Estimating the inflation threshold for South Africa

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Abstract

How detrimental is inflation to growth in South Africa? At what level? Motivated by the adoption of inflation targeting by many countries, this paper sets out to empirically determine the threshold level of inflation in South Africa. This study adopts quarterly time series data spanning over the period 1980:Q2 to 2010:Q3. The threshold regression model developed by Khan and Senhadji (2001) was used in this study. The econometric technique used is the Ordinary Least Squares (OLS) and the model was re-estimated using the two-stage least squares instrumental variable (2SLS-IV) to check for robustness. The results show that the inflation threshold level occurs at 4 percent. At inflation levels below and up to 4 percent there is a positive but insignificant relationship between inflation and growth. The relationship becomes negative and significant when the inflation rate is above 4 percent. The tests of robustness support these findings.

JEL Classification: *E31, C12, C22*

Keywords: *Inflation, GDP Growth, Threshold level, South Africa.*

1 Introduction

One of the fundamental macroeconomic objectives for most countries is economic stability characterised by high and sustained output growth with low inflation (Khan and Senhadji, 2001). This has led to many industrialized as well as developing countries adopting inflation targeting, including South Africa. The South African monetary policy system underwent a change through the adoption of inflation-targeting framework in February 2000, where it has been targeting single digit inflation rate of 3 to 6 percent. Since September 2003 the inflation rate moved into and remained within the target band of 3 to 6 percent. It later accelerated in 2007, exceeding the upper target band of 6 percent as set by the South African Reserve Bank (SARB, 2007).

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Some of the factors that have significantly contributed to recent trends in consumer price inflation in South Africa are economic which include food prices, housing costs, transport cost and medical care and health expenses, and increase in wage demand leading to higher anticipated inflation rate. Another reason for the increases in consumer price inflation was said to be as a result of excessive lending. Although banks are often exposed to companies than to households, their exposure to households is also momentous (SARB, 2004).

While the food prices peaked at 20.8 percent in October 2002, transport cost increased to 9.6 percent in December 2002, the range of the housing cost was between 8.1 and 11.3 percent in the same period and the inflation for medical care and health expenses was 13.5 percent in November and December 2002 (SARB, 2004). Although the inflation rates for these components declined considerably in the subsequent years, even to one digit numbers, they recently picked up (SARB, 2004).

Furthermore, it is also important to have a closer look at the consumer price inflation against changes in the gross domestic product (GDP) of South Africa. While inflation rate averaged 14.3 percent over the periods 1984 to 1993; GDP was 1 percent on average. However, the macroeconomic performance of South Africa improved considerably with a continuous increase in GDP growth, after 1994. On the other hand, the consumer inflation in South Africa has been fluctuating; it increased from 5.3 percent in 2000 to 5.7 percent in 2001; it was as high as 11.5 percent on average between August 2002 and March 2003, but remained on a down swing since then. It dropped sharply in 2004 to 1.4 percent, after which it increased to 3.4 percent in the following year and 4.6 percent in 2006. The rate increased to 5.3 percent in January 2007.

The annual GDP growth rate between September 1999 and June 2005 averaged 3.5 percent. The annual growth rate was 2.8 percent in 2003; it increased to 4.5 percent in 2004 and further increased to 4.9 percent in 2005 (Economy overview, 2006; Mboweni, 2006). Inflation rate stood at 5.5 percent in March 2007, but increased in the second quarter due to pressure on domestic prices namely, increase in prices of international crude oil and food prices. In April 2007, the rate of inflation was 6.3 percent exceeding the upper inflation target band and it was 7.7 percent in July 2007 (SARB, 2007; DTI, 2007).

The contribution of this study is its addition to the research carried out by Hodge (2005), where he used annual data over the period 1950 to 2002 and quarterly data for the period 1970 to 2003. He considered a relationship between inflation and growth. The two main issues he addressed were, Do South African data support the cross-section studies of adverse effect of inflation on growth in the long run? and secondly, Can higher growth be obtained with higher inflation in the short run? The result obtained showed that in the short run, movements in growth require increased speed of inflation and in the long run, inflation is detrimental to growth and suggested an abandonment of inflation targeting for increased growth to be achieved.

