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Article

Factors Affecting Economic Growth in Uzbekistan: Analysis Based on OLS and VAR Models for 2000–2023

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Abstract: This study examines the key macroeconomic determinants of real GDP growth in Uzbekistan over the period 2000–2023 using two complementary econometric approaches: Ordinary Least Squares (OLS) multiple regression and a Vector Autoregression (VAR) model. The analysis incorporates investment, inflation, export orientation, government expenditure, and a COVID-19 structural break dummy as explanatory variables. The OLS estimation reveals that export orientation is the strongest positive driver of economic growth, while inflation exerts a significant negative effect. Investment shows diminishing returns over the sample horizon, consistent with neoclassical growth theory. The COVID-19 pandemic is identified as the largest single structural shock of the period. The VAR model captures the dynamic interdependencies among growth, investment and exports, showing that investment is highly persistent while Granger causality tests indicate that growth relationships in Uzbekistan operate through long-run structural channels rather than short-run predictive dynamics. The findings provide evidence-based policy recommendations for sustaining economic growth within the New Uzbekistan 2030 development agenda.

Keywords: Intrusion Detection System (IDS); Robust Intelligent Security Algorithm (RISA); Hybrid Deep Learning; Convolutional Neural Networks (CNN); Long Short-Term Memory (LSTM); Anomaly Detection; Cybersecurity; Internet of Things (IoT); UNSW-NB15.

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1. Introduction

Understanding the macroeconomic determinants of economic growth is one of the central challenges of both development economics and policy design. For a transition economy like Uzbekistan, which has moved from a centrally planned Soviet system toward a market-oriented framework over the past three decades, this question has particular urgency: the country must simultaneously manage structural transformation, institutional reform, monetary stabilisation, and external integration, while sustaining the growth rates needed to improve living standards for a rapidly growing population[1].

Uzbekistan's growth record over 2000–2023 is impressive by regional and global standards. Real GDP expanded at an average annual rate of 6.52%, with a peak of 9.5% in 2007 and a minimum of 1.6% in 2020 during the COVID-19 pandemic. This performance reflects three distinct episodes: (i) a commodity-driven boom in 2004–2013, when gold, cotton and energy export revenues supported high public investment and double-digit nominal wage growth; (ii) a structural reform period from 2017 onward, when President Mirziyoyev's government liberalised the exchange rate, reformed state-owned enterprises, opened external trade, and sharply expanded foreign direct investment; and (iii) a pandemic contraction in 2020 followed by a strong post-COVID recovery. Econometrically identifying which observable variables explain this trajectory — investment, inflation, exports, or fiscal policy — is the central empirical question of this paper[2].

Two estimation frameworks are applied. First, OLS multiple regression with a COVID-19 dummy provides a parsimonious and interpretable decomposition of the growth variance across the full 2000–2023 horizon. Second, a VAR model captures the dynamic interdependencies among GDP growth, investment and exports, allowing us to assess Granger-causal linkages and the own-persistence of each series. The combination of OLS and VAR is standard in growth accounting exercises for transition economies and provides both a static decomposition and a dynamic impulse-response perspective[3].

The paper is organised as follows. Section 2 reviews the theoretical and empirical literature. Section 3 describes the data and methodological frameworks. Section 4 presents OLS results and diagnostics. Section 5 presents the VAR model results. Section 6 concludes with policy recommendations.

LITERATURE REVIEW

The theoretical framework underpinning this paper draws on four main strands of the growth literature.

The neoclassical growth model of Solow (1956) attributes long-run per capita output growth to exogenous technological progress, with the capital-output ratio and the savings rate determining the transition path toward the steady state [4]. In the Solow framework, an increase in the investment rate (GFCF/GDP) raises the capital-labour ratio and boosts growth in the short run but has no permanent growth effect — only technology can shift the steady-state growth rate. This prediction implies that diminishing returns to capital investment may suppress the contemporaneous growth return to high GFCF ratios, consistent with the negative OLS coefficient found in Section 4[5].

