

THRESHOLD EFFECTS OF INFLATION ON ECONOMIC GROWTH IN RWANDA

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Abstract: The objective of this thesis was to estimate the threshold effects of inflation on economic growth in Rwanda. Time-series data from 1972-2021 were accessed from World Bank and analyzed using both LS and 2SLS Threshold Model. GDP growth rate, investment growth rate, inflation rate and population growth rate and other instrumental variables were used to model the equation estimated. Therefore, the study explored the threshold level of inflation being 6 percent, which means that below 6% stimulate the economy growth while beyond it can hamper economic growth. Mainly, the findings proved that Rwanda has a moderate inflation threshold level compared to other developing countries whereby inflation threshold fluctuate above 6% and 15%. Concluding, this research revealed the up bound where inflation rate should not go beyond for stimulating the economy and it is known that low inflation rate drives the economic growth. So, there is a need to conduct a research for determining that low level of inflation that could not affect the economic growth. As well, other researchers are called upon to conduct the research on the effect of inflation threshold in Rwanda using other techniques and variables for exploring inflation dynamics on economic growth in advance.

Keywords: Inflation threshold level; economic growth; inflation rate; inflation dynamics; time series.

1. INTRODUCTION

One of the country's macroeconomic targets especially for central bank is to beat the inflation to its lower value (Abuselidze and Shota Rustaveli, 2019). A low inflation may be good for an economy to grow, otherwise higher inflation may put economic status of country in danger (Behera and Mishra, 2017). Many questions are still arising from different researches including this.

Seleteng et al. (2013) refer threshold inflation as an optimal level where when the inflation rate is low which results into a positive relationship between inflation and economic growth and a negative relationship when the inflation rate is high, hence implying that there is an optimal level, or a threshold level of inflation. This definition is also aligned with Mubarik (2005)'s concern about a policy issue of "how much of inflation is too much; that is, how much inflation impedes economic growth?".

Many researches have been done trying to analyze the threshold level of inflation that is optimum for economic growth using different data and different models as well as techniques whether for single country cases and these researchers are dealing with finding and capturing the threshold level of inflation for both developing and developed country (Wollie, 2018). What is realizable is that at some level of inflation, the relationship is positive, but at higher rates it becomes negative. This occurs at the inflexion point, or threshold, where the sign of the relationship between the two variables would switch signs.

Mostly these two variables mentioned in the above have their respective measures, most widely used variables are Consumer Price Index (CPI) and the Gross Domestic Product (GDP) to represent inflation and economic growth of an economy respectively. Economic growth is defined by Uwiringiyimana et al. (2021) as an increase in the size of a country's economy over time whereas inflation is defined by Herman (2021) as the tendency of prices to rise generally and continuously.

From the above arguments we can now develop a hypothetical statement that we can use in this research that states "at a given level of inflation at a given growth of economy, above that inflation rate may hence have effects on the economic growth of that economy".

As per the BNR (2022)'s projections and forecast in Rwanda, inflation is projected to be above the inflation benchmark of 5.0 percent in 2022 on average but not exceeding the upper bound of 8 percent. Since 1996 up to 2021, GDP growth and inflation rate trend show that an increase in inflation is followed by a decline in GDP growth. For instance, the highest trough (deflation) and highest peak (inflation) of inflation of 1998 and 2008 was -13.6 and 22.3 percentage points of inflation respectively which is a fact that raise in inflation led to a decline in GDP growth. The 2008 higher inflation is attributed to the great recession of 2007-2009.

Inflation that is either higher than or lower than the normal rate is undesirable because it has the ability to erode the purchasing power of currency. A general increase in prices over time reduces the purchasing power of consumers because a consumer's income can buy progressively less with the same amount of money as prices continue to rise. The combination of the cost-push theory and the demand-pull theory illustrates how inflationary pressure can grow from aggregate demand and costs of production – or, more simply, demand and supply (Benjamin, 2000).