However, this study aims to answer the following questions: How inimical is inflation to growth? How low or high should inflation rate be? And at what level does inflation significantly negatively affect growth? This study answers

these questions by adopting the threshold model developed by Khan and Senhadji (2001) in order to obtain the exact threshold level of inflation for South Africa. The point where the effect of inflation on GDP growth rates changes from positive to negative or vice versa will be the threshold level. This study is different from Hodge (2005) in that the inflation threshold is estimated. This is the point where the effect of inflation on GDP growth rates changes from positive to negative or vice versa. This study also considers data period beyond the period considered by Hodge (2005).

Figure 1 illustrates the trend in GDP growth and inflation rates over the period 2000 to 2009. It is clear from the figure that GDP growth rates were mostly below 6 percent during the period considered, while inflation rates were above average percentage of 5 percent. There is unfortunately no clear identification of the relationship between inflation and GDP growth rates from this figure. Nevertheless, the movement between these two variables somewhat shows a negative relationship between 2002 and 2004 in that while inflation rates declined, GDP growth was picking up. Also between 2006 and 2008, GDP growth was declining when inflation rates were increasing, beyond which it started falling when inflation rates were decreasing; this is the time of recession which was recorded during that period.

Insert Figure 1 on page 22 about here.

2 Review of the literature

A brief review of the studies that tested the relationship between inflation rates and GDP growth is first outlined followed by studies on the optimal inflation level. A number of studies that were carried out tested the relationship between inflation rate and GDP growth rate and the notion of negative inflation-growth nexus was found. Different conclusions were reached theoretically and empirically regarding the impact of inflation on economic growth (Frimpong and Oteng-Abayie, 2010). Some common negative effects of high inflation include the poor being adversely affected due to lack of financial assets, inhibiting financial development, increasing welfare cost, reduction in the international competitiveness of a country because of a more expensive export, and thereby resulting in the reduction of economic growth in the long run (Ocran, 2007; Khan and Senhadji, 2001; Feldstein, 1982).

Furthermore, several researchers such as Khan and Senhadji (2001), Dotsey and Sarte (2000), Chari *et. al* (1996) and Barro (1995) found a negative relationship between inflation and growth using non-linear model for the inflation-growth relationship. Fischer (1993) used several macroeconomic variables to identify their effect on the growth rate of 93 countries. Using consumer price inflation as one of the macroeconomic variables, he found a significant negative correlation between inflation and growth rates. Hodge (2005) estimated a simple linear model to study the relationship between inflation and growth in South Africa. He used annual data over the period 1950 to 2002 for the medium to long term model and quarterly data for the period 1970 to 2003 for the short run

model. He found a significant negative inflation-growth relationship for both models.

On the other hand, when Faria and Carneiro (2001) used monthly inflation and real output data from January 1980 to July 1995, they found no relationship between inflation and growth rates in the long run, for the case of Brazil. There was, however, a significant negative inflation-growth effect in the short run. Furthermore, Ahmed and Mortaza (2005) explored the relationship between inflation and economic growth for Bangladesh using Engle-Granger and Error Correction Model for the period 1950 to 2005. Their result demonstrates that there is a long-run negative relationship between inflation and economic growth.

However, research has further shown that there is a non-linear relationship between inflation and GDP growth; where the relationship changes from positive to negative or vice versa. The non-linearity which is the focus of this study gives the threshold of inflation for South Africa. Previous studies that addressed this issue, adopting both country-specific and panel data analysis for various economies, are reviewed.

Frimpong and Oteng-Abayie (2010) used the threshold regression model to estimate the threshold effect of inflation in Ghana using data over the period 1960 to 2008. Vector of control variables such as growth rate of the following variables: gross domestic investment as a proportion of GDP, terms of trade, aggregate labour force, and money supply were used. The result shows an inflation threshold level of 11 percent and if inflation increases beyond this level, growth is expected to fall by 0.02 percent. The sensitivity analysis used to check robustness also confirms this inflation threshold level.

