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Nonlinear effects of inflation on Iran's economic growth: The NARDL approach

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Abstract

The present manuscript investigated the nonlinear effect of inflation on Iran's economic growth. Numerous studies have been conducted on Iran's economic growth and presented different estimation methods. The GDP (Gross Domestic Product) per capita as an economic growth index was the dependent variable of the research, and the variables, namely inflation rate, investment, labor, income from oil exports, and government expenditures were explanatory variables. Using the nonlinear autoregressive distributed lag (NARDL) model with a bound approach, the present study asymmetrically examined the effect of the inflation rate on Iran's economic growth. The research period was from 1989 to 2018, and the data were annual. The results of the bound test indicated a long-term relationship between the research variables. The investment and government expenditures had positive and significant effects but labor had a negative and significant effect, and also the income from oil exports did not have any significant effect on the economic growth. Negative changes in the inflation rate had a negative and significant effect, while positive changes in inflation were insignificant, indicating the asymmetric effects of inflation on Iran's economic growth.

Keywords: nonlinear effect, inflation rate, economic growth, Nonlinear Autoregressive Distributed Lag (NARDL) model
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Introduction

The relationship between inflation and economic growth was an important macroeconomic issue. This relationship has been widely discussed in the economic literature and has changed according to the current status. Some researchers did not consider inflation to have a negative effect on growth given that increasing demand led to simultaneous increases in production and prices. Under such circumstances, Phillips argued for the first time that high inflation increased economic growth by reducing unemployment. However, when growth rates decreased in many countries with high and very high inflation rates in Latin America, the view emerged that inflation would have a negative effect on growth rather than a positive effect. Numerous empirical studies, which reached conflicting conclusions about the effects of inflation on growth, did not provide conclusive answers for relevant issues, but it was agreed over time that lower

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inflation rates would be more beneficial for higher economic growth. However, conclusions about the way of inflation effects on growth depend on the nature and structure of the economy, and different results can be obtained for different countries. At this stage, macroeconomic experts used nonlinear models to describe situations in which the effects of inflation on economic growth were different in increasing and decreasing status.
The present manuscript aimed to investigate the nonlinear effects of inflation on economic growth in Iran from 1989 to 2018. In this study, the theoretical bases related to the subject were first examined, and then the relevant experimental studies were introduced. Thereafter, the study introduced and estimated the model, and finally, presented the relevant conclusions.

1 Theoretical bases

1.1 The relationship between economic growth and inflation

Economic theories, which examine the effect of inflation on economic growth, can be divided into four categories:

1- Inflation has a positive effect on economic growth. In this regard, we can refer to a study by Tobin [36] as the initiator of the discussion of the relationship between inflation and growth. He entered money as a substitute asset into the Solow-Swan model. Since inflation increases the cost of saving money, its increase enhances capital accumulation and economic growth. According to the Phillips curve, if an increase in aggregate demand leads to an increase in inflation, inflation and economic growth can accompany. In this case, inflation does not cause growth, but if an increase in aggregate demand leads to economic growth, inflation hurts growth.

2- Miguel Sidrauski [33] had another view on the relationship between inflation and economic growth. Using the method of optimizing the behavior of economic factors and considering the real money balance in the utility function, he found that monetary inflation had a neutral effect on economic growth. This theory, known as the neutral theory, has been proposed by rational expectations. According to this view, when inflation is predicted, it has no effect on the real direction of the economy.

3- Stockman [35] presented a model in which money complemented capital, concluding that inflation had a negative effect on growth. By including money in budget constraints and considering the accumulation of human capital, Gomme [14], and Jones & Manuelli [17] concluded that increasing the inflation rate would lead to lower growth rates by reducing consumption and labor supply. De Gregorio [6] presented a model in which money was a tool to reduce the transaction costs of households and firms, indicating that as rising inflation decreased firms' reserves of stored money, it led to increased transaction costs, and would have a negative effect on investment, and consequently, on economic growth.

