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Impulse Effects of Income Inequality and Financial Development on Economic Growth (Case Study: Provinces of the Country) Using the PVAR Approach

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ABSTRACT

Economic growth has consistently been one of the primary objectives of policymakers and economic researchers, and numerous factors can either facilitate or hinder its trajectory. Income inequality and financial development are among the most critical factors exerting significant effects on economic growth. Income inequality may reduce economic growth by constraining the consumption and investment capacity of a substantial portion of the population, whereas financial development, by providing access to financial resources, facilitating investment, and enhancing productivity, can act as a driver of growth. Examining the impulse effects of these two factors at the provincial level enables the analysis of regional disparities and the identification of appropriate policies to enhance social equity and sustainable economic growth. This study aims to investigate the short-term and long-term effects of income inequality and financial development on the country's economic growth using provincial data. The study analyzes the impulse effects of income inequality and financial development on economic growth across the country's provinces over the period 2006–2024 using the Panel Vector Autoregression (PVAR) approach. For panel data analysis, the stationarity of variables was first examined using the LLC and IPS tests, and the results indicated that all variables are stationary or integrated of order zero, I(0). Cointegration tests confirmed the existence of a long-term relationship among the model variables. The optimal lag length, determined using the AIC, SC, and HQ criteria, indicated that a one-period lag is appropriate for the VAR model. The PVAR estimation results showed that income inequality has a negative and statistically significant effect on economic growth, while financial development, private investment, and education level have positive and growth-enhancing effects. Inflation and unemployment were also found to have negative effects on economic growth. The error correction coefficient (ECM) was estimated at −0.097 and was statistically significant, indicating that approximately 9.7% of short-term disequilibrium is corrected toward long-term equilibrium each year. Dynamic shock analysis and variance decomposition demonstrated that provincial economic growth responds gradually to shocks in inequality, financial development, and macroeconomic variables, with substantial long-term effects on growth. Model stability was also confirmed through the AR characteristic polynomial. The findings suggest that reducing inequality and strengthening financial development, domestic investment, and education can improve provincial economic growth, while controlling inflation and unemployment is essential for economic stability.

Keywords: Economic growth, income inequality, financial development, economic shock, cointegration

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Introduction

Economic growth remains one of the central objectives of economic policy because it is directly associated with improvements in welfare, employment creation, productive capacity, fiscal sustainability, and the long-run stability of social systems. Yet growth does not emerge in a vacuum; rather, it is shaped by a complex interaction among institutional quality, financial structures, human capital, distributive arrangements, and the broader macroeconomic environment. Among these determinants, income inequality and financial development occupy a particularly important place because each can independently influence the pace of growth, while their interaction may reinforce or weaken growth dynamics depending on the structural conditions of an economy. In contemporary policy debates, the key issue is no longer whether inequality and finance matter, but how they matter, through which channels, and under what circumstances their effects become growth-enhancing or growth-reducing (1-3).

The relationship between income inequality and economic growth has long generated theoretical and empirical debate. In one line of reasoning, inequality may stimulate growth by increasing aggregate saving, capital accumulation, and entrepreneurial risk-taking, particularly when higher-income groups possess greater investment capacity. In another, inequality suppresses growth by weakening human capital formation, reducing aggregate demand, intensifying social fragmentation, and restricting the economic participation of lower-income groups. More recent contributions increasingly emphasize that the growth effects of inequality are context-dependent and vary across levels of development, institutional capacity, and regional economic structure. This conditional perspective is especially relevant in subnational analyses, where differences in production structure, labor markets, educational attainment, access to credit, and fiscal capacity may cause the same degree of inequality to generate different growth outcomes across regions (1, 2, 4).

At the same time, financial development has been widely regarded as one of the fundamental drivers of economic growth. By mobilizing savings, allocating capital more efficiently, reducing transaction costs, facilitating risk diversification, and supporting innovation and private investment, a more developed financial system can improve the productivity of both labor and capital. Financial development may also contribute to regional growth by easing liquidity constraints for households and firms, supporting small and medium-sized enterprises, and enabling investment in education, housing, and productive activities. A growing body of empirical literature confirms that the depth, efficiency, and inclusiveness of financial systems are closely linked to economic expansion, though the magnitude and direction of this relationship may differ across countries and stages of development (5-7).

Despite this apparent consensus, the finance–growth nexus is not universally linear. Recent evidence suggests that finance may exhibit threshold effects, nonlinearities, and diminishing marginal returns. Excessive expansion of financial intermediation without sufficient institutional discipline may channel resources toward speculative or unproductive uses, amplify macroeconomic fragility, or generate imbalances that ultimately hinder growth. In this view, the beneficial impact of finance depends not only on the size of the financial sector but also on its composition, accessibility, regulatory quality, and alignment with the real economy. Luintel et al. have reexamined the burden of evidence and argued that the impact of finance on growth is subject to threshold effects, implying that financial development may be growth-enhancing only under specific structural conditions (3). This insight is highly relevant when studying heterogeneous provincial economies, where the level of institutional maturity and productive absorptive capacity may differ substantially.

The interaction between financial development and inequality adds further complexity to the analysis. On the one hand, deeper financial markets may reduce inequality by expanding access to credit, enabling low-income households to invest in education, entrepreneurship, and consumption smoothing, and reducing dependence on informal and high-cost financing channels. On the other hand, when financial opportunities are captured disproportionately by wealthier groups or by economically advanced regions, financial development may intensify disparities in income and opportunity. Empirical studies provide evidence for both possibilities. Chisadza and Biyase, using a comparative framework across advanced, emerging, and developing economies, show that the finance–inequality relationship is heterogeneous and sensitive to structural context (8). Similarly, Jaberi Khosroshahi et al. demonstrate for Iran that financial development can be meaningfully related to income distribution, making it necessary to consider both growth and equity implications simultaneously (9).