Mubarik (2005) conducted an empirical study on Pakistan, using the data from 1973 to 2000. The Granger causality test was adopted to decide the dependent and independent variables. Using 2-stage least squares to test for the robustness, the threshold level of inflation rate of 9 percent was obtained. If inflation rate is below 9 percent, it is found to be favourable for the Pakistani economy while it is harmful to economic growth if inflation rate is above 9 percent. Sweidan (2004) carried out a research on the Jordanian economy, and found that the threshold level of inflation in Jordan is 2 percent. It was found that there exists a positive relationship between inflation and economic growth when inflation is below 2 percent but it changes to having a strong negative effect on economic growth beyond this point.

Fabayo and Ajilore (2006) also examined the threshold level of inflation in Nigeria for the period 1970 to 2003. The threshold regression model used by Khan and Senhadji (2001) was adopted and they found the inflation threshold level of 6 percent for Nigeria. The tests for robustness also support the finding. Above this inflation threshold level, growth is adversely affected, while at inflation levels below 6 percent, there is a significantly positive relationship between inflation and growth.

Furthermore, the effect of non-linear inflation on economic growth was examined by Sarel (1996), using data on GDP and consumer price indices among other variables. Annual panel data from 87 countries over the period 1970 to 1990 was adopted. An evidence of a structural break was found and the result

further showed a significant and robust negative relationship between inflation and growth rates with the threshold inflation level of 8 percent. This is in line with the study carried out by Phiri (2010) on South Africa, where quarterly data over the period 2000 to 2010 was used. The variables considered are real GDP growth, inflation rate, investment, credit, equity and real effective exchange rate. While investigating the inflation threshold level that is unfavourable towards the South African finance-growth activity, the result showed that the inflation threshold level of 8 percent is the optimal point.

In addition, Li (2006) used data over 1961 to 2004 for 90 developing countries and 28 industrialised countries. Using growth as the dependent variable, some of the explanatory variables are inflation rate, growth rate of income, terms of trade and investment share of GDP. The evidence of nonlinearity in the inflation-growth was found with two threshold levels of inflation (14 percent and 38 percent) for developing countries, while one threshold level of 24 percent was found for industrialised countries. For the developing countries, below the first threshold point of 14 percent, inflation has a positive and significant effect on growth. Inflation has a significant and negative effect on growth between the two threshold levels of 14 percent and 38 percent. Beyond the second threshold of 38%, although there is still a significantly negative effect, it was slowing down.

Ghosh and Phillips (1998) used panel data covering IMF member countries over the period 1960 to 1996 and found that there is a positive relationship between inflation and growth at very low inflation rates of less than 2 to 3 percent. There is nevertheless a negative correlation at high level of inflation. Gillman *et. al* (2002) carried out an endogenous growth model of panel data study over a period of 1961 and 1997 for OECD and APEC countries. Their study was sub-divided into three panels; the first panel consists of 29 OECD countries, the second consists of 18 APEC countries while the third incorporates all the OECD and APEC countries. Their model tested the effect of a non-linear function of the annual inflation rate $g(\pi_{it})$, among other variables, on the average annual growth rate of GDP at constant prices, y_{it}, where i denotes the country and t is the year. The result shows that the hypothesis of negative inflation-growth effect is true especially for OECD countries, while the same is the case for APEC countries when they used instrumental variables. They further found that keeping inflation at single digit figures will have significantly positive effect on growth.

In the study by Khan and Senhadji (2001), dataset comprising of 140 industrialised and developing countries over the period 1960 to 1998 was used. Their study tested the threshold effect of inflation on growth by using variables such as inflation based on consumer price index (CPI), investment as a share of gross domestic product (GDP), population growth and growth rate of terms of trade. The results obtained showed that the threshold level of inflation above which it negatively affects growth is 1 to 3 percent for industrialised countries and 11 to 12 percent for developing countries.

