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Research paper

Dynamic Analysis of the Effects of Exchange Rate Volatility, Financial Development, and Trade Openness on Economic Growth in Iran: A TVP-VAR Approach

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Abstract:
Over recent decades, Irans economy has faced significant challenges, including international sanctions, severe exchange rate fluctuations, and high inflation rates, all of which have the potential to drastically alter the trajectory of economic growth. This study investigates the dynamic impacts of exchange rate volatility, financial development, trade openness, and inflation on Iran's economic growth over the monthly period from 2011 to 2024, using a Time-Varying Parameter Vector Autoregressive (TVP-VAR) model. This nonlinear approach is adopted due to the limitations of linear models in capturing such complex dynamics. The findings reveal that both exchange rate volatility and financial development exert a negative and statistically significant impact on economic growth, whereas trade openness contributes positively over the long term. Inflation is also found to have a detrimental long-run effect on growth. In the short run, economic growth responds asymmetrically to these variables across different time periods. These results underscore the necessity for policymakers to account for such asymmetric effects when designing and implementing economic policies, especially in contexts affected by currency shocks and sanctions.

Keywords: Exchange rate volatility; Financial development; Economic growth; TVP-VAR
Classification: C58, F31, O40, O16

1 Introduction

Economic growth, as the most crucial indicator of economic development, is influenced by various factors, including exchange rate volatility, financial development, financial sanctions, trade openness, and inflation. Exchange rate volatility can have particularly adverse effects in developing countries with less mature financial markets and high dependency on imports and exports. Such volatility leads to heightened uncertainty and reduced investment, ultimately constraining economic growth.

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Over the past decades, the Iranian economy has faced multiple challenges such as international sanctions, sharp fluctuations in exchange rates, and persistently high inflationfactors that have significantly altered its growth trajectory.

Traditionally, the exchange rate has not held a central role in economic growth theories, likely because it was not a critical variable for the countries and periods in which those theories were developed. However, in an open economy, growth can heavily rely on exports, making the exchange rate a pivotal element. A stable and low exchange rate, for instance, can boost exports and even reshape the production system by shifting economic activity from low-value-added sectors to higher ones like manufacturing (Ramoni-Perazzi & Romero, 2022).

On the other hand, financial developmentthrough expanded access to capital and facilitation of investmentis recognized as a strong driver of economic growth (King & Levine, 1993). Financial development indicators reflect the health and efficiency of a country's financial system, which can significantly accelerate growth.

Nevertheless, Robinson (1952) argued that financial development primarily follows economic growth, implying that the true engines of growth lie elsewhere. From a policy standpoint, if financial intermediaries exert a substantial impact on growth, this underscores the urgency of legal, regulatory, and policy reforms aimed at strengthening the financial sector (Levine et al., 2000).

In recent years, financial sanctionsparticularly relevant in the Iranian contexthave imposed significant constraints on economic growth by limiting access to foreign currency and international investment (Pourfathi & Kafae, 2020). These sanctions exacerbate currency volatility and undermine macroeconomic stability.

Furthermore, trade openness, by facilitating technology transfer and intensifying competition, can enhance economic growth. However, under conditions of sanctions and currency instability, these positive effects may be diminished (Frankel & Romer, 1999).

Exchange rate fluctuations also elevate investment risks and negatively affect national output (Keshtgar et al., 2020a). High inflationanother key factorerodes purchasing power, introduces economic instability, and suppresses growth (Fischer, 1993).

Volatility in currency markets often disrupts financial cycles, thereby impeding economic growth. In such scenarios, macroprudential policies are essential for smoothing financial cycles and maintaining financial stability (Keshtgar et al., 2021).

To analyze exchange rate volatility and other financial variables, advanced econometric models such as the GARCH familyespecially EGARCH models capable of modeling asymmetric shock effectshave become widely used in empirical studies (Nelson, 1991).

Sustainable growth, therefore, requires institutional reforms, sound regulation, and counter-cyclical fiscal policies to guide financial development.

2 Theoretical Framework

According to economic theory, the exchange rate is one of the key variables influencing macroeconomic performance. Fluctuations in exchange rates can affect international competitiveness, the trade balance, real income, and output. In Iran, the national currency has frequently experienced substantial fluctuations due to multiple exchange rate systems, including official rates, preferential rates, and market rates. These irregularities have significantly impacted the effectiveness of exchange rate policy, with all financial incentives and restrictions ultimately reflected in the effective exchange rate for exporters. Abnormal volatility in the exchange rate system is one of the major economic challenges in any country (Faraji Tabrizi et al., 2022).

2.1 Exchange Rate Volatility and Economic Growth

Exchange rate volatility increases economic uncertainty and transaction costs, which reduces investment and international trade, ultimately constraining economic growth. Aghion et al. (2009) demonstrated that the impact of exchange rate volatility on growth heavily depends on the level of financial development. In countries with underdeveloped financial markets, the negative effects are stronger. Recent research in developing nations and BRICS countries confirms that excessive exchange rate volatility significantly hinders economic growth (Bhat et al., 2024). Parcon-Santos et al. (2023), in a study on Asia-Pacific economies, identified an inverted U-shaped nonlinear relationshipmild volatility can foster growth, but excessive volatility becomes detrimental.

