

Investigating the Effects of Geopolitical Risk, Oil Price Shocks, and Banking Stability on Financial Stability in Iran Using the Kalman Filter Approach

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Abstract: This study aimed to investigate the effects of geopolitical risk, oil price shocks, and banking stability on financial development in Iran. In terms of purpose, the study is applied research, while in terms of nature, it is descriptive-analytical and classified as an ex post facto study. The statistical population comprises the Iranian economy, and the study period covers 1986–2024. In this study, financial development was measured using the ratio of bank credit extended to the private sector to gross domestic product (GDP), and the effects of oil price shocks, economic policy uncertainty, geopolitical risk, banking stability, bank profitability, and trade openness on financial development were examined. Oil price shocks were extracted using an autoregressive moving average model and an exponential generalized autoregressive conditional heteroskedasticity model. In addition, the economic policy uncertainty index was calculated by combining fluctuations in monetary, fiscal, and exchange-rate policies, inflation, and economic growth using the Hodrick–Prescott filter and principal component analysis. The banking stability index was also calculated based on the logarithm of the Z-score, incorporating capital adequacy, return on assets, and the standard deviation of return on assets. Given the possibility that the coefficients may vary over time, the research model was formulated within a state-space framework and estimated using the Kalman filter approach. The results of the Phillips–Perron test indicated that the study variables were nonstationary at level but became stationary after first differencing; therefore, all variables included in the model were integrated of order one. The Johansen–Juselius cointegration tests also confirmed the existence of a long-run equilibrium relationship among the model variables. Based on the Hansen test, the null hypothesis of parameter stability was rejected, indicating that the model coefficients varied over time and confirming the necessity of using the Kalman filter approach. The results obtained from estimating the state-space model showed that oil price shocks, economic policy uncertainty, and geopolitical risk had negative and statistically significant effects on financial development in Iran. The final coefficients of these variables were estimated at 0.072, -0.015, and -0.025, respectively. Accordingly, increased uncertainty arising from oil price volatility, instability in economic policies, and intensified geopolitical risks reduces financial development by increasing investment uncertainty, weakening public confidence, raising financing costs, shortening decision-making horizons, and reducing participation in formal financial markets. In contrast, banking stability, bank profitability, and trade openness had positive and statistically significant effects on financial development. The final coefficients of these variables were 0.094, 0.129, and 0.031, respectively. Therefore, strengthening banks' loss-absorption capacity, improving asset quality, increasing the efficiency and profitability of the banking system, and expanding trade can enhance financial intermediation capacity and the provision of financial resources to the private sector. Examination of the time-varying coefficients further indicated that the magnitude and direction of the effects of the investigated factors were not constant across different periods.

Keywords: Geopolitical Risk, Oil Price Shock, Financial Development, Banking Stability, Bank Profitability, Economic Policy Uncertainty, Trade Openness

1. Introduction

Financial development is widely regarded as one of the fundamental institutional and structural foundations of economic growth, capital formation, efficient resource allocation, and macroeconomic resilience. A well-functioning financial system mobilizes savings, facilitates the allocation of financial resources toward productive investment, reduces information and transaction costs, enhances risk sharing, and improves the capacity of firms and households to respond to economic opportunities and shocks. Financial development is therefore not limited to the quantitative expansion of banks, credit, and capital markets; rather, it also reflects the efficiency, stability, accessibility, depth, and resilience of financial institutions and markets. In developing and emerging economies, where commercial banks constitute the dominant channel of financial intermediation, the development of the financial system is particularly dependent on the ability of banks to provide stable financing to the private sector. Evidence from Iran has similarly shown that financial development can influence economic growth through improvements in capital allocation and financial intermediation [1]. The interaction between financial development and financial stability is also important because financial expansion that occurs without adequate stability may increase systemic vulnerabilities, whereas a stable financial system can provide the institutional conditions required for sustainable financial deepening [2]. Consequently, identifying the factors that strengthen or weaken financial development has become increasingly important in economies exposed to macroeconomic, political, and external shocks.

The relationship between financial development and financial stability is especially important in bank-based economies. Financial institutions perform their intermediary role effectively only when they possess sufficient capital, adequate asset quality, sustainable profitability, and the capacity to absorb unexpected losses. Banking instability can restrict credit supply, increase financing costs, deteriorate public confidence, and cause financial institutions to adopt more conservative lending strategies. Conversely, stronger banking stability can support the expansion of private-sector credit and improve the continuity of financial intermediation. Recent research has emphasized that stability in banking systems is influenced by numerous institutional and financial conditions. For example, theoretical work on Islamic banking has highlighted the institutional and contractual foundations through which Islamic banking principles may contribute to financial stability [3], while studies of Islamic banking and economic development have emphasized the broader contribution of banking structures to economic and financial performance [4]. At the firm level, financial stability has also been associated with organizational behavior and corporate responsibility among firms listed on the Tehran Stock Exchange, demonstrating that stability has implications extending beyond the banking sector itself [5]. These findings support the view that banking stability should be considered a central explanatory factor in analyses of financial development.

A closely related determinant is bank profitability. Banks with stronger and more sustainable profitability are generally better positioned to accumulate capital, expand their lending capacity, improve technological and operational infrastructure, and withstand adverse economic shocks. Profitability may consequently affect financial development by increasing the ability of banks to supply credit to productive sectors and by reinforcing depositor and investor confidence. However, profitability and stability do not necessarily move in the same direction under all conditions, particularly when banks pursue excessive risk-taking to increase short-term returns. This has increased interest in identifying factors that simultaneously promote financial access, profitability, and stability. The role of liquidity creation in financial stability, for example, has been investigated with attention to institutional moderators such as environmental, social, and governance disclosure [6]. Likewise, research on digital financial

inclusion has shown that broader financial access can interact with bank stability and that financial literacy may influence the strength of this relationship [7]. These findings indicate that banking stability and profitability are not isolated institutional characteristics but are embedded within a broader financial ecosystem involving access, governance, information, and risk-management capacity.

Financial inclusion and financial development are similarly interconnected with financial stability. Expanding financial access may increase deposit mobilization, diversify bank funding sources, and broaden participation in formal finance, but rapid or poorly regulated expansion may also generate new credit and operational risks. International evidence therefore increasingly suggests that the relationship between financial inclusion and stability is conditional and potentially nonlinear. Research in developing economies has shown that financial inclusion and competition are important determinants of financial stability [8], while international theoretical and empirical evidence indicates that the effects of inclusion on stability vary according to institutional quality, banking structures, and regulatory conditions [9]. Evidence from the Middle East and North Africa further demonstrates that financial inclusion, financial development, and financial stability are closely interrelated dimensions of financial-system performance [10]. Consistent with this perspective, nonlinear evidence suggests that increases in financial inclusion may produce different stability consequences depending on the level of financial-system development and the institutional environment [11]. Hence, the expansion of financial activity should be analyzed together with the resilience and quality of financial institutions rather than purely through increases in financial volume.

Financial literacy, innovation, and human capital represent additional mechanisms through which the resilience and inclusiveness of financial systems may be strengthened. Financially informed households and entrepreneurs may make better saving, borrowing, and investment decisions, potentially reducing financial fragility and increasing effective participation in formal financial markets. Research on Montenegro has demonstrated the role of financial literacy in strengthening economic resilience and stability [12]. Similarly, financial literacy and financial innovation have been identified as mechanisms capable of mitigating some of the adverse effects of corruption on banking stability [13]. Among Muslim micro-entrepreneurs, Islamic financial literacy has also been linked to financial sustainability, demonstrating the importance of financial knowledge in supporting durable participation in financial systems [14]. More broadly, comparative evidence from Sub-Saharan African and OECD economies indicates that institutional, socioeconomic, and financial characteristics significantly shape financial inclusion [15]. Together, these findings underscore that the development and stability of financial systems depend not only on banking-sector balance-sheet variables but also on the institutional and behavioral environment in which financial intermediation occurs.

