



The Fusion of Inflation and Economic Growth: A Time Series Analysis

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Abstract

This study addresses the two types of fusion between inflation and economic growth in Uzbekistan. The first is the quantitative relationship between inflation and economic growth, and the second is the marginal relationship between them. The first relationship is based on a simple regression model, while the second analysis is carried out by a threshold regression model. Also, the threshold regression model itself has been analyzed using two methods (TSLs and OLS). The data for the research was covered from 2000 to 2022. Also, the variables used in the analysis were checked for stationarity by the Dickey-Fuller and Phillips-Perron tests. The predictors were included in the study after confirmation of hypothesis tests that were positive. According to the results of the study, the correlation between inflation and economic growth in Uzbekistan is negative. Particularly when inflation is lower than a certain level, economic growth is influenced positively, while it has a negative effect on economic growth when it exceeds a certain level. In general, the study determined the optimal level of inflation for Uzbekistan in terms of its positive impact on economic growth.

Keywords: inflation; inflation-growth fusion; optimal inflation rate; threshold level; economic growth; GDP.

1. Introduction

Despite having been plenty of empirical studies on the inflation-growth fusion and its threshold levels, different results have been obtained regarding the relationship between them. Due to the different results obtained in different economies and countries, the limitations of research on the inflation-growth connection in the case of Uzbekistan also require additional studies.

It is known that ensuring the non-inflationary tendency of economic growth is the primary goal of all developing and developed countries, whereas its achievement is the result of a reasonable macroeconomic policy. Providing sustainable economic growth while ensuring a low and stable inflation rate describes the common goals of the government and central banks. Carrying out these aims of macroeconomic policy is considered one of the final goals of policymakers, also in the Republic of Uzbekistan. Even though the countries of the world have rich experience in reducing inflation as well as assessing their impact on GDP, there are no clear and exact conclusions about their quantitative impact on growth in the long and short term.

Furthermore, due to the different results from different studies, additional research is required in the case of Uzbekistan. In this research, we try to assess the impact of the inflation ratio on economic growth and its threshold level using appropriate methods and techniques. Accordingly, the purpose of this study is to determine the quantitative and marginal relationship between inflation and economic growth in Uzbekistan and to develop specific proposals and recommendations. The structure of the research paper consists of an introduction, literature review, research methodology, results and analyses, and conclusion sections.

2. Literature review

Many researchers have focused on the relationship between inflation and economic growth in addition to determining its threshold level. The conclusions of their studies are different from each other, even though their approaches were similar. In particular, in some of their studies, the threshold level of inflation was indicated at 10–12%, while others pointed to 1–3% (Table 1).

Table 1: Studies about determining the threshold level of inflation

No	Studies	Research method	Research object	Research period	Thresholds	
					Deve- loped	Deve- lopin g
1.	Barro, RJ, (1996) . Determinants of economic growth: A cross-country empirical study. NBER Working Paper 5698 , pp. 71-118 [1]	GMM , FE	100 countries	1960-1990	10%	
2.	Ghosh, A., Phillips, S. (1998) Warning: Inflation may be harmful to your growth. International Monetary Fund Staff Papers 45, pp. 672–710 [2]	LS, 2SLS	145 countries	1960-1996	3%	
3.	Judson, R. and Orphanides , A. (1999), Inflation, Volatility and Growth, International Finance, 2(1), 117-138. [3]	Cross-sectional time-average Regression, Panel data	119 countries	1960-1990	10%	
4.	Khan, MS, Senhadji, AS (2001). Threshold effects in the relationship between inflation and growth, IMF Staff Papers, 48(1), pp.1-21. [4]	Threshold regression model	140 countries	1960-1996	11-12%	1-3%
5.	RCK Burdekin, AT Denzau, MW Keil, T Sitthiyot, TD Willett (2004). When Does Inflation Hurt Economic Growth? Different Nonlinearities for Different Economies. Journal of Macroeconomics 26. pp. 519-532. [5]	Panel data, GLS, FE	72 countries	1965–1992	3%	8%
6.	Vaona, A., & Schiavo, S. (2007). Nonparametric and semiparametric evidence on the long-run effects of inflation on growth. Economics Letters, 94(3), 452-458.[6]	Non-parametric and semi-parametric estimator	167 countries	1960-1999	12%	-
7.	MRA Espinoza, A Prasad, MGL Leon (2010). Estimating the inflation-growth nexus — a smooth transition model. International Monetary Fund. (76), pp. 22. [7]	Logistic Smooth Transition Regression approach (LSTR)	165 countries	1960–2007	1%	11%
8.	Fakhri, H. (2011). Relationship between inflation and economic growth in the Azerbaijani economy: is there any threshold effect? Asian journal of business and management sciences, 1(1), 1-11. [8]	LS, 2SLS Threshold regression model	Azerbaijan	2001-2009	13%	