4- The effect of inflation on economic growth is nonlinear. In these models, the effects of the inflation rate are different in both decreasing and increasing modes. If the relationship between inflation and economic growth follows a nonlinear relationship, then the results obtained from studies, which have assumed the relationship between these two variables to be linear, will be biased [20]. Based on an endogenous growth monetary model, Gillman, M. et al. (2002) examined the nonlinear relationship between inflation and economic growth in OECD countries. Their results indicated that there was a negative nonlinear relationship for such countries.

1.2 The role of the endogenous growth model in the analysis of macroeconomic issues

The roles of inflation expectations in determining the general level of prices, as well as the effects of government expenditures and budget deficit along with inflation taxes, are issues that increase the general level of prices. In this regard, the theory of endogenous economic growth plays an important role in the analysis of growth issues and related variables by presenting serious challenges and fundamental problems of neoclassical growth patterns. A prominent feature, which has made such models desirable, is the attempt to study and analyze different economies based on specific characteristics, and the dynamic movement of economic indices in an optimal way, as well as endogenizing all economic variables.
After the contribution of Romer [32] and Lucas [22] in orienting growth issues towards endogenous growth issues, endogenous economic growth was considered a major current of economic research. This macroeconomic innovation has contributed significantly to understanding the roles of economic variables, and the government's economic policies on real economic variables. Phillips and Hansen [29], King and Rebelo, S. [31], Robert J Barro, Xavier Sala-i-Martin [4], Futagami, K., Morita, Y., and Shilbata, A. [12], and Mino, K. [23] introduced the exogenous indices, which affected monetary and fiscal policies throughout the economy, in an endogenous way and examined their various effects on growth. According to the desirable characteristics of endogenous growth models, we show the effects of inflation on economic growth using the endogenous growth model in the present study.

2 Research background

In an article titled "The roles of macroeconomic factors in the growth of some countries in Asia, Africa, and Latin America from 1965 to 1990", Fischer, S. [10] concluded that economic growth was negatively associated with inflation. Fischer argued that inflation decreased economic growth by reducing investment and capital accumulation. The study indicated that even though low inflation was not necessary to achieve high growth, high inflation was not compatible with growth. According to studies, Fischer indicated the causal direction from inflation to economic growth.
Barro, R.J. [4] systematically examined different effects of inflation on growth using the inflation domain test by examining 67 selected countries from 1960 to 1990. Barro estimated the model for the countries separately according to inflation rates below 15%, 15%-40%, and above 40% and concluded that the effect of inflation on growth was greater than in countries with medium and high inflation. He also entered the standard deviation of inflation into the model to examine whether inflation variability was related to growth. Due to the strong positive correlation between inflation and its variability, it was difficult to distinguish the effects of these two aspects of inflation. Entering both variables together into regression, Barro concluded that the estimated coefficient of inflation would be almost the same as when we used inflation alone as an explanatory variable, while the estimated coefficient on the standard deviation of inflation was zero. Barro concluded that inflation had no significant relationship with growth for a certain average inflation rate. His model of estimation was as follows:

$$DY_t = (Y_{t-1}, h_{t-1}, \cdots, \pi_t, s_e) \tag{2.1}$$

Where DY is the per capita growth rate in period t, Y_{t-1} is the initial GDP per capita, h_{t-1} is the initial human capital per person (based on education and health values), π_t is the inflation rate, and s_e is the standard deviation of the inflation rate. The other variables, shown by... here include a set of effects of control and environmental variables. Barro estimated two equations separately:

$$DY_t = (Y_{t-1}, h_{t-1}, \cdots, \pi_t) \tag{2.2}$$
$$DY_t = (Y_{t-1}, h_{t-1}, \cdots, s_e) \tag{2.3}$$