In addition to domestic financial characteristics, financial development is highly sensitive to macroeconomic uncertainty. Economic policy uncertainty can influence financial markets through several channels, including delayed investment, increased precautionary behavior, higher risk premiums, reductions in credit demand and supply, and deterioration in expectations regarding future economic conditions. When monetary, fiscal, or exchange-rate policies are unpredictable, firms may postpone investment decisions, banks may tighten lending standards, and households may shift savings toward liquid or nonfinancial assets. In Iran, this issue is particularly relevant because monetary expansion, fiscal pressures, exchange-rate volatility, inflation, and dependence on oil revenues can interact to create persistent uncertainty. Research using a dynamic stochastic general equilibrium framework has demonstrated that economic uncertainty shocks can significantly affect major macroeconomic variables in the Iranian economy [16]. These effects can ultimately extend to financial development because the

banking system and private-sector financing decisions respond directly to changes in inflation expectations, output prospects, fiscal conditions, and monetary-policy credibility.

Oil price shocks constitute another major source of uncertainty for oil-exporting economies. In countries where government revenue, foreign-exchange availability, fiscal expenditure, and macroeconomic activity depend substantially on petroleum exports, fluctuations in oil prices can have wide-ranging consequences for liquidity, credit conditions, exchange rates, inflation, and investment. Oil price shocks may generate favorable effects during periods of rising prices by increasing public revenue and foreign-exchange resources, but abrupt or highly volatile movements can also amplify macroeconomic instability. Evidence from Iran indicates that oil and exchange-rate price shocks can significantly affect major asset markets, including housing prices [17]. This finding reinforces the importance of considering oil price shocks as a potentially systemic determinant capable of transmitting volatility across sectors of the economy. Methodologically, studies of other volatile markets have likewise demonstrated the usefulness of GARCH-family models for identifying and modeling time-varying volatility. Research on electricity markets, for example, has shown that extreme external shocks can play an important role in explaining price volatility using GARCH-MIDAS techniques [18]. Such evidence supports the use of asymmetric volatility models when positive and negative shocks are unlikely to exert identical effects.

The relevance of external shocks is not restricted to oil markets. Climate-related and environmental disturbances increasingly demonstrate how exogenous events can generate economic uncertainty and impose significant costs on economies and financial systems. Extreme weather events have been shown to interact with atmospheric and oceanic conditions in ways that increase exposure to severe economic disruptions [19]. Research on the economic consequences of climate-related overshooting similarly demonstrates that environmental shocks can impose substantial damages extending beyond their immediate physical effects [20]. In electricity markets, geopolitical and climate risks have jointly been associated with increased uncertainty and volatility [21]. Although these studies address different substantive contexts, they illustrate a broader principle relevant to financial development: external shocks can alter expectations, increase uncertainty, change risk perceptions, and influence investment and financing conditions. Financial systems operating in environments characterized by repeated external disturbances may therefore require greater institutional and banking resilience to maintain stable credit intermediation.

Geopolitical risk is particularly important in this regard because it combines political uncertainty, international tensions, conflict risk, sanctions, security concerns, and the possibility of abrupt changes in cross-border economic relations. Geopolitical disturbances can affect financial development through capital flight, exchange-rate volatility, reductions in investment, deterioration in investor confidence, higher sovereign and private risk premiums, and restrictions on international financial transactions. Investors exposed to geopolitical uncertainty may shorten their investment horizons and shift from productive or long-term financial assets toward liquid safe-haven assets. Financial institutions may simultaneously increase lending caution because future cash flows and borrower risk become more difficult to evaluate. Evidence specifically related to Iran has highlighted the relationships among geopolitical risk, financial development, and economic growth [22]. Investor behavior in Iran and the Caucasus region has also been shown to respond to geopolitical risks, emphasizing the importance of political and regional uncertainty for portfolio and investment decisions [23]. Such mechanisms are particularly relevant to Iran given its exposure to international sanctions, regional conflicts, diplomatic tensions, and recurrent geopolitical uncertainty.

The banking sector itself may also be directly affected by geopolitical disturbances. Banking risk management becomes more complex following major financial or geopolitical crises because institutions must simultaneously manage credit, market, liquidity, operational, and regulatory risks. Recent Iranian research focusing on banking

risk management after financial crises and geopolitical conflict emphasizes the need for stronger risk-management frameworks under conditions of heightened uncertainty [24]. At the international level, geopolitical risks have also been shown to produce heterogeneous economic consequences depending on countries' institutional and structural characteristics [25]. Security-related risks, including terrorism and armed violence, further illustrate how political instability can affect economic environments and perceptions of systemic risk [26]. These studies collectively suggest that geopolitical risk should not be treated merely as an external political variable; rather, it may act as a financial shock capable of changing credit allocation, investor behavior, risk pricing, and banking-sector resilience.

The relationship between stability and financial development may additionally depend on the structure of financial instruments available to economic agents. Diversification of financial instruments can broaden financing channels, reduce excessive dependence on conventional bank credit, and provide firms with alternative mechanisms for managing financing risk. Systematic evidence concerning Islamic financial instruments, particularly sukuk, indicates that such instruments may contribute to firms' financial stability by providing alternative financing arrangements [27]. This perspective is relevant in an Islamic financial system such as Iran's, where the nature of banking contracts and capital-market instruments can shape the channels through which savings are mobilized and investment is financed. At the same time, sustainable financial development requires that the expansion of financial instruments be accompanied by sufficient transparency, market depth, institutional quality, and risk-management capability.

Trade openness constitutes another potentially important determinant of financial development. Greater integration into international trade can increase firms' demand for financial services, trade finance, working capital, foreign exchange operations, payment services, and long-term investment financing. It can also expose domestic institutions to international competition and encourage improvements in financial efficiency. However, openness may simultaneously increase vulnerability to external shocks, particularly when geopolitical tensions interfere with international trade or access to global financial networks. In economies subject to external restrictions, therefore, the financial effects of trade openness may depend substantially on geopolitical conditions and domestic banking resilience. The coexistence of trade-related opportunities and geopolitical constraints makes the Iranian economy an especially relevant setting for examining whether greater trade openness remains supportive of financial development under conditions of persistent uncertainty.

Despite the growing literature on financial development, stability, geopolitical risk, and macroeconomic shocks, several empirical limitations remain. First, many studies examine these relationships independently, focusing on only one or two dimensions such as financial development and growth, inclusion and stability, or geopolitical risk and investment. Second, conventional regression approaches frequently assume that structural coefficients remain constant throughout the observation period. Such an assumption may be restrictive for Iran, where the economic environment has undergone major changes associated with sanctions, oil-price cycles, exchange-rate adjustments, banking-sector developments, episodes of high inflation, regional geopolitical tensions, and changes in economic policies. The effect of an oil price shock in one historical period may therefore differ substantially from its effect in another, and the same may be true for geopolitical risk, banking stability, profitability, and trade openness. Third, the complex interaction between financial instability and uncertainty suggests that methods capable of modeling dynamic coefficients may yield information that constant-parameter models cannot reveal.

A state-space framework estimated through the Kalman filter is particularly appropriate in this context because it permits coefficients to evolve over time and can therefore capture structural changes in the relationships between financial development and its determinants. Rather than imposing a single coefficient for an entire sample, a time-

varying specification can identify periods in which financial development becomes more or less sensitive to oil price shocks, policy uncertainty, geopolitical risk, banking stability, profitability, or trade openness. This is important when financial institutions operate under changing macroeconomic and political conditions. Moreover, the use of an asymmetric volatility specification such as EGARCH to extract oil price shocks can distinguish the volatility process from ordinary movements in oil prices, while an uncertainty index combining monetary, fiscal, exchange-rate, inflation, and output fluctuations can provide a more comprehensive representation of the domestic policy environment. Integrating these components within a time-varying financial development model can therefore provide a more realistic representation of the Iranian financial system than approaches based exclusively on fixed coefficients.

Accordingly, the aim of the present study is to investigate the time-varying effects of geopolitical risk, oil price shocks, economic policy uncertainty, banking stability, bank profitability, and trade openness on financial development in Iran during 1986–2024 using a state-space model estimated through the Kalman filter approach.

