SHORT-TERM FORECASTING OF UZBEKISTAN'S PRODUCT EXPORT VOLUME USING HOLT-WINTERS MODELS

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Abstract. *This paper investigates the short-term dynamics and forecasting of Uzbekistan's monthly product export volume. Given the presence of pronounced trends and seasonal variations in macroeconomic export data, traditional linear models often fail to capture cyclical patterns adequately. To address this, the study applies the Holt-Winters exponential smoothing framework, incorporating both trend and multiplicative seasonal components. The analysis is based on official monthly time series data of export values spanning from January 2020 onward. The raw data is transformed into a formal time series object in RStudio with a fixed seasonal frequency of frequency = 12, reflecting standard monthly periodicity. The findings provide empirical insights into future export trajectories.*

Keywords: *Short-term forecasting, export volume, Holt-Winters exponential smoothing, seasonal variations, time series analysis, macroeconomic stability, Uzbekistan.*

In recent years, analyzing and forecasting foreign trade indicators has become a critical component of macroeconomic management and strategic planning in emerging economies like Uzbekistan. Export performance serves as a vital catalyst for economic growth, foreign exchange reserves accumulation, and overall macroeconomic stability.

However, macroeconomic export time series frequently exhibit complex characteristics, including pronounced upward trends and recurrent seasonal variations driven by agricultural cycles, fiscal periods, and industrial production schedules. Traditional stationary forecasting methods are often insufficient for capturing these dynamic patterns. To address this methodological challenge, exponential smoothing techniques—specifically the **Holt-Winters** model—provide a robust framework capable of simultaneously accounting for both level, trend, and seasonal components.

This study focuses on modeling and projecting the monthly export volume of Uzbekistan using historical data. By employing the Holt-Winters exponential

smoothing methodology, the research aims to uncover underlying seasonal regularities and generate reliable short-term out-of-sample forecasts.

Given the clear presence of an upward trend and recurring seasonal variations identified in the preliminary exploratory data analysis, the **Holt-Winters multiplicative model** is utilized. The model updates the level (L_t), trend (b_t), and seasonal indices (s_t) recursively using three smoothing equations:

$$Level: L_t = \alpha(Y_t/s_{t-s}) + (1-\alpha)(L_{t-1} + b_{t-1})$$

$$Trend: b_t = \beta(L_t - L_{t-1}) + (1-\beta)b_{t-1}$$

$$Seasonality: s_t = \gamma(Y_t/(L_{t-1} + b_{t-1})) + (1-\gamma)s_{t-s}$$

where Y_t represents the actual export value at period t, and α, β, $\gamma \in [0, 1]$ denote the smoothing parameters for the level, trend, and seasonal components, respectively.

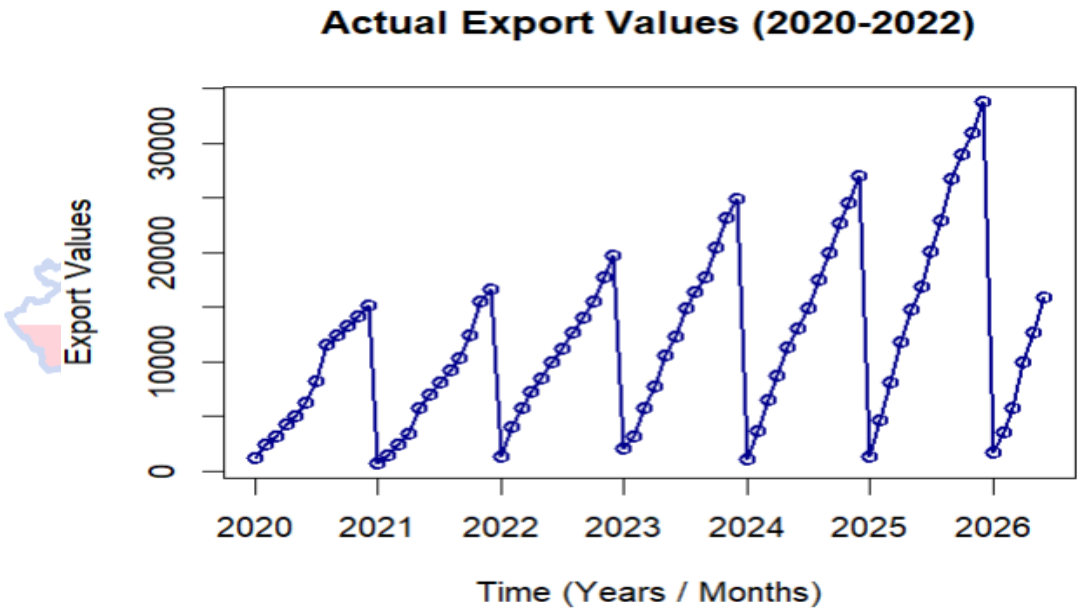


Figure 1. Actual Export Values Dynamics (2020–2026)

The Holt-Winters additive exponential smoothing model was applied to analyze and project Uzbekistan's monthly export volume. The estimation results yield the following optimized smoothing parameters and structural coefficients:

Smoothing Parameters:

- α = 0.4551: Indicates a moderate level-smoothing weight, balancing recent observations and historical levels.
- β = 0.0000: Shows that the trend component remains constant over time without local adjustments.
- γ= 1.0000: Reflects a high responsiveness to seasonal variations, capturing immediate cyclical shifts in export volumes.

Estimated Level and Trend Components:

- Level (a): 13,132.06 (representing the estimated baseline of the series at the end of the observation period).
- Trend (b): -42.22 (indicating the baseline slope coefficient).

Table 1.

Table 1. Short-Term Export Forecast for Uzbekistan

	Point Forecast	Lo 80	Hi 80	Lo 95	Hi 95
Jul 2026	16906.46	14090.22	19722.71	12599.39	21213.54
Aug 2026	18506.28	15412.09	21600.46	13774.13	23238.42
Sep 2026	20438.82	17089.69	23787.95	15316.77	25560.87
Oct 2026	21559.20	17973.20	25145.20	16074.89	27043.51
Nov 2026	22612.54	18804.38	26420.70	16788.46	28436.62
Dec 2026	24519.42	20501.36	28537.48	18374.33	30664.51

The additive seasonal structure captured by the model indicates that export performance accelerates continuously from summer through winter. The steady month-on-month increase highlights robust seasonal drivers characteristic of the analyzed trade aggregates.

The application of the Holt-Winters exponential smoothing model successfully captures the historical level, trend, and seasonal patterns of Uzbekistan's monthly export volume.

State authorities and transport logistics providers should utilize these short-term projections to optimize border customs clearance and transport corridors, ensuring adequate capacity to handle the anticipated surge in export volumes during the peak winter months.

Export-oriented manufacturing and trading companies should align their inventory management, supply chain inputs, and working capital allocations with the projected monthly trajectory to capitalize on seasonal demand peaks.

Given that prediction uncertainty increases over time, policymakers should maintain responsive monetary and foreign exchange buffers to mitigate potential external trade shocks.

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