Endogenous growth theory (Romer, 1986; Lucas, 1988) relaxes the diminishing-returns assumption by introducing human capital accumulation and knowledge spillovers that sustain long-run increasing returns [6]. For a country like Uzbekistan, where public investment has been directed toward physical infrastructure rather than R&D or human capital, the neoclassical prediction of diminishing returns may be more empirically relevant than the endogenous growth prediction.

The role of inflation in growth models is addressed most directly by Fischer (1993), who demonstrates in a cross-country panel that high inflation is robustly negatively associated with growth by distorting relative prices, shortening planning horizons and reducing real returns on investment [7]. Barro (1996) confirms that a 10-percentage-point increase in inflation is associated with a 0.2–0.3 percentage-point reduction in annual growth [8]. The CIS context adds an additional channel: in post-Soviet economies with residual price controls, inflation may reflect monetary financing of fiscal deficits that crowds out private investment.

The export-led growth hypothesis (Bhagwati, 1978; Edwards, 1993) posits that export expansion fosters growth through economies of scale, technology transfer from foreign buyers, learning-by-doing effects, and more efficient allocation of resources toward comparative-advantage sectors [9]. Panel evidence from transition economies (Havrylyshyn, 1990; De Melo et al., 1996) consistently confirms the positive association between trade openness and growth [6]. For Uzbekistan, the post-2017 exchange rate liberalisation substantially improved export competitiveness and is a key structural factor in the data.

On VAR methodology in growth studies, Sims (1980) introduced the VAR framework as a theory-free alternative to structural simultaneous-equation models, allowing the data to reveal Granger-causal linkages without imposing a priori exclusion restrictions [10]. Khodiyev, Shodiyev and Berkinov (2018) present the foundational Uzbek econometrics text; Habibullayev and Utanov (2018) discuss the structural-break issues arising from the 2017 liberalisation in time-series modelling of Uzbek macroeconomic data [11].

2. Materials and Methods

The study uses annual time-series data for Uzbekistan, 2000–2023 (n = 24 observations). All data are sourced from official publicly accessible databases. Table 1 provides full variable definitions.

Table 1. Variable definitions, measurement units and data sources

Symbol	Variable	Definition	Unit	Source
Y	GDP Growth	Annual real GDP growth rate	%	World Bank WDI, Stat.uz [13]
X_1	GFCF	Gross Fixed Capital Formation (investment) as share of GDP	% of GDP	World Bank WDI [14]
X_2	CPI	Consumer Price Index — annual inflation rate	%	Central Bank of Uzbekistan [15]
X_3	EXPORT	Export of goods and services as share of GDP	% of GDP	World Bank WDI, CBU [16]
X_4	GOVEXP	General government expenditure as share of GDP	% of GDP	Ministry of Finance of Uzbekistan [17]
D_{2020}	COVID Dummy	Structural-break dummy: 1 for 2020, 0 otherwise	Binary	Authors' construction

Source: compiled by the authors based on World Bank WDI, Stat.uz, Central Bank of Uzbekistan, Ministry of Finance of Uzbekistan

The COVID-19 structural break dummy D_{2020} takes the value 1 in 2020 and 0 in all other years. Its inclusion is theoretically motivated: the pandemic triggered a unique combination of supply-chain disruption, lockdown-induced demand contraction and emergency fiscal expansion that is fundamentally different from the cyclical and structural variation captured by the four continuous regressors. Failing to control for this outlier year would inflate residual variance and bias all coefficient estimates.

Model I: OLS multiple regression

The OLS model estimated in this study is:

$$Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + \beta_4 X_{4t} + \beta_5 D_{2020} + \varepsilon_t$$

where ε_t is the error term with classical OLS properties $E[\varepsilon_t] = 0$ and $Var[\varepsilon_t] = \sigma^2$. Parameters are estimated by OLS: $\hat{\beta} = (X^T X)^{-1} X^T Y$. Model adequacy is assessed by R^2, Adjusted R^2, the F-test (Fisher criterion), individual t-tests for each coefficient, and the mean approximation error $A = (1/n)\cdot\Sigma|(Y_t - \hat{Y}_t)/Y_t|\cdot 100\%$.

Critical values with n=24, k=5 regressors, df_2=18 at α=0.05: $t^{men} = 2.101$; $F^{men}(5,18) = 2.773$.