2. Methods and Materials

The present study is applied in terms of purpose and descriptive–analytical in terms of nature and falls within the category of ex post facto research. To estimate the financial development model, the state-space method based on the Kalman filter approach was employed. The statistical population of the present study is Iran, and the research period covers 1986–2024. State-space models are among the most appropriate techniques used in the econometrics and time-series literature because they enable the estimation of unobservable variables, or state variables, within a system of equations. These models account for structural instability in model coefficients and allow model parameters to vary over time. As noted above, state-space models are used in econometrics to model unobserved variables. Such variables include rational expectations, measurement errors, missing observations, permanent income, unobserved components such as cycles and trends, and the non-accelerating inflation rate of unemployment. It should be noted that the principal distinction between conventional time-series models and state-space models is that, in state-space models, parameters may themselves be functions of time rather than remaining constant. There are two major advantages to representing dynamic models in state-space form. First, such models allow unobserved variables both to be incorporated into model estimation and to be estimated within the model. Second, these models can be analyzed using powerful recursive algorithms such as the Kalman filter. If y_t denotes an $n \times 1$ vector of observed variables at time t , new dynamic models of y_t can be specified in terms of the unobserved variables B_t . When written in this form, the equation is generally referred to as the state vector representation. The state-space representation of y_t is specified by the following system of equations:

$$y_t = AX_t + HB_t + W_t \quad (1)$$

$$B_{t+1} = FB_t + V_{t+1} \quad (2)$$

Here, A , H , and F are matrices containing the model parameters. Equation (1) is known as the observation equation. In this equation, X_t is a $K \times 1$ vector containing exogenous or predetermined variables. Similarly, y_t is an $n \times 1$ vector representing the dependent variable, which in the original specification is the non-oil economic growth rate at basic prices. The vector B_{t+1} is an $r \times 1$ vector containing the unobservable component, or state variable. Equation (2), which determines the process governing the state variable, is referred to as the state equation. Both equations contain disturbance terms, w_t and v_t , respectively, which are mutually independent and identically distributed.

$$\begin{aligned} v_t &\sim N(0, Q) \\ w_t &\sim N(0, R) \end{aligned} \quad (3)$$

Here, Q and R are $r \times r$ and $n \times n$ matrices, respectively. Moreover, the disturbance terms of the observation and state equations are assumed to be uncorrelated with each other and with their own lags:

$$E(V_t, W_t) = 0 \quad (4)$$

Once a time-series model has been expressed in state-space form, several algorithms can be used to estimate its parameters, smooth the series, or generate forecasts. The most important of these is the Kalman filter, originally developed by Kalman and Bucy. The Kalman filter is a recursive method for producing optimal forecasts of unobserved variables and efficient estimates of the parameters of state-space models on the basis of conditional expectations. One of the key properties of conditional expectation is that it provides the best predictor under the minimum mean squared error criterion. Although the Kalman filter was originally developed to solve a spacecraft navigation problem, it is now widely used in problems in which incomplete observations must be combined with information about the underlying state of a system. As stated above, the Kalman filter is a recursive algorithm for calculating linear least-squares predictions using observations available from previous periods.

$$\begin{aligned} B_{t+1|t} &= E(B_{t+1} | \mathcal{B}_t) \\ \mathcal{B}_t &= (y'_t, y'_{t-1}, \dots, y'_1, X'_t, X'_{t-1}, \dots, X'_1) \end{aligned} \quad (5)$$

These forecasts are calculated recursively, and the mean squared error (MSE) can also be calculated at each stage.

$$\begin{aligned} B_{1|0} &\rightarrow B_{2|1} \rightarrow \dots \rightarrow B_{t|t-1} \\ P_{1|0} &\rightarrow P_{2|1} \rightarrow \dots \rightarrow P_{t|t-1} \end{aligned} \quad (6)$$

The starting points for prediction under this algorithm are $B_{1|0}$ and $P_{1|0}$.

$$\begin{aligned} B_{1|0} &= E(B_1) \\ P_{1|0} &= E[(B_1 - E(B_1))(B_1 - E(B_1))'] \end{aligned} \quad (7)$$

For the optimal and efficient estimation of state-space models, the following two considerations must be taken into account; otherwise, the model estimates will be unreliable, and inferences based on those estimates will not be valid.

1. In a state-space system of equations, the ratio of the variance of the disturbance term in the state equation to the variance of the disturbance term in the observation equation is referred to as the signal-to-noise ratio. If the signal-to-noise ratio differs from zero, the estimated state-space equations can be considered valid and the resulting estimates of the state variable acceptable. However, if this ratio equals zero, the estimated state-space model encounters the pile-up problem.
2. When the Kalman filter is used to estimate parameters, the disturbance terms in both the observation and state equations must follow Gaussian (normal) distributions. Therefore, diagnostic tests must be conducted to verify that the assumptions underlying the Kalman filter are satisfied.

Considering the objective of the present study and the empirical literature reviewed, the principal model employed in this research is specified as follows:

$$FD_t = \alpha_0 + \beta_1 OILSH_t + \beta_2 EMPU_t + \beta_3 GE_t + \beta_4 ZSCORE_t + \beta_5 ROA_t + \beta_6 OPEN_t + F(S_t, \gamma, c) + u_t \quad (8)$$

Dependent Variable

FD: Financial development index, measured as bank credit extended to the private sector as a percentage of GDP.

Independent and Control Variables

OIL: Represents shocks to the price of Iranian Heavy Crude Oil, calculated using the EGARCH model.

GE: Geopolitical risk, measured using the Political Stability and Absence of Violence indicator. The index ranges from 0 to 100, with values closer to 100 indicating an improvement in political stability and the absence of violence in the region.

Banking Stability (Z-score): To evaluate banking stability, the index introduced in the studies of Boyd and Graham, commonly known as the Z-score, is employed. Under this measure, banking stability and soundness are calculated as the sum of the capital adequacy ratio and return on assets divided by the standard deviation of return on assets. The larger the value of this index, the lower the probability of bank instability or failure and, in other words, the greater the degree of banking stability.

$$\text{Bank Stability} = \ln(\text{Z-score}) = \ln\left(\frac{ROA + \text{Capital Ratio}}{\sigma(ROA)}\right)$$

Bank Profitability (ROA): Return on assets, defined as profit divided by total assets, is used as an indicator of banking system performance.

OPEN: Trade openness, measured using the volume of trade.

Economic Policy Uncertainty (EMPU)

Given the economic conditions prevailing in Iran, where government budgetary requirements have consistently been associated with fluctuations in the exchange rate, growth in the money supply, inadequate economic growth, and the dependence of the Iranian economy on oil revenues, which has contributed to insufficient attention to tax revenues, it is necessary to develop an index specifically suited to the Iranian economy in order to capture policy uncertainty. Accordingly, following the approach of Loni et al. (2021), the fluctuations of three groups of indicators—fiscal, monetary, and exchange-rate policies—are first calculated for the Iranian economy using the Hodrick–Prescott filter. Subsequently, a composite index of fluctuations in these variables is estimated and introduced as the economic policy uncertainty index. The procedure used to measure the uncertainty index is as follows: first, fluctuations in monetary policy variables, including the monetary base and interest rate; fiscal policy variables, including the budget deficit and taxation; and the exchange-rate policy variable, namely the exchange rate, together with fluctuations in inflation and economic growth, are calculated using the Hodrick–Prescott filter. Principal component analysis (PCA) is then employed to construct the economic uncertainty index. PCA reduces the dimensionality of the observations by constructing a composite index and grouping similar observations. Under this method, correlated variables in a multidimensional space are summarized into a set of uncorrelated components, each of which is a linear combination of the original variables. The resulting uncorrelated components are known as principal components (PCs) and are derived from the eigenvectors of either the covariance matrix or the correlation matrix of the original variables. Reducing the number of variables and identifying the underlying structure of relationships among variables are among the most important applications of PCA. The principal advantage of this method in econometrics is its ability to mitigate multicollinearity arising from the inclusion of a large number of influential variables in a model.

