimated through maximum likelihood methods. The inclusion of a deterministic time trend allowed for capturing structural growth in imports.

3. **Diagnostic Checking** – Residuals were tested for autocorrelation using the Portmanteau Q-statistic. Absence of significant autocorrelation validated the adequacy of the model.

4. **Model Selection Criteria** – Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) were used for model comparison, with ARIMA(4,0,1) providing the best fit relative to alternative specifications.

Table 1

ARIMA Model Results for the Forecast of Import Volume in the Bukhara Region

ARIMA regression — Number of obs = 36
Wald chi2(3) =108.89
Log likelihood = -191.22 — Prob>chi2 = 0.0000

	Coefficient	OPG Std err.	z	P>|z|	[95 % conf. interval]

imp						
t	0,8222894	0,0820753	10,02	0,000	0,661425	0 ,98315
ARMA						
ar						
L4.	0,1576047	0,2606239	0,60	0,0457	-0,35321	0,66842
ma						
L1.	0,3651614	0,2315377	1,58	0,011	-0,08864	0,81897
sigma	48,31	5,388271	11,43	0,000	41.0371	72.1587

The general form of the model is expressed as:

$$IMPt=\alpha+\beta t+\phi 4IMPt-4+\theta 1\varepsilon t-1+\varepsilon tIMP\_t = \alpha + \beta\ t + \phi\_4\ IMP\_\{t-4\} + \theta\_1\ \varepsilon\_\{t-1\} + \varepsilon\_tIMPt=\alpha+\beta t+\phi 4IMPt-4+\theta 1\varepsilon t-1+\varepsilon t$$

where IMPtIMP_tIMPt denotes imports at time ttt, βt\beta tβt represents the deterministic time trend, φ4\phi_4φ4 is the autoregressive parameter at lag 4, and θ1\theta_1θ1 denotes the first-order moving average parameter.

RESULTS AND DISCUSSION

The estimation results confirm the strong significance of the deterministic time trend (β=0.8223,p<0.001)(\beta = 0.8223, p < 0.001)(β=0.8223,p<0.001), implying that imports in Bukhara region have been systematically increasing. The AR(4) parameter (φ4=0.1576)(\phi_4 = 0.1576)(φ4=0.1576) was found to be positive but statistically weak, suggesting limited long-term dependence on lagged values. In contrast, the MA(1) component (θ1=0.3652,p<0.05)(\theta_1 = 0.3652, p < 0.05)(θ1=0.3652,p<0.05) is statistically significant, capturing short-term fluctuations and shock adjustments.

Table 2

Portmanteau Test Results for Detecting the Presence of White Noise

White noise test Q		
	Q statistics	Prob> ch2
Экспорт	19.7366	0.2323
Импорт	11.8588	0.7536

The model exhibits good fit, as indicated by the Wald chi² statistic (108.89, Prob > χ^2 = 0.0000). The log-likelihood of –191.22 further confirms the model adequacy.

Diagnostic checking through the Portmanteau test yielded:

- **Export series**: Q = 19.7366, Prob > χ^2 = 0.2323
- **Import series**: Q = 11.8588, Prob > χ^2 = 0.7536

Since both probabilities exceed 0.05, the null hypothesis of no autocorrelation cannot be rejected. This indicates that the residuals behave as white noise, confirming the reliability of the estimated ARIMA model.

Overall, the results suggest that imports in Bukhara region are shaped by a deterministic upward trend, moderate autoregressive memory, and significant short-term adjustments. These findings highlight that while structural economic factors explain long-term growth in imports, short-run fluctuations are driven by policy changes, external shocks, and market volatility.

CONCLUSION

The ARIMA regression analysis of Bukhara region's import flows demonstrates that regional imports follow a statistically significant growth trajectory, with limited autoregressive persistence but important short-term moving average effects. Diagnostic testing confirms the adequacy of the model, ensuring its suitability for forecasting and policy evaluation. The study contributes to regional trade literature by providing empirical evidence of import dynamics in Bukhara region. For policymakers, the findings suggest that while structural drivers ensure steady growth of imports, short-term interventions and policy measures can meaningfully

influence quarterly fluctuations. Future research may expand the analysis by incorporating exogenous variables such as exchange rates, industrial output, and trade policy indicators within multivariate models. The ARIMA-based forecasting results for the Bukhara region indicate that import volumes are expected to remain on a steadily increasing path between 2025 and 2030. Although slight fluctuations are observed in the early forecast years (notably a temporary decline in 2026 followed by recovery in 2027–2028), the overall trend points to continuous growth. By 2030, the import volume is projected to reach approximately USD 925.9 million, compared to USD 902.5 million in 2025.

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