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Re-Estimating Inflation Threshold Level for Tanzania

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Abstract

This study estimates the relationship between inflation and economic growth, as well as the headline inflation threshold level beyond or below which Tanzania's economic growth is constrained. This is achieved through the Ordinary Least Squares (OLS) regressions employing quarterly data covering the period 2001:1 to 2021:4.

The findings suggest that the coefficient of the inflation variable that captures the effect of low inflation on growth is statistically significant and positive, implying that low inflation is pro-growth. A one percent increase in inflation leads to an economic growth of 0.352 percent. Furthermore, the coefficient of the high inflation proxy variable has a negative sign with the inflation threshold level of 7.0 percent. At this level, the total effect of inflation on growth is estimated at 0.3494 percent. Hence choosing an inflation threshold of 8.0 percent for example, would inflict a burden on growth of around -0.0026 per unit compared to -0.0024 per unit likely to originate from the optimal inflation level of 7.0 percent. Moreover, inflation levels of 1.0-3.0 percent have no impact on growth, as mirrored by invariable adjusted R2.

The recommendations from the results of this study are threefold. First, the Bank of Tanzania may consider inflation targets below 7.0 percent but above 3.0 percent in the monetary policy formulation to continue supporting economic growth. Second, since the Bank has largely depended on inflation behaviour in informing inflation targets to choose, which ended up picking targets far from the optimal inflation, it is essential that the Bank also benefits from empirically estimated threshold rates. In doing so, it would reduce the possibility of hampering price increases in the economy, thus negatively impacting supply. Third, in order to utilize any new information emanating from structural changes and developments in the economy, the inflation threshold level should be re-estimated regularly.

1.0 Introduction

Globally, price stability has been the major goal of monetary policy. For many economic policymakers, the main interest has been to sustain high economic growth with stable price levels. High inflation is not desirable because it can negatively affect the economy by disrupting the smooth functioning of markets, thus impeding efficient resource allocation; imposing welfare costs on society, discouraging savings and investment, inhibiting financial development and reducing international competitiveness (see, Ghosh and Phillips, 1998; Khan and Senhadji, 2001; Billi and Khan, 2008; Frimpong and Oteng-Abayie, 2010; Sindano, 2014; and Chindengwike, 2023). Businesses and households are more affected during times of high and unpredictable inflation (Barro, 1996).

It is not surprising therefore that countries seek to maintain low and stable inflation in their economies. According to Billi and Khan (2008) and Ghosh and Phillips (1998), inflation should not be allowed to fall below zero or be very low because of possible growth-harming effects.

How low should inflation be allowed to fall is however unclear. Uncovering this requires an empirical investigation, largely involving estimating the inflation threshold level for a country or a group of countries (Ghosh and Phillips, 1998; Mubarik, 2005; Burdekin et al., 2004; Lopez-Villavicencio and Mignon, 2011; Seleteng et al., 2013; and Thanh, 2015). Such estimations are also of paramount importance because there is a trade-off between maintaining policies that combat inflation and those that boost economic growth.

The case in point on the inflation-growth trade-off challenge is the phenomenon observed across the world since the first half of 2021, which was characterized by upward inflationary pressures[1] amidst slowing/low economic growth rates. As a result, many central banks are faced with the dilemma of scaling down or unwinding their accommodative monetary policies to contain inflation against pursuing an expansionary monetary policy stance to spur the recovery of the economies. The impact of this is much more severe for imports dependent and developing countries such as Tanzania (World Bank, June 2022) due to the high pass-through of foreign inflation[2] to the domestic economy.

The current study seeks to determine the relationship between inflation and growth in Tanzania and estimate the appropriate inflation threshold level that would allow monetary policy to continue supporting economic growth while containing inflation. The overriding research questions are twofold. What is the relationship between inflation and growth in Tanzania? What inflation target, besides the prevailing target of 5.4 percent in 2022/23, could be chosen amid the rising commodity prices in the country such that the monetary policy actions remain supportive of growth? This study attempts to provide answers to these questions using the most current data set.

Knowing the threshold rate is useful in guiding the decision on inflation target(s) to choose in the monetary policy formulation endeavour so as to continue supporting economic growth. This is much so as the Bank

[1] This is caused by supply disruptions emanating from COVID-19 impact and geopolitical tensions including the Russia-Ukraine war and the associated economic sanctions.
[2] Inflation in some of developed economies (some of whom are Tanzania's trade partners) exceeded targets, with those of UK and Euro zone for example hitting double digits in the second half of 2022.

transits from using the reserve money (monetary aggregate) targeting framework to an interest-based one. Here, a single level or a range of inflation targets are needed in the monetary policy programming framework.

After the introduction Section that provides motivation for this study, Section 2 offers a descriptive analysis of inflation dynamics in the country; the policy context; and factors that could be influencing the choice of inflation targets used in the monetary policy formulation. Theoretical and empirical literature underpinning inflation-real economic growth nexus, particularly inflation threshold estimation and evidence are in Section 3, followed by delineation of the estimation approach for the current study in Section 4. The obtained results are presented and discussed in Section 5, trailed by conclusion and policy recommendations in Section 6.

2.0 Tanzania's Policy Perspective on Inflation

2.1 Price Stability Policy and Targets

Prior to 1995, monetary policy was predominantly geared towards supporting Tanzania's economic development goal (Mbowe, 2010). In support, the Bank of Tanzania (the Bank) pursued multiple monetary policy objectives, achieved by employing direct monetary policy instruments. That policy setting led to an oversupply of money in the economy, which culminated in high inflation rates associated with low growth rates, particularly in most of the 1980s and first half of the1990s. To arrest the situation, three cornerstone acts were passed in the first half of the 1990s. The Banking and Financial Institutions Act was enacted in 1991 with a view to liberalizing the banking sector. This Act was trailed by the Foreign Exchange Act (1994), which opened the foreign exchange market to market forces, and the Bank of Tanzania Act (1995) which refocused the primary monetary policy objective to maintaining price stability, principally through the use of indirect policy instruments. Unique in the new setting is that, price stability is considered to be an important contributor to high and sustainable growth. Inflation-growth targets are accordingly pronounced in every National Annual Budget and Monetary Policy Statements, aimed at tracking the Government's broad development objectives.

Looking at historical numbers during the 2002/03 to 2022/23 period, one tends to believe that the setting of inflation targets in the country has largely been informed by inflation behaviour rather than empirical evidence on optimal inflation relative to economic growth. It is clear from Figure 2.1 that during periods of low inflation, the targets were mostly set at 4-5 percent; this is from 2002/03 to 2008/09. Single-digit inflation targets prevailed when inflation was more than 10 percent from 2011/12 to 2019/20. As inflation moderated, the targets were reduced to 3-5 percent in 2020/21 and 2021/22. Following demand and supply mismatch globally leading to increases in commodity prices[3], the inflation target was relaxed to 5.4 percent for the financial year 2022/23. Establishing the inflation threshold could provide additional useful information in determining the targets to pick in the interest-based framework[4].

[3] The mismatch was largely contributed by the reoccurrence of COVID-19 pandemic in China and the Ukraine-Russia war.
[4] This is more transparent and forward looking relative to the reserve money monetary policy framework (Bank of Tanzania - BOT, 2016).