In an article titled "Inflation and Economic growth: Evidence from a growth equation", Alexander, W.R. [2] examined the effect of inflation and its variability on economic growth based on the neoclassical growth equation. To this end, he used data from 11 OECD member countries from 1966 to 1988 in a combination of cross-sectional data and time series. Alexander first regressed the real growth rate of production on capital (K) and labor (L) and then stated that if we regressed the output growth only on $\left(\frac{K'}{Y}\right)$ and $(\frac{L'}{Y})$, we would probably have large residual components that included variables removed from the model, and thus the dummy variable (d), which was zero for the years before 1973 and one for the years after 1973, first entered the model to add other effective factors. He then added the inflation and inflation variability to the model step by step until it reached the following model:

$$\frac{Y'}{Y} = \beta_0 + \beta_1\left(\frac{K'}{Y}\right) + \beta_2\left(\frac{L'}{Y}\right) + \beta_3 d + \beta_4\pi + \beta_5\Delta\pi + \mathcal{E} \tag{2.4}$$

Where β_0 is a constant, π and $\Delta\pi$ are inflation and inflation variability, respectively, and ε is an error term. Alexander then stated that better results might be obtained by entering the government expenditures (g) and exports (x). Therefore, he entered the variables into the model. It is worth mentioning that Alexander estimated the model step by step by entering the above-mentioned variables to reach the final model. In another section of the article, he mentioned the range of inflation from -0.11266 to -0.16652, and also argued that the range of inflation variability also fluctuated from -0.09594 to -0.16366. The above analysis indicated that inflation and its variability had a significant negative effect on economic growth.
Khan and Senhadji [19] used panel data of 140 countries over 40 years to assess the nonlinear relationship between inflation and economic growth. They estimated a threshold of about 1-3% for developed countries and 11-12% for developing countries. They indicated that there was a significant negative relationship between inflation and economic growth for inflation rates above the threshold level.
Dong & Jha [8] examined the effect of inflation on the economic growth of 182 developing countries and 31 developed countries from 1961 to 2001 and obtained the following results:

1- There is significant evidence of the negative effect of instability on growth when inflation is high (especially when inflation is above 10%) for developing countries. Therefore, an increase in inflation leads to low economic growth.
2- There is no significant evidence that inflation instability is detrimental to economic growth in developed countries.

Frimpong & Abayie [11] sought to answer the following question: Is inflation harmful? If yes, to what extent is inflation harmful? They estimated the level of inflation threshold for Ghana from 1960 to 2008. The results of model estimation indicated that the inflation threshold rate was 11% for Iran as inflation had negative effects on the economic growth of Ghana at rates higher than this level, and had a mild effect on economic growth and activity at lower rates.
Akinbode, M. [1] used the nonlinear effect of inflation on economic growth for Nigeria using the NARDL method. Only inflation and economic growth were considered in this study. The results of this study indicated that the effect of inflation on economic growth was non-linear. This effect was a way that inflation had a positive effect on economic growth by increasing inflation (positive shocks), but the effect was negative in decreasing inflation (negative shocks) because the cost of production increased and the rate of production decreased as inflation increased. Therefore, the final price increased, but since the increase in prices was greater than the decrease in production, GDP and economic growth increased but the result was the opposite for declining inflation. Therefore, as inflation decreased, the production cost decreased and the amount of production increased; hence, final prices decreased, but since an increase in production was greater than the reduction in prices, economic growth increased.
In a study titled "inflation and economic growth in Turkey using the NARDL method using quarterly data from 2003 to 2017", Karahan & Colak [18] examined the relationship between inflation and economic growth. Their results indicated a non-linear relationship between inflation and economic growth in the long term.
Jafari Samimi and Gholizadeh Kenari [15] used time series and cross-sectional data to investigate the determinants of economic growth in developing countries and examined the hypothesis of the negative effect of inflation on economic growth in 90 developing countries from 2003 to 1993. To test the hypotheses, the researchers used a simultaneous equation system model, including the two equations of inflation and economic growth, with an emphasis on Gordon's triangle model. The results of estimating the regression models of the study confirmed the main hypothesis on the negative effect of inflation on economic growth in developing countries. According to the results, a 1% percent increase in inflation decreased economic growth by 2%.
Dadgar and Salehi Rezve [5] examined the relationship between inflation and economic growth in Iran using data from 1961 to 2001. They investigated the relationship between inflation and economic growth in the Iranian economy using a model presented by Barro and Alexander. Their results indicated that the effect of inflation on economic growth was negative and a 1% increase in inflation decreased economic growth by 2% in the short term and 0.25% in the long term. Finally, they suggested that inflation should be reduced to create and sustain growth and must be kept at a level that has no detrimental effect on growth.
Komijani and Memarnejad [20] studied the importance of labor and R& D (research and development) in Iran's economic growth through endogenous growth models. In their article, they expressed an endogenous economic growth model, namely the growth model with the endogenous change of technology from Romer [32], and made a model for Iran's economic growth and the positive impact of labor, human capital, physical capital, oil export revenues, and estimated the negative impact of inflation and the dummy variable related to the Iranian Revolution based on the test performed by the Autoregressive Distributed Lag (ARDL) method. Due to the small volume of R& D costs and the low ratio of non-oil exports to GNP and its traditional and non-factory structure, there was not any significant relationship between R& D and non-oil exports with economic growth in the period of 1958 to 1999.
Given the importance of economic growth and according to studies, the previous studies did not either enter into the nonlinear relationship between inflation and economic growth or they examined the nonlinear relationship between inflation and economic growth using the conventional methods such as the GLS method, but the present study aimed to use the nonlinear ARDL method to explain the exact relationship between inflation and economic growth variables in Iran.