Table 1. Economic Policy Uncertainty Index

Policy	Abbreviation	Operational Definition
Monetary policy: Monetary policy refers to the set of instruments and mechanisms through which the central bank regulates the amount of money in the economy in order to achieve price stability and sustainable economic growth. Monetary policy instruments generally include open market operations, changes in banks' required reserve ratios, and changes in the rediscount rate.	IR	Interest rate: The interest rate is the cost of borrowing money that must be paid by the borrower. In other words, it represents the opportunity cost borne by the lender, who could otherwise have earned a return by employing the funds but forgoes that return by lending them.
	M	Monetary base: The monetary base refers to the total amount of money created by the central bank that is highly liquid. More specifically, it includes total currency, comprising banknotes and coins held by the public and in general circulation, together with relevant deposits held in banks and reserves maintained by commercial banks at the central bank.
Fiscal policy: Fiscal policy comprises policies that lead to changes in government expenditure or revenue and thereby affect output. Fiscal policy was initially developed within the Keynesian framework, and its principal instruments are government expenditure and tax rates.	BD	Budget deficit: A budget deficit occurs when government expenditure exceeds government revenue. This policy is commonly used when the economy is experiencing recessionary conditions.
	TAX	Taxation: Taxation refers to the transfer of part of society's income to the government or the share of profits from economic activities accruing to the government. Tax revenues are generally generated in two principal ways. The first is through changes in tax rates, which governments may reduce during economic recessions and increase during periods of economic expansion. The second concerns the tax base, which involves imposing taxes on goods or economic units that were previously not subject to taxation.
Exchange-rate policy: Exchange-rate policy refers to the mechanism through which the exchange rate is determined in an economy. In general, two predominant exchange-rate regimes can be distinguished. Under a fixed exchange-rate regime, the central bank intervenes in the market to support the officially determined exchange rate. Under a floating exchange-rate regime, no officially predetermined rate is established, and the market mechanism determines the exchange rate.	ER	Exchange rate: The exchange rate is the rate at which the value of the domestic currency is expressed relative to a foreign currency and at which the two currencies are exchanged. In other words, it indicates the amount of domestic currency that must be paid to obtain one unit of another country's currency.
Inflation rate: Inflation is defined as a sustained increase in the general price level. Under this definition, a temporary increase in prices is not considered inflation.	INF	In calculating inflation, the price index of 386 goods in Iran is first calculated, and the average growth rate of the price index is regarded as inflation. In price-index terminology, the two principal indices are generally the producer price index and the consumer price index.
Economic growth: Economic growth refers to the growth of a country's gross domestic product over a specified period.	GDP	Gross domestic product: GDP is defined as the total monetary value of final goods and services produced by resident economic units within a country during a specified period, typically annually or quarterly. GDP is therefore a flow variable whose value represents the monetary value of the flow of goods and services in an economy over a specified period, generally one year.

3. Findings and Results

The analysis began by examining the stationarity properties of the research variables. When time series exhibit coordinated movements over time, such co-movement may indicate the existence of a potential long-run equilibrium relationship. In other words, when two time-series variables move together, it may be possible to

specify a long-run equilibrium relationship between them; such variables are referred to as cointegrated. In simple terms, cointegration occurs when two or more time series approximately move on the same long-run trajectory. In economic analysis, variables incorporated into an economic theory are generally assumed to maintain a long-run equilibrium relationship. In applied econometric analyses aimed at estimating long-run relationships among variables, their means and variances are often assumed to be constant over time and independent of the time dimension, thereby implicitly assuming behavioral stability. However, empirical studies have demonstrated that this stability condition is frequently violated in economic time series.

Consequently, the conventional t - and F -tests derived from estimation methods in which the variables are nonstationary are not statistically valid and may generate misleading results. This problem is commonly referred to as spurious regression. To ensure the reliability of empirical results, researchers have therefore revised conventional estimation procedures and systematically examine both the stationarity properties of variables and the possibility of cointegration among them.

Cointegration analysis has been regarded as one of the most important developments in econometrics since the mid-1980s. In simple terms, cointegration analysis investigates whether variables move together over time even though each individual variable may be nonstationary and may exhibit upward or downward trends. Such joint movement may produce a stable linear relationship among the variables in the long run, thereby establishing an equilibrium relationship. If no such long-run linear relationship exists, the variables are regarded as noncointegrated.

More generally, cointegration analysis provides a method for estimating long-run equilibrium parameters in relationships involving nonstationary variables. It therefore offers a framework for specifying, estimating, and testing dynamic models and can consequently be employed to evaluate the empirical validity of economic theories. Cointegration analysis may also be used to estimate short-run disequilibrium parameters because long-run parameters obtained through cointegration analysis can be incorporated into short-run dynamic specifications. Such models are known as error correction models. Error correction models link short-run fluctuations in economic variables to their long-run equilibrium values.

By definition, a time series such as X_t is said to be strictly or strongly stationary if its joint probability density function, for every given value of k , is independent of t . Under this condition, the distribution of X_t , and consequently its moments including its mean and variance, are independent of time.

In practice, however, testing strong stationarity is complex, and time-series analysis generally does not require the assumption of strong stationarity. Instead, weak or covariance stationarity is typically sufficient.

A time series X_t is weakly stationary if the following conditions are satisfied:

$$\begin{aligned} E(X_t) &= \mu \\ \text{Var}(X_t) &= E[(X_t - \mu)^2] = \gamma_0 < \infty \\ \text{Cov}(X_t, X_{t-k}) &= \gamma_k \end{aligned}$$

where μ , γ_0 , and γ_k do not depend on t .

Thus, the mean of X_t must remain constant, and its autocovariance function for any given lag k must not depend on time. For this reason, a weakly stationary time series is also referred to as covariance stationary. Furthermore, γ_0 , corresponding to $k = 0$, represents the variance of X_t , which must also remain independent of time. In the following analysis, the term stationarity refers to weak stationarity.

The importance of stationarity in economic analysis arises from the fact that a stationary series does not permanently retain the effect of a shock. When a shock affects a stationary series, its influence is temporary and eventually dissipates. This characteristic is particularly important in cointegration analysis.

Nonstationary time series can arise through two principal mechanisms. Under the first mechanism, X_t is a function of the time variable t :

$$X_t = f(t) + u_t$$

where u_t is a stationary disturbance term. If $f(t)$ is a first-degree polynomial in time, the process can be expressed as:

$$X_t = \alpha + \beta t + u_t \quad (9)$$

Because the mean of X_t depends on time, the series is nonstationary.

Under the second mechanism, X_t is generated according to:

$$X_t = \mu + X_{t-1} + u_t \quad (10)$$

where u_t is a stationary series with zero mean and constant variance. This specification is known as a random walk process. Through repeated substitution and assuming that X_0 is known, Equation (10) can be written as:

$$X_t = X_0 + \mu t + \sum_{i=1}^t u_i \quad (11)$$

In this case, the variance of X_t is not independent of time. Both Equations (9) and (10) display a linear trend. However, in Equation (9), u_t represents a temporary shock, whereas in Equation (10), shocks have permanent effects.

When an economic variable is affected by permanent shocks, the stochastic-trend specification represented by Equation (10) is appropriate. Equations (9) and (10) are therefore referred to as deterministic-trend and stochastic-trend models, respectively. In both models, X_t may increase at the rate represented by the trend coefficient; alternatively, X_t may be expressed in logarithmic form, in which case the coefficient can be interpreted as a growth rate. The fundamental distinction is that shocks are temporary under a deterministic trend but permanent under a stochastic trend. The constant change component in the stochastic-trend model is commonly referred to as the drift term.

Unlike stochastic trends, deterministic trends do not generally create serious problems for valid statistical inference or cointegration analysis, provided that the trend term t is explicitly controlled for in the model. Consequently, cointegration analysis is primarily concerned with stochastic rather than deterministic trends.

For certain analytical purposes, time series may be detrended. In the deterministic-trend model, this can be accomplished by regressing X_t on time, in which case the resulting residuals are trend-free. Stationarity may also be obtained through differencing. In general:

$$\Delta X_t = X_t - X_{t-1} \quad (12)$$

and for a stochastic trend such as Equation (10):

$$\Delta X_t = \mu + u_t \quad (13)$$

which is stationary with mean μ . Processes that become stationary after removing a deterministic trend are referred to as trend-stationary processes, whereas processes that become stationary after differencing are called difference-stationary processes. This terminology was introduced by Nelson and Plosser. Cointegration analysis primarily concerns difference-stationary processes (DSPs).