9.	Nazir, S., Saeed, S., & Muhammad, A. (2017). Threshold modeling for inflation and GDP growth. MPRA Paper No. 79649, posted on June 14, 2017. [9]	OLS, FMOLS, TAR Threshold regression model	Pakistan	1972 - 2016	5.5% - 9%
10.	Aydin, C., Odabasioglu, FG (2017). Financial Development and Economic Growth: The Case of Turkey and Romania. International Journal of Academic Research in Business and Social Sciences, 7(6), 23-38. [10]	Threshold Autoregressive model (TAR)	Turkey, Romania	1999 Q1 -2015 Q1. 2002 Q 4 - 2015 Q 2	Turkey 3.99% Romania 4.07-6.69 %
11.	Ekinci, R., Tüzün, O., Ceylan, F. (2020). The relationship between inflation and economic growth: Experiences of some inflation targeting countries. Financial Studies, 24(1 (87)), 6-20. [11]	Dynamic panel threshold model (DPTR)	24 countries that adopted IT	From the year of admission to IT	4.182 %
12.	Thouraya B. (2021). "Nonlinearity Relationship between Inflation and Economic Growth: Role of Institutional Quality," Journal for Economic Forecasting, Institute for Economic Forecasting, vol. 0(1), pages 166-179, December. [12]	Dynamic panel threshold model (DPTR)	Algeria, Egypt, Libya, Morocco, Tunisia	1980–2016	5.69%

Source: Developed by the author.

The only generalizing feature of the studies discussed above is the determination of the percentage of the inflation rate that does not negatively affect economic growth. According to studies, the relationship between economic growth and inflation is threshold but not linear. It means that if the inflation rate is lower than its threshold level, it does not have a negative impact on economic growth, while it has a negative impact when inflation is higher than the threshold level. However, the main goal of macroeconomic policy is not only to keep the price level at its threshold but also to keep it at a level that does not negatively affect the expectations, incomes, and well-being of economic agents.

3. Research methodology

In order to analyze the empirical relationship between inflation and economic growth in the national economy, we follow the methodology of some studies [9], [14]. The simple regression model in their paper is written as follows:

$$Y = f(x) \quad (1)$$

Taking into account that real GDP is a function of inflation and that there is a linear relationship between them, the model can be written as:

$$\Delta y_t = a_0 + \sum_{t=1}^n a_1 \Delta \pi_t + \varepsilon_t \quad (2)$$

Here: Δy_t – growth rate of real GDP; $\Delta \pi_t$ – the inflation rate reflected in the consumer price index; a_0, a_1 – unknown parameters; ε_t – standard errors.

Now, we try to determine the threshold level of inflation through the threshold regression model exploited in the studies [2], [8]. The standard view of threshold regression can be written as follows:

$$\Delta y_t = a_0 + \sum_{t=1}^n a_1 \Delta \pi_t + \sum_{t=1}^n a_2 D_t (\Delta \pi_t - k) + \sum_{t=1}^n a_3 Z_t + \varepsilon_t \quad (3)$$

Here: Δy_t – growth rate of real GDP; $\Delta \pi_t$ – inflation rate; D_t – dummy variable; k - marginal amount of inflation; Z_t - is, a set of control variables such as gap GDP and the sum of squared values of inflation; $\mathcal{E}_t$ – standard errors; a_0, a_1, a_2, a_3 are unknown coefficients. A dummy variable included in the model is defined as:

$$D_t = \begin{cases} 1: & \text{if } \Delta \pi_t > k \\ 0: & \text{if } \Delta \pi_t \leq k \end{cases} \quad (4)$$

Here is the k -indicator, which demonstrates the threshold coordinator of the impact of inflation on economic growth. To be more precise, we replace different coefficients on k until the sum of squared residuals of the model reaches a minimum value, while the coefficient of determination (R^2) is the largest. A general description of the model variables is provided below (Table 2).

Table 2: General description of the model variables

Names of variables	The sign of the variables	Description	Status of variables
Economic Growth Rate (%)	Δy_t	Real GDP growth	Dependent variable
Inflation rate (%)	$\Delta \pi_t$	The rate of inflation expressed in the consumer price index	Independent variable
Squared inflation rate	$\Delta \pi_t^2$	The rate of inflation expressed in the consumer price index	Control variable (Instrumental variable)
Output gap	Δgap_gdp_t	The gap between potential and actual GDP (developed using the Hodrick-Prescott (HP) filter)	Control variable (Instrumental variable)

Source: Developed by the author.