Model II: Vector Autoregression (VAR)

A VAR(p) model treats all variables as jointly endogenous and regresses each variable on p lags of all variables in the system:

$$Z_t = c + A_1 Z_{t-1} + A_2 Z_{t-2} + \cdots + A_p Z_{t-p} + \varepsilon_t$$

where $Z_t = [Y_t, X_{1t}, X_{3t}]^T$ is the vector of endogenous variables (GDP growth, investment, exports), A_i are coefficient matrices, and ε_t is a vector of white-noise disturbances. With n=24 and five parameters per equation per lag, the maximum estimable lag is p=1 for a trivariate system (df = 24 − 4 = 20 per equation). Lag order p=1 is confirmed by the Akaike Information Criterion (AIC). Granger causality from variable j to variable i is tested by the F-test of joint significance of the lags of variable j in the equation for variable i.

3. Results and Discussion

Descriptive statistics

Table 2 presents pooled descriptive statistics and Table 3 presents the full annual dataset.

Table 2. Descriptive statistics for Uzbekistan macroeconomic variables, 2000–2023

Variable	Obs.	Mean	Std. Dev.	Min	Max
Y — Real GDP Growth (%)	24	6.52	1.97	1.60	9.50
X_1 — GFCF (% of GDP)	24	28.98	6.16	18.20	39.80
X_2 — CPI Inflation (%)	24	13.16	6.27	5.60	27.50
X_3 — Export/GDP (%)	24	27.48	2.99	21.80	32.80
X_4 — Gov. Expenditure/GDP (%)	24	25.09	2.00	21.90	29.30

Source: World Bank WDI (https://databank.worldbank.org); Central Bank of Uzbekistan (https://cbu.uz); State Statistics Committee (https://stat.uz)

Over the 24-year horizon, real GDP growth averaged 6.52% per annum with a standard deviation of 1.97 percentage points, reflecting the predominantly stable growth trajectory interrupted only by the 2020 pandemic. GFCF/GDP rose monotonically from 18.2% in 2000 to 39.8% in 2023 — a 21.6-percentage-point increase reflecting sustained public infrastructure investment and post-2017 FDI inflows[12]. CPI inflation fell dramatically from 25.0–26.2% in 2000–2002 (early transition period) to 5.6% in 2012–2015, before rebounding to 17.5% in 2018 following the exchange rate liberalisation. Export/GDP peaked at 32.8% in 2008 and declined to 23.8% in 2016, then recovered post-reform[13].

Table 3. Annual macroeconomic data: Uzbekistan, 2000–2023 (highlighted row = COVID-19 year)

Year	Y GDP Growth (%)	X_1 GFCF/GDP (%)	X_2 CPI Inflation (%)	X_3 Export/GDP (%)	X_4 GovExp/GDP (%)	D_{2020} (COVID Dummy)
2000	3.8	18.2	25.0	22.4	29.3	0
2001	4.2	19.1	26.2	23.1	27.8	0
2002	4.0	19.8	27.5	21.8	28.4	0
2003	4.2	21.3	22.0	23.6	27.9	0
2004	7.7	22.8	10.0	26.4	26.8	0
2005	7.0	23.4	10.0	28.1	25.6	0
2006	7.5	24.1	14.0	29.4	24.8	0
2007	9.5	25.8	12.0	31.2	24.1	0
2008	9.0	26.4	14.6	32.8	24.6	0
2009	8.1	27.1	14.1	28.4	25.1	0
2010	8.5	28.3	9.4	29.7	24.4	0
2011	8.3	29.2	7.6	31.4	23.8	0

2012	8.2	29.8	5.6	30.2	23.2	0
2013	8.0	30.4	6.8	28.9	22.8	0
2014	8.1	31.1	6.1	27.4	22.3	0
2015	8.0	31.8	5.6	25.1	21.9	0
2016	6.1	32.4	8.4	23.8	22.4	0
2017	4.5	33.2	14.4	26.4	23.1	0
2018	5.4	35.8	17.5	28.6	24.2	0
2019	5.8	36.4	15.2	29.8	24.8	0
2020	**1.6**	34.2	12.9	24.6	27.3	**1**
2021	7.4	36.8	10.8	27.4	25.6	0
2022	5.7	38.4	11.4	28.8	26.1	0
2023	6.0	39.8	8.8	30.2	25.8	0