3 Econometric method

The previous studies presented several methods for long-term cointegration between time series variables and widely used them, for example, the univariate cointegration method, including the Engle-Granger test [9], the modified method by Philips-Hansen [29], and the multivariate cointegration method by Johansen-Juselius [16]. This study used the Autoregressive Distributed Lag (ARDL) approach proposed by Pesaran et al. [28] to investigate the long-term relationship between variables. The approach had several advantages over other approaches:

1) Short-term and long-term parameters were estimated simultaneously.
2) Some cointegration techniques were sensitive to sample size, but the ARDL approach could be used for small samples.
3) The ARDL approach could perform estimation regardless of whether the variables are $I(0)$ or $I(1)$. The cointegration relationship between the variables was determined using the bound test in this approach, and then the

study of asymmetry was added to the model using a study by Shin et al. [34], and its applications are presented in studies by Bahmani Oskooee, M. [3].

According to the existing literature in this field, the function of Iran's economic growth is as follows:

$$\text{Ln GDPPC}_t=\alpha_1+\alpha_2\text{Ln}K_t+\alpha_3\text{Ln}L_t+\alpha_4\text{LnXOIL}_t+\alpha_5\text{Ln}G_t+\alpha_6\text{INF}_t+\varepsilon_t \tag{3.1}$$

Where GDPPC refers to GDP per capita, INF: inflation rate, K: investment, L: labor, XOIL: oil export earnings, G: government expenditures, and ε_t : error term. This equation is known as a linear long-term pattern, in which the coefficients are long-term if there is cointegration between the variables.
The long-term model (3.1) can be written in terms of error correction (EC) in Equation (3.2) according to Pesaran et al. [28] to observe the short-term and long-term effects simultaneously and applied the bound test approach for it.

$$\begin{aligned}\Delta\ln\text{GDPPC}_t &= \omega_1+\sum_{i=1}^{n_1}\omega_{2i}\triangle\ln\ \text{GDPPC}_{t-i}+\sum_{i=0}^{n_2}\omega_{3i}\triangle\ \text{INF}_{t-i}+\sum_{i=0}^{n_3}\omega_{4i}\triangle\ln\ K_{t-i}\\ &+\sum_{i=0}^{n_4}\omega_{5i}\triangle\ln L_{t-i}+\sum_{i=0}^{n_5}\omega_{6i}\triangle\ln\text{XOIL}_{t-i}+\sum_{i=0}^{n_6}\omega_{7i}\triangle\ln G_{t-i}\\ &+\theta_1\ln\text{GDPPC}_{t-1}+\theta_2\text{INF}_{t-1}+\theta_3\ln K_{t-1}+\theta_4\ln L_{t-1}+\theta_5\ln\text{XOIL}_{t-1}+\theta_6\ln G_{t-1}+\varepsilon_t\end{aligned} \tag{3.2}$$