3 Methodology

3.1 *Data Source and Model Specification*

This paper adopts a country-specific time series data from 1980:Q2 to 2010:Q3. The variables considered are growth rate of real GDP measure at 2000 constant prices, inflation rate computed from the consumer price index, average (2005 = 100), the growth rate of terms of trade, and total investment, which is the ratio of gross capital formation as a percentage of GDP. The data was sourced from the *International Monetary Fund,* IFS database. The inclusion of the terms of trade was to reduce the problem of negative correlation between inflation and growth rates as analysed by Fischer (1993) and Sarel (1996). External supply shocks such as changes in oil price affect the actual value of inflation and thereby affect growth. For instance, a negative shock of increase in oil prices tends to drive up inflation and reduce growth, which causes negative relationship between inflation and growth.

The threshold model developed by Khan and Senhadji (2001) for industrialised and developing countries is used to analyse the threshold level of inflation on GDP growth in South Africa. The econometric technique used is the Ordinary Least Squares (OLS) and the model was re-estimated using the two-stage least squares instrumental variable (2SLS-IV) to check for robustness.

The model for the threshold effect of inflation is specified in equation {1}:

$$GROWTH_t = \alpha_0 + \alpha_1 INF_t + \alpha_2 D_t * (INF_t - INF_t^{\#}) + \alpha_3 INV_t + TOT_t + \mu_t \quad (1)$$

where $GROWTH_t$ is the growth rate of real GDP at 2000 constant price US$, INF_t is the inflation rate computed from the consumer price index (2005 = 100), $INF_t^{\#}$ is the threshold level of inflation where *# = 1, 2... 7%* to incorporate the inflation target band set by the South African Reserve Bank (SARB), INV_t is the ratio of investment as a percentage of GDP and TOT_t is the percentage change in the terms of trade. The term of trade was computed as the ratio of export index to import index multiplied by 100. Data on export and import indices were available from 1980:Q2 to 2006:Q1. Exponential and Cubic methods were used to compute the missing values from 2006:Q2 to 2010:Q3.

D is the Dummy variable which is defined as follows:

$$D_t = \begin{array}{l} 1 \; if \quad INF > INF^{\#} \\ 0 \; if \quad INF \leq INF^{\#} \end{array} \quad (2)$$

3.2 *Estimation Techniques/Method*

The threshold levels were arbitrarily chosen, but specifically to incorporate the Reserve Bank target band that was set. The relationship between inflation and GDP growth as represented by threshold level, $INF^{\#}$, is given by α_1 for low inflation and $\alpha_1 + \alpha_2$ for high inflation. For high inflation, both α_1 and

α_2 will be added at the value of inflation where the estimate is significant in order to determine their impact on growth; and this inflation rate will be the threshold level of inflation. Although the values of $INF^{\#}$, over which the model is estimated, are arbitrarily chosen, the breakpoint INF$^{\#}$ is further obtained by choosing the value that minimizes the sum-of-squared residuals from the regression. This is the same as picking the $INF^{\#}$ that maximizes R^2.

The choice of the dependent and independent variable in the threshold model specification, following the study carried out by Mubarik (2005), was determined by applying Granger Causality which measures the linear causation between inflation and economic growth. However, this test does not give a conclusive basis for determining the dependent variable in a regression model; it only determines the variable that precedes the other (Gujarati, 2003).

The two-stage least squares instrumental variable (2SLS-IV) technique is the diagnostic test adopted in this study. The purpose of this test is to check the possible misspecification bias that could be in the estimate of the threshold effect model. Such misspecifications could be as a result of exclusion of other important variables that determine growth. Hence, in order to test for the possible bias, the explanatory variables in the previous result with one-period lag of investment were regressed, where one period lag of investment was used as the instrument. The validity of these instruments was established by testing the autocorrelation in the error term.