Volatility refers to irregular, unpredictable changes in the exchange rate over time, which can affect growth by increasing economic uncertainty, discouraging investment, and disrupting trade. Numerous studies in Iran and elsewhere have shown a significant negative relationship between exchange rate volatility and economic growth. For example, Shojaei et al. (2023) found that exchange rate fluctuations had the most severe negative effects on Irans industrial and mining sectors. Volatility also increases production costs and reduces economic stability, which further hinders growth (Aziznejad & Komijani, 2017).

Changes in exchange rates can influence growth through their effects on import/export prices, foreign direct investment, and expectations of economic agents. Research shows that the short-run and long-run impacts of exchange rate volatility on growth can differ (Shojaei et al., 2023).

2.2 Financial Development and Economic Growth

Financial development enhances economic growth by expanding access to finance, lowering funding costs, and improving resource allocation. Classic studies (e.g., King & Levine, 1993) and more recent empirical evidence show that financial devel-

opment promotes investment and productivity and may mitigate the adverse effects of exchange rate volatility (Aghion et al., 2009).

Financial development reflects the depth and efficiency of a countrys financial system. Indicators such as bank credit to the private sector and the ratio of liquidity to GDP are commonly used (Shojaei et al., 2023). Research has shown that financial development can play a moderating role in offsetting the negative effects of currency volatility, particularly in countries with more mature financial markets (Mohammadzadeh Asl et al., 2016).

However, financial development can harm growth when it is unbalancedi.e., when improvements in the financial sector are not matched by real sector growth. De Gregorio and Guidotti (1995) argued that unregulated financial liberalization and expectations of government bailouts in Latin America during the 1970s and 1980s led to a negative relationship between growth and financial development. Similarly, Ibrahim and Alagidede (2018) cautioned that excessive credit expansionespecially if misallocatedcan destabilize the economy and crowd out productive investment.

2.3 Financial Sanctions and Economic Growth

Financial sanctions constrain a countrys access to foreign exchange and international investment, thereby impeding economic growth. Such sanctions increase economic risk, trigger exchange rate volatility, and undermine macroeconomic stability. Case studies on Iran and other sanctioned countries have clearly illustrated these adverse effects (Heydarian et al., 2020).

By disrupting capital flows and raising perceived risk, financial sanctions weaken investment incentives and restrict financing for development projects. In Iran, international financial sanctions have directly contributed to heightened exchange rate fluctuations and a decline in investor confidence (Rahimi Kahkeshy et al., 2023). These developments have severely hampered the countrys capacity for sustainable economic growth (Dejpasand, 2016).

2.4 Trade Openness and Economic Growth

Trade opennessmeasured as the ratio of total exports and imports to GDPreflects a countrys degree of integration with the global economy. Openness can accelerate growth by facilitating technology transfer, enhancing competitiveness, and enabling efficient resource allocation. However, under conditions of exchange rate instability and sanctions, these benefits may diminish or even reverse (Asgharpour et al., 2023).

Empirical research shows that trade openness can support growth, but its effectiveness depends on broader macroeconomic and institutional conditions. For example, during times of high volatility or political uncertainty, the positive effects of trade may be muted (Hokmati Farid et al., 2024). Nevertheless, under more stable conditions, greater openness can help economies exploit comparative

advantages and drive long-run development (Frankel & Romer, 1999).

2.5 Inflation and Economic Growth

High inflation reduces purchasing power, increases production costs, and creates economic instabilityall of which hinder growth. Fischer (1993) and other studies have emphasized the importance of controlling inflation for sustained economic development. Some research even suggests that moderate inflation may stimulate activity in certain contexts, but persistent high inflation has consistently been shown to negatively affect growth.

In Iran, inflation has been one of the main barriers to sustained economic growth (Asgharpour et al., 2023). By creating uncertainty and distorting price signals, inflation undermines investment, savings, and long-term planning. Thus, effective inflation control is essential for achieving stable growth.

The reviewed domestic literature mainly focuses on the effects of exchange rate volatility on economic sectors and macroeconomic indicators such as inflation and investment, employing advanced econometric techniques like ARDL, GARCH, SVAR, and Markov-switching models. The findings generally confirm that exchange rate volatility and financial sanctions have negative effects on economic growth, whereas financial development and trade openness have positive influences. Inflation and exchange rate effects tend to differ over short and long-term horizons, highlighting the crucial role of monetary and exchange rate policies.

International studies over the past decade similarly emphasize the importance of exchange rate volatility, financial sanctions, financial development, trade openness, and inflation in shaping economic growth trajectories. In the Iranian context, financial sanctions and currency instability are the major constraints on growth, while financial development and trade openness may serve as mitigating factors. Many foreign studies also underscore the nonlinear and asymmetric nature of these relationships, providing a robust theoretical and empirical foundation for the present analysis.

3 Literature Review

3.1 Domestic Studies

Asgharpour et al. (2023) examined the role of the exchange rate in the transmission of monetary policy to economic growth and inflation in Iran using a TVP-VAR approach. Their findings indicate that excessive growth in the monetary base beyond the economy's productive capacity leads to rising inflation and declining output, which in turn results in currency depreciation.

Mohammadzadeh Asl et al. (2016) explored the impact of financial development on exchange rate volatility and economic growth. Their results suggest that in highly developed financial markets, the negative effects of exchange rate volatil-

ity on growth can be neutralized or even turn positive, while in countries with underdeveloped financial systems, the impact remains significantly negative.