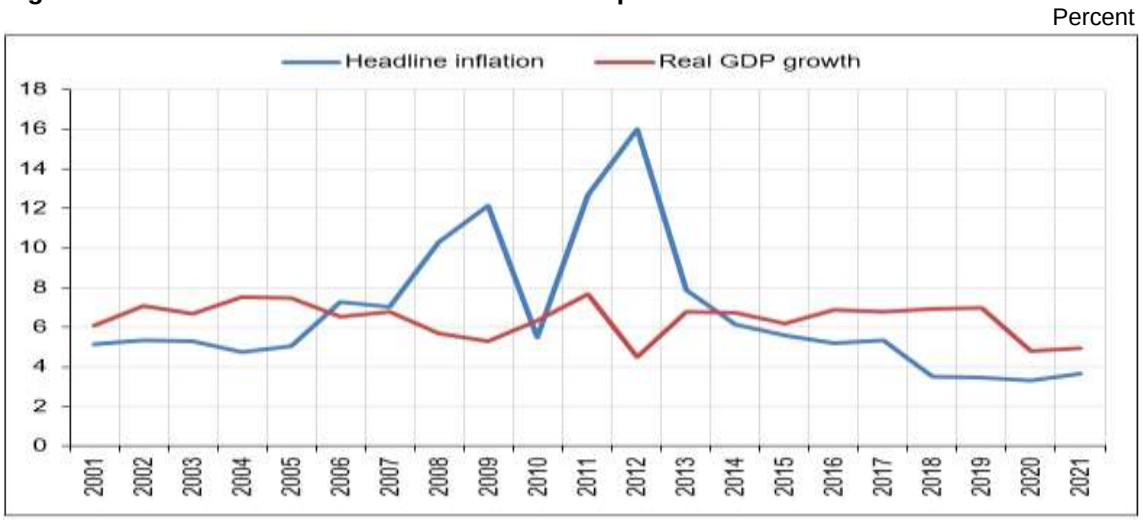
Figure. 2.1: Actual Inflation Against Targets

Source: Authors compilation from various BOT Monetary Policy Statements.

2.2 Relationship between Inflation and Real GDP Growth

Generally, the study finds no clear pattern between inflation and growth that can be traced over the study period ((**Figure 2.2**)[5]. Some few inverse relationships are evident—though not one-to-one—during periods of high inflation. The case in point is the times of the global financial crisis in 2007-2009 and the Euro debt crisis of 2011-2013, which negatively impacted Tanzania's economy. Such an' unclear pattern between inflation and growth warrants further analysis including the aid of descriptive statistics, correlation, and causality tests. This issue is pursued in detail in the subsequent sections.

Fig. 2.2: Inflation—Real GDP Growth Relationship



Source: Authors construction using data from Tanzania National Bureau Statistics

[5] See, Mbowe (2010), p.48; and BOT (2016), p.24 for more details on evolution of inflation in Tanzania and inflation-growth relationship, respectively.

3.0 Literature Review

3.1 Theoretical Literature

Theoretical conceptualization of output growth and inflation nexus dates back to Adam Smith's classical era. In that period, growth was postulated to be supply-side driven, with an implicit negative relationship between inflation and growth. Over time, other theoretical interplays also came in including Structuralist, Monetarist, and Keynesian views. While the former theory suggests that inflation positively influences output growth through capital accumulation (Mundell 1965 and Tobin 1965), the latter two theories see inflation as detrimental to growth as it may lower domestic and foreign savings, reduce the efficiency of resource allocation, and deteriorate the balance of payments (Mallik and Chowdhury, 2001; Dornbusch et al., 1996; and Barro, 1996). The Keynesians, on their part, view the economy as not moving directly to a higher inflation rate but rather following a transitional path where it rises then falls i.e., non-linear relationship (see, Dornbusch et al.,1996). Such a diverse inflation-growth effect is also evident under the neo-classical construction where authors such as Tobin (1965), Stockman (1981), and Sidrauski (1967) postulate positive, negative, and no effect relationships, respectively. The hypothesis of non-linearity suggests that the adverse effects of inflation on economic growth are not universal; it appears only when inflation exceeds some turning point or threshold level below which inflation has a positive or non-significant impact on economic growth.

3.2 Rundown on Empirical Literature

The empirical literature in this area, i.e., the inflation-growth relationship, is plentiful. Two estimation approaches are evident from the literature. The first approach is linear Ordinary Least Squares (OLS) where the inflation threshold is obtained by tracing the level of inflation that minimizes the Residual Sum of Squares (RSS) or maximizes the adjusted R^2. The second is the introduction in the OLS model a nonlinear inflation variable (i.e., a squared inflation variable) to capture the threshold effect.

On empirical results, while some of the studies argue for a negative relationship between inflation and output growth, others suggest a case for an optimal level (non-linearity) where inflation may be harmful to output growth. Studies that suggest the existence of inflation optimal levels, which is the focus of the current study, are summarized in **Table 3.1**.

Table 3.1: Summary of Empirical Results on Inflation Threshold Levels Across Different Countries

Developed countries		
Balcilar, Gupta and Jooste (2019)	USA (1801 to 2013)	Growth and inflation relationship is hump shaped —that higher levels of inflation reduce growth more compared to low inflation or deflation. Inflation above 2% negatively affects growth.
Hwang and Wu (2011)	China (1986 to 2006)	Inflation threshold effect is highly significant and robust in China. Above the 2.5% threshold, every 1 percentage point increase in the inflation rate impedes economic growth by 0.61%; below this threshold, every 1 percentage point increase in the inflation rate stimulates growth by 0.53%.
Omay and Kan (2010)	Canada, France, Italy, Japan, UK and USA	Inflation and growth are negatively related for the inflation rates above the critical threshold level of 2.52%.
Yerger and Freeman (2006)	Germany (1962 Q1 to 1998 Q4)	There is a discernible difference in the impact of inflation upon productivity growth in Germany depending upon the inflationary regime. In the low inflationary regime (below 2.95%) there is no statistically significant impact from an inflation shock upon productivity, but in the high inflationary regime the inflation shock has a significant negative impact upon productivity growth.
Industrialized against non-industrialized countries		
Kremer, Bick and Nautz (2013)	124 countries (1950 to 2004)	For industrialized countries inflation threshold of aboMut 2% is confirmed, whereas for non-industrialized countries, inflation rates exceeding 17% are associated with lower economic growth.
Developing and emerging economies		
Komain (2017)	Thailand (1990 to 2015)	Inflation rate above 3% can jeopardize economic growth rate.