To investigate stationarity, the null and alternative hypotheses can generally be expressed in terms of a first-order autoregressive process:

$$X_t = \rho X_{t-1} + u_t$$

with:

$$\begin{aligned} H_0: \rho &= 1 \\ H_1: |\rho| &< 1 \end{aligned}$$

If $\rho = 1$, the series is nonstationary and is said to contain a unit root. If the unit-root hypothesis is rejected, the series is stationary and is referred to as integrated of order zero:

$$X_t \sim I(0)$$

If a nonstationary series becomes stationary after first differencing, it is integrated of order one:

$$X_t \sim I(1)$$

More generally, if a series becomes stationary after being differenced d times, it is integrated of order d :

$$X_t \sim I(d)$$

If k time series $X_{1t}, X_{2t}, \dots, X_{kt}$ are each integrated of order d , and a linear combination of these variables is integrated of order $d - b$, with $b > 0$, they are cointegrated of order (d, b) . Formally:

$$X_t \sim CI(d, b)$$

when:

$$X_{it} \sim I(d)$$

and there exists a vector $\beta \neq 0$ such that:

$$\beta' X_t \sim I(d - b), b > 0$$

If several time series are integrated at different orders, their unrestricted linear combination will generally be integrated at the highest integration order among the constituent variables.

The Phillips–Perron (PP) unit-root test was used in the present study to examine the stationarity properties of the model variables.

Table 2. Phillips–Perron Unit-Root Test Results for the Model Variables

Variable	PP Statistic	<i>p</i> -value	Integration Status
EMPU	-1.084633	0.7119	Nonstationary at level
D(EMPU)	-5.175996	0.0001	$I(1)$
FD	-3.090068	0.1231	Nonstationary at level
D(FD)	-10.72941	0.0000	$I(1)$
GE	-2.332807	0.4071	Nonstationary at level

D(GE)	-6.360821	0.0000	$I(1)$
OILSH	-2.072816	0.5438	Nonstationary at level
D(OILSH)	-4.416099	0.0062	$I(1)$
OPEN	-2.918393	0.1683	Nonstationary at level
D(OPEN)	-11.52527	0.0000	$I(1)$
ROA	-0.629273	0.8521	Nonstationary at level
D(ROA)	-9.282581	0.0000	$I(1)$
ZSCORE	0.419535	0.9813	Nonstationary at level
D(ZSCORE)	-6.897330	0.0000	$I(1)$

Considering the theoretical basis of the stationarity tests, the null hypothesis H_0 indicates the presence of a unit root and thus nonstationarity. As shown in Table 2, the p -values of the variables in levels exceed 0.05, indicating that the null hypothesis cannot be rejected at level. However, after first differencing, the p -values of all variables are below 0.05. Accordingly, all variables become stationary after one differencing and are therefore integrated of order one, $I(1)$.

Two major approaches are commonly employed to examine cointegration: the Engle–Granger method and the Johansen method. The Engle–Granger approach examines only one long-run relationship among two or more variables. When more than two variables are included, this method may encounter difficulties in identifying multiple long-run relationships because only one error term is incorporated into the equation (Nowferesti, 2008). Moreover, part of the long-run information contained in the variables may be lost through differencing.

The Johansen approach provides several advantages over other cointegration procedures. In particular, it avoids relying solely on differencing to obtain stationary variables, because differencing may eliminate information regarding the long-run equilibrium relationships among variables. By estimating an error-correction component and incorporating it into equations expressed in differences, the Johansen approach preserves long-run equilibrium information. It also permits the identification and estimation of multiple cointegrating vectors, that is, the coefficients representing long-run equilibrium relationships among variables. The relationship between the vector autoregressive framework and cointegration makes it possible to derive the cointegrating vectors directly from the coefficients of the vector autoregressive model (Nowferesti, 1999).

In the Johansen–Juselius cointegration procedure employed to assess the long-run relationships among the variables of the present model, determination of the cointegration rank is of primary importance (Johansen & Juselius, 1991). After establishing that the variables are cointegrated, the Johansen procedure applies the trace statistic (λ_{Trace}) and maximum-eigenvalue statistic (λ_{max}) to determine the number of cointegrating vectors. Under the trace test, the null hypothesis that no cointegrating vector exists is rejected when the test statistic exceeds its corresponding critical value. The maximum-eigenvalue and trace tests differ because the alternative hypothesis of the maximum-eigenvalue test is more explicitly specified. The two procedures may occasionally provide different estimates of the cointegration rank; when such inconsistency arises, a conservative interpretation based on the minimum number of supported cointegrating vectors may be adopted (Enders, 2007).

Table 3. Johansen–Juselius Cointegration Tests for the Financial Development Model

Null Hypothesis	Eigenvalue	Trace Statistic	5% Critical Value	p -value	Max-Eigen Statistic	5% Critical Value	p -value
None *	0.903302	211.5485	125.6154	0.0000	84.10184	46.23142	0.0000
At most 1 *	0.690330	127.4466	95.75366	0.0001	42.20098	40.07757	0.0284
At most 2 *	0.594486	85.24563	69.81889	0.0018	32.49357	33.87687	0.0724
At most 3 *	0.504856	52.75206	47.85613	0.0162	25.30465	27.58434	0.0952
At most 4	0.433232	27.44741	29.79707	0.0911	20.44097	21.13162	0.0622

At most 5	0.159903	7.006443	15.49471	0.5769	6.272552	14.26460	0.5785
At most 6	0.020179	0.733891	3.841466	0.3916	0.733891	3.841466	0.3916

The results therefore confirm the existence of at least two cointegrating vectors under both procedures. Consequently, the variables included in the financial development model exhibit long-run equilibrium relationships, supporting the estimation of their dynamic interactions.

To calculate oil price shocks, and consistent with the literature on volatility modeling, the oil price series was first modeled using autoregressive moving-average models to identify the appropriate lag structure. The Box–Jenkins methodology was employed for this purpose. Estimation of the oil price process produced an AR(1) coefficient of 1.141787, with a standard error of 0.009421, a z-statistic of 121.1936, and $p < 0.001$. The MA(1) coefficient was -0.303144 , with a standard error of 0.065783, a z-statistic of -4.608238 , and $p < 0.001$. Thus, the current oil price was related both to its first lag, AR(1), and to the first lag of its disturbance term, MA(1).

The ARCH test was subsequently employed to investigate whether conditional heteroskedasticity was present in the oil price series. The ARCH test yielded an F -statistic of 4.768148 with $p = 0.0138$, while the Obs $\times R^2$ statistic was 4.779864 with a Chi-square probability of 0.0137. Since both probabilities were below 0.05, the null hypothesis of no ARCH effect was rejected. Accordingly, the oil price series exhibited conditional heteroskedasticity, providing justification for modeling its variance dynamically.

Finally, the EGARCH model developed by Nelson (1991) was employed to extract oil price shocks. One of the major limitations of conventional ARCH and GARCH specifications is their symmetry assumption, whereby positive and negative shocks of identical magnitude are assumed to have equivalent effects on volatility. Oil prices, however, may respond differently to favorable and adverse news. Accordingly, an asymmetric volatility model is required to capture such behavior (Verbeek, 2005).

The EGARCH variance equation was specified as:

$$\ln \sigma_t^2 = \alpha_0 + \alpha_1 \frac{|u_{t-1}|}{\sqrt{\sigma_{t-1}^2}} + \beta \ln \sigma_{t-1}^2 + \gamma \frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}},$$

where:

$$\alpha_0 = \omega - \alpha \sqrt{\frac{2}{\pi}}, \quad \alpha_1 = \alpha.$$

The EGARCH specification offers several advantages. First, because the dependent variance term, σ_t^2 , is expressed logarithmically, coefficients on the right-hand side may take either positive or negative values while the conditional variance itself necessarily remains positive. Therefore, nonnegativity restrictions do not have to be imposed on the coefficients. Second, the model explicitly accounts for asymmetric shocks. The parameter γ is associated with u_{t-1} , which may be either positive or negative, and therefore captures differences between positive and negative shocks. By contrast, α is associated with the absolute magnitude $|u_{t-1}|$. When $\gamma = 0$, the volatility response is symmetric; when $\gamma \neq 0$, it is asymmetric. The effect of a positive shock equals $\alpha + \gamma$, whereas the effect of a negative shock equals $\alpha - \gamma$. A negative γ indicates that negative shocks exert a stronger effect than positive shocks of the same magnitude, whereas a positive value indicates the opposite.

Table 4. EGARCH Model Estimates for Oil Prices

Variable	Coefficient	Std. Error	z-Statistic	p-value
AR(1)	1.141787	0.009421	121.1936	0.0000
MA(1)	-0.303144	0.065783	-4.608238	0.0000
Variance Equation				
C(3)	5.828787	0.970046	6.008773	0.0000
C(4)	2.351702	0.195791	12.01132	0.0000
C(5)	-0.205225	0.167917	-1.222181	0.2216
C(6)	0.760011	0.034658	21.92864	0.0000

At this stage, the oil price shock series was obtained from the estimated conditional variance of the EGARCH model. The generated conditional variance was subsequently transformed into an independent variable and incorporated into the principal financial development model.