4 Results

4.1 *Main Test Result – OLS*

The result of the Granger causality test is shown in Table 1. Inflation causes growth at lag of 3. All the lag length criteria used selected the lag length of 3 except Schwarz and HQ criteria. We reject the first null hypothesis that inflation does not Granger cause GDP growth at 5% and 10% levels of significance. The second null hypothesis that GDP growth does not cause inflation is however not rejected. This not only shows that there is no feedback from GDP growth to inflation; it also supports the first hypothesized result. This means that there is uni-directional causality from inflation to GDP growth.

Insert Table 1 on page 23 about here.

Given that both GDP growth and inflation rates are growth rates where inflation rate is computed from consumer price index (CPI) and GDP growth is the growth rate of GDP, the two variables are normally stationary. The stationarity test was however conducted and these variables were found to be stationary in levels. Therefore inflation can be regressed on GDP growth and the Granger causality test is thus valid.

Furthermore, since Granger Causality tests show that inflation Granger causes GDP growth, we were able to select the real GDP growth as the dependent variable and inflation rate as the explanatory variable along with other explanatory variables, and this has theoretical basis as earlier reviewed. The

exact value of the threshold level of inflation and the measure of its impact on growth was estimated from equation {1} and presented in Table 2. The sum-of-squared residuals and the adjusted R^2 obtained from the regression are also reported in the table. The results about the relationship between growth and other explanatory variables will not be discussed since this study focuses on the threshold level of inflation on growth.

Insert Table 2 on page 24 about here.

The results in Table 2 confirm the negative relationship between inflation and GDP growth rates, at high levels of inflation ($\# > 4$). Since this study concentrates on the threshold effect of inflation on growth, we discard the fact that the other explanatory variables are insignificant, as shown in the table. However, the instrumental variable used in the model is significant.

Furthermore, the positive relationship between inflation and growth, at lower inflation levels, was transformed into a significant negative relationship for higher inflation levels, $\# > 4$. At 5 percent, inflation begins to significantly negatively affect growth. By finding the value of u_t that minimizes the sum-of-squared residuals, we obtained the inflation threshold level as 4 percent. This is also the level where adjusted R^2 is the highest at about 17 percent. If inflation increases beyond the threshold level (at high inflation levels), GDP growth is estimated to fall by 0.35 percent. Inflation is therefore seen to be unfavorable through its negative effect on growth.

4.2 *Tests for Robustness*

The results in Table 3 show similar threshold level of inflation as in the OLS result in Table 2, where the error terms are minimized at 4 percent, with the highest adjusted R^2. The value of the estimated coefficients $\alpha_1 + \alpha_2$ of 0.12 percent, at high inflation level of 5 percent, are quite close in the two models. The positive relationship depicted at low levels of inflation became a negatively significant one at inflation levels higher than 4 percent. The validity of the instruments used was determined by testing the error term for autocorrelation and the result shows that the presence of autocorrelation in the error term can be rejected at all levels of significance.

Insert Table 3 on page 25 about here.

This further confirms that the threshold level of inflation above which inflation significantly negatively affects growth in South Africa is 4 percent. While the result obtained in this study is contrary to some earlier studies, it is in line with other studies that found the same low inflation threshold level.

5 Conclusion

Given the recent behaviour of inflation in South Africa, it was imperative to carry out a study on how it negatively affects the economic growth of the country. Although, the macroeconomic performance of South Africa has been improving over the past decade, the inflation rate is also increasing which, if not

curbed, could be detrimental in the future.

This paper adopts time series data over 1980:Q2 to 2010:Q3 period to examine the relationship between inflation and GDP growth rates and empirically determine whether inflation is indeed detrimental to growth; the level at which this occurs and to suggest the estimated threshold inflation level. Threshold regression models designed to estimate inflation thresholds was adopted to find the precise level of inflation threshold in South Africa, instead of imposing them. Firstly, Granger causality test was conducted and the result shows that we reject the null hypothesis that inflation does not Granger cause GDP growth at all levels of significance. This means that there is uni-directional causality from inflation to GDP growth.