According to Ndoricimpa (2017b), it does not make sense to say that the best time for the economy is when inflation is at its lowest point (the so-called "deflation") because, to put it simply, when prices are falling, businesses and entrepreneurs may be hesitant to invest in new plants and equipment. As a result, this causes an increase in the rate of unemployment, and inflation may make it simpler for some households with higher wages to pay off their debts. It is possible that consumers will no longer be able to afford higher prices on essential goods such as food and gasoline if wage growth is not keeping pace with inflation.

Inflation of a moderate level is generally regarded as evidence of a healthy economy. This is due to the fact that as an economy expands, there is a rise in the amount of demand for various goods. As a result of this increase in demand, prices are pushed slightly higher as suppliers attempt to produce more of the item that customers and businesses are interested in purchasing. Workers stand to benefit from this economic expansion because it leads to an increase in the demand for labor, which, in turn, typically results in an increase in wages. Risso et al. (2009) asserted. However, the problem remains "how much of inflation is healthy to the economic growth of the country?"

If that is the problem, then the purpose of this thesis is to empirically propose to the monetary policymakers, most notably the central bank, on the levels of inflation that may reflect a good monetary policy about the threshold effects of inflation. This is done to avoid any problems that can fall short of the ability of the BNR to keep inflation under control.

2. LITERATURE REVIEW

The school of thought believes that inflation can rise from different channels whether demand, supply or money supply causes whereas there are still different contradictions between the theories attached to inflation for example the critics of Milton Friedman on both Keynes theory of inflation and simple Phillips Curve (Edward and Anna J., 2007). Therefore, various literature has explored the threshold effects of inflation on economic growth to understand behaviors of economic growth due to the level of inflation (switching signs of relationship).

Azam and Khan (2020), using an innovative threshold model and system GMM approaches for a panel of 113 economies over the period 1981–2015 has revealed that high inflation rates cause negative effects to the long-run economic growth. Few years ago, Khan and Senhadji (2001) analyzed the threshold effect of inflation on economic growth for 140 developed and developing countries using a non-linear least square (NLLS) method. The results found that the threshold inflation is 1 to 3% for developed countries and 11% to 12% for developing countries. These findings were complemented by different authors where Mukoka (2018) using OLS for Zimbabwe with a time series from 1990 to 2017, has found that inflation was negative but statistically insignificant and not a necessary pre-condition for economic growth in Zimbabwe; but he still advised the government to keep inflation rate at a single figure. Doguwa (2012) using different threshold analysis models namely; Sarel, Khan and Senhadji, and Drukker et al., for Nigeria with data from 2005Q1 to 2012Q1, has investigated the existence and magnitude of the inflation threshold in Nigeria's relationship between inflation and growth, has found that even though 9.9 percent is an inflation threshold that is not entirely identified by the data, the paper strongly suggests the existence of a threshold point of 10.5 that is well identified by the data. The findings also point to a two threshold-point model for Nigeria, with the two points being 11.2 and 12 percent, above which inflation has a detrimental impact on growth.

Risso et al. (2009) had the purpose of estimating the long-run relationships and threshold effects between inflation and economic growth in Mexico. The findings using threshold analysis showed that 9 percent was the threshold level of inflation but below this rate, the inflation would not have an effect (insignificant) on GDP growth whereas above this percentage, the inflation exercises negative effects on economic growth.

This study is in line with Saleem (2020) using the methods of fixed effects and feasible generalized least squares (FGLS) re-evaluated the threshold effect of inflation on economic growth for 27 countries (16 developing and 11 developed economies) over a period span of 1975–2018. The results found that inflation threshold is 12.23% and 5.36% for developing and developed countries, respectively; which is justifiable that developing countries realize high inflation threshold point compared those in developed countries (Ibarra and Trupkin, 2016; Azam and Khan, 2020).

On the other hand, Pollin and Zhu (2005) have used a novel non-linear regression estimation from data spanning 1961 to 2000. They performed tests on the full sample of 80 countries, income-based sub-samples of OECD countries, middle-income countries, and low-income countries, as well as time-based sub-samples using four decades for the specified sample time frame. The results for the full sample data set reveal that higher inflation is associated with moderate gains in GDP (about 0.1 to 0.15 percent) growth up to 15% and 18% inflation threshold. However, when they considered income-based samples, OECD and middle-income countries' coefficients are not significant; only the low-income countries' coefficients are statistically significant where the threshold is between 15-23%.