This duality has given rise to the Financial Kuznets Curve perspective, which proposes that financial development may initially increase inequality before later reducing it as access broadens and financial institutions become more inclusive. Evidence on this proposition remains mixed, but it offers an important conceptual framework for understanding why finance does not uniformly produce equitable outcomes. Farahati and Salimi provide an empirical test of the Financial Kuznets Curve hypothesis for Iran, indicating that the finance–inequality nexus may be nonlinear and development-stage specific (10). Kamalu and Ibrahim likewise investigate the Islamic finance context and find that the relationship between financial development, human development, and income inequality must be interpreted through structural and institutional lenses rather than through a simple monotonic effect (11). These findings suggest that any analysis of provincial growth must consider not only the aggregate size of financial activity but also its distributive profile and social reach.

The issue becomes even more important when income inequality is viewed alongside poverty, entrepreneurial opportunity, and regional underdevelopment. Financial development may stimulate growth most effectively when it enables poorer households and lagging regions to participate more fully in production and market exchange. Blanco-Arana and Angulo-Guerrero show that financial development can contribute to poverty reduction in developing countries, particularly through the channel of entrepreneurial activity (12). Lu and Dilanchiev similarly document a close nexus between financial deepening and poverty reduction in Black Sea economies, emphasizing that deeper financial systems can improve social outcomes when they support broader economic participation (13). Khoshniat and Zarei further highlight the role of development banks in poverty alleviation in economically disadvantaged areas, implying that the structure and mission of financial institutions are critical for translating financial expansion into inclusive growth (14). These arguments are directly relevant to provincial analysis because regional inequality often reflects uneven access not only to income but also to credit, formal banking, entrepreneurial infrastructure, and public investment.

Another dimension concerns the bidirectional relationship between growth and finance. While finance may shape economic growth, economic growth itself may create the conditions for deeper and more sophisticated financial systems. Rising incomes, urbanization, productive diversification, and increasing market complexity can expand financial demand and induce financial innovation. This reverse causality complicates inference and underlines the importance of dynamic modeling approaches. Shams Gharneh et al. compare developed and developing countries and show that economic growth can affect financial development, indicating that the relationship is interactive rather than one-way (15). Such evidence supports the use of multivariate dynamic frameworks capable of tracing feedback effects across variables over time, especially in panel settings where cross-sectional heterogeneity is substantial.

The same logic applies to inequality. Economic growth may reduce inequality through employment generation and fiscal redistribution, but it may also widen disparities when growth is concentrated in capital-intensive sectors, metropolitan regions, or groups with better initial endowments. Castaldo and De Bonis revisit the Kuznets-type logic in the short run and show that technological transformation, including the Fourth Industrial Revolution, can affect income distribution in ways that are not always equalizing (16). Huynh also demonstrates that inequality patterns in Asia are shaped by broader interactions among economic freedom, development, and structural transformation, consistent with a Kuznets curve interpretation but not reducible to it (4). These findings indicate that growth, inequality, and finance should not be studied in isolation; rather, they should be modeled as mutually interacting forces within evolving economic systems.

For countries characterized by regional disparities, this issue is particularly salient. Provincial economies often differ markedly in industrial structure, natural resource endowments, urbanization, educational attainment, labor market composition, public expenditure capacity, and banking penetration. Consequently, the impact of financial development on growth may be stronger in provinces with greater entrepreneurial capacity and more diversified production structures, while the adverse effect of inequality may be more severe in provinces where household liquidity constraints, unemployment, and low human capital reinforce one another. Studies focused on Iran and comparable developing contexts suggest that these structural asymmetries matter. Beheshti et al. show that financial development, especially when combined with trade liberalization, can support growth in upper-middle-income contexts (6). Jalili Fard emphasizes that the finance–growth linkage is also important in non-oil developing and MENA economies (5). These findings provide a useful macro-level background, but they also point to the need for more granular subnational analysis.

Iran offers a compelling case for such an investigation. The country exhibits significant interprovincial differences in income distribution, employment opportunities, industrialization, access to financial services, educational attainment, and fiscal capacity. Some provinces are characterized by relatively diversified production, stronger banking infrastructure, and better human capital conditions, while others remain more dependent on limited sectors and face persistent disadvantages in income generation and access to formal finance. In such an environment, examining only national averages can obscure important regional dynamics. Provincial-level evidence is therefore essential for identifying whether financial development mitigates or amplifies regional disparities and whether inequality uniformly constrains growth across provinces or does so more strongly in specific local conditions (9, 10, 14).

Recent Persian-language studies also reinforce the relevance of this topic in the domestic research agenda. Shams Gharneh et al. compare developed and developing countries and emphasize the close interdependence between economic growth and financial development (15). Sadeghi et al. analyze the future outlook of societies through the joint lens of income inequality, poverty, and economic growth, underlining the strategic importance of distributive outcomes for development trajectories (1). Karami focuses on the effects of social inequalities on economic growth and highlights the role of human capital and income distribution in shaping development outcomes (2). Ghorishvandi Irag et al. show that financial inclusion has important implications for growth, suggesting that not all financial development is alike and that access-based measures may be especially relevant for policy (7). Together, these studies suggest that a meaningful analysis of growth must integrate inequality, finance, and broader social capabilities.