Zarei (2021) studied the nonlinear and asymmetric effects of real exchange rate volatility on Irans economic growth using monthly data from November 2009 to November 2019. The study found strong, asymmetric, and nonlinear relationships between exchange rate fluctuations and growth, with long-run effects being more pronounced than short-run ones.

Shojaei et al. (2023) analyzed the impact of exchange rate volatility on various sectors of Irans economy using GARCH models and simultaneous equations from 1988 to 2018. The findings showed that the industrial and mining sectors experienced the most severe negative effects.

Aziznejad and Komijani (2017) investigated how exchange rate changes influence macroeconomic variables in Iran. Their econometric analysis showed that exchange rate volatility negatively affects economic growth and positively influences inflation.

3.2 International Studies

Aghion et al. (2009) examined the relationship between exchange rate volatility and economic growth, focusing on the moderating role of financial development. Their results confirm that financial development reduces the adverse effects of currency volatility, especially in countries with weaker financial institutions.

Frankel and Romer (1999) explored the relationship between trade openness and economic growth. Their empirical analysis found that openness generally accelerates growth, although the strength of this effect may vary depending on the political and economic environment.

Parcon-Santos et al. (2023), using panel data models, investigated the effects of exchange rate volatility in Asia-Pacific economies. They identified a nonlinear (inverted-U) relationship, where moderate volatility can promote growth, but excessive volatility harms it.

Bhat et al. (2024) assessed the link between conditional exchange rate volatility and economic growth in BRICS countries using dynamic panel techniques. Their findings reveal that when exchange rate volatility exceeds a threshold (e.g., 1.54), growth declines by an average of 5%.

Ridwan et al. (2025) empirically investigated the causal relationships among trade openness, inflation, exchange rates, and economic growth in Bangladesh using annual time series data (19902020) and the ARDL approach. A unidirectional causality from trade openness to growth was found, supporting the argument that openness drives economic performance.

Harnphattananusorn (2023) examined the effects of exchange rate volatility and inflation on economic growth in Thailand using an ARDL model. Results indicated a negative impact of exchange rate volatility and a positive correlation between moderate inflation and growth.

Eichengreen et al. (2023) analyzed how financial and economic sanctions affect

exchange rates across historical episodes. The study found that sanctions increase exchange rate volatility and reduce macroeconomic stability, with effects varying by the type and scope of sanctions.

4 Methodology

4.1 Model Specification

Based on the theoretical framework proposed by Aghion et al. (2009), the relationship between economic growth, exchange rate volatility, and financial development can be specified as follows:

$$GY_t = \lambda_1 ER_t + \lambda_2 ER_t \times FD_t + \delta FD_t \tag{1}$$

Where GY_t denotes economic growth, ER_t indicates exchange rate volatility, and FD_t represents financial development. The interaction term $ER_t \times FD_t$ captures the joint effect of exchange rate volatility and financial development, highlighting the moderating role of the financial sector.

In applied studies such as Levine et al. (2000), additional control variables like trade volume and inflation have been included to account for macroeconomic dynamics. Accordingly, the extended model is expressed as follows:

$$\mathrm{GY}_t = \alpha\,\mathrm{GY}_{t-1} \;+\; \lambda_1\,\mathrm{ER}_t \;+\; \lambda_2\,\mathrm{ER}_t \times \mathrm{FD}_t \;+\; \delta\,\mathrm{FD}_t \;+\; \beta\,Z_t \tag{2}$$

Here, GY_{t-1} is the lagged value of GDP (economic growth), and Z_t is a vector of control variables including trade openness and inflation. Thus, the empirical model estimated in this study is:

$$\mathrm{GY}_t = \alpha\,\mathrm{GY}_{t-1} \;+\; \lambda_1\,\mathrm{ER}_t \;+\; \lambda_2\,\mathrm{ER}_t \times \mathrm{FD}_t \;+\; \delta\,\mathrm{FD}_t \;+\; \beta_1\,\mathrm{TO}_t \;+\; \beta_2\,P_t \;+\; \varepsilon_t \tag{3}$$

In this equation, TO_t refers to trade openness, calculated as the ratio of total exports and imports to GDP, while P_t is the inflation rate, used as a proxy for macroeconomic instability (Basirat et al., 2014).

Exchange rate volatility (ER_t) is extracted using the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model. Financial development (FD_t) is proxied by the ratio of credit extended to the private sector, based on King & Levine (1993). Ameziane and Benyacoub (2022) also used similar variables to assess the impact of exchange rate volatility on growth.

$$\mathrm{GY}_t = \beta_0 \;+\; \beta_1\mathrm{GY}_{t-1} \;+\; \beta_2\mathrm{ER}_t \;+\; \beta_3\mathrm{FD}_t \;+\; \beta_4\mathrm{TO}_t \;+\; \beta_5 P_t \;+\; \varepsilon_t \tag{4}$$

Table 1: Description of Variables

Variable	Symbol	Operational Definition
Economic Growth	GY_t	Change in real gross domestic product
Exchange Rate Volatility	ER_t	Extracted using GARCH model based on unofficial exchange rate
Financial Development Index	FD_t	Change in real bank credit to the private sector
Trade Openness	TO_t	(Exports + Imports) / GDP
Inflation Rate	P_t	Change in Consumer Price Index

Data for this study are sourced from the Central Bank of Iran and the Statistical Center of Iran, covering the monthly period from April 2011 to March 2024. The model is estimated using the Time-Varying Parameter Vector Autoregression (TVP-VAR) method, which captures nonlinear and time-varying effects of independent variables on economic growth. Linear estimations failed to produce results consistent with theoretical expectations. Therefore, the TVP-VAR approach is employed to better interpret the dynamic responses of economic growth to changes in key variables over time.