Source: World Bank WDI; Stat.uz; Central Bank of Uzbekistan; Ministry of Finance of Uzbekistan

Correlation analysis

Table 4 presents the pairwise Pearson correlation matrix. The strongest bivariate relationships with GDP growth are: Export/GDP (r = 0.711, strong positive), government expenditure (r = −0.627, strong negative) and CPI inflation (r = −0.632, strong negative). The positive Y–X_3 correlation confirms the export-led growth hypothesis; the negative Y–X_2 correlation is consistent with the growth-reducing effect of inflation documented by Fischer (1993) and Barro (1996). Notably, the correlation between GFCF (X_1) and GDP growth (Y) is only 0.050, reflecting the non-linear, regime-dependent nature of the investment-growth relationship over the sample[15].

Table 4. Pearson correlation matrix (highlighted diagonal = perfect collinearity; bold off-diagonal = |r| > 0.6)

Variable	Y	X_1 (GFCF)	X_2 (CPI)	X_3 (Export)	X_4 (GovExp)
Y	1.000	0.050	**−0.632**	**0.711**	**−0.627**
X_1	0.050	1.000	−0.566	0.401	−0.488
X_2	**−0.632**	−0.566	1.000	−0.565	**0.772**
X_3	**0.711**	0.401	−0.565	1.000	−0.496
X_4	**−0.627**	−0.488	**0.772**	−0.496	1.000

Source: authors' calculations

Two notable multicollinearity concerns: X_2 (CPI) and X_4 (GovExp) are highly correlated (r = 0.772), reflecting the fiscal-monetary nexus in early transition; and X_2 and X_3 are negatively correlated (r = −0.565). These relationships mean that OLS standard errors for the individual coefficients must be interpreted with awareness of the partial-regression framework: each β_i measures the growth impact of one regressor controlling for all others[16].

OLS estimation results

Table 5 presents the full OLS regression results.

Table 5. OLS regression results: determinants of real GDP growth in Uzbekistan, 2000–2023

Variable	Coefficient (β_i)	Std. Error	t-statistic	Significance
Constant (β_0)	7.9581	3.8307	2.077*	Significant
X_1 — GFCF/GDP (β_1)	−0.1399	0.0325	−4.302***	Highly sig.
X_2 — CPI Inflation (β_2)	−0.1610	0.0452	−3.564***	Highly sig.
X_3 — Export/GDP (β_3)	0.3048	0.0664	4.593***	Highly sig.
X_4 — GovExp/GDP (β_4)	−0.1397	0.1347	−1.037	Not sig.
D_{2020} — COVID Dummy (β_5)	−3.1836	0.9047	−3.519***	Highly sig.
Model Diagnostics				
Coefficient of determination R^2	0.8874	n = 24	k = 5	
Adjusted R^2	0.8561	$df_1 = 5$	$df_2 = 18$	
F-statistic (F^{aen})	28.370	F^{men} (5,18) = 2.773	Significant***	
Mean approximation error (A)	8.03%	< 10%	Satisfactory	
t-critical (df=18, α=0.05)	2.101			

Note: ***p<0.01; **p<0.05; *p<0.10. t-critical (df=18, α=0.05) = 2.101. F-critical (5, 18, α=0.05) = 2.773.

Source: authors' calculations based on data from Stat.uz, World Bank WDI, Central Bank of Uzbekistan

The estimated OLS equation is:

$$\hat{Y} = 7.958 - 0.140 \cdot X_1 - 0.161 \cdot X_2 + 0.305 \cdot X_3 - 0.140 \cdot X_4 - 3.184 \cdot D_{2020}$$

The model achieves strong explanatory power with $R^2 = 0.8874$ — the five regressors jointly explain 88.74% of the total variation in annual GDP growth over 2000–2023. The Adjusted $R^2 = 0.8561$ confirms that this fit is not inflated by unnecessary regressors. The F-statistic (28.370) decisively exceeds the critical value (2.773), confirming the overall model significance at the 1% level. The mean approximation error A = 8.03% falls below the 10% threshold, classifying model accuracy as satisfactory[17].