Methodologically, this multidimensional relationship calls for an approach that can capture simultaneity, dynamic interactions, lagged responses, and endogenous feedback. Conventional static regression models may identify average associations, but they are often less capable of describing how a shock to one variable, such as a rise in inequality or an expansion in financial development, propagates over time through the system. A panel vector autoregression framework is particularly useful in this regard because it treats the main variables as jointly endogenous, allows the estimation of impulse responses and variance decompositions, and is well suited for panel data with both temporal and cross-sectional variation. Given that provincial economies are not isolated from one another and that the effects of finance and inequality are likely to unfold gradually rather than instantaneously, a dynamic panel framework provides a stronger basis for inference than purely static alternatives (3, 8, 15).

The policy importance of this line of inquiry is considerable. If inequality has a persistent negative effect on provincial growth, then policies centered solely on aggregate expansion may prove insufficient unless they also improve distributional conditions, labor market access, and human capital accumulation. If financial development promotes growth but only under certain thresholds or when it becomes more inclusive, then the design of banking policy, credit allocation, development finance, and financial inclusion programs becomes central to regional development strategy. If growth and finance reinforce one another but unequal access to finance prevents lagging provinces from benefiting, then regional planning must move beyond aggregate monetary expansion toward targeted institutional interventions. The evidence from developing countries increasingly points in this direction, showing that the structure, accessibility, and social embeddedness of finance determine whether it reduces poverty and supports inclusive growth or instead reproduces existing disparities (7, 12, 13).

In sum, the literature suggests that economic growth, income inequality, and financial development are linked through a dense set of reciprocal and potentially nonlinear relationships. Existing empirical findings confirm the importance of finance for growth, document the distributive consequences of financial development, highlight the role of poverty and entrepreneurial opportunity, and point to threshold effects and contextual heterogeneity across countries and regions (5, 6, 16). However, an important gap remains in understanding how shocks to inequality and financial development affect economic growth dynamically at the provincial level within a heterogeneous national economy. This study therefore aims to investigate the impulse effects of income inequality and financial development on economic growth across the provinces of Iran using a panel vector autoregression approach.

Methods and Materials

This study examines the impulse effects of income inequality and financial development on economic growth (case study: provinces of the country) using the Panel Vector Autoregression (PVAR) approach. The study period covers 2006–2024 and is conducted using the Panel Smooth Transition Regression (PSTR) framework. This research is classified as an applied and descriptive-correlational study in which statistical methods are employed to test the research hypotheses. For model estimation, stationarity and cointegration tests are first conducted, and subsequently, the economic growth model for the provinces is estimated using the PVAR method. The provinces included in this study are East Azerbaijan, West Azerbaijan, Ardabil, Isfahan, Alborz, Ilam, Bushehr, Tehran, Chaharmahal and Bakhtiari, South Khorasan, Razavi Khorasan, North Khorasan, Khuzestan, Zanjan, Semnan, Sistan and Baluchestan, Fars, Qazvin, Qom, Kurdistan, Kerman, Kermanshah, Kohgiluyeh and Boyer-Ahmad, Golestan, Gilan, Lorestan, Mazandaran, Markazi, Hormozgan, Hamedan, and Yazd.

In the present study, following prior research such as Krofeh et al. (2023), Merino (2022), Chen et al. (2021), and Akif Destek et al. (2020), the impulse effects of income inequality and financial development on economic growth are analyzed using the PVAR framework.

$$LGDP_{i,t} = \alpha_0 + \beta_1 LWTOP_{i,t} + \beta_2 LFD_{i,t} + \beta_3 LEDU_{i,t} + \beta_4 LGOV_{i,t} + \beta_5 LFAC_{i,t} + \beta_6 LCPI_{i,t} + \beta_7 LUNE_{i,t} + u_{i,t}$$

Provincial Gross Domestic Product (GDP), the financial development index through household credit provision (FAC), domestic credit to the private sector by banks (as a percentage of GDP) (FD), education level (EDU), WTOP representing the Gini coefficient as a measure of income inequality, government expenditure (provincial budget) (GOV), provincial inflation (CPI), and provincial unemployment (UNE) are included in the model.

Findings and Results

Initially, the stationarity of the research variables is examined. Compared to time-series unit root tests, which often involve complex asymptotic distributions, panel unit root tests provide statistics with standard normal asymptotic distributions (Baltagi, 2005). Among various panel unit root tests, the Levin, Lin, and Chu (LLC) test (Levin et al., 2002) and the Im, Pesaran, and Shin (IPS) test (Im et al., 2003) are more commonly used. These tests are based on the Augmented Dickey–Fuller (ADF) specification. The LLC test is based on the following form:

$$\Delta y_{it} = \alpha y_{it-1} + \sum_{j=1}^{p_i} \beta_{ij} \Delta y_{it-j} + X'_{it}\delta + \varepsilon_{it}$$

Here, $i$denotes cross-sectional units and $t$denotes time periods. $p_i$represents the number of lags selected for the ADF test, and $X_{it}$is the vector of exogenous variables. The LLC test assumes a homogeneous autoregressive coefficient (α) across all cross-sections. The null and alternative hypotheses are defined as:

$H_0: \alpha = 0$(presence of a unit root); $H_1: \alpha < 0$(absence of a unit root)

The IPS test, in contrast, allows heterogeneity in autoregressive coefficients across cross-sections and is based on the following regression:

$$\Delta y_{it} = \alpha_i y_{it-1} + \sum_{j=1}^{p_i} \beta_{ij} \Delta y_{it-j} + \mu_{it}$$

The null hypothesis for the IPS test is:

$H_0: \alpha_i = 0$for all i

while the alternative hypothesis is that at least one series is stationary:

$H_1: \alpha_i < 0$for at least one i.

