Investment, Inflation and Economic Growth Nexus

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Abstract

The paper has twofold objectives. Firstly, the impact of the inflation rate on economic growth with the possibility of two threshold levels for Pakistan using annual data from 1961 to 2008 was examined and secondly, nonlinear relationship between inflation and investment have been investigated. Inflation and growth model supported the existence of a nonlinear relationship with two thresholds (6 percent and 11 percent). Inflation below the first threshold effects economic growth insignificantly and positively; at moderate rates of inflation, between the two threshold levels, the effect of inflation is significant and strongly negative and at high rates of inflation, above the second threshold, the marginal impact of additional inflation on economic growth diminishes but is still significantly negative. Investment is one of the possible channels through inflation hit economic growth and analysis indicates the nonlinear relationship between these two variables with only one threshold at 7 percent. Rate of inflation below the threshold level has positive but insignificant impact, while above the threshold has strong negative and significant impact on the investment. Therefore, it is desirable to keep the inflation below 6 percent because it may be helpful for the achievement of sustainable economic growth and investment.

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1. Introduction

Cyclical movement of rate of inflation and economic growth, especially in developing countries, has received much attention among the economists, policy makers and the central bankers. High and sustained economic growth with low inflation is the central objective of the macroeconomic policy makers (Khan and Senhadji, 2001). High rate of inflation negatively effects the real economic growth and thus causes adverse consequences for economic performance at the aggregate level. However, the nature of relationship between inflation and economic growth and the channels through which inflation affects real economic activities is still a debatable issue (Li, 2006).

Earlier studies show mix results about the relationship between inflation and economic growth. Few predict negative relationship (Mundell, 1963; Stockman, 1981; Fisher, 1993; Barro, 1995; Bullard and Keating, 1995; Malla, 1997; and Faria and Carneiro, 2001) while other confirms positive relationship between inflation and economic growth (Lucas, 1973; Mallik and Chowdhury, 2001 and Gillman et al. 2002). Recent literature, however, emphasizes the existence of non linear relationship between these two variables and supports the hypothesis that low and stable inflation promotes economic growth while higher inflations rates have significantly negative effect on the growth (Sarel, 1995; Bruno and Easterly, 1996; Ghosh and Phillips, 1998; Nell, 2000; Khan and Senhadji, 2001; Sweidan, 2004; Sepehri and Moshiri, 2004; Ahmed and Mortaza, 2005; Lee and Wong, 2005; Mubarik, 2005; Hussain, 2005; Munir and Mansur, 2009).

This strand of literature highlights various channels through which inflation can affect economic growth in non linear fashion and investment might be considered as an important channel. Investment, inflation and economic growth non linear nexus can be explained by using financial market development. A predictable increase in the rate of inflation can slow down financial market development. Nonlinearity between inflation and finance is well documented in literature (Boyd and Smith, 1998; Huybens and Smith, 1998, 1999; Boyd et al. 2001; Khan et al, 2001). Investment is most important channel through which financial market affects economic growth (Li, 2006). Inflation, a tax on real balance, reduces real returns to savings which in turn causes an informational friction afflicting the financial system. These financial market frictions results in credit rationing and thus limit the availability of investment and finally this reduction in investment adversely impacts economic growth. Choi et al. (1996) explains nonlinear effects of inflation on economic growth by saying that credit market frictions are potentially innocuous at low rates of inflation. Thus, in low inflationary environments, credit
rationing might not emerge at all, and the negative link between inflation and capital accumulation vanishes. In such a case, higher inflation reduces the rate of return received by savers in all financial markets and consequently increases capital accumulation (Li, 2006).

Recently, uncertainty in financial market, high inflation and low economic growth are major problems for Pakistan. The total investment has declined from 22.5 percent of GDP in 2006-07 to 19.7 percent of GDP in 2008-09 and private sector investment was decelerating persistently since 2004-05 and its ratio to GDP has declined from 15.7 percent in 2004-05 to 13.2 percent in 2008-09 (GoP, 2009). Therefore, it is important to investigate the nexus among inflation, investment and economic growth. Few studies, in Pakistan, envisage the existence of non linear relationship between inflation and economic growth (Mallik and Chowdhury, 2001; Mubarik, 2005; and Hussain, 2005). These studies focuses on the existence of only one threshold level between these two variables by ignoring the possibility of second threshold in the relationship of inflation and growth. These studies completely ignore the channel through which inflation adversely impacted growth. Literature highlights investment as main channel through which inflation effect economic growth. Keeping this in view, the objective of this study is to fill the gap in literature by exploring the nature of relationship among inflation, investment and economic growth. Following questions are analyzed in this context:

1) Does a second threshold level exist in the inflation-growth relationship?