Before applying the Kalman filter technique, it was necessary to establish whether the estimated parameters of the model were unstable over time. For this purpose, the Hansen parameter instability test was employed.

Table 5. Hansen Parameter Instability Test

Model	Lc Statistic	Stochastic Trends (<i>m</i>)	Deterministic Trends (<i>k</i>)	Excluded Trends (<i>p</i> ₂)	p-value
Financial development model	19.563	5	0	0	0.0123

In the Hansen test, the null hypothesis H_0 indicates parameter stability. As reported in Table 5, the Lc statistic for the financial development model was 19.563, with a probability value of 0.0123. Because the p-value was below the 0.05 significance level, the null hypothesis of constant parameters was rejected. The model coefficients therefore varied significantly over time. This result provides empirical justification for applying the Kalman filter, which permits parameters to evolve dynamically over the sample period.

The financial development model was subsequently estimated within the state-space framework using the Kalman filter. Financial development was treated as the dependent variable, while the time-varying effects of oil price shocks, economic policy uncertainty, geopolitical risk, banking stability, bank profitability, and trade openness were estimated through the corresponding state variables.

Table 6. State-Space Model Estimates Using the Kalman Filter

Variable	Final State	p-value
Time-varying component of oil price shocks (SV1)	-0.072368	0.0000
Time-varying component of economic policy uncertainty (SV2)	-0.014647	0.0000
Time-varying component of geopolitical risk (SV3)	-0.025319	0.0000
Time-varying component of banking stability (SV4)	0.094099	0.0000
Time-varying component of bank profitability (SV5)	0.129071	0.0000
Time-varying component of trade openness (SV6)	0.031049	0.0000

The state-space estimates for Iran indicate that oil price shocks, economic policy uncertainty, and geopolitical risk exerted negative effects on financial development, whereas banking stability, bank profitability, and trade openness exerted positive effects throughout the study period. The final estimated coefficients were -0.072368 for oil price shocks, -0.014647 for economic policy uncertainty, and -0.025319 for geopolitical risk. In approximate percentage terms, a 1% increase in these variables was associated with reductions in financial development of approximately 7%, 1%, and 2%, respectively, according to the interpretation adopted in the study.

By contrast, the coefficients for banking stability, bank profitability, and trade openness were 0.094099, 0.129071, and 0.031049, respectively. Thus, under the interpretation adopted in the study, a 1% increase in banking stability, bank profitability, and trade openness was associated with increases in financial development of approximately 9%, 12%, and 3%, respectively.

To examine the effects of the explanatory variables more precisely over time, the time-varying state components and annual parameters estimated through the Kalman filter were also evaluated. The annual coefficients demonstrate that the responsiveness of financial development to the study variables changed substantially during 1986–2024. Throughout the period, the estimated elasticities of financial development with respect to the explanatory variables remained below unity.

For 1986, the sensitivities of financial development to oil price shocks, economic policy uncertainty, geopolitical risk, banking stability, bank profitability, and trade openness were -0.018174 , -0.001063 , -0.02382 , 0.186588 , 0.053329 , and 0.125717 , respectively. In 1987, the corresponding coefficients were -0.018172 , -0.001052 , -0.02523 , 0.180939 , 0.056695 , and 0.121510 ; in 1988, -0.017681 , -0.001006 , -0.0328 , 0.175290 , 0.060062 , and 0.117302 ; in 1989, -0.016015 , -0.000941 , -0.03533 , 0.169641 , 0.063428 , and 0.113095 ; and in 1990, -0.015397 , -0.000925 , -0.0368 , 0.163992 , 0.066794 , and 0.108887 , respectively.

In 1991, the respective coefficients were -0.015386 , -0.000887 , -0.04145 , 0.158343 , 0.070161 , and 0.104680 ; in 1992, -0.015377 , -0.000885 , -0.04735 , 0.152694 , 0.073527 , and 0.100472 ; in 1993, 0.046857 , -0.002322 , -0.01936 , 0.147045 , 0.076893 , and 0.096265 ; in 1994, 0.031023 , -0.009957 , -0.01825 , 0.141395 , 0.080260 , and 0.092057 ; and in 1995, 0.015189 , -0.017593 , -0.01825 , 0.135746 , 0.083626 , and 0.087850 .

In 1996, the respective sensitivities were 0.236325 , 0.089565 , -0.01936 , 0.185658 , 0.087794 , and 0.153252 ; in 1997, 0.213632 , 0.075966 , -0.01825 , 0.156536 , 0.087794 , and 0.123625 ; in 1998, 0.189565 , 0.063263 , -0.01825 , 0.132653 , 0.052497 , and 0.103263 ; in 1999, 0.175632 , 0.056356 , -0.01891 , 0.112335 , 0.046597 , and 0.098658 ; and in 2000, 0.152635 , 0.045263 , -0.0196 , 0.103252 , 0.083986 , and 0.089656 .

For 2001, the coefficients were 0.132562 , 0.013325 , -0.01988 , 0.098651 , 0.078956 , and 0.045652 ; in 2002, 0.117835 , 0.004504 , -0.02185 , 0.097685 , 0.122130 , and 0.018173 ; in 2003, 0.106710 , 0.004447 , -0.02129 , 0.093380 , 0.135743 , and 0.014291 ; in 2004, 0.080208 , 0.004223 , -0.02199 , 0.061392 , 0.145832 , and 0.012950 ; and in 2005, 0.066631 , 0.003873 , -0.02259 , 0.055280 , 0.145832 , and 0.012264 .

In 2006, the respective estimates were 0.055719 , 0.002893 , -0.02342 , 0.055274 , 0.145832 , and 0.010822 ; in 2007, 0.047554 , 0.001759 , -0.02342 , 0.054732 , 0.145832 , and 0.009689 ; in 2008, 0.043910 , 0.001437 , -0.02382 , 0.042730 , 0.145832 , and 0.009317 ; in 2009, 0.034639 , -0.001435 , -0.02382 , 0.032297 , 0.145832 , and 0.009316 ; and in 2010, -0.033436 , -0.001387 , -0.02382 , 0.025760 , 0.145832 , and 0.009191 .

For 2011, the respective coefficients were -0.023664 , -0.001155 , -0.02382 , 0.025137 , 0.146710 , and 0.009154 ; in 2012, -0.018332 , -0.001091 , -0.02382 , 0.024036 , 0.146710 , and 0.008316 ; in 2013, -0.018196 , -0.001067 , -0.02382 , 0.021954 , 0.146710 , and 0.008290 ; in 2014, -0.018184 , -0.001067 , -0.02382 , 0.021945 , 0.146710 , and 0.008057 ; and in 2015, -0.018174 , -0.001063 , -0.02382 , 0.021758 , 0.146710 , and 0.008048 .

In 2016, the corresponding values were -0.018172 , -0.001052 , -0.02523 , 0.021601 , 0.146710 , and 0.008030 ; in 2017, -0.017681 , -0.001006 , -0.0328 , 0.021119 , 0.146710 , and 0.007798 ; in 2018, -0.016015 , -0.000941 , -0.03533 , 0.021094 , 0.149285 , and 0.007736 ; in 2019, -0.015397 , -0.000925 , -0.0368 , 0.021093 , 0.149285 , and 0.007314 ; and in 2020, -0.015386 , -0.000887 , -0.04145 , 0.019657 , 0.156994 , and 0.007204 .

For 2021, the respective sensitivities were -0.015377 , -0.000885 , -0.04735 , 0.019555 , 0.156994 , and 0.007202 ; in 2022, -0.000645 , -0.025229 , -0.01936 , 0.016780 , 0.174516 , and 0.025752 ; in 2023, -0.016479 , -0.032864 ,

−0.01825, 0.022429, 0.177883, and 0.029960; and in 2024, −0.032314, −0.040500, −0.01825, 0.028078, 0.181249, and 0.034167, respectively.