The main reason for selecting a threshold regression model based on the two methods, like Least Squares and Two-Stage Least Squares, is that this model allows minimizing residuals, and does not require too many variables, and causes difficulties. According to the research methodology, the observation period is 2000–2021 years and illustrates the date of variables in percentage. So as to achieve the purpose of the research, we use the two methods mentioned above, LS and 2SLS, with dummy techniques. However, the 2SLS method requires control variables, which help minimize the model residuals and give a clear result. In this case, we select the squared values of inflation as well as the output gap as the instrumental variables for the 2SLS method. Additionally, the variables must be stationary for both methods. So that we know whether the variables in the model are stationary or not, we use two-unit root tests like the Dickey-Fuller and Phillips-Perron tests.

4. Results and analyses

We begin by analyzing the descriptive statistics of the model variables below (Table 3).

Table 3: Descriptive statistics of variables

Variable	Obs	Mean	Std. Dev.	Min	Max
rgdpg	22	6.35	2.079841	1.887	9.5
inflation (cpi)	22	10.52	6.906669	3.7	28.2
inflation (cpi) ²	22	156.35	218.8135	10753.7	16435.2

gap_gdp	22	0.0064	1.16368 2	- 2.4874 8	3.0432 1
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Source: Developed by the author using Stata 16 © software.

This table summarizes the summary statistics of each variable in the model as well as the central tendencies of them. The dispersion of real GDP has been in the range of 1.9 and 9.5 percent, while the inflation rate was much higher and in the range of 3.7 and 28.2 percent of variations during the observed period. Although this table cannot represent the statistical relationship between the variables, it allows one to make decisions visually about the normal distribution. It should be noted that the stationarity of the variables is one of the main conditions for determining the significance of the model. Usually, non-stationary variables are made stationary by means of a difference operator. However, there was no need to use this operator in our model. The following table presents the results of tests of the stationarity of variables (Table 4).

Table 4: Results of the stationarity tests

Variables	Unit root tests		Conclusion
	Dickey- Fuller test	Phillips-Perron test	
rgdpg	0.0117 **	0.0371 **	Stationary
inflation (cpi)	0.0275 **	0.0241 **	Stationary
inflation (cpi) ²	0.0025 ***	0.0015 ***	Stationary
gap_gdp	0.0001 ***	0.0001 ***	Stationary

Source: Developed by the author using Stata 16 © software.

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Theoretically, the null hypothesis (H0) is accepted when the p values of the Dickey-Fuller and Phillips-Perron tests are higher than the critical values. Since our result is at a significant level of 0.05, we reject the null hypothesis and accept the alternative hypothesis (H1). The positive results of the unit root tests, that is, the existence of non-stationarity in the variables, confirm that they can be used in the model. The following table (Table 5) illustrates the results obtained from the regression model.

Table 5: Regression analysis results

Source	SS	df	MS	Number of obs.	=	22
Model	37.75798 8	1	37.75798 8	F (1, 20)	=	14.23
Residual	53.08249 8	20	2.654124 9	Prob > F	=	0.0012
Total	90.84048 7	21	4.325737 5	R-squared	=	0.4157
				Adj R-squared	=	0.3864
				Root MSE	=	1.6291
rgdpg	Coef.	Std. Err.	t	P> t	[95% Conf. interval]	
inflationcpi	- 0.194145	0.0514 73	-3.77	0.001	- 0.301516	- 0.08677 3
cons.	8.696892	0.6436 37	13.51	0.000	7.354288	10.0395 0

Source: Developed by the author using Stata 16 © software.

From the results of the analysis, it can be seen that there is a negative fusion between economic growth and inflation in Uzbekistan. Taking into account the "Ceteris paribus" rule, a 1% increase in inflation will reduce real GDP growth by almost 2%. The fact that the coefficient of determination is 0.41 percent (41%), and it corresponds to the calculation of one variable, led to the preservation of the residuals of the model at 53.08 units. The state of P values is considered an indicator representing the reliability of the model, and its value

is 0.01; 0.05; and its retention at 0.1 percent proves that the model is significant. In our model, we accept the alternative hypothesis that this indicator is below the 0.05 percent value threshold. In general, the model is statistically significant, and the obtained results allow for causal analysis.

Based on the results of the analysis, it can be concluded that effective anti-inflation measures should be used to stimulate economic growth in Uzbekistan. In the table below, we analyze the results obtained from the marginal regression model for determining this marginal indicator of inflation for Uzbekistan. (Table 6).