Mubarik (2005)	Pakistan (1973-2000)	The estimated model suggests 9 percent threshold level of inflation above which inflation is inimical for economic growth.
Munir, Mansur and Furuoka (2009)	Malaysia (1970 to 2005)	The inflation threshold level is 3.89%. In addition, below the threshold level, there is a statistically significant positive relationship between inflation rate and growth.
Sinelnikova-Muryleva and Makeeva (2020)	Three country groups –the largest emerging market countries (EM countries), EM countries with main source of earnings from export of raw materials, post-Soviet countries and central and eastern Europe countries (CEE countries) (1990 to 2018)	Threshold above which a significant negative impact of inflation on Gross Domestic Product (GDP) growth rates are found at 4% for the largest EM and post-Soviet countries, 3.5% for EM countries exporters of raw materials and 5.5% for CEE countries.
African countries		
Frimpong and Oteng-Abayie (2010)	Ghana (1960-2008)	Inflation threshold level of 11% at which inflation starts to significantly hurt economic growth
Leshoro (2012)	South Africa (1980: Q2 to 2010:Q3)	Inflation threshold level occurs at 4%. At inflation levels below and up to 4%, there is a positive but insignificant relationship between inflation and growth. The relationship becomes negative and significant when the inflation rate is above 4%.
Mosikari and Eita (2018)	Swaziland (1980 to 2015)	Inflation rate beyond optimal level of 12 percent decrease growth by 1.02 percent
Salami and Kelikume (2010)	Nigeria (1970-2008)	The optimum inflation rate of 8% is found beyond which inflation is inimical to growth.
Yabu and Kessy (2015)	Tanzania, Kenya and Uganda (1970 to 2013)	Average inflation beyond 8.46% has statistically significant and negative impact on economic growth for the three EAC partner states. For individual countries, optimal level of inflation for Kenya is 6.77%; Tanzania, 8.80%; and Uganda, 8.41%.

Source: Authors compilation from different sources

As shown in **Table 3.1**, inflation threshold levels vary amongst industrialized and developing countries. Even in the group of developing and emerging market economies, countries with more developed economies exhibit lower inflation threshold levels (see for example, inflation threshold levels for Thailand, Malaysia and South Africa). Developed economies experience low inflation threshold levels in the range of 2.0 to 2.95 percent, whereas for developing and emerging economies, it is between 3.0 and 9.0 percent. In Africa, the threshold levels are between 4.0 and 12.0 percent, with South Africa exhibiting the lowest inflation threshold level of 4 percent.

Studies of this nature are scanty in Tanzania. Known to the authors, there is only one cross-country study by Yabu and Kessy (2015) that used annual data up to 2013 while introducing a squared inflation variable in the model. Since the Tanzanian economy has witnessed significant structural changes associated with the increasing integration of the economy into that of the world, it is crucial to exploit the new information in determining the inflation beyond which growth is constrained. Goncalves and Salles (2008) and Lin and Ye (2009) underscore the need to utilize all available information in estimating inflation threshold levels, implying the levels could change with developments in an economy. Unlike Yabu and Kessy's study, the current one uses quarterly data, thus, capturing better the short-term dynamics in the economy. It also employs a different estimation approach (as illustrated in the methodology section) for robustness check purposes.

4.0 Estimation Approach

The study assumes a non-linear impact of inflation on economic growth. That is, inflation is supportive of economic growth or has a non-significant impact when it is below a certain threshold (turning point). Inflation beyond the threshold is detrimental to growth.

4.1 Model

4.1.1 Empirical Model

In analysing the threshold level of inflation in Tanzania, the model by Khan and Senhadji (2001) is adopted with some modifications to suit the Tanzanian environment. The model was used by Khan and Senhadji to analyse inflation threshold levels for industrial and developing countries and it has been adopted by many other studies including developing and emerging market economies.

The model comprises four variables: the economic growth rate, inflation rate, population growth, and investment-GDP ratio. The latter two are control variables, considered in the model because they enhance growth (see, Solow, 1956; Mankiw et al., 1992; and Salai-i-Martin, 1997). Our conjecture is that inflation in Tanzania has an adverse effect on economic growth after it exceeds a certain limit.

The threshold model can be specified as follows:

$$rgdp_t = \alpha_0 + \alpha_1 \inf_t + \alpha_2 D_t * (\inf_t - k) + \alpha_3 pop_t + \alpha_4 inv_t + e_t , \quad (1)$$

where *t* is the time indicator; $rgdp_t$, is the growth rate of real GDP; inf_t, is the Consumer Price Index (CPI) inflation rate; *pop,* is the growth rate of population, all variables are in log difference. The log transformation helps in smoothing time trends in the dataset (Mubarik, 2005) and provides the best fit in the class of non-linear models (Khan and Senhadji, 2001). $invr_t$ is the percentage ratio of private investment spending to GDP; *k,* threshold level of inflation; e_t, the error term; α_0, a constant; and α_i (where, i= 1 . . . 4) are coefficients. The relationship between inflation and growth is captured by α_1. D_t is a dummy variable, in which:

$$D_t = 1 : \inf_t > k, = 0 : \inf \leq k \quad (2)$$

The parameter *k* possesses the property that the relationship between inflation and growth is given by α_1, representing a low inflation rate; and a high inflation rate represented by $\alpha_1 + \alpha_2$. If α_2 is statistically significant, the impact of inflation on economic growth will be added to see their impact on economic growth. That is, the effect of inflation on output growth is given by α_1 if the economy is faced with less or equal to threshold inflation, and $\alpha_1 + \alpha_2$ when the country experiences a higher inflation rate.

Since the value of k is arbitrary, chosen in ascending order (i.e., 1,2,3 . . .), the optimal k can be obtained from estimates of equation (1) by selecting the value from the estimated equation that minimizes the sum of squared residuals from the respective regressions. Said differently, the optimal threshold level is the one that maximizes the adjusted coefficient of determination (R^2). At this level, inflation has a significant impact on growth (Mubarik, 2005 and Frimpong and Oteng-Abayie, 2010).

4.1.2 Estimated Model

In the current study, the model is modified by adding more control variables to avoid growth model misspecification (equation 3). The explanatory variables are the ratio of credit to GDP (*fin*) to capture the effect of finance on economic growth, and the degree of openness (*ope*) measured as the percentage ratio of Tanzania's total external trade (exports and imports) to GDP. As Tanzania opens itself to the world, it benefits from capital flows (investment) and external markets for the country's goods and services; these contribute to economic growth. With this modification, we end up with the following equation:

$$rgdp_t = \alpha_0 + \alpha_1 \inf_t + \alpha_2 D_t * (\inf_t - k) + \alpha_3 pop_t + \alpha_4 inv_t + \alpha_5 fin_t + \alpha_6 ope_t + e_t \,. \quad (3)$$

All coefficients in equation (3), except α_2, are assumed to bear positive signs. For α_2, the sign may be positive or negative.

4.2 Estimation Technique

Estimation of the baseline model is done using the Ordinary Least Squares (OLS) method. Since inflation could be non-exogenous in the growth-inflation model leading to biased estimated parameters (Khan and Senhadji, 2001), and the effect could be felt with a lag, estimations are also carried out by Two-Stage Least Squares (2SLS) and with a lag.

The threshold level of inflation is computed for the headline (overall) inflation, which is the Government's main reference variable for fiscal and monetary policy decisions. Price stability is perceived to be crucial for supporting the high and sustainable growth of the economy.

4.3 Data

The objective is to estimate the model using quarterly data, covering the period 1995-2021, largely to capture the period when the country adopted price stability as its overriding monetary policy objective and to increase the degree of freedom. But, due to data limitations only quarterly data series from 2001:1 to 2021:4 was employed. Data related to the consumer price index (used to compute inflation), population and real GDP were sourced from the Tanzania National Bureau of Statistics, while those of credit, investment and trade were obtained from the Bank of Tanzania.