4.2 Estimation Method: TVP-VAR

The Time-Varying Parameter Vector Autoregressive (TVP-VAR) model has recently gained popularity in macroeconomic research. Unlike standard VAR models with fixed coefficients, the TVP-VAR allows parameters to evolve over time, offering more flexibility in capturing structural breaks, cyclical shifts, and changing economic dynamics (Koop et al., 1996).

The original model introduced by Sims (1980) is one of the fundamental frameworks for analyzing the relationships among various economic variables using impulse response functions. In these models, the vector of variables y_t is regressed on its own lags, and the functional form is expressed as follows:

$$y_t = c_t \; + \; \sum_{j=1}^{L} A_j \, y_{t-j} \; + \; e_t \tag{5}$$

Where e_t is the error term with mean zero and variance-covariance matrix Ω_e , c_t and A is a matrix of coefficients. The above model is a linear framework in which the predicted values of y are a function of several lagged variables, and the relationship is time-invariant. However, numerous studies have shown that higher-order moments of economic variables vary over time. This issue was first highlighted by the introduction of ARCH models by Engle (1982).

To incorporate time variation in coefficients, one option is to introduce time-varying dummy variables or apply nonlinear models such as threshold VAR or Markov-switching VAR. However, a more flexible approach is to directly estimate a TVP-VAR model, as shown below:

$$y_t = c_t \; + \; \sum_{j=1}^{L} A_{(j,t)} \, y_{t-j} \; + \; e_t \tag{6}$$

The lag matrix can be written using a Kronecker product:

$$X_t' = I \otimes \begin{bmatrix} 1 & y_{t-1} & \cdots & y_{t-L} \end{bmatrix}^\top \tag{7}$$

The vector of time-varying coefficients is defined as:

$$\theta_t \equiv \begin{bmatrix} c_t \\ A_{1t} \\ A_{2t} \\ \vdots \\ A_{Lt} \end{bmatrix} \tag{8}$$

The model is then expressed as:

$$y_t = X_t' \, \theta_t \; + \; e_t \tag{9}$$

Assuming θ_t follows a random walk, we have:

$$\theta_t = \theta_{t-1} \; + \; u_t \tag{10}$$

Where u_t is normally distributed with mean zero and constant variance, independent of e_t. The variance-covariance matrix is decomposed as:

$$\Omega_e \; = \; \Lambda^{-1} \left(\sum \sum \left(\Lambda^{-1} \right)^\top \right)^\top \tag{11}$$

Where Λ is a lower triangular matrix with ones on the diagonal, and Σ is a diagonal matrix. In the above relation, it can be demonstrated that the parameters derived from Ω_e vary over time. (Hatami & Alavi-Rad, 2024).

The error term in the TVP-VAR model is decomposed as:

$$e_t \; = \; \Lambda^{-1} \, \Sigma_t \, \varepsilon_t \tag{12}$$

Assuming orthogonal errors, the model is estimated using Bayesian methods via Markov Chain Monte Carlo (MCMC) simulation. This technique allows for recursive sampling from lower-dimensional distributions, avoiding the "curse of dimensionality" associated with large parameter spaces.

4.3 Estimating Exchange Rate Volatility (Uncertainty)

In this study, exchange rate volatility is estimated using the coefficient of variation derived from conditional variance obtained through the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model proposed by Bollerslev

(1986). This model is widely used for monthly exchange rate series, particularly in analyzing volatility in nominal exchange rates. The decision to use nominal exchange rates (rather than real exchange rates) stems from the fact that real rates may incorporate price fluctuations from other sources, potentially distorting the analysis.

Barguellil et al. (2018) reviewed several studies on exchange rate volatility and its macroeconomic impacts, most of which utilized GARCH-type models.

It is assumed that the conditional variance depends on the lagged squared residuals from the past q periods and on the lagged conditional variances from the past p periods, as shown in the following equation.

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \cdots + \alpha_q \varepsilon_{t-q}^2 + \beta_1 h_{t-1} + \beta_p h_{t-p} \tag{13}$$

Where h_t is the conditional variance, and ε_t represents the residual term of the model:

$$\Delta^d \mathrm{er}_t = \beta_0 + \sum_{i=1}^{p} \beta_i \Delta^d \mathrm{er}_{t-i} + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i} + \varepsilon_t \tag{14}$$

In which er_t is the logarithm of the nominal exchange rate.

5 Findings

5.1 Descriptive Statistics

The descriptive statistics of the studys variables are summarized in the following table:

Statistic Economic Growth Exchange Rate Volatility Financial Development Trade Openness Inflation.

Table 2: Descriptive statistics of the data

	GY_t	ER_t	FD_t	TO_t	P_t
Mean	0.124	41.495	-0.0001	3.156	2.001
Median	0.260	17.098	0.0016	3.269	1.760
Maximum	1.684	604.59	0.0442	5.441	10.590
Minimum	-3.260	0.387	-0.0738	1.573	-0.330
Std. Dev.	0.902	71.351	0.0174	0.928	1.578
Obs.	154	154	154	154	154

5.2 Stationarity Tests

The results confirm that all variables are stationary, allowing the model to be estimated without concerns of spurious regression.