The coefficients for the first-order difference variables in Equation (3.2) are short-term. Furthermore, long-term coefficients are obtained for Equation (3.1) by normalizing the coefficients of the lagged variable θ_2 to θ_5) on θ_1. For the long-term coefficients to be valid, the cointegration between them must be determined. The f-statistic can be used for the bound test approach to test $H_0=\theta_1=\theta_2=\theta_3=\theta_4=\theta_5=\theta_6=0$. Rejecting the hypothesis indicates a long-term relationship. The critical values of the statistics of such a test are different from the standard values of the F-test; hence, its values were presented by Pesaran et al. Two critical values are determined for the bound test. The critical value for the upper bound assumes that all pattern variables are $I(1)$. The critical value for the lower bound is also based on the assumption that the variables are $I(0)$. The F-statistic calculated for the pattern is measured by the critical values of the upper and lower bounds. If the statistic is higher than the upper bound value, it indicates the existence of a cointegration relationship. If the statistic is less than the lower bound value, it rejects cointegration. Finally, if the calculated F-statistic is between the bound values, the bound test for cointegration is without result.
According to Shin et al. [34], the inflation rate variable is divided into positive and negative components to examine the asymmetric effects of inflation on economic growth:

$$\text{POS}_t=\sum_{j=1}^{t}\triangle\text{INF}_j^+=\sum_{j=1}^{t}\max\left(\triangle\text{INF}_j,0\right) \tag{3.3}$$

$$\text{NEG}_t=\sum_{j=1}^{t}\triangle\text{INF}_j^-=\sum_{j=1}^{t}\min\left(\triangle\text{INF}_j,0\right) \tag{3.4}$$

Where POS_t represents the partial sum of positive changes in inflation and NEG_t represents the partial sum of negative changes in inflation.
The following pattern can be obtained by inserting Equations (3.3) and (3.4) in Equation (3.1):

$$\text{Ln GDPPC}_t=\beta_0+\beta_1\text{Ln}K_t+\beta_2\text{Ln}L_t+\beta_3\text{LnXOIL}_t+\beta_4\text{Ln}G_t+\beta_5\text{POS}+\beta_6\text{ NEG}+\varepsilon_t \tag{3.5}$$

Equation (3.5) presents the long-term economic growth function in Iran, and it is estimated by the nonlinear autoregressive distributed lag (NARDL) method with nonlinear effects of inflation. According to the studies of Pesaran & Shin [26], this pattern can be rewritten as a NARDL pattern in the form of error correction (EC) as follows:

$$\begin{aligned}\Delta\ln\text{GDPPC}_t &= \varphi_1+\sum_{i=1}^{n_1}\varphi_{2,i}\triangle\ln\text{GDPPC}_{t-i}+\sum_{i=0}^{n_2}\varphi_{3,i}\triangle\ln K_{t-i}\\ &+\sum_{i=0}^{n_3}\varphi_{4,i}\triangle\ln L_{t-i}+\sum_{i=0}^{n_4}\varphi_{5,i}\triangle\ln\text{XOIL}_{t-i}+\sum_{i=0}^{n_5}\varphi_{6,i}\triangle\ln G_{t-i}\\ &+\sum_{i=0}^{n_6}\varphi_{7,i}\triangle\ \text{POS}_{t-i}+\sum_{i=0}^{n_7}\varphi_{8,i}\triangle\ \text{NEG}_{t-i}+\theta_1\ln\text{GDPPC}_{t-1}\\ &+\theta_2\ln K_{t-1}+\theta_3 lnL_{t-1}+\theta_4\ln\text{XOIL}_{t-1}+\theta_5\ln G_{t-1}+\theta_6\text{ POS}_{t-1}+\theta_7\text{NEG}_{t-1}+\varepsilon_t\end{aligned} \tag{3.6}$$