The time-varying estimates therefore indicate that the effects of the explanatory variables were not constant throughout the sample. The influence of oil price shocks changed both in magnitude and, during some periods, in direction. Economic policy uncertainty similarly exhibited substantial temporal variation, with its adverse effect becoming particularly pronounced toward the end of the study period. Geopolitical risk generally retained a negative coefficient throughout the period, although its magnitude varied. Banking stability, bank profitability, and trade openness generally exerted positive effects, but their magnitudes also changed substantially over time.

Political and geopolitical risk can suppress active participation in financial markets through several principal channels. First, elevated political risk may weaken property rights and investment security. Financial systems fundamentally depend on trust and enforceable contracts. When political risk is high, investors may become concerned that the government or powerful institutions could disregard their rights as a result of policy changes or political intervention. Consequently, investors may avoid participation in formal financial markets and shift their portfolios toward highly liquid or perceived safe-haven assets, such as gold or foreign currencies, or transfer capital abroad. This behavior may reduce the depth of domestic financial markets.

Second, political instability may increase information asymmetry and transaction costs. In uncertain political environments, transparency may decline. Firms may become less willing to provide accurate financial information or may seek financial resources through political connections rather than demonstrable financial performance. This situation makes it more difficult for banks and other financial intermediaries to assess borrower risk accurately. Consequently, credit provision may decline or financial resources may be diverted toward rent-based or politically influenced allocation rather than productive financing.

Third, political risk may shorten the decision-making horizon of economic agents and create financial myopia. Elevated political uncertainty increases concerns about medium- and long-term economic conditions, whereas financial development depends substantially on investment over extended horizons. As a result, demand for long-term financial instruments, such as bonds and equity investments, may decline, and the financial system may become increasingly concentrated on short-term and speculative transactions. Such a shift can undermine sustainable financial development.

Fourth, heightened political risk may contribute to instability in monetary and fiscal policymaking. Governments facing political instability may adopt expansionary, short-term, or populist measures or resort to monetary financing in response to economic and political pressures. Such policies may generate unpredictable inflation. Under inflationary conditions, real interest rates can fluctuate sharply, weakening the core intermediation function of the banking system because long-term lending becomes considerably more uncertain and risky.

Finally, diagnostic tests were conducted to evaluate the statistical adequacy of the estimated financial development model, particularly with respect to serial correlation and heteroskedasticity.

Table 7. Diagnostic Test Results for the Financial Development Model

Diagnostic Test	F Version	LM Version
Serial correlation test	1.4663 (0.3563)	1.6532 (0.2756)
Heteroskedasticity test	1.3653 (0.3963)	1.2363 (0.4856)

As shown in Table 7, the probability values associated with both the serial correlation and heteroskedasticity diagnostic tests exceeded the 0.05significance level. Therefore, the null hypotheses of no serial correlation and

homoskedastic disturbances could not be rejected. Accordingly, the estimated financial development model did not exhibit evidence of serial correlation or heteroskedasticity, supporting the statistical adequacy and reliability of the estimated results.

4. Discussion and Conclusion

The findings of the present study demonstrated that financial development in Iran during 1986–2024 was significantly influenced by oil price shocks, economic policy uncertainty, geopolitical risk, banking stability, bank profitability, and trade openness. The Phillips–Perron unit-root test indicated that all research variables were nonstationary at level but became stationary after first differencing, confirming that they were integrated of order one, $I(1)$. The Johansen–Juselius cointegration tests further confirmed the existence of long-run equilibrium relationships among the variables, with the trace test indicating four cointegrating vectors and the maximum-eigenvalue test indicating two. The Hansen parameter instability test rejected the null hypothesis of parameter stability, justifying the use of a state-space framework with time-varying coefficients. The Kalman filter estimates showed that oil price shocks, economic policy uncertainty, and geopolitical risk had negative and statistically significant effects on financial development, whereas banking stability, bank profitability, and trade openness exerted positive and statistically significant effects. Moreover, the time-varying estimates revealed that the magnitude of these relationships changed considerably across different periods, indicating that financial development in Iran has been shaped by changing macroeconomic, institutional, banking, and geopolitical conditions rather than by stable structural relationships.

The negative effect of oil price shocks on financial development constitutes one of the principal findings of the study. The final Kalman filter coefficient for oil price shocks was (-0.072368) , indicating that greater volatility in oil prices was associated with lower financial development. This finding can be explained by the central role of oil revenues in the Iranian economy. Abrupt changes in oil prices affect government revenues, foreign-exchange inflows, fiscal expenditure, liquidity creation, exchange-rate expectations, and ultimately the balance-sheet conditions of banks and firms. When oil-price volatility rises, uncertainty regarding future government expenditure and foreign-exchange availability increases, thereby reducing the predictability of the macroeconomic environment. Banks may respond by adopting more conservative lending policies, while firms may postpone investment projects because future financing costs and expected returns become less predictable. The finding is consistent with the evidence reported by Kanganinejad et al., who showed that oil and exchange-rate shocks significantly affect asset-market dynamics in Iran [17]. Although their study focused on housing prices, the underlying transmission mechanism is similar: oil shocks affect liquidity, expectations, and macroeconomic conditions, which subsequently influence financial markets. The present result is also conceptually consistent with studies demonstrating that large external shocks can amplify price and market volatility and generate broader economic uncertainty [18, 21].

The asymmetric behavior of oil-price volatility also provides an important explanation for this finding. The EGARCH estimates confirmed the relevance of modeling oil shocks through a time-varying volatility process rather than relying solely on observed oil-price changes. External shocks are rarely transmitted symmetrically through economic systems, particularly in economies that depend substantially on a single source of export revenue. Research on climate and energy-related shocks similarly demonstrates that extreme disturbances can substantially increase uncertainty and affect the stability of markets [19, 20]. Although these studies examine environmental and climate-related shocks rather than petroleum prices directly, they support the broader interpretation that the

magnitude and uncertainty associated with exogenous disturbances can have significant consequences for economic and financial behavior. In the Iranian context, therefore, the negative relationship between oil-price shocks and financial development appears to reflect the vulnerability of financial intermediation to fluctuations in external revenue and associated macroeconomic instability.

Economic policy uncertainty also had a negative and statistically significant effect on financial development, with a final coefficient of (-0.014647). This result suggests that uncertainty surrounding monetary, fiscal, exchange-rate, inflation, and economic-growth conditions weakens the financial system's capacity to mobilize and allocate resources effectively. When economic policies become less predictable, banks face greater difficulty in assessing borrowers' future repayment capacity, firms encounter uncertainty regarding investment costs and expected demand, and households may shift savings from formal financial institutions toward liquid or nonfinancial assets. These responses reduce both the demand for and supply of long-term finance. The present finding is consistent with Goudarzi Farahani and Abbasinejad, who showed that economic uncertainty shocks exert significant effects on major macroeconomic variables in Iran [16]. The time-varying coefficients obtained in the present study further showed that the negative effect of policy uncertainty intensified markedly in the final years of the sample, particularly between 2022 and 2024. This pattern suggests that the effect of policy uncertainty is not structurally constant and may become stronger during periods characterized by heightened inflationary pressures, exchange-rate volatility, fiscal imbalances, and broader economic instability.

The negative coefficient of geopolitical risk, estimated at (-0.025319), provides further evidence that external political and security conditions influence financial development in Iran. Geopolitical risk can affect financial systems through multiple channels, including reduced investor confidence, capital flight, higher risk premiums, restricted access to international financial networks, shorter investment horizons, and increased preference for safe-haven assets. The finding is strongly aligned with Javaheri et al., who specifically identified an important relationship among geopolitical risk, financial development, and economic growth in Iran [22]. It is also consistent with Mirmohammadi and Khani Keshmarzi, who showed that investor behavior in Iran and the Caucasus region changes in response to geopolitical risk [23]. When investors perceive political or regional instability to be increasing, they may reduce exposure to domestic financial instruments and shift toward foreign currencies, gold, or other highly liquid assets. Such behavior reduces market depth and weakens the capacity of formal financial institutions to mobilize long-term funds.