Table 3: Stationarity of variables

Variable	ADF Test Statistic	p-value	Stationarity
Economic Growth	-4.167	0.0064	$I(0)$
Exchange Rate Volatility	-3.836	0.0172	$I(0)$
Financial Development	-6.302	0.0000	$I(0)$
Trade Openness	-3.000	0.0029	$I(0)$
Inflation	-6.814	0.0000	$I(0)$

5.3 GARCH Estimation of Exchange Rate Volatility

Initially, exchange rate volatility is extracted using the GARCH model. This process requires, in sequence, testing for stationarity, estimating ARIMA models, confirming the presence of heteroskedasticity, and ultimately obtaining the conditional variance of the exchange rate.

As shown in Table 3, the exchange rate series is confirmed to be stationary. Following the estimation of various ARIMA models, the selected specification is ARMA(1,1), as it yields the lowest Akaike Information Criterion (AIC) value. Subsequently, the presence of conditional heteroskedasticity was identified using the ARCH test, as its p-value was less than 5% ($p = 0.0000$). Therefore, the null hypothesis of no heteroskedasticity was rejected.

Finally, the EGARCH(3,3) model is selected as the most appropriate specification for modeling conditional variance, and the extracted exchange rate volatility values are depicted in the figure below.

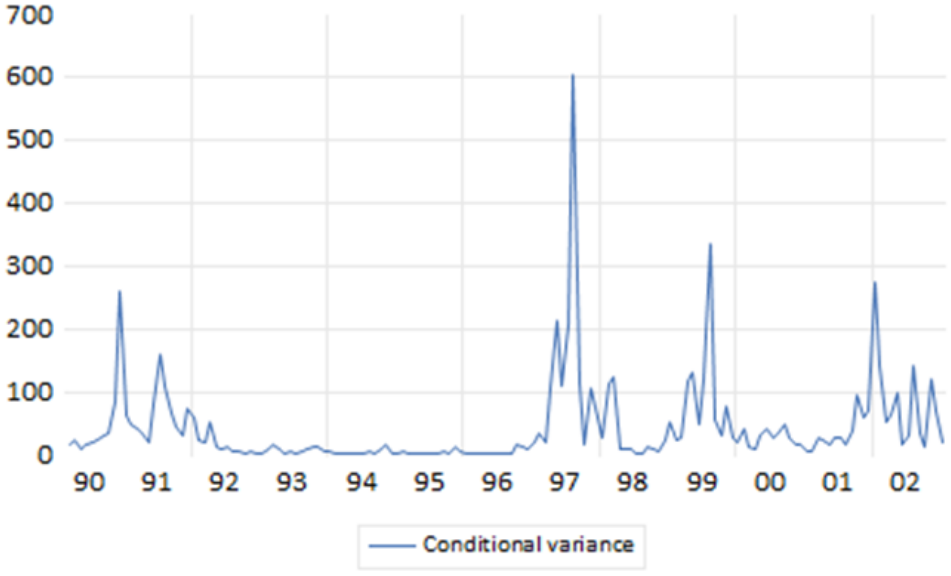

Figure 1: Exchange Rate Volatility Curve Extracted from the GARCH Model

The above figure illustrates episodes of excessive exchange rate volatility in the years 2011, 2018, 2020, and 2022, primarily driven by the oil embargo, the U.S. withdrawal from the JCPOA under President Trump, the COVID-19 pandemic, and the sudden surge in global food prices as a consequence of the RussiaUkraine war.

5.4 TVP-VAR Estimation Results

First, the optimal lag length of the model was determined using the Akaike and Schwarz information criteria. Since both criteria reached their minimum values at four lags, the optimal lag length was selected as four.

Time-Varying Parameter Analysis

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a.The Impact of Exchange Rate Volatility on Economic Growth

The following figure presents the estimated time-varying coefficients for the impact of exchange rate volatility on economic growth over the monthly period from 2011 to 2024.

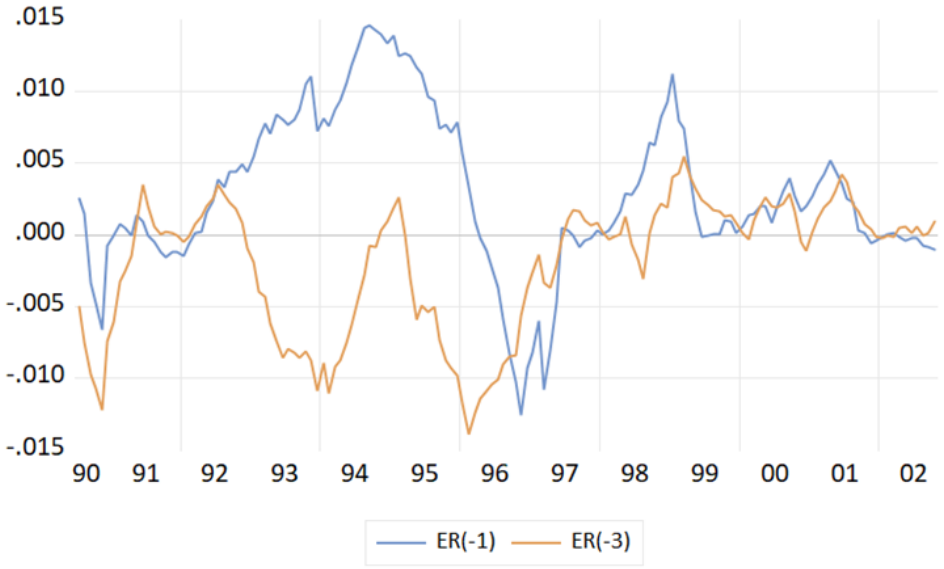

Figure 2: Time-Varying Coefficient of Exchange Rate Volatility on Irans Economic Growth(Monthly Data, 20112023)