The above equation is an asymmetric autoregressive distributed lag pattern that can examine the asymmetric effects of inflation on economic growth in the short and long term. Like the model (3.2), the coefficients φ_2 to φ_7 represent short-term coefficients, and long-term coefficients can be calculated using φ_1 to φ_7. The model (3.6) is first estimated, and the long-term coefficients (3.5) are obtained by normalizing the estimated coefficients. To this end, the coefficients φ_2 to φ_7 are divided by φ_1 to obtain long-term coefficients corresponding to each independent variable.
The pattern diagnostic tests are used after estimating the model by the NARDL method. To do this, the autocorrelation test, the heteroscedasticity test, the residual normality test, and the model stability tests are used to examine the quality of the model. Then, the bound test by Pesaran et al. [28] is used to confirm the long-term relationship between the dependent variable and explanatory variables. Therefore, F-statistic is calculated and compared with critical values at different significance levels. The coefficients of the model (3.5) can be interpreted if the diagnostic tests indicate the acceptability of the model and the bound test confirms the existence of cointegration.
The research period was from 1989 to 2018, and the variables of the model were as follows:

1- Inflation rate: Its increase and decrease in the NARDL model for the symmetry or asymmetry of its effect on economic growth are called POS to increase (positive shock) inflation rate and NEG to reduce (negative shock) inflation rate.
2- Gross capital formation logarithm as an investment index (Ln(K))
3- Active labor logarithm, i.e. a part of the population that is at the working age and supply the labor force of markets (Ln(L))
4- Logarithm of revenue from crude oil and petroleum product exports as an index of revenues from oil sales (Ln(xoil))
5- Government expenditure logarithm as the government expenditure index (Ln(G))
These variables were considered endogenously as independent variables in the model.
6- The logarithm of GDP per capita was also considered as a dependent variable (Ln(GDPPC)).

In this study, the NARDL method was used to investigate the effect of inflation on economic growth in Iran.
All statistics and data were extracted from the World Development Indicators (WDI), the International Monetary Fund (IMF), the reports of the United Nations Development (UNDP) website, and the Organization of the Petroleum Exporting Countries (OPEC).

4 Pattern analysis

An advantage of the NARDL model is its flexibility with respect to the variables $I(0)$ and $I(1)$. This econometric method can be easily used since economic variables are usually stationary at the level or the first-order difference. However, an Augmented Dickey-Fuller Test was performed for all variables in the pattern to ensure the absence of variable $I(2)$, as Table 1 presents its results:

Table 1: Results of the augmented dickey-fuller test

Variable	With intercept	With intercept and trend	Without intercept and trend
Ln(GDPPC)	-2.29	-1.46	-1.66
Ln(K)	-1.45	-1.68	1.11
Ln(L)	-1.52	-2.57	1.73
Ln(XOIL)	-1.65	-3.51***	1.150
Ln(G)	-1.88	-1.68	1.37
INF	-3.65**	-2.75	0.85
D(Ln(GDPPC))	-3.67*	-4.03*	-3.54*
D(Ln(K))	-3.89*	-3.83*	-3.86**
D(Ln(L))	-2.46	-2.65	-1.95**
D(Ln(XOIL))	-4.25*	-4.41*	-4.37*
D(Ln(G))	-4.70*	-4.39*	-4.52*
D(INF)	-4.74*	-4.72*	-4.83*

Note 1: *, **, and *** b indicate reliability at the levels of 1%, 5%, and 10% respectively
Note 2: D indicates the first-order difference of the variables.

According to the table above, the degree of integration of the variables is as follows:

Table 2: Degree of integration of the variables

Variable	Ln(GDPPC)	Ln(K)	Ln(l)	Ln(G)	Ln(XOIL)	INF
Degree of integration	$I(1)$	$I(1)$	$I(1)$	$I(1)$	$I(0)$	$I(0)$

Source: Researcher's results

The results of the unit root test indicated the stationary variables at the level or in the first-order difference.
Using the Eviews software, we first estimated Equation (3.6) to determine the optimal lag length. The AIC criterion was used to select the best model. Therefore, the optimal lags (1, 0, 2, 1, 1, 0, 0) were selected. Table 3 presents the estimated short-term coefficients:

Table 3: Results of the short-term model

Variable	Coefficient	Standard error	t-statistic	Probability
C	-4.738	1.96	-2.41	0.02
Ln(GDPPC(-1))	-0.75	0.19	-3.80	0.001
Ln(L)	-0.31	0.11	-2.64	0.01
Ln($K(-1)$)	0.28	0.05	4.77	0.0002
Ln($G(-1)$)	0.38	0.12	3.12	0.005
Ln(XOIL(-1)	-0.02	0.02	-1.07	0.29
NEG	-0.0019	0.0006	-2.87	0.01
POS	-0.0006	0.0007	-0.86	0.40
D(Ln(K))	0.20	0.04	4.56	0.0002
D(Ln($K(-1)$))	-0.12	0.03	-3.24	0.004
D(Ln(G))	0.15	0.11	1.35	0.19
D(Ln(XOIL))	0.04	0.01	2.36	0.02

Source: Researcher's results

To test the validity of the model, the Breusch-Godfrey serial correlation LM test examined the autocorrelation, the Breusch-Pagan-Godfrey test examined the heteroscedasticity, the Ramsey test examined the specification bias, and the Jarque-Bera test checked the n ormality of the residuals as presented in the following table:

Table 4: Model validity tests

Type of test	LM test	Breusch-Pagan -Godfrey test	Ramsey test	Jarque-Bera test
Statistic (Probability level)	1.570838 (0.2382)	0.466062 (0.9010)	1.140190 (0.2700)	0.484982 (0.78467)

Source: Researcher's results

As shown, given the probability level obtained in the LM test, the null hypothesis based on the lack of autocorrelation in the error terms is not rejected. Therefore, there is not any autocorrelation in the error terms of the estimated model. The results of the Breusch-pagan-Godfrey heteroskedasticity test also indicate that the null hypothesis based on the lack of heteroskedasticity is not rejected and there is no heteroskedasticity. Ramsey test also examines the accuracy of the model specification. This test shows that the null hypothesis based on the model specification is not rejected and there are no problems such as an incorrect form of the model, the omission of some important variables, and other problems in the model. In the Jarque-bera test (normality), if the probability value is greater than 0.05, the null hypothesis based on the normality of residuals is not rejected at a 95% confidence level. The results presented in Table 6 for the Jarque-bera test indicate that the residuals are normal.
The Cumulative Sum of Recursive Residuals and the Cumulative Sum of Squares of Recursive Residuals (CUSUM of Squares) were used to investigate the structural stability of the estimated model in Iran. The long-term relationship is unstable if the charts are outside the site between the two critical lines at a 5% level. In other words, the stability of a long-term relationship over different periods is compromised, but if these charts are between two critical levels, the stability of the estimated coefficients is confirmed. Figures 1 and 2 present the results:

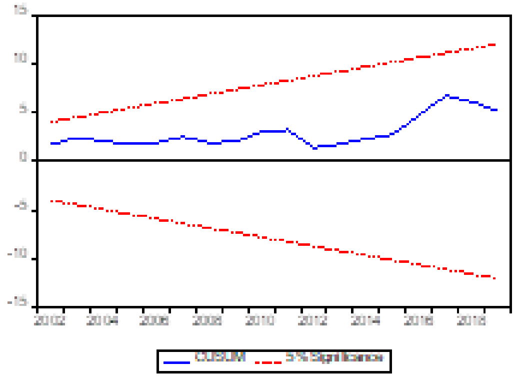

Figure 1: CUSUM test results

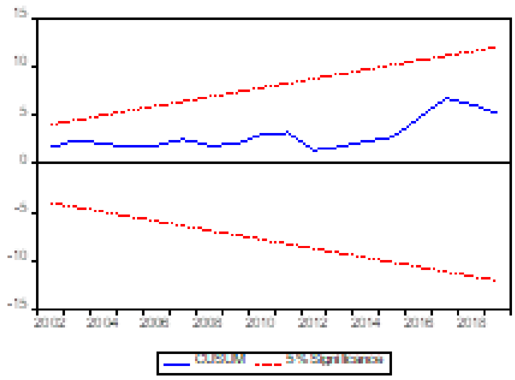

Figure 2: CUSUM of squares test results

As shown, the Cumulative Sum of Recursive Residuals and the Cumulative Sum of Squares of Recursive Residuals did not exceed the specified bounds at a significant level of 5%., indicating that the stability of the long-term model was confirmed.
The Bound test presented by Pesaran et al. [28] was used to evaluate the validity of long-term coefficients. Table 5 presents the values of the F-statistic and its critical values at different significance levels. According to the results of the bound test, the null hypothesis about the "lack of long-term relationship" was rejected at significance levels of 10%, 5%, and 2.5%, indicating a cointegration relationship and the validity of long-term coefficients.