2) What is the relationship between inflation and investment? Does the effect of inflation on investment show a similar pattern to that inflation on economic growth?

The remainder of paper is organized as follows: Section 2 gives the conceptual framework of the study and literature review is presented in section 3. Data and descriptive statistics are explained in section 4 and methodology is discussed 5. Results are discussed in section 6 while conclusion and policy recommendation are in last section.

2 Conceptual Framework

Classical economist predict that the relationship between inflation and output is implicitly negative because rise in prices lead to reduction in firm’s profit level through higher wage costs. Under Keynesian analysis, there is a short run trade off between output and change in inflation, but no permanent trade off between output and inflation. Monetarism suggest that in the long run, prices are mainly affected by the growth rate in money, while having no real effect on the growth. If the growth in the money supply is
higher than the economic growth rate, inflation will cause. Neo-classical economist presents different views regarding the impact of inflation on economic growth. Mundell (1963) was one of the first to articulate a mechanism relating inflation and output growth separate from the excess demand for commodities and increased inflation, reduced the people’s wealth. Tobin (1965) extended the Mundell (1963) model further and concludes that a higher inflation rate permanently raises the level of output. This predicts the positive relationship between inflation and economic growth (Choi et al. 1996). Sidrauski (1967) analysis reveals that an increase in the inflation rate does not affect the steady state capital stock, so neither output change nor economic growth is affected. Stockman (1981) developed a model in which an increase in the inflation rate is results in a lower steady state level of output and people’s welfare declines. This theoretical review demonstrates that models in the neo-classical frameworks can yield very different results with regards to inflation and growth. An increase in inflation can result in higher output (Tobin Effect) or lower output (Stockman Effect) or no change in output (Sidrauski Effect). Noe-Keynesian came with the idea of ‘Potential Output’ and according to this theory; inflation depends on the level of actual output (GDP) and the natural rate of employment.

Various theoretical explanations are documented in literature to explain the inflation investment nexus. Firstly, in endogenous growth theory, the growth rate has depended on rate of return and inflation decreases rate of return (Nelson, 1976; Fama and Schwert, 1977; Gultekin, 1983 and Boyd et al., 1996), so reduces capital accumulation and hence decrease the growth rate. Secondly, inflation creates uncertainty in the financial market and increases the risk associated with the investment which translated into reduction in economic activities (Hellerstein, 1997). Inflation has a significantly negative effect on financial markets after certain level, but below which inflation has no significant effect on financial markets. There is range of inflation that significantly damages the financial market and beyond this inflation will have no additional consequences for the financial sector performance or economic growth (Boyd and Smith, 1998; Huybens and Smith, 1998, 1999 and Boyd et al., 2001). Financial market development is positively linked with the level of investment (King and Levine, 1993; Levine and Zervos, 1998 and Atje and Jovanovic, 1993). So adverse impact of inflation in financial market is directly translated into reduction in investment (Xu, 2000). Thirdly, inflation can discourage investors by reducing their confidence in investments that take a long time to mature in stock market. Fourthly, in an inflationary environment intermediaries will be less eager to provide long-term financing for capital formation and growth.
Theoretical discussion depict following transmission mechanism: Inflation adversely affect the financial market and uncertainty in financial market translated into reduction of investment and this reduction in investment hurt the economic growth. Relationship between inflation and economic growth and between inflation and financial development is nonlinear. So there is strong possibility of existence of nonlinear relationship between inflation and investment.

3 Empirical Review of Literature

3.1 Inflation and Economic Growth

Barro (1995) explores the inflation economic growth relationship using a large sample covering more than 100 countries from 1960 to 1990. His empirical findings indicate that there exists a statistically significant negative relationship between inflation and economic growth if a certain number of the country characteristics (e.g., fertility rate, education, etc.) are held constant. More specifically, an increase the average inflation by 10 percentage points per year reduces the growth rate of real per capita GDP by 0.2 to 0.3 percentage points per year. In other words, his empirical analysis suggests that the estimated relationship between inflation and economic growth is negative when some reasonable instruments are considered in the statistical process. Finally, he added that there is at least some reason to consider that higher long-term inflation reduces economic growth.