The above figure presents the time-varying coefficients of exchange rate volatility on economic growth in Iran. The horizontal axis represents time and the vertical axis represents the coefficient of influence of exchange rate fluctuations on economic

growth. It shows that increased exchange rate volatility in the previous month led to a decline in economic growth during specific periodsparticularly in late 2011 and from July 2017 to September 2018. In other periods, however, economic growth responded positively to such volatility.

When considering the effect of exchange rate volatility from three months earlier, the negative impact on growth becomes more evident across a wider range of periods, notably in late 2011 and between February 2014 and September 2018. Interestingly, from mid-2018 to the end of 2023, exchange rate volatility has contributed positively to economic growth.

Thus, during sanction-heavy periodssuch as the early 2010s when the EU imposed an oil embargo on Iran, and in early 2018 when the Trump administration withdrew from the JCPOAheightened exchange rate volatility severely reduced economic growth. In contrast, during periods when the impact of sanctions was eased, particularly after the 2015 nuclear agreement, volatility even had a stimulating effect on growth.

In other words, the negative impact of exchange rate volatility becomes more pronounced three months after the shock than just one month later.

Parcon-Santos et al. (2023) proposed a nonlinear relationship between exchange rate volatility and economic growth, arguing that low levels of volatility may stimulate growth, while excessive volatility is harmful. The pattern observed in the above figure supports this hypothesis, as growth responds negatively to high volatility during periods of severe sanctions and positively in other, more stable periods.

b. The Impact of Financial Development on Economic Growth

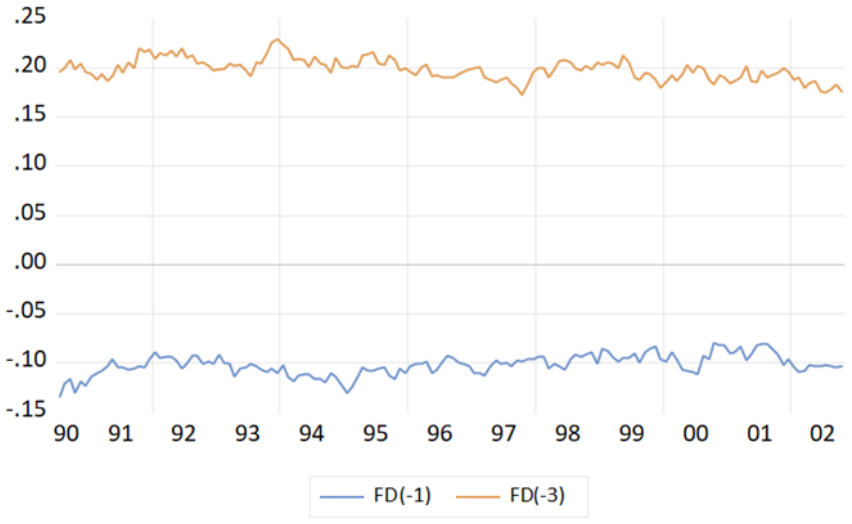

Figure 3: Time-varying coefficient of financial development on economic growth (monthly data from 2011 to 2023)

In the figure above, the time-varying coefficient of financial development on economic growth is analyzed. The horizontal axis represents time and the vertical axis represents the coefficient of influence of financial development on economic growth. An increase in financial development one month prior has led to a decline in Irans economic growth throughout the study period (20112023), although the intensity of this negative impact has varied across different time intervals. However, an increase in the financial development indexi.e., an increase in the growth of credit extended to the private sectorthree months earlier has resulted in an increase in economic growth.

This finding suggests that positive growth in financial development in the current month tends to reduce economic growth in the following month but boost it three months later.

As De Gregorio and Guidotti (1995) observed in the case of Latin American countries, unregulated financial liberalization and expectations of government bailouts can lead to a negative relationship between financial development and economic growth. A similar pattern is observed in Iran during the 2010s, where unregulated financial liberalization and the emergence of unlicensed non-bank institutions were widespread. This may support the idea that financial development had a negative impact on growth during the studied period.