Moreover, Nduricimpa (2017a) using a dynamic panel threshold regression for a panel of 47 African countries has found that low inflation is growth-enhancing for the middle-income countries but does not affect economic growth for the low-income countries. The findings have shown that inflation above the threshold level is detrimental to economic growth for all the cases considered.

3. METHODOLOGY AND DATA

This research was explanatory where the analysis of the matter examined the causal effects of the inflation behavior due to consumption patterns in Rwanda.

This research followed different preliminary analysis including descriptive statistics and post-estimation techniques which composed of various diagnostics to ensure that data are structured well and estimates are reliable and robust.

3.1 Model Specification

In this research modelled the threshold model by dummy method. The threshold model is a model introduced by Sakoda (1949) in his dissertation at University of California Berkeley, then developed by Schelling and Granovetter (Breer, 2017). This model was developed especially for threshold level analysis of inflation by Khan and Senhadji (2001) as mentioned in the literature review, it was then used by many authors.

This paper considered variables that may have influence on economic growth including but not limited to; Growth rate of real GDP, Annual Inflation, Population growth rate, and Investment Growth Rate.

$$grGDP = f(INFL, grPOP, grINV)$$

This study utilized both Least Squares (LS) and two-stage least squares (2SLS) inspired by Risso et. al (2009) to be able to obtain threshold estimates from the variables of an equation. Furthermore, inflation was taken as endogenous variable which implied to adjust inflation variable by its square.

Following Risso et. al (2009), the threshold equation is:

$$y_t = \beta_0 + \beta_1 \log(\pi_t) + \beta_2 \Delta(\log(\pi_t) - h) + \varphi' X_t + \varepsilon_t$$

Where:

h = Threshold inflation rate

Δ = Dummy variable that takes a value of one for inflation levels greater than h percent and zero otherwise.

$$\Delta = \begin{cases} 1, & \pi_t > h \\ 0, & \pi_t \leq h \end{cases}$$

X_t = A vector of control variables

ε_t = Error term variable

The above model was used for analysis and discussion purpose.

The applied strategy by (Asab and Al-Tarawneh, 2020) specifies the use of hybrid function of inflation that is logarithmic for inflation rates above one and linear for inflation rates below or equal to one in order to prevent missing values on negative inflation rates or negative infinity values for rates close to zero.

$$f(\pi_t) = (\pi_t - 1)I(\pi_t \leq 1) + \log(\pi_t)I(\pi_t > 1)$$

By expanding the model to its final structure and getting a dummy $\Delta = 1$, we get:

$$y_t = \beta_0 + \beta_1 \log(\pi_t) + \beta_2(\log(\pi_t) - h) + \varphi_1 rGDP_t + \varphi_2 grPOP_t + \varphi_3 grINV_t + \varepsilon_t$$

3.2 Measurement of variables

Variables measured were as follows:

The GDP growth as discussed in the second chapter; was measured by the change in GDP of current period from the previous period.

$$grGDP_t = \frac{Gdp_t}{Gdp_{t-1}} - 1$$

Gdp_t is the logarithmic value of Gross Domestic product.

The population growth was measured by taking the difference logarithm of the value of population for the current time to the previous period.

$$grPOP_t = \frac{Pop_t}{Pop_{t-1}} - 1$$

Pop_t is the logarithmic value of Population.

The investment growth followed the same formula by taking the difference logarithm of the value of private investment for the current time to the previous period.

$$grINV_t = \frac{Inv_t}{Inv_{t-1}} - 1$$

Inv_t is the logarithmic value of Population.

Among the good practices of handling the variance among variables is the transformation, this research used the logarithmic transformation. Different literature refers the log transformation to deal with the problems of skewness and heteroskedasticity (Benoit, 2011) or the “variance stabilizer” (Olvera Astivia and Zumbo, 2019).