Bruno and Easterly (1995) examine the determinants of economic growth using annual CPI inflation of 26 countries which experienced inflation crises during the period between 1961 and 1992. In their empirical analysis, inflation rate of 40 percent and over is considered as the threshold level for an inflation crisis. They find inconsistent or somewhat inconclusive relationship between inflation and economic growth below this threshold level when countries with high inflation crises are excluded from the sample. In addition, the empirical analysis suggests that there exists a temporal negative relationship between inflation and economic growth beyond this threshold level. The robustness of the empirical results is examined by controlling for other factors such as shocks (e.g., terms of trade shocks, political crises, and wars). Finally, they find that countries recover their pre-crisis economic growth rates following successful reduction of high inflation and there is no permanent damage to economic growth due to discrete high inflation crises.

Sarel (1995) mentions that inflation rates were somewhat modest in most countries before the 1970s and after that rate started to be high. Therefore, most empirical studies
conducted before the 1970s show the evidence of a positive relationship between inflation and economic growth and a negative relationship between the two beyond that time period due to the severe inflation hike. Malla (1997) conducts an empirical analysis using a small sample of Asian countries and countries belonging to the Organization for Economic Cooperation and Development (OECD) separately. After controlling for labor and capital inputs, the estimated results suggest that for the OECD countries there exists a statistically significant negative relationship between economic growth and inflation including its first difference. However, the relationship is not statistically significant for the developing countries of Asia. The crucial finding of this empirical analysis suggests that the cross-country relationship between inflation and long-term economic growth experiences some fundamental problems like adjustment in country sample and the time period. Therefore, inconclusive relationship between inflation and economic growth can be drawn from comparing cross-country time-series regressions with different regions and time periods.

Mallik and Chowdhury (2001) examine the short-run and long-run dynamics of the relationship between inflation and economic growth for four South Asian economies: Bangladesh, India, Pakistan, and Sri Lanka. Applying co-integration and error correction models to the annual data retrieved from the International Monetary Fund (IMF) International Financial Statistics (IFS), they find two motivating results. First, the relationship between inflation and economic growth is positive and statistically significant for all four countries. Second, the sensitivity of growth to changes in inflation rates is smaller than that of inflation to changes in growth rates. These results have important policy implications, that is, although moderate inflation promotes economic growth, faster economic growth absorbs into inflation by overheating the economy. Therefore, these four countries are on the turning point of inflation-economic growth relationship.

Faria and Carneiro (2001) investigate the relationship between inflation and economic growth in the context of Brazil which has been experiencing persistent high inflation until recently. Analyzing a bivariate time series model (i.e., vector auto-regression) with annual data for the period between 1980 and 1995, they find that although there exists a negative relationship between inflation and economic growth in the short-run, inflation does not affect economic growth in the long-run. Their empirical results also support the superneutrality concept of money in the long run. This in turn provides empirical evidence against the view that inflation affects economic growth in the long run.
Khan and Senhadji (2001) analysed the inflation and growth relationship separately for industrial and developing countries. The authors re-examine the issue of the existence of “Threshold” effects in relationship between inflation and growth, using econometric techniques initially developed by Chan and Tsay (1998) and Hansen (1999, 2000). They used the data set for 140 countries from 1960 to 1998. Their findings strongly suggested the existence of threshold beyond which inflation exerts a negative effect on growth. Inflation level below the threshold level has no effect on the growth, while inflation rates above the threshold have a significant negative effect on growth.

Sweidan (2004) examines whether the relationship between inflation and economic growth has a structural breakpoint effect or not for the Jordanian economy from the period between 1970 and 2003. He finds that this relation tends to be positive and significant below an inflation rate of 2-percent and the structural breakpoint effect occurs at an inflation rate equal to 2-percent. Beyond this threshold level inflation affects economic growth negatively.