Moreover, the negative effect of financial development on economic growth is consistent with the findings of Ibrahim and Alagidede (2018), who argued that financial development harms economic growth when improvements in the financial sector are not accompanied by higher growth in the real sector. In Iran, during the 2010s, the growth of credit was largely unregulated and outpaced economic growth, mainly to finance the government's severe budget deficits.

c. The Impact of Trading volume on Economic Growth

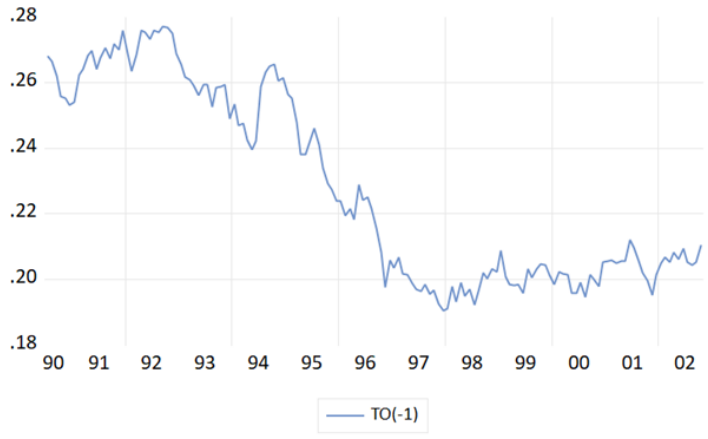

Figure 4: Figure 4. Time-varying coefficient of trade openness on economic growth(monthly data from 2011 to 2023)

The above chart analyzes the time-varying coefficient of trade openness on economic growth. The horizontal axis represents time and the vertical axis represents the coefficient of influence of the degree of trade openness on economic growth. Overall, during the study period, an increase in trade volumeor greater trade opennesshad a positive effect on Irans economic growth. In other words, higher levels of exports and imports contributed to economic growth; however, this positive impact was more pronounced during the period from 2011 to late 2017 compared to the years 2018 to 2023.

d. The Impact of Inflation Rate on Economic Growth

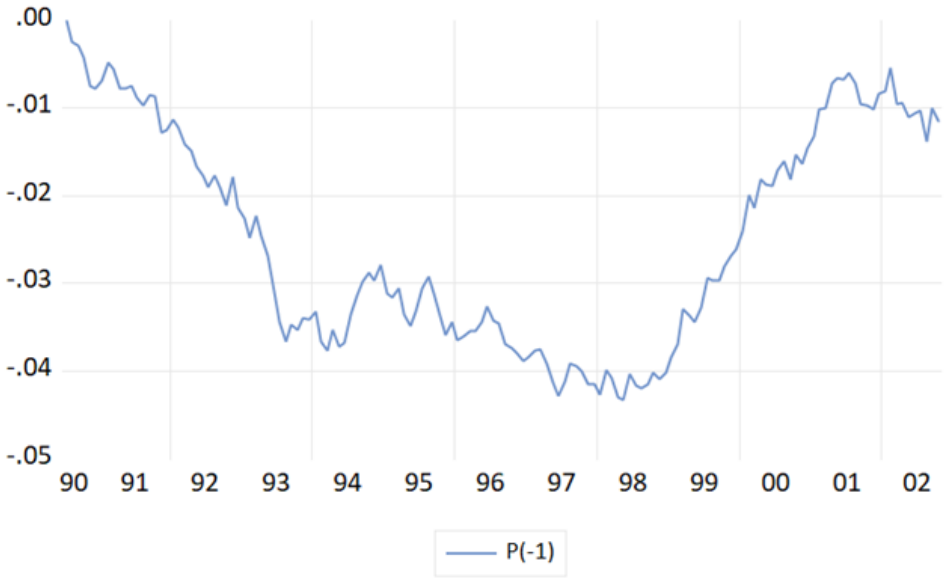

Figure 5: Figure 5. Time-Varying Coefficient of Inflation Rate on Economic Growth during the Monthly Period from 2011 to 2023

The above chart analyzes the time-varying coefficient of the inflation rate on economic growth. The horizontal axis represents time and the vertical axis represents the coefficient of inflation's impact on economic growth. Over the entire study period, the impact of rising inflation on economic growth has been negative, though the intensity and magnitude of this effect have varied over time. The chart shows that from mid-2014 to early 2020, increases in inflation significantly reduced economic growth. However, before 2014 and after 2020, the negative impact of inflation on growth was less pronounced.

In other words, while inflation has generally reduced economic growth in Iran between 2011 and 2023, the extent of this reduction was lower before mid-2014 and after early 2020. During the period following the U.S. withdrawal from the JCPOA and the escalation of sanctions against Iran (from May 2018 to late 2019), as well

as during the COVID-19 pandemic in 2020, the rise in inflation led to a sharper decline in economic growth compared to other periods.

These findings indicate that Iran's economic growth has responded differently and asymmetrically to various macroeconomic factorsnamely, exchange rate volatility, financial development, trade volume, and inflationacross different time periods. Therefore, economic policymakers should pay close attention to these asymmetric effects in order to better anticipate and understand the potential consequences of their policy decisions.

Impulse Response Functions

In the TVP-VAR model, Impulse Response Functions (IRFs) are also time-varying. Therefore, it is essential to examine the IRFs at different time points to observe how the responses to shocks have evolved over time. In this study, the IRFs are analyzed at three specific time points.

The first date corresponds to July 2012, when the European Union's oil sanctions against Iran were initiated. The second date refers to May 2018, marking the U.S. withdrawal from the JCPOA under President Trump and the onset of new sanctions against Iran. The third date is February 2021, which coincides with the beginning of President Bidens administration and a relative easing of the sanctions imposed during the Trump era.

By analyzing the IRFs at these three time points, it was observed that the impulse responses followed the patterns described below.