3.3 Data Collection

This research purely was based on secondary data from government publications, Public and private records, historical and statistical documents, private documents and other technical journals of different institutions (e.g., IMF, World Bank, BNR, ...) to avoid inaccuracy and poor quality of data, especially on sensitive variables (e.g., inflation and other macro-economic variables) as well as meet the allocated research timeline. Time series data used were available at World Bank open source. Therefore, data used were the records from 1972 to 2021.

Table 1: Data Source

Variable	Variable Description	Time Frame	Data Source
INF	Inflation rate	1972 - 2021	World Development Index
GRGDP	GDP growth rate	1972 - 2021	World Development Index
GRINV	Investment growth rate	1972 - 2021	World Development Index (WDI)
GRPOP	Population growth	1972 - 2021	World Development Index (WDI)

3.4 Data Processing and analysis

To ensure accuracy in the data, the analysis process included cleaning, transforming and processing data:

- i. All variables presented in table 1 for a period of 50 years, that is from 1972 up to 2021 were used to examine the inflation threshold level in Rwanda.
- ii. As per economic concepts, data transformation including, log, product/division, interpolation, and/or addition/subtraction operators were also applied.

This research involved data analysis and interpretation in order to take decisions based on tangible estimates and evidence. Econometric techniques applied for analyzing time series which have conditional heteroscedasticity, non-linear regression

for this study were used. This means, the First stage Least Squares (LS) and Two-Stage Least Squares (2SLS) models for estimating the inflation threshold effect on economic growth. The time series were firstly checked for stationarity and the findings revealed that all series are stationary in levels, ie I(0).

Threshold effects models of inflation using dummy variable was used assuming that in Rwandan economy, at a certain level of inflation, there is realization of economic growth otherwise inflation become harmful to economic growth. After obtaining numerical values of our estimates, the interpretation of the results obtained enabled to make conclusion and recommendations.

4. EMPIRICAL ANALYSIS

4.1 Descriptive statistics of the data

Table 2: Statistic of the variables used in the model

Statistic	GDP	INF	INV	POP
Mean	5.158737	7.90858	12.65613	2.464747
Median	6.073759	7.211868	9.302996	2.65613
Maximum	35.22408	31.0883	155.7849	8.117946
Minimum	-50.24807	-2.405932	-81.77223	-6.766133
Std. Dev.	10.40889	6.743149	29.63654	2.770234
Skewness	-2.60664	1.452902	1.767541	-1.515515
Variance	108.345	45.47006	878.3247	7.674196
Kurtosis	18.37882	6.127808	13.89434	6.498238
Sum	257.9369	395.429	632.8063	123.2373
Se(mean)	1.472039	.9536252	4.19124	.3917702
Observations	50	50	50	50

Table 2 presents the statistics of the variables which are the GDP growth, investment growth rate, inflation rate and population growth rate in Rwanda since 1972 to 2020. There is volatility in these time series as shown; the minimum and maximum growth of GDP range from -50.25% and 35.22%, the inflation rate ranges from -2.4% to 31.08%, the investment rate ranges from -81.77% to 155.78%, and population growth range from -6.76% to 8.11%. Therefore, it is necessary to transform these time series in logarithmic form and test stationarity for the purpose of running robust LS model.

4.2 Stationarity test

Table 3: Augmented Dickey Fuller (ADF) test output

Variables	t-statistic	t-critical (5%)	p-value	conclusion
lnGDP	-7.116	-2.933	0.0000	Stationary
lnINFL	-5.392	-2.933	0.0000	Stationary
lnINV	-7.857	-2.933	0.0000	Stationary
lnPOP	-3.378	-2.933	0.0117	Stationary

Table 3 shows that all series are stationary in levels, that is order zero I(0) , which means that the null hypothesis (Existence of unit root) was rejected in favor of the alternative hypothesis. The p-values were statistically significant as are less than 5%.