The IPS test statistic is computed as the average of individual ADF t-statistics:

$$\bar{t}_{NT} = \frac{1}{N}\sum_{i=1}^{N} t_{iT}$$

Table 1: Results of Panel Unit Root Tests for Variables

Variable	LLC W-stat	Probability	Stationarity
LCPI	-8.79945	0.0000	I(0)
LEDU	-5.46642	0.0000	I(0)
LFAC	-3.46504	0.0003	I(0)
LFD	-4.65414	0.0000	I(0)
LGDP	-6.89551	0.0000	I(0)
LGOV	-14.2149	0.0000	I(0)
LUNE	-6.15248	0.0000	I(0)
LWTOP	-20.0020	0.0000	I(0)

The results presented in Table 1 indicate that all research variables are stationary at level.

Most economic theories express long-run relationships among variables in level form. To confirm the existence of a long-term relationship, variables must either be stationary or integrated of the same order. If the residuals from estimated regressions are stationary, i.e., $I(0)$, the existence of a long-term relationship can be confirmed. In this study, the Kao panel cointegration test is employed to verify the presence of long-run equilibrium relationships.

Table 2: Results of Kao Cointegration Test

Test	Statistic	Probability
ADF	-8.630618	0.0000

As shown in Table 2, the null hypothesis of no cointegration is rejected at the 5% significance level, confirming the existence of a long-term relationship among the variables.

To determine the appropriate model for pooled data, several tests are applied. One of the most common is the Chow test, used to compare pooled regression against panel data models.

The fixed effects model is specified as:

$$Y_{it} = \alpha_i + \beta_1 X_{1it} + \beta_2 X_{2it} + \cdots + \beta_k Z_{kit} + e_{it}$$

where Y_{it}represents the dependent variable for unit $i$at time t, and X_{jit}represents explanatory variables. Differences across cross-sections are captured by α_i. The null hypothesis assumes identical intercepts across provinces, while the alternative suggests at least one differs.

The F-statistic for the Chow test is given by:

$$F = \frac{(RRSS - URSS)/(N-1)}{URSS/(NT - N - K)}$$

If the calculated F exceeds the critical value, the null hypothesis is rejected, indicating the appropriateness of the panel data model.

Table 3: Results of Model Selection Test

Test Type	Test Statistic	Degrees of Freedom	Probability	Model Selection
Limer Test	12.285513	(30, 551)	0.0000	Panel Data
—	301.665982	30	0.0000	—

Based on Table 3, since the probability value is less than 0.05, the null hypothesis of pooled estimation is rejected, and the panel data model is selected as the appropriate estimation framework.

To estimate the model using the Panel VAR method, the optimal lag length of the model is first examined. Determining the optimal number of lags in the VAR model is of substantial importance. Accordingly, in this study, the Akaike Information Criterion (AIC), Hannan–Quinn Criterion (HQ), Schwarz Criterion (SC), and Final Prediction Error (FPE) statistic are used to identify the optimal lag length for the autoregressive model. For determining the optimal lag length in the autoregressive model, the Schwarz Bayesian Criterion is considered more reliable. The results obtained from these criteria for the research regression are presented in the following table.

Table 4. Determination of the Optimal Lag Length of the Regression Model (*VAR Lag Order Selection Criteria)*

Lag	LogL	LR Statistic	FPE	AIC	SC	HQ
0	845.1221	NA	3.77e-12	-3.600525	-3.529264	-3.572477
1	2541.881	3327.837	3.46E-15*	-11.62314*	-9.981796*	-10.97071*
2	2679.530	265.2341	2.45E-15	-10.93991	-9.728480	-10.46309
3	2724.412	84.93803	2.66e-15	-10.85769	-9.076166	-10.15648
4	2789.762	121.4244*	2.65e-15	-10.86349	-8.511885	-9.937896

Based on the results reported in the above table, all criteria confirm a lag length of one for the regression model. Therefore, in this study, the optimal lag is used to estimate the long-run relationship within the autoregressive framework.

There are two major techniques for examining cointegration: the Engle–Granger method and the Johansen method. In the Engle–Granger approach, only one long-run relationship between two or more variables is investigated. When the number of variables exceeds two, this method encounters difficulties in identifying long-run relationships because only one error term is included in the equation. In addition, part of the information is lost through differencing. Compared with other cointegration tests, the Johansen method offers greater advantages. One of its advantages is that it does not rely on differencing to render variables stationary, because differencing causes the loss of long-run equilibrium properties among variables. By calculating the error correction term and incorporating it into equations formulated in differenced form, this method preserves long-run equilibrium properties. In this method, the determination and estimation of cointegrating vectors, that is, the coefficients related to long-run equilibrium relationships among variables, are carried out using the coefficients of the Vector Autoregression (VAR) model among those variables. The relationship between the VAR model and cointegration makes it possible to derive cointegrating vectors directly from the coefficients of the autoregressive model. In the Johansen–Juselius cointegration test, which is used in this study to examine the long-run relationship among the model variables, determining the degree of cointegration of the model variables is of particular importance in the first stage. In the second stage, after determining the degree of cointegration and confirming that the model variables are cointegrated, the cointegrating vectors are identified on the basis of Johansen's proposed method using the trace statistic $(\lambda_{\text{Trace}})$and the maximum eigenvalue statistic $(\lambda_{\max})$. As shown in the table, in the (λ_{Trace})test, the null hypothesis that no cointegrating vector exists is rejected, and the alternative hypothesis indicating the existence of more than one cointegrating vector is accepted. At the second level, the hypothesis of at least four cointegrating vectors against six vectors is tested, and since the test statistic exceeds the critical value, the existence of four cointegrating vectors is confirmed. Finally, the existence of three cointegrating vectors is confirmed according to the maximum eigenvalue test. Rejection of the null hypothesis $r = 0$at the 5% significance level indicates the existence of a cointegrating vector, or $r = 1$. The difference between the $(\lambda_{\max})$and (λ_{Trace})statistics is that the alternative hypothesis in the $(\lambda_{\max})$statistic is explicitly specified. It is possible for the results of the $(\lambda_{\max})$and (λ_{Trace})tests to be inconsistent. In fact, the $(\lambda_{\max})$test has a more specific and clearer alternative hypothesis. In any case, if a contradiction arises, selecting the minimum number of cointegrating vectors is preferable. The results are presented in the following table.