Second, the result obtained shows that there is a strong negative relationship between real GDP growth and inflation rates, but this became significant at inflation levels above 4 percent. Although, the estimated inflation threshold level above which inflation significantly slows growth is found to be 4 percent, which is contrary to the findings of Khan and Senhadji (2001) for developing countries, Phiri (2010) for South Africa and Sarel (1996); it is however consistent with the studies carried out by Swiedan (2004) for Japan, as a developed and IMF member country and Ghosh and Phillips (1998) for IMF member countries. The possible reason for the contradiction in results could be due to different time period considered in the studies. Therefore, this study shows that inflation rate is indeed inimical to GDP growth especially at high inflation levels, above 4 percent in South Africa. Policy makers should therefore strive to keep inflation within the inflation target band, preferably below 5 percent in order to avoid its pronounced adverse effect on growth.

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APPENDIX

Figure 1: Trend in GDP growth and inflation rates in South Africa (2000 – 2009)

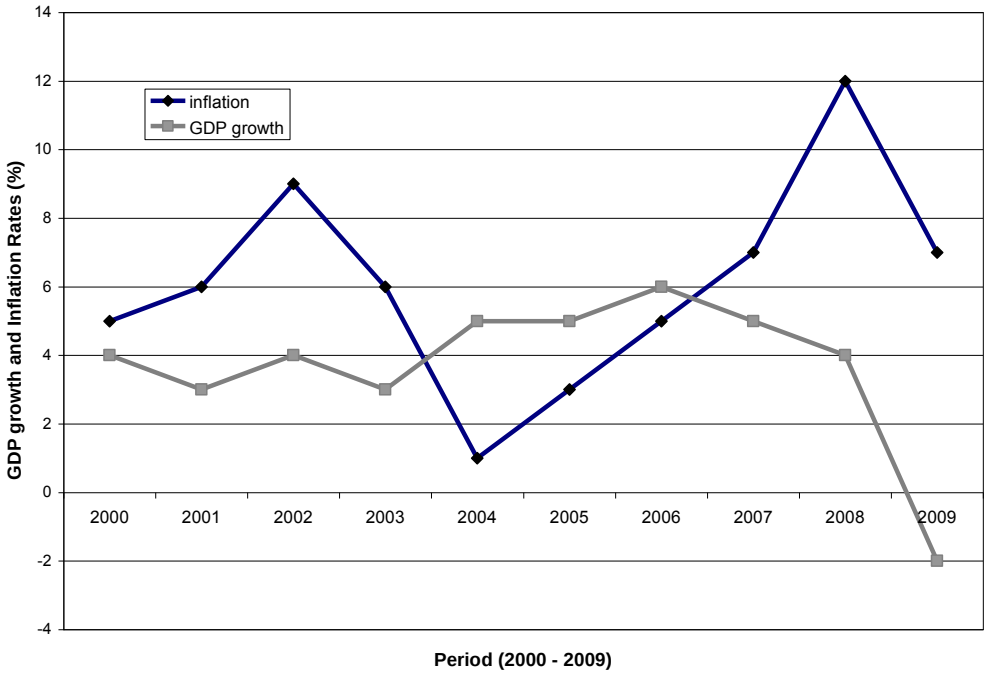

Table 1: Pairwise Granger Causality tests: Inflation and GDP Growth

Sample: 1980:Q2 – 2010:Q3			
Null Hypothesis:	**Observations**	**F-stat**	**Prob.**
INF does not Granger Cause GROWTH	**119**	**3.566**	**0.017**
GROWTH does not Granger Cause INF	**119**	**1.800**	**0.151**

Lags: 3

Table 2: OLS estimates of the Inflation Threshold Model for South Africa at INF$^{\#}$ = 1 to INF$^{\#}$ = 7. Dependent variable: GDP Growth