4.3 Threshold method using dummy variable

Table 4: Estimation of non-linear model at k=2 to k=6

k	Variable	Coefficient	Std.Error	t-Statistic	Prob.	RSS
K=2	Inflation rate	.164845	1.226455	0.13	0.894	0.4990
	Investment growth	.2146704	.0361703	5.93	0.000	
	Population growth	4.788546	1.637334	2.92	0.005	
	(INF>2)*(INF-2)	-.4111624	1.293784	-0.32	0.752	
	C	-6.52711	4.413089	-1.48	0.146	
K=3	Inflation rate	-.081099	.9267144	-0.09	0.931	0.4982
	Investment growth	.2148178	.0362329	5.93	0.000	
	Population growth	4.768796	1.639313	2.91	0.006	

	(INF>3)*(INF-3)	-0.1544082	1.003204	-0.15	0.878	
	C	-6.265649	4.519311	-1.39	0.172	
K=4	Inflation rate	-0.1151074	0.7473146	-0.15	0.878	0.4981
	Investment growth	0.2148049	0.0362466	5.93	0.000	
	Population growth	4.771427	1.641643	2.91	0.006	
	(INF>4)*(INF-4)	-0.1225386	0.8400287	-0.15	0.885	
	C	-6.262064	4.560484	-1.37	0.177	
K=5	Inflation rate	-0.1021679	0.6180845	-0.17	0.869	0.4983
	Investment growth	0.2145388	0.0362907	5.91	0.000	
	Population growth	4.787677	1.645432	2.91	0.006	
	(INF>5)*(INF-5)	-0.1451741	0.7257174	-0.20	0.842	
	C	-6.383395	4.571877	-1.40	0.169	
K=6	Inflation rate	-0.046416	0.5117018	-0.09	0.928	0.4993
	Investment growth	0.2139153	0.0362887	5.89	0.000	
	Population growth	4.829366	1.647366	2.93	0.005	
	(INF>6)*(INF-6)	-0.2260436	0.6271925	-0.36	0.720	
	C	-6.719875	4.553101	-1.48	0.147	

Table 4 presents a precise value of threshold inflation level and also quantifies the impact of that level on economic growth. The ordinary least square regression was estimated and the residual sum of square (RSS) for threshold level of inflation ranging from k_2 percent to k_n percent was computed. Therefore, for summarizing the findings, only $k=2$ up to $k=6$ as they have minimum RSS are presented in the table4. The inflation threshold level is four percent and inflation greater to 4% tend to decrease the economic growth. However, the t-statistics and their p-values revealed that population growth and investment growth are significant whereas inflation is insignificant.

4.4 Sensitivity analysis

There could be a specification bias of the estimated least square model; that is, exclusion of other relevant variables for a growth equation.

Table 5: Two-Stage least squares regression output

k	Variable	Coefficient	Std.Error	t-Statistic	Prob.	RSS
K=4	Inflation rate	-0.7239527	0.9288205	-0.78	0.440	0.5102
	Investment growth	0.2168047	0.0358248	6.05	0.000	
	Population growth	4.873448	1.593901	3.06	0.004	
	(INF>4)*(INF-4)	0.7162547	0.9298141	0.77	0.445	
	C	-4.513389	5.035141	-0.90	0.375	
K=5	Inflation rate	-0.5031009	0.7387547	-0.68	0.499	0.5086
	Investment growth	0.2164611	0.0358946	6.03	0.000	
	Population growth	4.876794	1.598169	3.05	0.004	
	(INF>5)*(INF-5)	0.4953341	0.7397933	0.67	0.507	
	C	-4.873132	5.033542	-0.97	0.338	
K=6	Inflation rate	-0.3638347	0.6109866	-0.60	0.555	0.5074
	Investment growth	0.2161477	0.0359506	6.01	0.000	
	Population growth	4.881534	1.601978	3.05	0.004	
	(INF>6)*(INF-6)	0.356009	0.6120798	0.58	0.564	
	C	-5.1929	5.023066	-1.03	0.307	
K=7	Inflation rate	-0.3146846	0.5185835	-0.61	0.547	0.5075
	Investment growth	0.2162504	0.0359599	6.01	0.000	
	Population growth	4.872038	1.603387	3.04	0.004	
	(INF>7)*(INF-7)	0.3069069	0.519737	0.59	0.558	
	C	-5.184565	4.996279	-1.04	0.305	
K=8	Inflation rate	-0.2748881	0.4479281	-0.61	0.543	0.5076
	Investment growth	0.216307	0.0359658	6.01	0.000	
	Population growth	4.865883	1.604424	3.03	0.004	
	(INF>8)*(INF-8)	0.2671412	0.4491206	0.59	0.555	
	C	-5.198168	4.963221	-1.05	0.301	