Table 6: Results from the calculation of the model (using the OLS method)

Method: Ordinary Least Squares estimation								
Threshold from k=4% to k=11%.								
rgdpg	Coef.	Std. Err	t	P> t	[95% Conf. Interval]		R ²	RSS
cons.	8.273305	1.363952 0	6.07	0.00 0	5.41852	11.12809 0		
inflation	- 0.128544	0.192353 4	- 0.67	0.01 2	- 0.53114	0.274055 7	0.419 5	52.73 3
D (Δπ _t − 4)	- 0.048828	0.137710 9	- 0.35	0.02 7	- 0.33706 1	0.239403 5		
cons.	9.376860	1.066982 0	8.79	0.00 0	7.14364 5	11.61008		
inflation	- 0.289205	0.129246 5	- 2.24	0.03 7	- 0.55972 1	- 0.018689	0.434 8	51.33 9
D (Δπ _t − 5)	0.077037	0.095913 4	0.80	0.03 2	0.12371 1	0.277786 6		
cons.	8.133740	0.936259 7	8.69	0.00 0	6.17413	10.09336 0		
inflation	- 0.050439	0.179940 0	- 0.28	0.08 2	- 0.42705 8	0.326179	0.436 3	51.20 7
D (Δπ _t − 6)	- 0.116524	0.139712 6	- 0.83	0.01 5	- 0.40894 6	0.175897 0		
cons.	9.093540	0.757209 3	12.0 1	0.00 0	7.50868 4	10.67840		
inflation	- 0.417031	0.229831 9	- 1.81	0.08 5	- 0.89807 5	0.064012	0.444 6	50.45 3
D (Δπ _t − 7)	0.201570 9	0.202569 4	1.00	0.03 2	0.22241 1	0.625553 6		
cons.	4.835315	0.967422 3	5.00	0.00 0	2.81047 7	6.860153		
inflation	0.438646 4	0.144374 8	3.04	0.00 7	0.13646 6	0.740826 4	0.719 1	25.51 3
D (Δπ _t − 8)	- 0.468795	0.103462 0	- 4.53	0.00 0	- 0.68534 4	- 0.252247		
cons.	5.211727 0	1.022723 0	5.10	0.00 0	3.07114 5	7.352310 0		
inflation	0.412280 3	0.160840 7	2.56	0.01 9	0.07563 69	0.748923 6	0.674 6	29.55 6
D (Δπ _t − 9)	- 0.451021 6	0.115977 4	- 3.89	0.00 1	- 0.69376 5	- 0.208278		

cons.	9.321935 0	0.641990 8	14.5 2	0.00 0	7.97823 3	10.66564 0		
inflation	- 0.944703 7	- 0.326594 1	- 2.89	0.00 9	- 1.62827 3	- 0.261134	0.544 8	41.34 9
D ($\Delta\pi_t - 10$)	0.714317 1	0.307642 4	2.32	0.03 2	0.07041 41	1.358220 0		
cons.	8.200541 0	1.717491 0	4.77	0.00 0	4.60579 1	11.79529 0		
inflation	- 0.117783 7	- 0.246628 3	- 0.48	0.03 8	- 0.63398 2	- 0.398415 3	0.419 4	52.74 2
D ($\Delta\pi_t - 11$)	- 0.056238 8	- 0.173959 7	- 0.32	0.02 0	- 0.42034 0	- 0.307863 0		

Source: Developed by the author using Stata 16 © software.

In order to determine the threshold level of inflation, different values of k from 4 to 11 percent are used in the ordinary least square (OLS) method. When k coefficients were 8 percent, the sum of squared residuals was the smallest ($RSS = 25.51$), while the coefficient of determination had the largest value ($R_2 = 0.71$). In the table below (Table 7), we can see the results of the Two-Stage Least Squares method.

In this 2SLS method, we use the same parameters for k and obtain similar and very close results to LS. In particular, the determination coefficient (R^2) is made up of 0.71 percent, while the residuals of the model (SSR) are minimized to 26.4 percent, illustrating the most alternative result. That is, having inflation at 8 percentage points in Uzbekistan will have a positive impact on growth. However, if inflation exceeds its acceptable threshold range, it might have a negative effect. In average calculations, the first method represented 0.03 percentage units ($a_1 + a_2 = 0.4386 - 0.4687$), while the second method represented -0.05 percentage units ($a_1 + a_2 = 0.5449 - 0.5924$). This means that in order to prevent the negative impact of inflation on economic growth, the government and the central bank need inflation to provide no more than 8 percent. Although the negative effect is inconspicuous, the stimulus to economic growth is significant, especially when the speech talks about changes in expectations and savings.