Mubarik (2005) estimates the threshold level of inflation for Pakistan using an annual data set from the period between 1973 and 2000. He employed the Granger Causality test as an application of the threshold model and finally, the relevant sensitivity analysis of the model. His estimation of the threshold model suggests that an inflation rate beyond 9-percent is detrimental for the economic growth of Pakistan. This in turn, suggests that inflation rate below the estimated level of 9-percent is favorable for the economic growth. Moreover, the sensitivity analysis performed for the robustness of the threshold model also confirms the same level of threshold inflation rate.

Ahmed and Mortaza (2005) empirically explore the relationship between inflation and economic growth in the context of Bangladesh. An assessment of the empirical evidence has been acquired through the co-integration and error correction models. Further, the paper explores an interesting policy issue of what is the threshold level of inflation for the economy. The empirical evidence demonstrates that there exists a statistically significant long-run negative relationship between inflation and economic growth for the country as indicated by a statistically significant long-run negative relationship between CPI and real GDP.

Hussain (2005) empirically estimate the threshold level of inflation in Pakistan using annual data for the period 1973-2005. By using standard econometrics technique to estimate the threshold effect and suggests that targeting inflation exceeding a range of 4-6% will be deterrent to economic growth. He found no threshold level of inflation for Pakistan. These results are in sharp contrast to the findings of Mubarik (2005) where
inflation threshold level for Pakistan is at 9%. So according to him, for sustainable economic growth, inflation must be fall in the range of 4 and 6%.

Lee and Wong (2005) estimated the threshold levels of inflation for Taiwan and Japan using quarterly data set from the period between 1965-2002 for Taiwan and 1970-2001 for Japan. Their estimation of the threshold models suggest that an inflation rate beyond 7.25% detrimental for the economic growth of Taiwan. On the other hand, they found two threshold levels for Japan, which are 2.52% and 9.66%. This suggests that inflation rate below the estimated level of 9.66% is favorable to economic growth and beyond this threshold value it is harmful for the economic growth.

Li (2006) estimate the non linear relationship between inflation and economic growth for 27 develop and 90 developing countries over the period 1961-2004. For developing countries, Li found the presence of two thresholds in the function relating economic growth and inflation. When the rates of inflation is below the first threshold, the effects of inflation on the economic growth rate are insignificant or even positive; at moderate rates of inflation, that is, rates of inflation between the two thresholds, the effects of inflation are significantly and strongly negative; at extremely high rates of inflation, the marginal impact of additional inflation on the economic growth diminishes rapidly but is still significantly negative. Furthermore, the first threshold level of inflation is estimated at 14 percent per year, and the second threshold level is estimated at 38 percent per year. For developed countries, only one threshold is detected and proved to be significant. This unique threshold is estimated to be at 24 percent per year and works the same way as the second threshold for developing countries.

Munir and Mansur (2009) investigate the non linear relationship between inflation rate and economic growth rate in the period 1970-2005 in Malaysia. They suggest that there is one inflation threshold value exist for Malaysia and strongly supports the view that the relationship between inflation rate and economic growth is nonlinear. The estimated threshold regression model suggests 3.89% as the threshold value of inflation rate above which inflation significantly retards growth rate of GDP. In addition, below the threshold level, there is statistical significant positive relationship between inflation rate and growth. Sergii (2009) investigate the growth-inflation interaction for CIS countries for the period of 2001-2008 and found that when inflation level is higher than 8 % economic growth is slowed down, otherwise, it is promoted. The non-linear growth-inflation interaction is quite robust to the estimation method and specification.

3.2 Inflation and Investment
According to Barro (1995) reduction is economic growth is occurred due to reduction in the in the propensity to investment that is outcome of inflation. He further shows that an increase in average inflation by 10 percentage points per year cause reduction in the ratio of investment to GDP by 0.4-0.6 percentage points and this reduction in investment reduces the real per capita GDP by 0.2-0.3 percentage points per year. So inflation reduces the level of investment and hence reduction in investment adversely affects economic growth.

Khan et al. (2001) estimate the threshold level of inflation, for 168 countries by using NLLS estimation beyond which inflation had powerful negative effects on all measures of financial dept and below which inflation had insignificant or even positive effects on financial depth. They founded that inflation between the range of 3 to 6 percent had negative impact. McClain and Nichols (1994) used newly developed time series techniques to test for a long-run relationship between inflation and investment by using U.S. time series data from 1929 to 1987. Surprisingly, these authors found that investment and inflation are positively correlated to each other. They argued that this finding is consistent with the interpretation that the income effect of inflation increases savings, the incomplete Fisher effect lowers the real cost of funds, and that bond price movements from inflation increase real corporate wealth, all leading to higher real investment, not lower.