The actual credit (LOGFIN), investment (LOGINV) and openness (LOGOPE) variables were instead used in estimations to allow for log difference transformation. Despite the change, as depicted in appendix **Figure A1**, the two sets of variables are not qualitatively different (see RGDP scaled variables: LOGFIN_R, LOGINV_R and LOGOPE_R) suggesting either of them can be employed. CPI and RGDP were seasonally adjusted to remove seasonal components to allow for a meaningful comparison between observations. The inflation threshold variable was constructed using the actual inflation data while assuming an optimal inflation level of 1 to 10. The graphs of the ultimately used variables are appended as **Figure A2**.

4.4 Pre-estimation Tests

As pointed out earlier, macroeconomic data are characterized by a stochastic trend, which if unresolved, the statistical behaviour of the estimators will be influenced by such a trend such that results may be spurious. Hamilton (1994) suggests different methods of overcoming the problem of spurious regression arising from using non-stationary time series. These include using a lagged endogenous variable as an explanatory variable and differencing the non-stationary time series (until they become stationary) before variables are used in the regression. Another approach is to transform variables into growth rates and ratios. This notwithstanding, tests on correlation and causality help to trace relationships among the variables. Discussions on pre-estimation tests is undertaken in detail below.

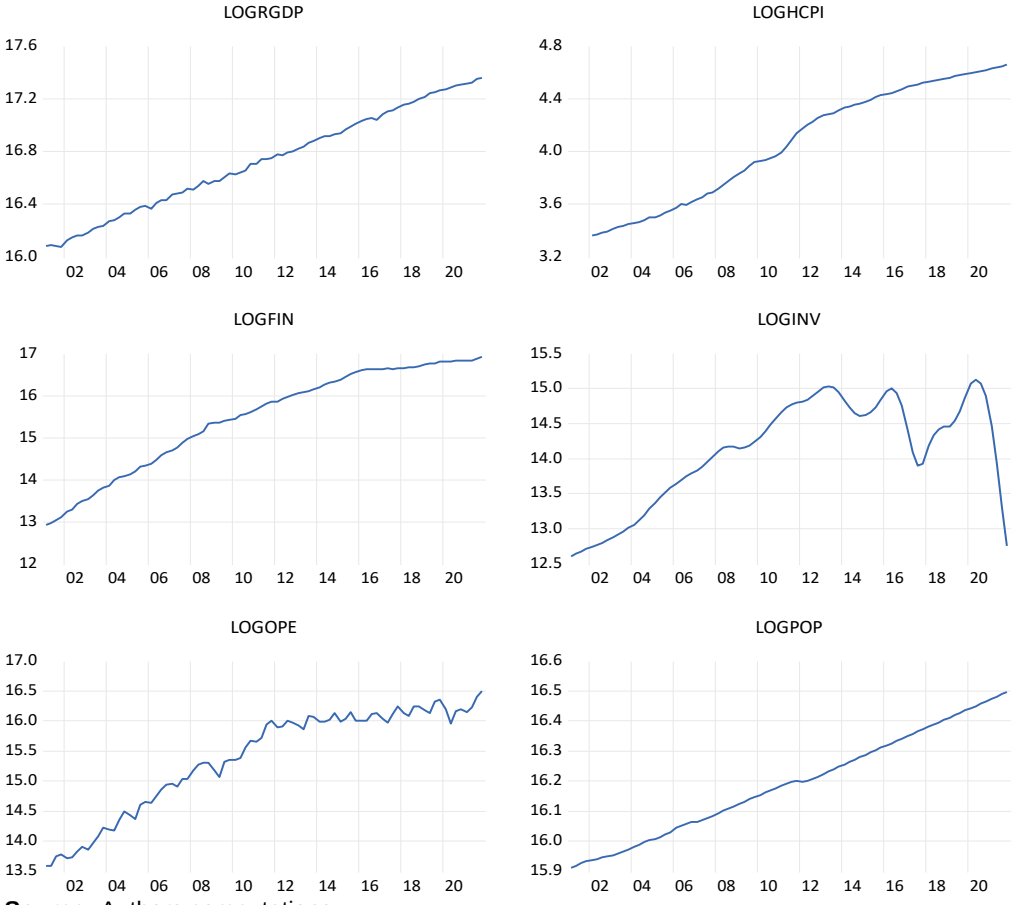
All variables (in logs) exhibit low standard deviation suggesting stability in the data-generating process, (**Table 4.1**). As portrayed in **Figure 4.1**, the series displays an upward trend. Generally, the variables are non-stationary in levels, but strongly stationary after the first difference with intercept and trend (see, **Table 4.2** and Appendix **Figure A2**). With these results, the variables could be considered in log difference.

Table 4.1: Descriptive Statistics of Log Variables

	logrgdp	loghcpi	logfin	loginv	logope	logpop
Mean	16.73	4.06	15.46	14.10	15.38	16.19
Median	16.74	4.15	15.78	14.21	15.79	16.19
Maximum	17.36	4.66	16.92	15.13	16.50	16.50
Minimum	16.08	3.36	12.91	12.60	13.59	15.91
Std. Dev.	0.38	0.44	1.22	0.76	0.86	0.17
Skewness	-0.03	-0.20	-0.57	-0.56	-0.71	0.08
Kurtosis	1.81	1.52	2.03	2.06	2.13	1.82
Jarque-Bera	4.97	7.88	7.85	7.53	9.70	4.93
Probability	0.08	0.02	0.02	0.02	0.01	0.08
Sum	1405.07	325.10	1298.43	1184.32	1291.85	1360.08
Sum Sq. Dev.	12.25	15.05	123.42	47.97	61.84	2.47
Observations	84.00	80.00	84.00	84.00	84.00	84.00

Source: Authors computations

Fig. 4.1: Plots of Log Variables



Source: Authors computations

Table 4.2: Unit Root Tests

Variable	Augmented Dickey-Fuller				Phillips-Perron			
	Level		1st Difference		Level		1st Difference	
	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend
logrgdp	-0.8929	-6.0150***	-9.5908***	-9.5911***	-0.3555	-6.1401***	-20.8429***	-22.9220***
loghcpi	-1.3605	-0.3658	-4.2752***	-4.4807***	-1.1609	-0.2453	-4.2902***	-4.4835***
logfin	-6.8404***	-0.2723	-1.9942	-8.6354***	-6.7945***	-0.1772	-5.7475***	-8.6880***
loginv	-1.9467	0.2408	-2.0046	-3.7209**	-1.7385	0.1470	-1.7475	-2.1393
logope	-2.6397*	-0.9606	-10.7905***	-11.3844***	-3.6045***	-1.5563	-9.2334***	-14.2040***
logpop	1.4755	-1.9863	-3.3485**	-3.7203**	1.6131	-1.7619	-5.2572***	-5.5001

Notes: ***, **, and * means statistically significant at 1%, 5%, and 10%, respectively.
Source: Authors computations

Furthermore, the explanatory variables are positively and significantly correlated with LOGRGDP, the dependent variable (**Table 4.3**). High correlation coefficients are also evident across explanatory variables, a tendency normally observed in macroeconomic variables. The high correlation coefficients among explanatory variables point to the need to also opt for lags of the variables or use the variables one at a time to avoid multicollinearity. The importance of using lags is also justified by causality tests, which are statistically significant, running from the dependent variable to some explanatory variables including LOGFIN and LOGPOP (**Table A1**).