T	Variable	Coefficient	Std. Error	t-stat	RSS
1%	INF	0.250	1.118	0.224	73.552
	(INF>1)*(INF-1)	-0.365	1.119	-0.326	
	INV	-0.048	0.016	-3.040***	
	TOT	-0.006	0.009	-0.732	
	C	1.809	1.182	1.530	
2%	INF	0.073	0.298	0.244	73.369
	(INF>2)*(INF-2)	-0.188	0.298	-0.631	
	INV	-0.047	0.016	-2.850***	
	TOT	-0.006	0.009	-0.738	
	C	1.795	0.710	2.527	
3%	INF	0.063	0.162	0.389	72.859
	(INF>3)*(INF-3)	-0.181	0.164	-1.104	
	INV	-0.043	0.017	-2.604**	
	TOT	-0.007	0.009	-0.751	
	C	1.637	0.615	2.661***	
4%	INF	0.009	0.112	0.084	**72.827**
	(INF>4)*(INF-4)	-0.129	0.114	-1.128	
	INV	-0.042	0.017	-2.492**	
	TOT	-0.006	0.009	-0.729	
	C	1.682	0.577	2.915***	
5%	INF	-0.035	0.088	-0.398	73.063
	(INF>5)*(INF-5)	-0.085	0.090	-0.944**	
	INV	-0.043	0.017	-2.465	
	TOT	-0.006	0.009	-0.711	
	C	1.785	0.559	1.193***	
6%	INF	-0.048	0.072	-0.663	73.012
	(INF>6)*(INF-6)	-0.075	0.076	-0.986**	
	INV	-0.042	0.017	-2.429	
	TOT	-0.006	0.009	-0.705	
	C	1.797	0.538	3.342***	
7%	INF	-0.066	0.061	-1.075	73.150
	(INF>7)*(INF-7)	-0.058	0.067	-0.866**	
	INV	-0.043	0.017	-2.457	
	TOT	0.006	0.009	-0.705	
	C	1.862	0.522	3.568***	

* 10%; ** 5%; *** 1%.

Table 3: Inflation Threshold Robustness test – 2 Stage Least Squares Instrumental Variable.

T	Variable	Coefficient	Std. Error	t-stat	RSS
1%	INF	0.178	1.106	0.161	
	(INF>1)*(INF-1)	-0.298	1.107	-0.269	
	INV(-1)	-0.052	0.016	-3.223***	70.918
	TOT	-0.001	0.009	-0.143	
	C	1.937	1.174	1.649*	
2%	INF	0.040	0.296	0.135	
	(INF>2)*(INF-2)	-0.160	0.297	-0.541	
	INV(-1)	-0.050	0.017	-3.016***	70.784
	TOT	-0.001	0.009	-0.146	
	C	1.908	0.713	2.675**	
3%	INF	0.040	0.164	0.243	
	(INF>3)*(INF-3)	-0.162	1.164	-0.985	
	INV(-1)	-0.046	0.017	-2.736**	70.374
	TOT	-0.001	0.009	-0.152	
	C	1.742	0.624	2.791**	
4%	INF	0.005	0.113	0.045	
	(INF>4)*(INF-4)	-0.118	0.114	-1.035	
	INV(-1)	-0.045	0.017	-2.618**	**70.314**
	TOT	-0.001	0.009	-0.128	
	C	1.770	0.584	3.029***	
5%	INF	-0.046	0.088	-0.517	
	(INF>5)*(INF-5)	-0.079	0.090	-0.873	
	INV(-1)	-0.046	0.018	-2.597**	70.499
	TOT	-0.001	0.009	-0.113	
	C	1.866	0.564	3.308***	
6%	INF	-0.056	0.072	-0.777	
	(INF>6)*(INF-6)	-0.071	0.076	-0.934	
	INV(-1)	-0.045	0.018	-2.561**	70.433
	TOT	-0.0009	0.009	-0.105	
	C	1.870	0.540	3.461***	
7%	INF	-0.073	1.061	-1.195	
	(INF>7)*(INF-7)	-0.055	0.067	-0.827	
	INV(-1)	-0.046	0.018	-2.597**	70.547
	TOT	-0.0009	0.009	-0.106	
	C	1.933	0.522	3.701***	

Instrument list: INV(-1). * 10%; ** 5%; *** 1%.