Table 5: Bound test results for a cointegration relationship in the long-term

Values	Lower bound	Upper bound	F-statistic
10% level	1.99	2.94	6.80
5% level	2.27	3.28	
2.5% level	2.55	3.61	

Source: Researcher's results

Table 6 presents the results of the long-term coefficients of the model:

Table 6: Results of long-term relationships

Variable	Coefficient	Standard error	t-statistic	Probability
Ln(L)	0.42	0.16	-2.56	0.01
Ln(K)	0.38	0.08	4.78	0.0001
Ln(G)	0.51	0.12	4.08	0.0007
Ln(XOIL)	-0.031	0.03	-0.96	0.34
NEG	-0.002	0.001	-2.25	0.03
POS	0.0008	0.001	-0.74	0.46
C	-6.34	2.53	-2.50	0.02

Source: Researcher's results

The model can be interpreted due to the cointegration, and consequently, the existence of a long-term relationship between the variables. The government expenditures variable is significant both in the short and long term. The expected investment variable is significant at a high confidence level. In other words, increased investment enhances economic growth. With a 1% increase in investment, economic growth increases by an average of 0.38%. Given the major role of the government in the Iranian economy, this sign is expected and positive. A positive 1% shock causes economic growth to increase by an average of 0.51%. The coefficient of the share of oil revenues is negative and insignificant in the model. The coefficient related to labor is negative and significant. In the Iranian economy model, the coefficients related to positive and negative inflation shocks indicate the negative effect of inflation on economic growth because both coefficients are negative. The difference in the coefficients of these two variables indicates that this relationship is nonlinear. In the short and long term, the coefficients of the negative shock of inflation are significant as a 1% decrease in inflation causes a 0.001% increase in economic growth in the short term, and a 0.002% increase in economic growth in the long term but the coefficients of positive inflation shock are insignificant.

5 Conclusion

Given the importance of economic growth in increasing social welfare, it is important to study factors that increase or decrease economic growth. The study of economic literature indicates that inflation is a determinant of economic growth. The existing literature review shows that there are different views on the effect of inflation on economic growth. According to some views, inflation can have a positive effect on economic growth. Several views point out the negative effect of inflation, while others argue that there is no relationship between the two variables. Some researchers also believe that there is a non-linear relationship between inflation and economic growth. Due to such differences in the way that inflation affects economic growth, an empirical study of this issue can indicate the type of relationship between these two variables according to the conditions and characteristics of each country.
Based on endogenous growth models, the present study considered a model for Iran's economic growth in which GDP per capita was a dependent variable, and inflation, investment, labor, oil export revenues, and government expenditures were independent variables. In this regard, the inflation rate variable was divided into negative and positive inflation variability variables to examine the nonlinear relationship between the inflation rate and economic growth in Iran. The nonlinear autoregressive distributed lag (NARDL) model was also used to examine the effects of positive and negative shocks of inflation on economic growth.

Thereafter, we used the bound test to examine the presence or absence of a long-term relationship. The results of the bound test indicated that there was a long-term relationship between the research variables. The investment and government expenditures variables were positive and significant, and the labor variable was negative and significant. Furthermore, the oil exports revenues variable was insignificant. Negative inflation variability had an inverse significant effect, but positive variability was statistically insignificant. Therefore, the asymmetric effects of inflation on Iran's economic growth were visible. The declining inverse effect of inflation on economic growth indicated that decreasing inflation increased Iran's economic growth. Furthermore, increasing inflation had no significant effect on economic growth. According to the research results, monetary policymakers can consider the determinants of economic growth according to their way of effect and extent.

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