Li (2006) estimate the non linear relationship between inflation and investment for 27 develop and 90 developing countries over the period 1961-2004. He found that the efficiency of investment is the channel through which inflation adversely and nonlinearly affects economic growth. Moreover, at low to moderate inflation, specifically, below 65% for developing countries and below 42% for developed countries and inflation even has a significantly positive effect on the level of investment. These mixed empirical results suggest that the relationship between inflation and investment is far from clear.

4 Data and Descriptive Statistics

The data are taken from Economic Survey of Pakistan (various editions), Fifty Year Economy of Pakistan (SBP) and World Bank Quick Query selected from World Development Indicators. Data are ranging from 1961 to 2008 and consists on the following variables. Inflation is measured as annual percent change of average consumer price index; population growth rate is measured as annual population growth rate; investment is measured as gross fixe capital formation as percent of GDP and openness is measured as share of export plus import in GDP.
Descriptive statistics of sample data shows that the average value of growth rate of output is 5.48%, and growth rate of population has the average value of 2.67%, investment has average value 18.08% and openness of the economy has average value 35.39%. Inflation has mean 7.81% while M2 as share of GDP has average value of 34.7 (Table 1).

**Table 1: Descriptive Statistics**

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP Growth Rate</td>
<td>48</td>
<td>5.48</td>
<td>2.09</td>
<td>1.20</td>
<td>9.80</td>
</tr>
<tr>
<td>Investment as % of GDP</td>
<td>48</td>
<td>18.08</td>
<td>2.15</td>
<td>12.93</td>
<td>22.95</td>
</tr>
<tr>
<td>Inflation</td>
<td>48</td>
<td>7.81</td>
<td>5.29</td>
<td>-0.52</td>
<td>26.66</td>
</tr>
<tr>
<td>Growth rate of population</td>
<td>48</td>
<td>2.67</td>
<td>0.33</td>
<td>1.78</td>
<td>3.19</td>
</tr>
<tr>
<td>M2 as % of GDP</td>
<td>48</td>
<td>34.76</td>
<td>4.89</td>
<td>24.28</td>
<td>46.69</td>
</tr>
<tr>
<td>Openness</td>
<td>48</td>
<td>35.39</td>
<td>3.19</td>
<td>28.85</td>
<td>42.62</td>
</tr>
</tbody>
</table>

The stationarity of the series is confirmed by applying Augmented Dickey–Fuller (ADF) test. Table 2 gives the result of ADF for all series. Real GDP growth rate and openness are stationary at level while Investment to GDP ratio, Inflation, Population Growth rate and M2 as % of GDP are non stationary at level and become stationary at first difference.

**Table 2: Test for Non-Stationarity of Variables**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Level</th>
<th>First Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Trend</td>
<td>With Trend</td>
</tr>
<tr>
<td>GDP Growth Rate</td>
<td>-5.73</td>
<td>-6.01</td>
</tr>
<tr>
<td>Investment as % of GDP</td>
<td>-2.12</td>
<td>-2.39</td>
</tr>
<tr>
<td>Inflation</td>
<td>-2.15</td>
<td>-2.86</td>
</tr>
<tr>
<td>Growth rate of population</td>
<td>-0.25</td>
<td>-2.44</td>
</tr>
<tr>
<td>M2 as % of GDP</td>
<td>-0.73</td>
<td>-1.44</td>
</tr>
<tr>
<td>Openness</td>
<td>-3.62</td>
<td>-3.76</td>
</tr>
</tbody>
</table>

Note: 5% critical value is -2.87 for the case of no-trend, and -3.42 when a trend is included. AIC is used for lag selection.

5 The Model Specification

The relationship between inflation and economic growth can be derived using the following equation (Barro, 1991 and Martin, 1997):

\[ d \log Y = X \beta + \varepsilon \]  

(1)

Where \( Y \) is real output, \( X \) is explanatory variable, \( \beta \) slope coefficients and \( \varepsilon \) is the error term. This basic growth model is extended to captures the link between inflation and economic growth. The following linear regression model was estimated:

\[ d \log Y = \alpha_0 + \alpha_1 \text{Inf} + X \beta + \varepsilon \]  

(2)
Where $d \log Y$ is growth rate of real GDP, $Inf$ is growth rate of CPI and $X$ is matrix of other explanatory variables, $\beta$ matrix of slope coefficients and $\varepsilon$ is the error term.