Interpreting individual coefficients:

Export/GDP (X_3, $\beta_3 = +0.305$, t = 4.593*):** The strongest positive and most statistically significant driver. Each additional percentage point of exports/GDP is associated with a 0.305-percentage-point increase in real GDP growth, ceteris paribus. This confirms the export-led growth hypothesis: greater trade openness channels domestic resources toward comparative-advantage sectors, brings productivity-enhancing technology transfer, and enlarges effective market size.

CPI Inflation (X_2, $\beta_2 = -0.161$, t = −3.564*):** Each percentage point of inflation reduces growth by 0.161 percentage points. This result is consistent with Fischer (1993) and Barro (1996): inflation distorts relative prices, shortens investment horizons, erodes real wages and crowds out private credit. In Uzbekistan, the high-inflation episodes of 2000–2002 and 2017–2019 both coincided with below-trend growth, while the low-inflation years of 2012–2015 delivered near-maximum growth rates.

GFCF/GDP (X_1, $\beta_1 = -0.140$, $t = -4.302$*):** Negative and highly significant. This unexpected sign is explained by two complementary mechanisms. First, in a Solow framework, Uzbekistan's monotonic rise in GFCF from 18.2% to 39.8% pushes the economy toward its steady-state capital-output ratio, where diminishing marginal returns compress the growth return on each additional unit of investment. Second, a substantial portion of gross fixed capital in the sample period consisted of state-directed infrastructure investment with long payback periods; the contemporaneous growth return is therefore low or negative until the infrastructure capital matures.

COVID-19 Dummy (D_{2020}, $\beta_5 = -3.184$, $t = -3.519$*):** The pandemic depressed GDP growth by an estimated 3.18 percentage points relative to the predicted value based on fundamentals — the single largest identifiable structural shock in the 24-year sample. The significance of this coefficient validates its inclusion: without the dummy, residual variance would be inflated and remaining coefficients biased.

Government Expenditure (X_4, $\beta_4 = -0.140$, $t = -1.037$): Not statistically significant ($|t| < t^{men} = 2.101$). While the coefficient is negative — consistent with a crowding-out interpretation — it is not reliably distinguishable from zero after controlling for the other regressors. This may reflect offsetting effects: productive public spending supports growth while deficit-financed transfers crowd out private investment.

Goodness of fit: actual vs. fitted values

Table 6 reports actual and model-fitted GDP growth rates together with the annual approximation errors.

Table 6. OLS model: actual vs. fitted GDP growth rates and approximation errors, 2000–2023

Year	Y actual (%)	Ŷ fitted (%)	$\lvert Y - \hat{Y} \rvert$	Relative error (%)
2000	3.8	4.12	0.32	8.52%
2001	4.2	4.23	0.03	0.66%
2002	4.0	3.44	0.56	13.99%
2003	4.2	4.73	0.53	12.73%
2004	7.7	7.46	0.24	3.07%
2005	7.0	8.07	1.07	15.22%
2006	7.5	7.83	0.33	4.42%
2007	9.5	8.56	0.94	9.87%
2008	9.0	8.48	0.52	5.80%
2009	8.1	7.05	1.05	12.97%
2010	8.5	8.13	0.37	4.33%
2011	8.3	8.90	0.60	7.20%
2012	8.2	8.85	0.65	7.97%
2013	8.0	8.24	0.24	2.95%
2014	8.1	7.86	0.24	2.92%
2015	8.0	7.20	0.80	9.99%
2016	6.1	6.20	0.10	1.64%
2017	4.5	5.82	1.32	29.27%
2018	5.4	5.47	0.07	1.32%

2019	5.8	6.04	0.24	4.14%
2020	**1.6**	**1.60**	**0.00**	**0.00%**
2021	7.4	5.85	1.55	20.96%
2022	5.7	5.89	0.19	3.25%
2023	6.0	6.58	0.58	9.61%
Average	**8.03%**			

Note: 2020 row highlighted in orange — COVID-19 structural break year. Fitted values for 2020 incorporate the D_{2020} dummy, yielding an exact fit (error = 0.00%) by construction.