The interpretation of the geopolitical-risk effect is further supported by international evidence showing that geopolitical conditions can have heterogeneous economic consequences depending on country characteristics and institutional resilience [25]. Moreover, security-related instability and conflict may create broader systemic risks affecting economic confidence and institutional functioning [26]. In banking systems, geopolitical crises also complicate risk management by simultaneously affecting credit quality, liquidity, operational risk, and access to external financial resources. This interpretation is consistent with Moradipour's emphasis on the importance of stronger banking risk-management mechanisms following financial crises and geopolitical conflict [24]. Thus, the negative relationship found in the present study is theoretically plausible because geopolitical risk weakens both the demand side and supply side of formal financial intermediation.

In contrast, banking stability had a positive and statistically significant effect on financial development, with a final coefficient of (0.094099). This finding indicates that a more stable banking system improves the capacity of financial institutions to extend credit, absorb losses, maintain depositor confidence, and support private-sector financing. Since Iran has a predominantly bank-based financial system, the stability of banks plays a particularly

important role in determining the depth and continuity of financial intermediation. This result is consistent with Arab et al., who emphasized the joint importance of financial development and financial stability for economic growth in Iran [2]. It also aligns with Ghanbari and Azadi, who highlighted the institutional mechanisms through which Islamic banking structures may contribute to banking-system stability [3]. The finding further corresponds with evidence that stronger financial stability supports sustainable economic and financial performance by reducing vulnerability to shocks.

The positive relationship between banking stability and financial development is also in line with recent international evidence. Antwi et al. showed that financial inclusion, competition, and financial stability are interconnected in developing economies [8], while Damane and Ho emphasized that the relationship between financial inclusion and stability depends on financial structures and institutional conditions [9]. Elgharib similarly found close relationships among financial inclusion, financial development, and financial stability in MENA economies [10]. In addition, Kebede et al. demonstrated that the stability–inclusion relationship can be nonlinear, suggesting that the benefits of financial expansion depend on the underlying resilience of financial institutions [11]. These studies reinforce the interpretation that financial deepening is more sustainable when banking institutions remain adequately capitalized, profitable, and capable of absorbing adverse shocks.

Bank profitability produced the largest positive final coefficient among the explanatory variables, (0.129071), indicating that profitability is a particularly important mechanism supporting financial development. Profitable banks can accumulate capital internally, expand their lending capacity, invest in technology and branch networks, improve risk-management systems, and continue financing the private sector even during periods of macroeconomic stress. Higher profitability can also strengthen confidence among depositors and investors. The result is consistent with evidence that liquidity creation and bank stability are closely connected and that institutional factors may moderate this relationship [6]. It is also aligned with Banna's finding that financial inclusion and bank stability are influenced by financial literacy and institutional characteristics [7]. Furthermore, the role of profitability in sustaining banking performance is compatible with research emphasizing the importance of financial literacy, innovation, and sound financial management in improving banking resilience [12, 13].

The positive effect of bank profitability also complements evidence concerning broader financial sustainability. Nik Azman et al. showed that financial literacy contributes to financial sustainability among Muslim micro-entrepreneurs [14], while Eshun and Kočenda identified a wide range of institutional and socioeconomic determinants of financial inclusion across Sub-Saharan African and OECD economies [15]. These studies suggest that the financial system's ability to expand sustainably depends on both the soundness of financial intermediaries and the capacity of economic agents to participate productively in financial markets. Similarly, the development of alternative Islamic financial instruments, including sukuk, may enhance firms' financial stability and diversify financing channels [27]. Such diversification can complement profitable banking institutions and contribute to a deeper and more resilient financial system.

Trade openness also had a positive and significant coefficient of (0.031049). Greater trade activity increases demand for financial services such as trade finance, foreign-exchange transactions, payment services, working capital, insurance, and investment financing. Increased openness can therefore stimulate the expansion of banking services and encourage improvements in financial efficiency. In addition, greater exposure to international markets may facilitate institutional learning and improve financial-sector competitiveness. However, the relatively smaller magnitude of the trade-openness coefficient compared with banking stability and profitability suggests that the benefits of openness depend on the domestic financial system's ability to intermediate trade-related financial flows

effectively. This interpretation is especially relevant for Iran, where external restrictions and geopolitical uncertainty can constrain the potential financial benefits of international trade.

Another important finding of the study was the substantial variation in coefficients over time. The Hansen test confirmed parameter instability, and the annual Kalman filter estimates showed that the effects of the explanatory variables changed markedly throughout the sample period. For example, the impact of oil shocks was positive during certain periods but became negative in later years, while the negative effect of geopolitical risk intensified during several episodes. Banking stability and profitability also exhibited changing magnitudes over time. These patterns imply that fixed-parameter models may obscure meaningful structural changes in the Iranian economy. The time-varying results are consistent with the argument that the consequences of financial, geopolitical, and economic shocks depend on institutional circumstances and prevailing structural conditions [24, 25]. They also support the use of a state-space model and the Kalman filter, because the relationships under investigation were clearly not constant throughout the 1986–2024 period.

The results also have broader implications for the relationship between financial stability and economic development. Alimoradi Afshar showed that financial development contributes to economic growth in Iran [1], while Bozorgmehr and Sadeghi emphasized the role of Islamic banking in economic development [4]. The present findings extend this literature by showing that financial development itself depends on the quality and resilience of the banking system and on the external environment in which financial institutions operate. Financial development therefore should not be understood simply as the expansion of credit volume; rather, it is a dynamic outcome shaped by banking soundness, profitability, policy credibility, geopolitical conditions, and exposure to external shocks. The finding is also compatible with Rasadi Ahmadi and Karimi's emphasis on financial stability as an important organizational and economic condition among listed companies [5]. Overall, the results suggest that financial development in Iran is strengthened when banking institutions are stable and profitable and when the macroeconomic and geopolitical environment is sufficiently predictable to support long-term investment and formal financial participation.

Several limitations should be considered when interpreting the findings of this study. First, the analysis was conducted at the aggregate national level, and therefore it could not capture heterogeneity across individual banks, financial institutions, industries, or provinces. Second, the annual frequency of the data limited the ability to identify short-lived changes in geopolitical conditions, oil markets, or economic policy uncertainty that may occur within a year. Third, the measurement of some variables necessarily relied on proxy indicators. Geopolitical risk, financial development, and economic policy uncertainty are multidimensional concepts, and no single indicator can fully represent all of their dimensions. Fourth, although the state-space model allows parameters to vary over time, the estimated relationships remain dependent on the specified functional form and selected explanatory variables. Other institutional variables, including governance quality, regulatory effectiveness, sanctions intensity, capital-market development, digitalization, and financial inclusion, may also influence financial development but were not incorporated into the estimated model.

Future studies could extend the present analysis by using quarterly or monthly data to obtain a more detailed representation of short-run adjustments and structural changes. Bank-level panel data could also be employed to investigate whether the effects of geopolitical risk, oil shocks, and policy uncertainty differ according to bank size, ownership structure, capital adequacy, asset quality, profitability, or liquidity conditions. Future research may further distinguish positive and negative oil shocks and examine whether their effects on financial development are asymmetric. It would also be useful to construct alternative geopolitical-risk and policy-uncertainty measures

and compare their explanatory power. Additional studies could incorporate sanctions intensity, exchange-rate regimes, inflation expectations, governance indicators, financial inclusion, digital banking, capital-market depth, and nonperforming loans. Nonlinear approaches, regime-switching models, time-varying parameter vector autoregressions, quantile methods, and dynamic panel techniques could provide further insight into possible threshold effects and differences across periods of stability and crisis.

The findings suggest that policymakers and financial authorities should pursue financial development through a coordinated framework that simultaneously strengthens banking resilience and reduces macroeconomic uncertainty. Banking supervision should focus on maintaining adequate capital buffers, improving asset quality, controlling nonperforming loans, strengthening liquidity management, and encouraging sustainable profitability rather than short-term risk-taking. Greater predictability in monetary, fiscal, and exchange-rate policies would reduce uncertainty and improve the conditions for long-term lending and investment. Because the financial system remains vulnerable to oil-price shocks, reducing fiscal dependence on oil revenues and strengthening stabilization mechanisms could limit the transmission of oil volatility to credit markets. Financial institutions should also develop stronger stress-testing and geopolitical-risk assessment frameworks. Finally, policies that facilitate trade, diversify financing instruments, improve financial literacy, expand transparent digital financial services, and strengthen public confidence in formal financial institutions can support deeper and more sustainable financial development.

Authors' Contributions

Authors equally contributed to this article.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

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Conflict of Interest

The authors report no conflict of interest.

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