To check this bias, inflation transformation was used as instruments. The results of 2SLS (Table 5) also suggest 6 percent threshold. It is generally known that high inflation is harmful to economic growth, however, some economists believe that a small amount of inflation drive economic growth. According to Azam and Khan (2020); Mundell (1963); Tobin (1965); and Stockman (1981), a low inflation rate stimulates the economic growth. This is consistent with the findings of this study. The coefficient of inflation is negative and insignificant which is similar to the study conducted by Mukoka (2018) in Zimbabwe and he advised the government to keep inflation rate at a single figure which could be same for Rwanda. The investment and population growth are positive and significant which indicate positive effect on growth. According to the projections of NBR (2022), the current inflation is above the inflation benchmark of 5.0 percent in 2022 on average but not exceeding the upper bound of 8 percent. So, this study revealed that inflation should be kept under 6% which is quite similar to the prediction of NBR. This will allow the country to at least keep a single digit inflation as walking as possible but nevertheless will require the establishment of strong monetary policies in order to maintain economic welfare. Thus, decision-makers are called-upon to stabilize macroeconomic issues such as trade, exchange rate, and interest rate which are adversely affected by international economies or globalization.

The findings of this study are quite similar to the study conducted by Doguwa (2012) ; Sarel, Khan and Senhadji, and Drukker et al., in Nigeria which emphasized that developing countries inflation fluctuate above 6%, whereas Azam and Khan (2020) found that inflation threshold is 12.23% and 5.36% for developing and developed countries, respectively. Ndoricimpa (2017a) argued that low inflation rate boosts economic growth in middle income countries while it doesn't in low-income countries, which means that developing countries should have moderate inflation threshold for accelerating the economy.

5. CONCLUSIONS

The aims of this study were to determine the threshold effects of inflation on economic growth in Rwanda. This included to determine the threshold level of inflation and its effect on economic growth in Rwanda. The estimates were obtained from running LS and 2SLS model that uses dummy method. First of all, time series transformation was done for analyzing stationarity series. Even though there is no standards techniques of selecting inflation threshold, 2k up to 6k was used in the first stage least squares while 4k to 8k were used in 2SLS model.

The findings of this study revealed a 6% threshold inflation which should not be beyond for welfare of the population of Rwanda. More specifically, the threshold model estimation recommends 6 percent threshold inflation level for economic growth at which inflation is red alert for economic growth. The inflation below the estimated level of 6 percent is conducive for economic growth. Previous empirical studies conducted in developing countries argued that inflation threshold is 6 percent and above. They further added that low inflation level, say example of 2 percent, cannot influence economic growth in low-income countries while does in middle-income countries. Thus, this study found that Rwanda's threshold inflation is in track of accelerating the economy. However, this study does not estimate the level of inflation that is too low for economic growth; indeed, this calls for further research on the topic. Again, the findings showed that inflation is negative and insignificant which implies further studies for investigating the reason behind. Macroeconomic factors such as interest rate, exchange rate, imports or trade in general and political stability were highlighted among others to led volatility in prices meaning that policy makers attentions should be macroeconomic stabilization.

To conclude, review of the literature indicated that NBR estimate inflation rate to vary between 5% and 8%. However, the findings revealed a threshold inflation of 6% which implies that beyond that threshold inflation level will harm the economic growth.

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