Table 7: Results from the calculation of the model (TSLS method)

Method: Two-Stage Least Squares estimation								
Threshold from $k=4\%$ to $k=11\%$.								
Instrumental variables: $\text{inflation}(\text{cpi})^2$; gap_gdp								
rgdpg	Coef.	Std. Err	t	P> t	[95% Conf. Interval]		R²	SSR
cons.	8.20054 1	1.71749 1	4.77	0.00 0	4.60579 1	11.7952 9		
inflation	- 0.11778 37	- 0.24662 83	- 0.48	0.03 8	- 0.63398 27	- 0.39841 53	0.419 4	52.74 2
D ($\Delta\pi_t - 4$)	- 0.05623 88	- 0.17395 97	- 0.32	0.02 0	- 0.42034 05	- 0.30786 3		
cons.	9.64875 2	1.21202 9	7.96	0.00 0	7.11194 6	12.1855 6		
inflation	- 0.32452 52	- 0.14924 23	- 2.17	0.04 3	- 0.63689 29	- 0.01215 76	0.432 6	51.54 1
D ($\Delta\pi_t - 5$)	0.10103 89	0.10852 05	0.93	0.06 4	- 0.12609 72	- 0.32817 5		
cons.	8.99631 5	0.80729 88	11.1 4	0.00 0	7.30661 9	10.6860 1	0.443 5	50.54 9

inflation	- 0.37320 82	0.26195 79	- 1.42	0.07 0	- 0.92149 24	0.17507 6		
D ($\Delta\pi_t - 6$)	0.16392 74	0.22955 56	0.71	0.08 4	- 0.31653 8	0.64439 28		
cons.	9.10708 9	0.68843 58	13.2 3	0.00 0	7.66617 6	10.548		
inflation	- 0.73616 06	0.39854 55	- 1.85	0.08 0	- 1.57032 6	0.09800 46	0.535 0	42.23 6
D ($\Delta\pi_t - 7$)	0.51988 62	0.37421 59	1.39	0.18 1	- 0.26335 66	1.30312 9		
cons.	4.15655 5	1.15772 1	3.59	0.00 2	1.73341 6	6.57969 3		
inflation	0.54491 84	0.17520 8	3.11	0.00 6	0.17820 4	0.91163 29	0.711 1	26.24 1
D ($\Delta\pi_t - 8$)	- 0.59246 31	0.12433 39	- 4.36	0.00 0	- 0.80269 7	- 0.28222 92		
cons.	5.55484 1	1.19216 4	4.66	0.00 0	3.05961 2	8.05006 9		
inflation	0.35541 7	0.19015 41	1.87	0.07 7	-0.04258	0.75341 41	0.672 5	29.75 0
D ($\Delta\pi_t - 9$)	- 0.41126 89	0.13595 79	- 3.02	0.00 0	- 0.69583 21	- 0.12670 56		
cons.	9.10708 9	0.68843 58	13.2 3	0.00 0	7.66617 6	10.5481		
inflation	- 0.73616 06	0.39854 55	- 1.85	0.08 0	- 1.57032 6	0.09800 46	0.535 0	42.23 6
D ($\Delta\pi_t - 10$)	0.51988 62	0.37421 59	1.39	0.18 1	- 0.26335 66	1.30312 9		
cons.	8.15684	1.01922 3	8.00	0.00 0	6.02358 2	10.2901		
inflation	- 0.05560 89	0.20125 84	- 0.28	0.08 5	- 0.47684 76	0.36562 98	0.436 3	51.20 9
D ($\Delta\pi_t - 11$)	- 0.11268 16	0.15495 73	- 0.73	0.07 6	- 0.43701 08	0.21164 77		

Source: Developed by the author using Stata 16 © software.

5. Conclusions

In general, the result of the analysis confirmed again that there is a negative correlation between inflation and economic growth in Uzbekistan. An effective anti-inflationary policy is required for any economy to reduce the negative impact of inflation. Additionally, the fusion of monetary and fiscal policies is also strongly required in order to decrease the inflation rate. Nevertheless, there is a certain limit to inflation, which has a positive effect on the economy. In our research, it was confirmed that this threshold level is 8 percent. However, it is important to note that this threshold level is only for setting a limit for preventing the negative impact on economic growth and not for the inflation target. That is, it does not mean that we need to set this threshold as a target-level indicator. Additionally, providing economic growth is not considered the main goal of the Central bank.

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