Table 4.3: Correlation Coefficients

Variable	logrgdp	loghcpi	logfin	loginv	logope	logpop
logrgdp	1	0.987	0.973	0.661	0.938	0.999
loghcpi	0.987	1	0.983	0.713	0.956	0.983
logfin	0.973	0.983	1	0.777	0.984	0.966
loginv	0.661	0.713	0.777	1	0.805	0.638
logope	0.938	0.956	0.984	0.805	1	0.927
logpop	0.999	0.983	0.966	0.638	0.927	1

Source: Authors computations

5.0 Results and Discussions

Table 5.1 summarizes regression results tracing the threshold level of inflation beyond which growth is constrained. In the baseline OLS model, the coefficient of the inflation variable, which captures the effect of low inflation on growth, is statistically significant and positive. An increase in inflation by 1 percent, for example, could stimulate growth by 0.352 percent.

The coefficient reflecting the impact of high inflation on growth bears a negative sign with the inflation threshold level being seven percent. At this level of inflation, the requisite coefficient is statistically significant at 1 percent with the highest adjusted R^2 of 0.233. The total effect of inflation on growth is estimated a 0.3494 percent;

indicating in aggregate inflation is pro-growth. Detailed results of the baseline OLS model are shown in **Table 5.1**[6].

Table 5.1: Inflation Threshold Level Results (OLS)

Dependent Variable: DLOGRGDP				
Method: Least Squares				
Date: 12/26/22 Time: 08:02				
Sample (adjusted): 2002Q2 2021Q4				
Included observations: 79 after adjustments				
No lag				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.035781	0.006716	5.32755	0
DLOGRGDP(-1)	-0.380225	0.100996	-3.764761	0.0003
DLOGHCPI	0.352684	0.200496	1.759056	0.0829
DLOGFIN	-0.036136	0.041876	-0.862924	0.3911
DLOGINV	0.007267	0.009237	0.786727	0.4341
DLOGOPE	0.012857	0.01416	0.907987	0.367
DLOGPOP	-2.167929	0.791328	-2.739608	0.0078
Threshold level: k=7	-0.002414	0.000801	-3.012318	0.0036
R-squared	0.301674	Mean dependent var		0.015562
Adjusted R-squared	0.232825	S.D. dependent var		0.014007
S.E. of regression	0.012269	Akaike info criterion		-5.867745
Sum squared resid	0.010687	Schwarz criterion		-5.627801
Log likelihood	239.7759	Hannan-Quinn criter.		-5.771616
F-statistic	4.381667	Durbin-Watson stat		2.269726
Prob(F-statistic)	0.000435			

Dependent Variable: DLOGRGDP				
Method: Least Squares				
Date: 12/26/22 Time: 08:57				
Sample (adjusted): 2002Q3 2021Q4				
Included observations: 78 after adjustments				
One lag				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.021886	0.007234	3.025491	0.0035
DLOGRGDP(-1)	-0.543983	0.113121	-4.808848	0
DLOGHCPI(-1)	0.58228	0.25251	2.305971	0.0241
DLOGFIN(-1)	-0.028338	0.042393	-0.668462	0.506
DLOGINV(-1)	0.005411	0.010436	0.518505	0.6057
DLOGOPE(-1)	0.00544	0.014569	0.373387	0.71
DLOGPOP(-1)	-0.318316	0.806747	-0.394567	0.6944
Threshold level: k=6	-0.002383	0.000894	-2.6666	0.0095
R-squared	0.272924	Mean dependent var		0.015509
Adjusted R-squared	0.200216	S.D. dependent var		0.01409
S.E. of regression	0.012601	Akaike info criterion		-5.813164
Sum squared resid	0.011115	Schwarz criterion		-5.571451
Log likelihood	234.7134	Hannan-Quinn criter.		-5.716402
F-statistic	3.753721	Durbin-Watson stat		2.159097
Prob(F-statistic)	0.001652			

Source: Authors computations

Picking an inflation threshold of 8 percent for example would impose a burden on growth estimated at -0.0026 per unit compared to -0.0024 per unit likely to emanate from an optimal inflation level of seven percent. Although an inflation threshold of 6 percent appears statistically significant when the regression accounts for a lag, such a level of inflation is associated with a lower adjusted R^2 of 0.2002, pointing to a possibility to accommodate a higher inflation target to spur growth.

Another key finding of this study is that the optimal inflation levels of 1 to 3 percent do not have an impact on growth, as reflected by unchanging adjusted R^2. This infers that inflation targets in this range could safely be ignored.

In 2SLS regressions, the coefficient of inflation threshold variable is significant for the 7 percent (**Table 4.2**). But this has a relatively high standard error (S.E.) of regression[7]. Although the overall model for the six percent inflation threshold yields the lowest S.E. of regression, the coefficient thereof appears statistically insignificant.

[6] The F-test suggests that the model fits the data well, with F-statistic of 4.382 and p=value of 0.0004 which is far less than the 1 percent significance level. This fact is also supported by residuals plotted in appended Fig. A4, which exhibit a random walk (stability). Also, the Q-test (Figure. A5) does not provide any evidence to support presence of autocorrelation and partial correction in the data as the residuals fall within the estimated bounds.

[7] S.E. of regression is used to identify the optimal inflation level because in 2SLS, adjusted R^2 is not meaningful and may bear a negative value since some of the regressors enter the model as instruments when the parameters are estimated. Here, the model's residuals are computed over a set of regressors different from those used to fit the model, while the residual sum of squares (RSS) are not constraining to be smaller than the total sum of squares (TSS) leading to negative R^2.