Table 5. λ_{Trace} and $\lambda_{\max}$ Tests for the Regression Model

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability
None *	0.398324	746.9382	159.5297	0.0000
At most 1 *	0.250529	479.2034	125.6154	0.0001
At most 2 *	0.198544	327.2234	95.75366	0.0000
At most 3 *	0.153007	210.5849	69.81889	0.0000
At most 4 *	0.132952	123.0698	47.85613	0.0000
At most 5 *	0.051831	47.88744	29.79707	0.0002
At most 6 *	0.034271	19.83922	15.49471	0.0104
At most 7	0.002770	1.461655	3.841466	0.2267

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Probability
None *	0.398324	267.7348	52.36261	0.0001
At most 1 *	0.250529	151.9800	46.23142	0.0000
At most 2 *	0.198544	116.6385	40.07757	0.0000
At most 3 *	0.153007	87.51510	33.87687	0.0000
At most 4 *	0.132952	75.18240	27.58434	0.0000
At most 5 *	0.051831	28.04822	21.13162	0.0045
At most 6 *	0.034271	18.37757	14.26460	0.0106
At most 7	0.002770	1.461655	3.841466	0.2267

Max-eigenvalue test indicates 7 cointegrating equation(s) at the 0.05 level.

According to the results reported in the cointegration test table, it can be stated that in both cointegration tests, the existence of at least seven cointegrating vectors is confirmed for the research regression. Therefore, the long-run equilibrium relationship among the variables of the regression model is supported.

After determining the optimal lag length, performing the diagnostic tests, and confirming the existence of a long-run relationship among the variables of the regression model, the model is estimated using the Panel VAR method. The results are presented in the following table.

Table 6. **Results of Model Estimation Using the Panel VAR Method**

Explanatory Variables	Response Variable: Provincial Economic Growth	Coefficient	Standard Error	Test Statistic
LWTOP	Provincial Economic Growth	-0.326912	(0.11156)	-2.930369
LFD	Provincial Economic Growth	0.261852	(0.10288)	2.545218
LEDU	Provincial Economic Growth	0.559450	(0.14041)	3.984400
LGOV	Provincial Economic Growth	0.625156	(0.15312)	4.082785
LFAC	Provincial Economic Growth	0.363486	(0.12838)	2.831329
LCPI	Provincial Economic Growth	-0.256156	(0.10226)	-2.504950
LUNE	Provincial Economic Growth	-0.526557	(0.20156)	-2.612410

To examine the statistical significance of the coefficients of the independent variables in each model, the t-statistic is used. The null hypothesis in the t-test is expressed as follows:

$$H_0: \beta_i = 0$$

This hypothesis is tested using the following statistic:

$$t = \frac{\hat{\beta}_i}{SE(\hat{\beta}_i)}$$

To decide whether to accept or reject the null hypothesis, the calculated t-statistic is compared with the critical t-value from the table, computed with $N - K$ degrees of freedom at the 95% confidence level. If the absolute value

of the calculated $T$is greater than the tabulated t-value, that is, $| T |> t_{\text{critical}}$, the test statistic falls within the critical region and the null hypothesis is rejected. In this case, with 95% confidence, the coefficient under consideration is statistically significant, indicating the existence of a relationship between the independent and dependent variables.

To compute the significance statistic, that is, the t-statistic, the partial regression coefficient is divided by its standard error. If the calculated value lies within the interval $-1.96$to 1.96, this indicates confirmation of the null hypothesis of the t-test, namely, the non-significance of the variable. Otherwise, the alternative hypothesis is confirmed, and the effect is considered statistically significant.

According to the estimated model results, the impulse effect of the Gini coefficient, as an indicator of income inequality, on provincial economic growth is negative and statistically significant.

Likewise, the impulse effects of domestic credit to the private sector and household credit on provincial economic growth over the study period are positive and statistically significant at the 95% confidence level.

Finally, the impulse effects of the consumer price index and the unemployment rate on economic growth in the provinces are negative and statistically significant.

Using the long-run equilibrium relationship, it is possible to estimate short-run relationships, which are interpreted as error correction models. These models make it possible to identify the short-run fluctuations of variables and their relationship with long-run equilibrium values. The estimated coefficient of the error correction model for the research regression model is presented below.

Table 7. **Estimated Coefficients of the Error Correction Model**

Variable	ECM(-1)	Standard Error	Statistic
Regression Model	-0.097247	(0.03558)	[-2.73325]

The key coefficient in the error correction model is the coefficient associated with $ECM(-1)$, which indicates the speed of adjustment of the disequilibrium process. As can be seen, the error correction coefficient in the model specification is equal to $-0.09$and is statistically significant. The fact that this coefficient is negative and less than one indicates that short-run disequilibria converge toward long-run equilibrium. Since the time period in this study is annual, it can be concluded that in each year, 0.09 of the short-run disequilibrium is adjusted toward achieving long-run equilibrium in the research regression model.