Source: authors' calculations

The average approximation error of 8.03% is satisfactory. The largest individual deviations occur in 2017 (29.27%) and 2021 (20.96%). The 2017 outlier reflects the unprecedented September 2017 exchange-rate liberalisation — a discrete institutional shock that is only partially captured by the contemporaneous CPI and export variables; a 2017 reform dummy would reduce this error but was omitted to maintain parsimony. The 2021 deviation reflects the pace of post-COVID recovery being faster than the model's continuous-variable predictors anticipated.

Var Model: Dynamic Analysis

VAR(1) system estimates

The trivariate VAR(1) system with $Z_t = [Y_t, X_{1t}, X_{3t}]$ is estimated over 2001–2023 (n=23 observations, one lost to lagging). Lag order p=1 is selected by the Akaike Information Criterion. Table 7 presents the coefficient estimates for all three equations.

Table 7. VAR(1) coefficient estimates: GDP growth, investment and exports (2001–2023)

Regressor	Eq.1: ΔY_t (GDP Growth)	Eq.2: ΔX_{1t} (Investment)	Eq.3: ΔX_{3t} (Exports)
Constant	0.321	2.837	8.213
[t-statistic]	[0.089]	[1.413]	[1.733]
Y_{t-1} (GDP Growth, lag-1)	0.2576	−0.1027	−0.0821
[t-statistic]	[0.971]	[−0.697]	[−0.236]
X_{1t-1} (Investment, lag-1)	−0.0950	0.9998***	0.0039
[t-statistic]	[−1.436]	[27.218]	[0.045]
X_{3t-1} (Exports, lag-1)	0.2684	−0.0446	0.7278**
[t-statistic]	[1.410]	[−0.422]	[2.916]
Equation diagnostics			
R^2	0.3957	0.9798	0.5265
Observations	23	23	23

Note: ***p<0.01; **p<0.05. t-critical (df=19, α=0.05) = 2.093. Each equation is estimated by OLS applied to the full system.

Source: authors' calculations

Three findings stand out from the VAR estimates. First, investment (X_1) exhibits near-unit-root own-persistence: the coefficient on X_{1t-1} in Equation 2 is 0.9998 (t = 27.218, R^2 = 0.980), indicating that investment shares are extremely stable from year to year and are largely predetermined by prior-period capital budgeting decisions — a finding consistent with the five-year planning cycles that characterise Uzbek public investment. Second, exports (X_3) show moderate persistence (lag coefficient 0.728, t = 2.916, R^2 = 0.527), reflecting partial adjustment of trade flows to reform and commodity-price conditions. Third, GDP growth (Equation 1) has a positive but insignificant own-lag (0.258, t = 0.971), confirming that year-to-year growth dynamics are largely driven by contemporary structural factors rather than cyclical momentum.

The cross-equation coefficients in the GDP growth equation are economically interpretable even absent statistical significance: the negative lagged investment coefficient (−0.095) echoes the OLS finding of diminishing returns; the positive lagged export coefficient (0.268) reflects the delayed export-led growth effect as trade agreements and capacity expansion materialise with a one-year lag.

Granger causality tests

Table 8 presents formal Granger causality tests for all directional pairs among the three VAR variables.

Table 8. Granger causality test results, VAR(1) system, Uzbekistan 2001–2023

Null Hypothesis (H_0)	**F-statistic**	**F-critical (1,20)**	**Decision**
X_3 (Exports) does NOT Granger-cause Y (GDP growth)	0.686	4.351	H_0 not rejected
Y (GDP growth) does NOT Granger-cause X_3 (Exports)	0.072	4.351	H_0 not rejected
X_1 (Investment) does NOT Granger-cause Y (GDP growth)	2.128	4.351	H_0 not rejected
Y (GDP growth) does NOT Granger-cause X_1 (Investment)	0.418	4.351	H_0 not rejected
Note: VAR lag order = 1 selected by AIC criterion (n=24, lag-1 optimal for short sample). Bidirectional Granger non-causality suggests long-run structural relationships rather than short-run predictive feedback.			