Table 4.2: Inflation Threshold Results

Threshold level	Ordinary Least Squares, OLS						Two-stage Least Squares, 2SLS					
	No Lag			One Lag			No lag			One lag		
	dlogrgdp	Threshold variable	Adj R^2	dlogrgdp	Threshold variable	Adj R^2	dlogrgdp	Threshold variable	S.E. of regression	dlogrgdp	Threshold variable	S.E. of regression
	Coefficient; p-value in brackets	Coefficient; p-value in brackets		Coefficient; p-value in brackets	Coefficient; p-value in brackets		Coefficient; p-value in brackets	Coefficient; p-value in brackets		Coefficient; p-value in brackets	Coefficient; p-value in brackets	
k0	-0.077436	--	0.146794	0.025816	--	0.131381	1.905586	--	0.192173	0.025816	--	0.013132
	(0.6035)	--		(0.8622)	--		(0.9731)			(0.8622)		
k1	0.260841	-0.00132	0.181314	0.384509	-0.001278	0.149507	0.931137	-0.001674	0.014969	0.306337	-0.000999	0.013005
	(0.2449)	(0.0483)**		0.1583	0.1174		(0.8346)	(0.3094)		(0.3567)	(0.3462)	
k2	0.260841	-0.00132	0.181314	0.384509	-0.001278	0.149507	0.931137	-0.001674	0.014969	0.306337	-0.000999	0.013005
	(0.2449)	(0.0483)**		0.1583	0.1174		(0.8346)	(0.3094)		(0.3567)	(0.3462)	
k3	0.260841	-0.00132	0.181314	0.384509	-0.001278	0.149507	0.931137	-0.001674	0.014969	0.306337	-0.000999	0.013005
	(0.2449)	(0.0483)		0.1583	0.1174		(0.8346)	(0.3094)		(0.3567)	(0.3462)	
k4	0.279399	-0.001429	0.187227	0.419415	-0.001437	0.155822	0.711944	-0.001805	0.030417	0.331297	-0.001115	0.01296
	0.21	(0.0357)**		0.1226	(0.0848)*		(0.924)	(0.6074)		(0.3219)	(0.309)	
k5	0.308811	-0.001672	0.201823	0.491116	-0.001798	0.171939	0.568572	-0.001875	0.043567	0.388766	-0.001403	0.012842
	(0.1527)	(0.0171)**		(0.0663)*	(0.0379)**		(0.9424)	(0.8004)		(0.2396)	(0.2211)	
k6	0.362587	-0.002134	0.229567	**0.58228**	**-0.002383**	**0.200216**	0.475974	-0.002429	0.064531	0.471537	-0.001909	0.012626
	(0.0814)*	(0.0042)***		**(0.0241)****	**(0.0095)*****		(0.972)	(0.8188)		(0.1421)	(0.1209)	
k7	**0.352684**	**-0.002414**	**0.232825**	0.551697	-0.002576	0.194926	0.04614	-0.003158	0.120323	0.496221	**-0.002305**	**0.012649**
	(0.0829)*	**(0.0036)*****		(0.0303)**	(0.0123)**		(0.9988)	(0.8479)		(0.1192)	**(0.0978)***	
k8	0.314513	-0.002628	0.226856	0.46815	-0.002544	0.177613	2.954315	0.002136	0.367217	0.526233	-0.002878	0.012786
	(0.1117)	(0.0049)***		(0.06)*	(0.0287)**		(0.9808)	0.9962		'(0.0953)*	(0.0739)*	

Source: Authors computations

The findings in this study compare well with those found for countries with similar economies, where developing economies exhibit relatively high inflation threshold levels. Such a situation could be explained by the fact that the economies are operating far below their potential so increases in prices are crucial in spurring growth, chiefly from the supply side. As the economy advances, the required threshold level declines as well. This phenomenon could be operating in Tanzania's economy as well. Certainly, the seven percent threshold found in this study is below the 8.80 percent results obtained by Yabu and Kessy (2015), probably reflecting economic advancements, which also helped the country graduate to the lower middle-income group in 2020. Worth noting as well is the fact that Tanzania is catching up with Kenya, the more advanced economy in the region with an inflation threshold of around 6.77 percent.

However, in the whole study period, it is only 2008/09 when the inflation target in Tanzania coincides with the estimated seven percent inflation threshold. As depicted in **Figure 3.1**, most of the time inflation targets were far below or above the threshold level, suggesting a possibility for improvement.

6.0 Conclusion and Policy Recommendations

6.1 Conclusion

Price stability is an important policy drive for many countries, mostly pursued with a view to stimulating and sustaining high economic growth. In order to attain this, countries target to attain low and stable inflation. Due to costs associated with high inflation on growth, understanding the inflation threshold rate beyond which growth is hampered is stressed. This study attempts to contribute to this using the OLS regression technique and Tanzanian quarterly data spanning the period from 2001:1 to 2021:4. Two research questions are addressed: What is the relationship between inflation and growth? What inflation target, besides the prevailing

target of 5.4 percent in 2022/23, could be chosen amid the rising commodity prices in the country such that the monetary policy actions continue to spur growth?

The findings suggest that the coefficient of the inflation variable is statistically significant and positive—indicating low inflation supports growth—in which a one percent increase in inflation would lead to an increase in growth by 0.352 percent. The inflation threshold level is seven percent. At this level, the total effect of inflation on growth is estimated at 0.3494 percent suggesting, overall, inflation in the country is pro-growth. Choosing an inflation threshold of eight percent for example would inflict a burden on growth of around -0.0026 per unit compared to -0.0024 per unit likely to originate from the optimal inflation level of seven percent.

It is also found that the inflation levels of 1 to 3 percent have no impact on growth, as echoed by invariable adjusted R^2.

6.2 Policy Recommendations

It is recommended that the Bank may consider inflation targets below seven percent but above three percent in its monetary policy planning with a view to stimulating growth in the country. Since the Bank has largely depended on inflation behaviour in informing inflation targets to choose, which culminated in setting targets far below the optimal inflation, it is recommended to as well benefit from empirically estimated optimal targets. This would reduce the possibility to hamper price increases in the economy, consequently limiting supply. The inflation threshold level should be re-estimated regularly to benefit from any new information stemming from structural changes and advancements in the economy.