In a VAR model, testing the estimated coefficients with optimal lags does not provide sufficient information about the dynamic relationship among the variables in the model. However, it is useful for examining the response of the system to ordinary random shocks that generate a positive residual equal to one standard deviation in each equation of the system. Sims (1980) proposed the use of impulse response functions and variance decomposition in order to obtain a logical interpretation of the VAR model. Consider a two-variable $VAR(1)$model specified as follows:

$$\begin{bmatrix} x_{1t} \\ x_{2t} \end{bmatrix} = \begin{bmatrix} x_{11} & x_{12} \\ x_{21} & x_{22} \end{bmatrix} \begin{bmatrix} x_{1,t-1} \\ x_{2,t-1} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix}$$

A disturbance in e_{1t}has an immediate and direct effect on x_{1t}. In period $t+1$, the disturbance in x_{1t}affects $x_{1,t-1}$through the first equation and also affects $x_{2,t-1}$through the second equation. These effects also operate in period $t+2$and continue in subsequent periods. Therefore, a random shock in one variable in a VAR model generates a chain reaction over time across all VAR variables. An impulse response function is computed to trace these chain reactions. Impulse response functions face one limitation: a disturbance in one variable is not contemporaneously separated from the other variables in the model, although it generates a chain reaction over

time in each of the variables. The assumption that in the above two-variable model one variable receives a disturbance while the other does not is questionable. One solution to this problem is to transform the variables into orthogonal variables that are pairwise uncorrelated and have unit variance. In other words, this indicates how provincial economic growth responds when a shock or sudden change equal to one standard deviation is imposed on the financial development index, income inequality, and the other explanatory variables.

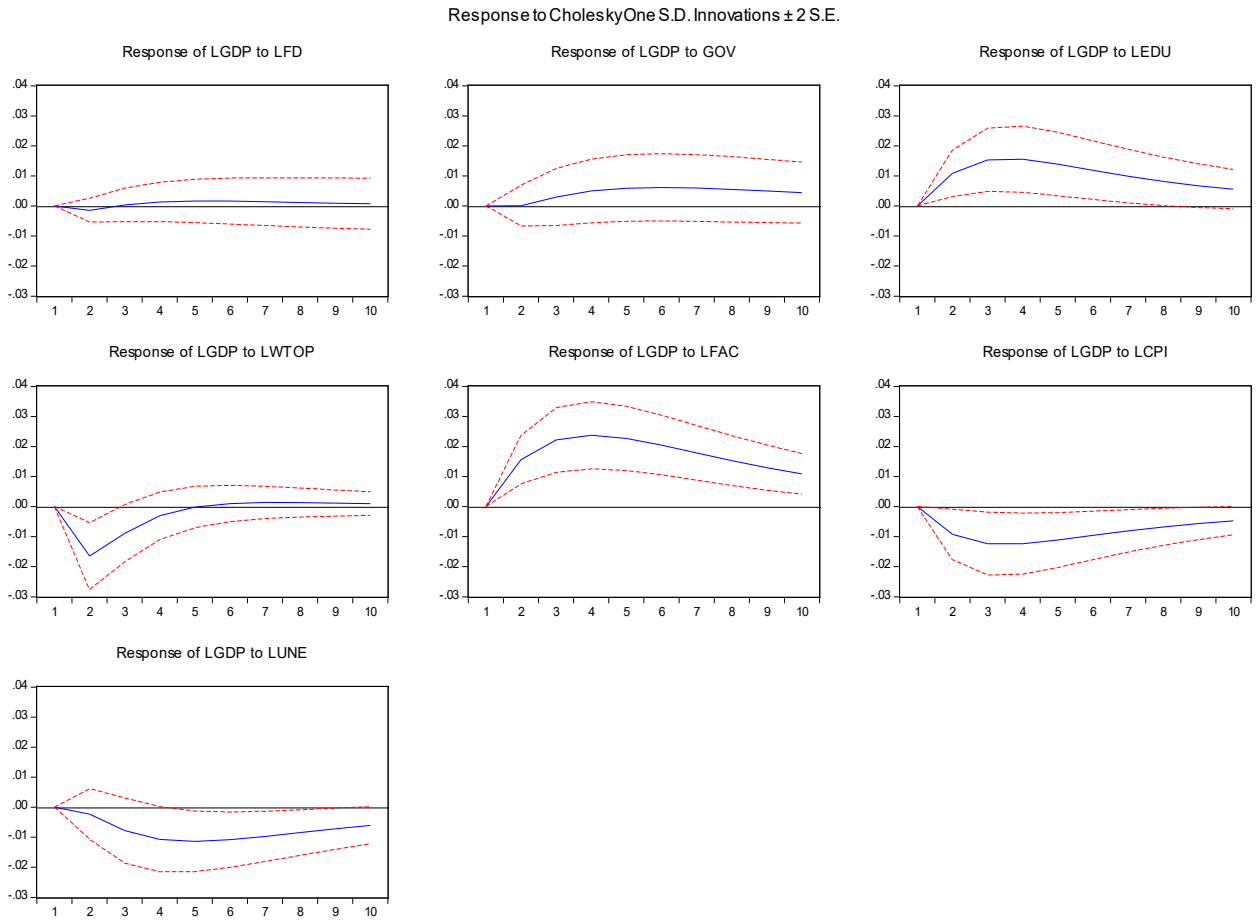

Figure 1. Impulse Response Function of Sudden Shocks

As can be seen from the above graph, the responses of the explanatory variables to the structure of economic growth in the country's provinces are presented. According to the results, if a shock equal to one standard deviation is imposed on the income inequality index, the response of provincial economic growth is such that it begins to decline, and for up to two periods it reduces provincial economic growth; over time, this shock gradually dissipates. Likewise, regarding a one-standard-deviation shock originating from the financial development index, it can be stated that it increases provincial economic growth and then gradually disappears over time. With respect to the unemployment rate, it can be stated that a shock on this variable leads to a decline in provincial economic growth for up to five periods and then gradually vanishes over time.