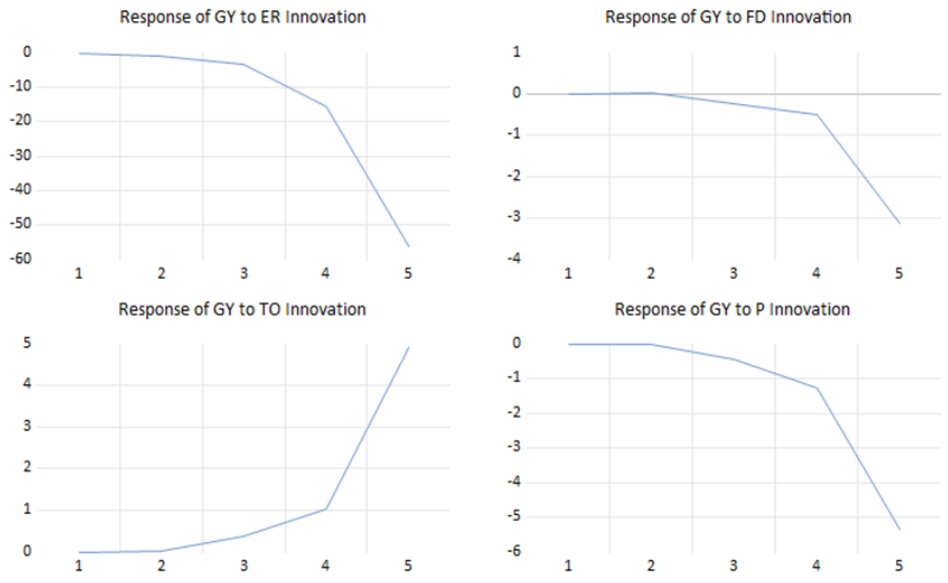

Figure 6: Figure 6. Impulse Response Functions of Economic Growth Rate to Shocks in Independent Variables

In the above graphs, the horizontal axis indicates the time period of the shock and the vertical axis indicates the standard deviation of the economic growth variable. When a one standard deviation shock is applied to exchange rate volatility, economic growth does not change in the same period but subsequently declines and does not return to its long-run equilibrium. Therefore, increased exchange rate volatility leads to a long-term decrease in economic growth.

Similarly, when a one standard deviation shock is applied to the financial development indexmeasured by credit growth to the private sectoreconomic growth remains unchanged initially but later declines and fails to revert to its long-run equilibrium. Thus, an increase in credit growth to the private sector results in a long-term reduction in economic growth. Notably, the expansion of credit and liquidity in the economy has not only failed to promote long-term growth but has even contributed to its decline. This may be attributed to unregulated financial liberalization and the emergence of non-bank financial institutions in Irans economy during the 2010s.

In the case of a one standard deviation shock to trade openness (i.e., trade volume), economic growth shows no immediate change but subsequently increases, although it does not fully return to long-run equilibrium. In other words, an increase in exports and imports leads to long-term improvement in economic growth.

Finally, a one standard deviation shock to the inflation rate does not affect economic growth in the current period but results in a decline afterward, without returning to the long-run equilibrium. Thus, rising inflation leads to a long-term decrease in economic growth.

6 Conclusion and Recommendations

This study examined the asymmetric effects of exchange rate volatility, financial development, trade openness, and inflation on Iran's economic growth over the monthly period from 2011 to 2023. Given that linear models do not yield accurate insights for effective economic policymaking, the nonlinear TVP-VAR approach was employed. This estimation method captures the asymmetric and time-varying impact of independent variables on economic growth.

The findings of this research indicate that in the short run, these variables have asymmetric effects on economic growth across different time periods. For instance, during sanction-heavy periodssuch as the early 2010s, marked by the EU's oil embargo on Iran, and early 2018, when the U.S. exited the JCPOAintensified exchange rate volatility significantly reduced economic growth. However, during periods when the impact of sanctions was relatively eased, such as following the 2015 nuclear agreement, increased exchange rate volatility even contributed to higher economic growth. These results align with the findings of Parcon-Santos et al. (2023). In the long run, however, intensified exchange rate volatility leads to a decline in economic growth.

An increase in financial developmentspecifically, credit growth to the private sectorone month prior, generally resulted in reduced economic growth throughout the study period. However, the intensity of this negative effect varied over time. Interestingly, an increase in financial development three months prior led to higher economic growth, suggesting that while credit expansion may negatively affect the following months growth, it has a positive impact after a longer lag. Nonetheless, in the long run, financial development had a damaging effect on economic growth, likely due to unregulated credit expansion aimed at financing large fiscal deficitsa finding consistent with studies by Ibrahim and Alagidede (2018), and De Gregorio and Guidotti (1995).

An increase in trade volume or trade openness led to higher economic growth in both the short and long run, aligning with theoretical findings such as those by Frankel and Romer (1999). Trade openness can boost growth through technology transfer, increased competition, and better exploitation of comparative advantages.

Rising inflation, both in the short and long term, weakened economic growth, in line with theoretical insights such as those by Fischer (1993). High inflation reduces purchasing power and raises production costs, thereby limiting growth.

Overall, it can be concluded that Irans economic growth has responded asymmetrically to exchange rate volatility, financial development, trade openness, and inflation across different time periods. Therefore, economic policymakers should pay special attention to these asymmetric effects to better anticipate and understand the implications of their policy decisions.

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