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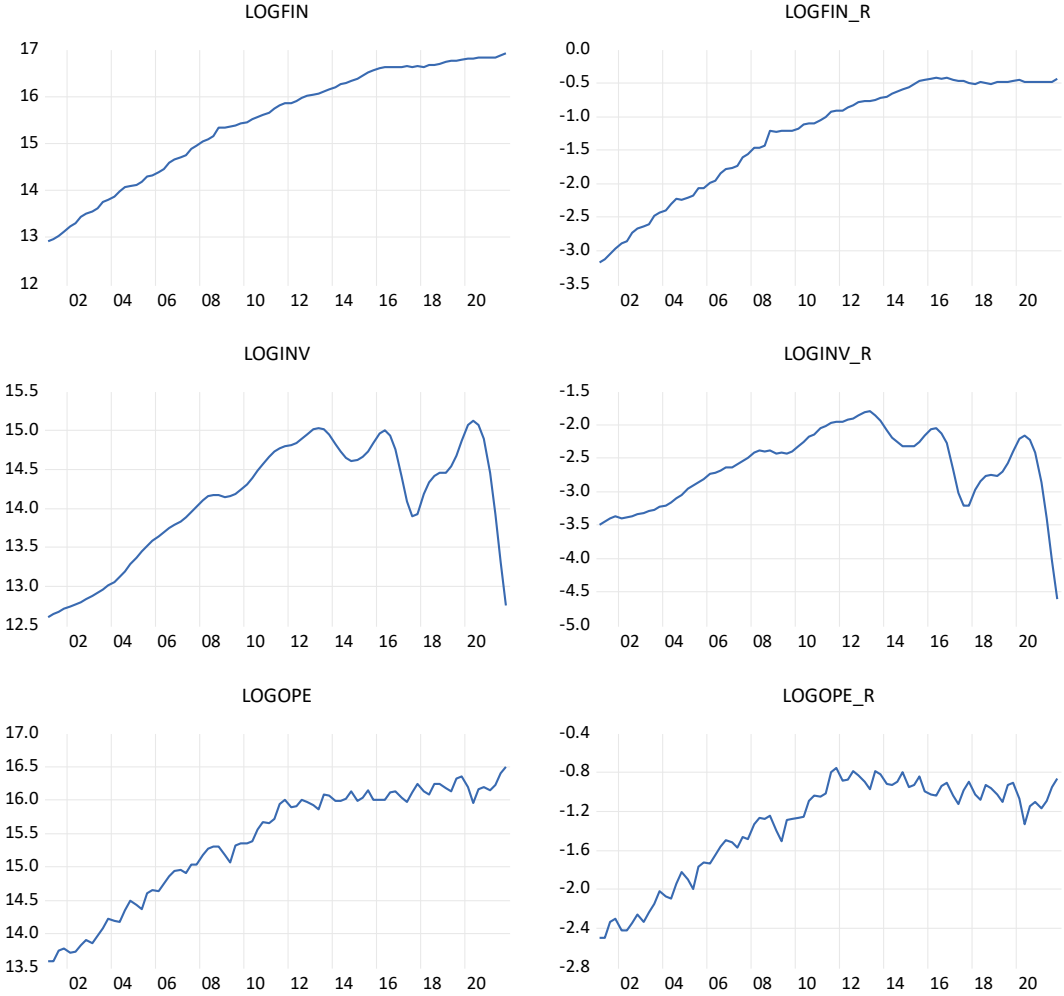
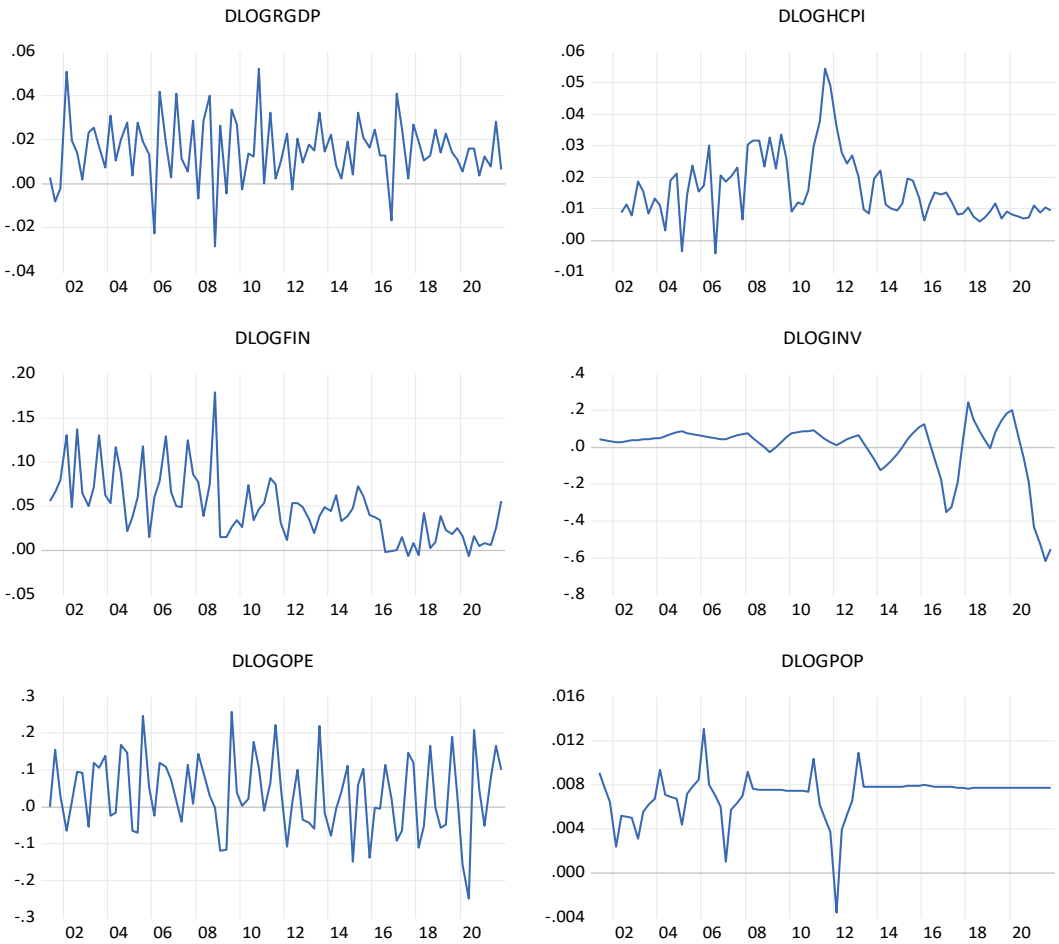
Appendices

Fig.A1: Plots of FIN, INV, OPE as Ratios of RGDP against Logs of Actual Variables



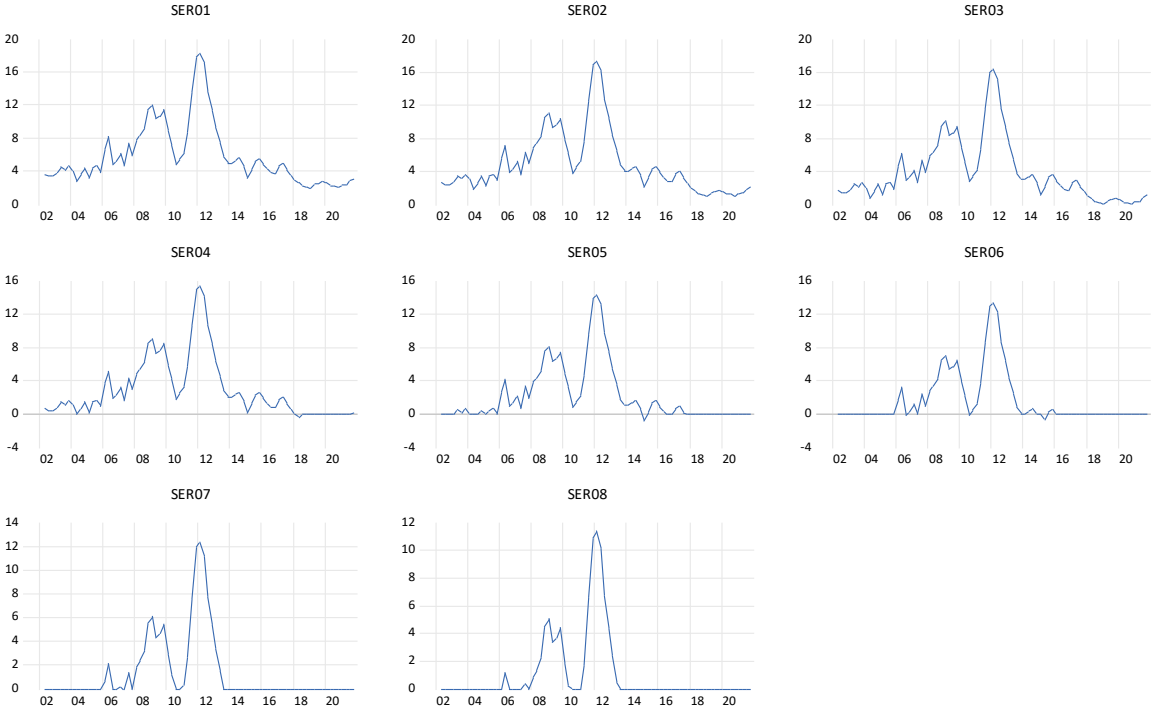
Source: Authors computations

Fig. A2: Plots of Log Difference Variables



Source: Authors computations

Fig.A3: Inflation Threshold Levels used in Regression



Note: SER denotes an inflation threshold level.