Source: authors' calculations

None of the Granger causality hypotheses are rejected at the 5% level: all F-statistics fall well below the critical value of 4.351. This result — common in short annual time-series panels for transition economies — has an important economic interpretation: it does not imply that investment or exports are irrelevant to growth, but rather that their effects operate through long-run structural channels (capital deepening, productivity convergence, institutional development) rather than through short-run predictive feedback captured by first-order autoregressive dynamics. The absence of Granger causality from X_3 to Y with only 23 observations also reflects the limited statistical power of pairwise Granger tests in small samples; a longer time series or higher-frequency data would be needed to detect any short-run feedback relationship.

Together, the OLS and VAR results paint a consistent picture: contemporaneous export orientation and price stability are the key observable growth drivers, while investment operates through a slower, long-run capital-accumulation channel that is not captured by annual Granger dynamics.

4. Conclusion

This study has applied OLS multiple regression and a VAR(1) model to annual Uzbekistan macroeconomic data (2000–2023) to identify the determinants of real GDP growth. Four main conclusions emerge.

First, the OLS model ($R^2 = 0.8874$, $F = 28.370 >> 2.773$, $A = 8.03\%$) provides a statistically robust and practically accurate account of Uzbekistan's growth trajectory over 24 years. The COVID-19 dummy captures the 2020 structural break cleanly and is essential for coefficient stability.

Second, export orientation (X_3) is the single most significant positive growth driver ($\beta = +0.305$, $t = 4.593$), confirming that the 2017 trade liberalisation and exchange-rate reform were pivotal structural decisions. CPI inflation is the most significant negative growth driver ($\beta = -0.161$, $t = -3.564$), underscoring the importance of monetary stability.

Third, the negative GFCF coefficient (−0.140, $t = -4.302$) reflects diminishing returns to capital accumulation rather than the irrelevance of investment: as Uzbekistan's GFCF ratio has risen from 18% to nearly 40% of GDP, the marginal return on additional gross investment has declined. Shifting emphasis from quantity to quality of investment — toward human capital, R&D and institutional capacity — is the implied policy direction.

Fourth, the VAR(1) results confirm near-perfect own-persistence of the investment ratio (coefficient 0.9998) and moderate export persistence, while Granger causality tests reveal no short-run predictive feedback. Growth in Uzbekistan is driven by structural long-run forces rather than short-cycle dynamics.

Based on these findings, the following policy recommendations are advanced:

1. Prioritise export diversification and market access: The strongest OLS coefficient belongs to exports/GDP. Policies that diversify Uzbekistan's export basket beyond gold, cotton and natural gas toward manufactured goods, agro-processing and IT services will have the highest-leverage growth impact. Ratification of WTO membership and bilateral trade agreement expansion are key instruments.
2. Anchor inflation at single-digit levels: The Central Bank of Uzbekistan's inflation-targeting framework should be strengthened to durably anchor expectations at 5–7% per annum. Each percentage point of sustained disinflation is estimated to add 0.161 percentage point to annual growth. Coordinated fiscal restraint is essential to reduce monetary financing pressure.
3. Improve investment quality rather than quantity: With GFCF/GDP approaching 40%, the marginal return on additional gross investment is low. Resources should be redirected from low-return state-directed projects toward private-sector investments in education, health, digital infrastructure and R&D, which generate positive knowledge externalities not captured in the Solow accounting framework.
4. Build post-pandemic fiscal space: The COVID dummy (−3.184 percentage points) reveals extreme vulnerability to aggregate demand shocks. Uzbekistan should rebuild fiscal buffers during the growth recovery to ensure adequate counter-cyclical capacity for future shocks — consistent with the IMF's Article IV recommendations.
5. Extend the empirical framework: Future research should incorporate human capital (education enrolment, PISA scores), institutional quality (EBRD transition indicators, World Bank Governance Index), and sectoral decomposition to identify the within-sector sources of growth. A cointegration and error-correction model (VECM) would be appropriate for a longer time series and would allow formal identification of the long-run equilibrium relationships among the variables.

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