In this section, based on the estimated model, variance decomposition of the model variables is carried out, and its results for the model are presented in the following table. In this table, the $S.E.$column shows the forecast error of the relevant variables over different periods. Since this error is calculated each year on the basis of the previous year's error, and its source is changes in current values and future shocks, it increases over time.

Table 8. Variance Decomposition for the Model (Response Variable: Provincial Economic Growth)

Period	S.E.	LGDP	LEDU	LFAC	LWTOP	LGOV	LFD	LUNE	LCPI
1	0.121141	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.144256	97.43560	0.003542	0.053149	0.249915	1.196237	0.801607	0.154575	0.105372
3	0.158878	94.31116	0.036951	0.168531	1.258873	0.999974	1.898872	1.231237	0.094408
4	0.167352	91.05718	0.039131	0.237241	1.998830	1.081458	3.011150	2.410112	0.164893
5	0.173636	88.32921	0.037477	0.253125	2.602829	1.287815	3.952876	3.234184	0.302486
6	0.178321	86.29504	0.036355	0.245490	3.073388	1.377815	4.723015	3.752927	0.495971
7	0.182006	84.71469	0.035527	0.236388	3.468983	1.439330	5.349297	4.051458	0.704326
8	0.184913	83.44654	0.034470	0.239383	3.795492	1.473810	5.862950	4.243178	0.904173
9	0.187241	82.40655	0.034221	0.260079	4.067175	1.498707	6.286485	4.367097	1.079689
10	0.189114	81.54761	0.033941	0.299394	4.291495	1.511087	6.636314	4.453049	1.227110

The results of the above table for the model indicate that the forecast error in the first period is 0.121141 and in the second period is 0.144256, and it increases over time. The subsequent columns show the percentage of variance resulting from a specific sudden change or shock. The third column indicates that although in the first period 100% of the changes are explained by the provincial economic growth variable itself, and in the second period 97.43% of the changes are due to shocks in provincial economic growth, by the tenth period the share of changes in this index falls to 81.54%, indicating the influence of the other variables in the model. In the tenth period, 4.29% of the changes in economic growth are related to the Gini coefficient index, 6.63% are related to shocks in domestic credit to the private sector, and 4.45% are related to the unemployment rate. This finding is justifiable in the context of Iran's economy.

Finally, to ensure model stability, the stability of the regression model is examined using the unit circle root test method.

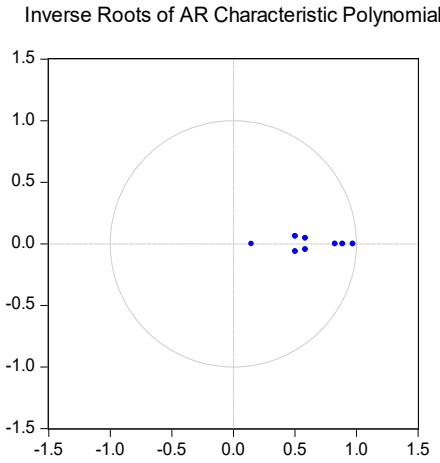

Figure 2. Unit Circle Root Test of the Regression Model

If the Panel VAR model is unstable, the obtained results are not reliable. To examine the stability of the estimated model, the AR graph is used. This graph shows the inverse roots of the characteristic polynomial of an AR process. If the absolute values of all these roots are less than one and lie inside the unit circle, the estimated Panel VAR model is stable. The AR graph of the model shown in the figure indicates that the inverse roots of all characteristic roots lie in the unit circle, and the estimated Panel VAR model satisfies the stability condition.

Discussion and Conclusion

The present study investigated the impulse effects of income inequality and financial development on provincial economic growth using a dynamic panel vector autoregression framework. The empirical results provide several important insights into the short-run and long-run interactions among the key variables. First, the estimation results indicate that income inequality, proxied by the Gini coefficient, exerts a negative and statistically significant effect on provincial economic growth. This finding suggests that higher levels of inequality constrain growth by limiting the consumption and investment capacity of lower-income groups and by weakening the overall efficiency of resource allocation across provinces. Second, financial development—captured through domestic credit to the private sector and household credit—has a positive and statistically significant impact on economic growth, indicating that improved access to financial resources enhances productive investment and economic performance. Third, human capital, measured by the level of education, and government expenditure both exhibit positive and significant effects on growth, highlighting the importance of public investment and human capital formation in regional development. In contrast, inflation and unemployment are found to have negative and statistically significant effects, reflecting macroeconomic instability and labor market inefficiencies as key impediments to growth. Furthermore, the error correction model results reveal a negative and significant adjustment coefficient, indicating that short-run disequilibria converge toward long-run equilibrium, with approximately 9.7% of the adjustment occurring annually. The impulse response analysis shows that shocks to income inequality reduce economic growth in the short run, while shocks to financial development increase growth, although these effects dissipate over time. Variance decomposition results further demonstrate that, although economic growth is initially driven primarily by its own shocks, the explanatory power of other variables—particularly financial development and inequality—gradually increases over time.

The negative effect of income inequality on economic growth observed in this study is consistent with a large body of empirical literature emphasizing the detrimental impact of unequal income distribution on economic performance. Sadeghi et al. argue that rising inequality can reduce aggregate demand and weaken social cohesion, thereby undermining long-term growth prospects (1). Similarly, Karami highlights that social inequalities adversely affect economic development by restricting access to education, employment opportunities, and productive resources (2). From a theoretical perspective, this finding aligns with models in which inequality reduces human capital accumulation and increases credit constraints among lower-income households. The results are also consistent with Huynh's analysis of Asian economies, which demonstrates that inequality can have adverse growth effects depending on structural conditions and institutional quality (4). In the context of provincial economies, where disparities in infrastructure, labor markets, and financial access are often pronounced, the negative effect of inequality may be even more significant, as it reinforces existing regional imbalances and limits inclusive participation in economic activity.