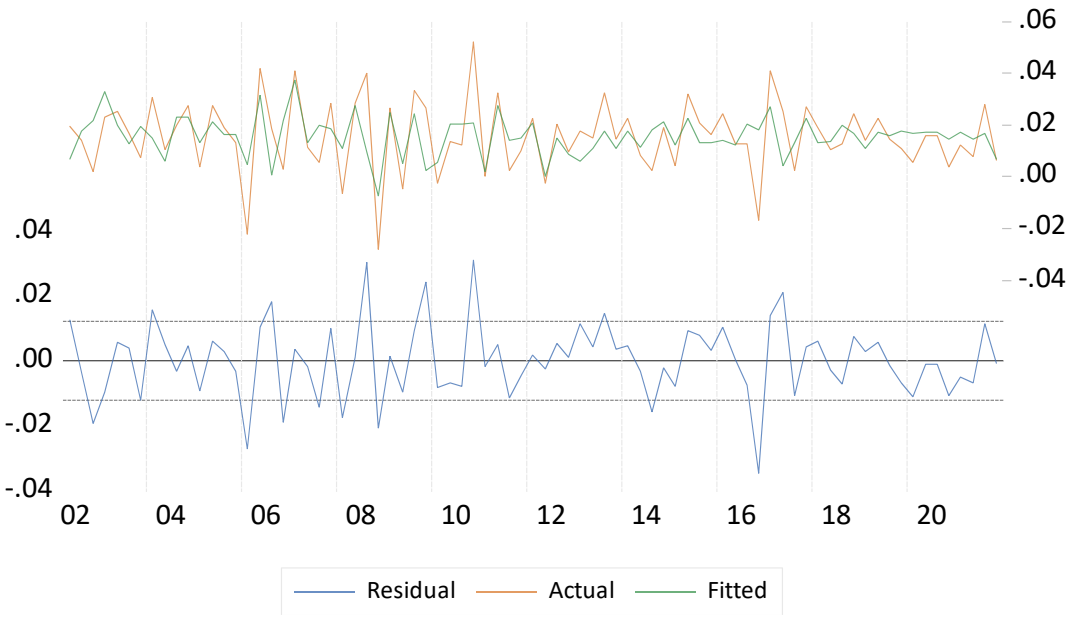
Source: Authors computation.

Table A1: Granger Causality Tests

Pairwise Granger Causality Tests			
Date: 12/25/22 Time: 08:00			
Sample: 2001Q1 2021Q4			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
LOGHCPI does not Granger Cause LOGRGDP	78	0.51359	0.6005
LOGRGDP does not Granger Cause LOGHCPI		2.16005	0.1226
LOGFIN does not Granger Cause LOGRGDP	82	0.49751	0.6100
LOGRGDP does not Granger Cause LOGFIN		2.5518	0.0845*
LOGINV does not Granger Cause LOGRGDP	82	0.00536	0.9947
LOGRGDP does not Granger Cause LOGINV		1.44397	0.2423
LOGOPE does not Granger Cause LOGRGDP	82	0.13065	0.8777
LOGRGDP does not Granger Cause LOGOPE		0.84874	0.4319
LOGPOP does not Granger Cause LOGRGDP	82	1.76204	0.1785
LOGRGDP does not Granger Cause LOGPOP		5.45624	0.0061***
LOGFIN does not Granger Cause LOGHCPI	78	6.92308	0.0018***
LOGHCPI does not Granger Cause LOGFIN		0.24025	0.7871
LOGINV does not Granger Cause LOGHCPI	78	4.3725	0.0161**
LOGHCPI does not Granger Cause LOGINV		2.89935	0.0614**
LOGOPE does not Granger Cause LOGHCPI	78	6.82156	0.0019***
LOGHCPI does not Granger Cause LOGOPE		0.92899	0.3996
LOGPOP does not Granger Cause LOGHCPI	78	0.01448	0.9856
LOGHCPI does not Granger Cause LOGPOP		4.40844	0.0156**
LOGINV does not Granger Cause LOGFIN	82	0.47168	0.6257
LOGFIN does not Granger Cause LOGINV		3.09138	0.0511*
LOGOPE does not Granger Cause LOGFIN	82	3.93211	0.0237**
LOGFIN does not Granger Cause LOGOPE		4.16234	0.0192**
LOGPOP does not Granger Cause LOGFIN	82	0.69368	0.5028
LOGFIN does not Granger Cause LOGPOP		0.35285	0.7038
LOGOPE does not Granger Cause LOGINV	82	5.97178	0.0039***
LOGINV does not Granger Cause LOGOPE		1.64188	0.2003
LOGPOP does not Granger Cause LOGINV	82	0.1918	0.8259
LOGINV does not Granger Cause LOGPOP		0.01131	0.9888
LOGPOP does not Granger Cause LOGOPE	82	0.98958	0.3764
LOGOPE does not Granger Cause LOGPOP		0.2979	0.7432

Source: Authors computations.

Fig. A4: Actual-Fitted Residuals



Source: Authors computations

Fig. A5: Correlogram – Q-Test

Date: 12/28/22 Time: 09:25
Sample (adjusted): 2002Q2 2021Q4
Q-statistic probabilities adjusted for 1 dynamic regressor

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.142	-0.142	1.6615	0.197
		2	-0.222	-0.247	5.7417	0.057
		3	0.000	-0.081	5.7417	0.125
		4	-0.081	-0.165	6.3079	0.177
		5	0.119	0.060	7.5266	0.184
		6	-0.131	-0.177	9.0388	0.171
		7	-0.020	-0.042	9.0757	0.247
		8	-0.006	-0.119	9.0786	0.336
		9	0.207	0.213	13.011	0.162
		10	-0.091	-0.120	13.783	0.183
		11	-0.088	0.028	14.506	0.206
		12	0.095	0.003	15.371	0.222
		13	0.080	0.182	15.990	0.250
		14	-0.049	-0.095	16.229	0.300
		15	-0.143	-0.011	18.264	0.249
		16	-0.042	-0.151	18.442	0.299
		17	0.156	0.180	20.969	0.228
		18	0.133	0.028	22.824	0.197
		19	-0.200	-0.035	27.101	0.102
		20	0.040	0.025	27.275	0.128
		21	0.027	0.011	27.355	0.159
		22	0.029	0.001	27.452	0.195
		23	-0.028	-0.011	27.539	0.234
		24	-0.138	-0.066	29.760	0.193
		25	0.145	0.100	32.265	0.150
		26	0.061	0.011	32.712	0.171
		27	-0.047	-0.012	32.985	0.198
		28	-0.171	-0.125	36.667	0.126
		29	-0.013	-0.080	36.690	0.154
		30	0.117	-0.058	38.476	0.138
		31	-0.057	-0.089	38.906	0.156
		32	-0.063	-0.085	39.438	0.172

*Probabilities may not be valid for this equation specification.
Source: Authors computations