The positive and significant impact of financial development on economic growth found in this study is strongly supported by prior research. Financial development enhances economic performance by improving capital allocation, reducing transaction costs, and facilitating investment in productive sectors. Jalili Fard finds that financial development significantly contributes to growth in non-oil developing countries and MENA economies, emphasizing the role of financial intermediation in mobilizing resources (5). Likewise, Beheshti et al. demonstrate that financial development, particularly when combined with trade liberalization, can promote growth in upper-middle-income

countries (6). More recent studies further highlight the importance of financial inclusion and accessibility. Ghorishvandi Irag et al. show that financial inclusion positively affects economic growth through improved access to credit and financial services (7). These findings are consistent with the results of the present study, which indicate that both private sector credit and household credit contribute positively to provincial growth. The implication is that not only the depth but also the inclusiveness of financial systems matters for economic performance.

However, the relationship between financial development and growth is not necessarily linear, and the results of this study should be interpreted in light of the threshold effects identified in the literature. Luintel et al. argue that financial development may exhibit nonlinear effects on growth, with positive impacts emerging only after certain thresholds are reached (3). Similarly, Chisadza and Biyase emphasize that the effects of financial development vary across countries and depend on structural characteristics such as institutional quality and economic maturity (8). The positive results obtained in this study suggest that, at the provincial level, financial development has reached a stage where its marginal contribution to growth remains beneficial. Nonetheless, policymakers should remain cautious about excessive financial expansion without adequate regulatory frameworks, as such expansion may lead to inefficiencies or financial instability.

The findings related to human capital and government expenditure further reinforce the importance of structural and institutional factors in shaping economic growth. The positive effect of education is consistent with the argument that human capital enhances productivity, innovation, and the capacity to absorb new technologies. Karami underscores the role of human capital in mediating the relationship between inequality and growth, suggesting that investment in education can mitigate the adverse effects of inequality (2). The positive impact of government expenditure also aligns with the view that public investment in infrastructure, education, and social services can stimulate economic activity and reduce regional disparities. These results are consistent with broader empirical evidence showing that fiscal policy plays a critical role in supporting economic development, particularly in regions with structural disadvantages.

The negative effects of inflation and unemployment on economic growth observed in this study are also consistent with theoretical expectations and empirical findings. High inflation creates uncertainty, reduces purchasing power, and discourages investment, while high unemployment reflects underutilization of labor resources and weak economic conditions. These findings align with the broader macroeconomic literature, which emphasizes the importance of price stability and labor market efficiency for sustained growth. In the context of the present study, the negative impact of these variables highlights the importance of maintaining macroeconomic stability as a prerequisite for leveraging the benefits of financial development and reducing inequality.

The dynamic analysis conducted through impulse response functions provides additional insights into the temporal behavior of the system. The finding that shocks to income inequality have a negative effect on economic growth in the short run is consistent with the notion that sudden increases in inequality disrupt economic activity and reduce aggregate demand. Conversely, the positive response of growth to shocks in financial development suggests that improvements in financial access and intermediation can have immediate beneficial effects on economic performance. These results are consistent with the findings of Lu and Dilanchiev, who emphasize the role of financial deepening in supporting economic activity and reducing poverty (13). Moreover, the gradual dissipation of these effects over time indicates that the impact of shocks is not permanent and that the system tends to return to equilibrium, as confirmed by the error correction mechanism.

The variance decomposition results further support the dynamic interplay among the variables. While economic growth is initially driven primarily by its own shocks, the increasing contribution of financial development and inequality over time indicates that these variables play an important role in shaping long-term growth dynamics. This finding is consistent with the argument that structural factors such as financial systems and income distribution exert cumulative effects on economic performance. The results also align with the findings of Castaldo and De Bonis, who highlight the evolving nature of the relationship between structural transformations and income distribution (16). Similarly, Kamalu and Ibrahim emphasize the importance of considering the interaction between financial development and inequality in understanding economic outcomes (11). Taken together, these findings underscore the importance of adopting a dynamic and multidimensional approach to analyzing economic growth.

Finally, the confirmation of model stability through the AR characteristic roots indicates that the estimated relationships are robust and reliable. This adds credibility to the empirical findings and supports the validity of the conclusions drawn from the analysis. Overall, the results of this study highlight the importance of reducing income inequality, promoting inclusive financial development, investing in human capital, and maintaining macroeconomic stability as key strategies for enhancing provincial economic growth.

One limitation of this study is that it relies on aggregate provincial data, which may mask important within-province heterogeneity and micro-level dynamics. Additionally, the measurement of financial development and inequality may not fully capture all relevant dimensions, such as informal financial activity or wealth inequality. The use of annual data may also limit the ability to capture short-term fluctuations and high-frequency dynamics.

Future research could extend this analysis by incorporating more granular data, such as household-level or firm-level information, to better understand the microeconomic mechanisms underlying the observed relationships. It would also be valuable to explore nonlinear models and threshold effects in greater detail, as well as to examine the role of institutional quality, governance, and technological change in shaping the finance–inequality–growth nexus.

From a policy perspective, the findings suggest that efforts to promote economic growth should focus on reducing income inequality, enhancing financial inclusion, and strengthening human capital development. Policymakers should also prioritize macroeconomic stability by controlling inflation and reducing unemployment, while ensuring that financial systems are effectively regulated and aligned with the needs of the real economy.

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Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

All ethical principles were adheried in conducting and writing this article.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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