Neoclassical growth model uses investment and population growth in the regression equation as increase in investment together with a decrease in population growth rate promotes economic growth. International trade theory proposes to include openness of the economy in the growth regression which is positively related to growth. Money supply is important indicator for financial development. Finally, our empirical analysis uses the following explanatory variables: investment, population growth, M2 and openness of the economy. This choice of variables is consistent with the choice made by other researchers (Khan and Senhadji, 2001; Drukker et al. 2005; Mubarik, 2005; Hussain, 2005; Li, 2006; and Sergii, 2009). Following linear regression model is estimated:

$$d \log Y = \alpha_0 + \alpha_1(Inf) + \beta_1(P) + \beta_2(INV) + \beta_3(F) + \beta_4(O) + \varepsilon.................(3)$$

Where $d \log Y$ is growth rate of real GDP, $Inf$ is growth rate of CPI and $P$ is population growth rate, $INV$ is investment to GDP ratio, $F$ is M2 to GDP ratio, $O$ is openness ((Export + Import)/GDP) and $\varepsilon$ is the error term. As discussed earlier, theoretical and empirical studies predict that threshold effects are associated with a rate of inflation exceeding some “critical value” or below some “critical value”. Threshold Model was developed by Khan and Senhadji (2001) for the analysis of threshold level of inflation for industrialized and developing countries. Mubarik (2005) use the same model for the estimation of threshold level of inflation in Pakistan. Again this model with little development is used by the estimation of threshold level in Pakistan by Hussain (2005). Buy introducing two threshold level of inflation; following final regression equation is designed:

$$d \log Y = \alpha_1 + \alpha_2(Inf)*I(Inf < \pi_1) + \alpha_3(Inf)*I(\pi_1 \leq Inf \leq \pi_2) + \alpha_4(Inf)*I(Inf > \pi_2) + \beta_1(P) + \beta_2(INV) + \beta_3(F) + \beta_4(O) + \varepsilon.................................................(4)$$

Where dependant variable and the control variable are defined as the same as in equation 3 while $\pi_1$ and $\pi_2$ are two threshold level of inflation. $I(Inf < \pi_1)$, $I(\pi_1 \leq Inf \leq \pi_2)$ and $I(Inf > \pi_2)$ are indicators functions which take the value of one if the term between parentheses is true and are zero otherwise. This model specifies the effects of inflation with three coefficients: $\alpha_2$, $\alpha_3$, and $\alpha_4$. $\alpha_2$ denotes the effect of inflation below the first threshold level $\pi_1$, $\alpha_3$ denotes the effect of inflation on economic
growth between $\pi_1$ and $\pi_2$, and $\alpha_4$ denotes the effect of inflation on economic growth exceeding the second threshold level $\pi_2$.

Identification of threshold is based on the methodology defined by Khan and Senhadji (2001). Regression equation is estimated for different values of threshold which is chosen in an ascending order (i.e., 1, 2 and so on), the optimal value threshold is obtained by finding the value that maximizes the $R^2$ from the respective regressions. This also implies that the optimal threshold level is that which minimizes the residual sum of squares (RSS). This procedure has become widely accepted in the literature on this topic. Search of optimal threshold for wider range of threshold is very tedious. Moreover, Hansen (2000) proposed to search optimal value only in the region where we do expect the threshold should be. Graphical analysis is also used to narrow the range of values for inflation threshold.

Theoretical literature has suggested that investment might be the channel from inflation to economic growth. Following linear model specification is used to measure the linear relationship between investment and inflation:

$$INV = \delta_0 + \delta_1 \text{Inf} + \delta_2 \text{INV}_{t-1} + \varepsilon$$

Where $I$ is the gross fixed capital accumulation as share of GDP and first lag of $I$ is included to control the economic conditions in the last period (Li, 2006). For non-linear following regression equation is used:

$$INV = \delta_1 + \delta_2 (\text{Inf}) \cdot I(\text{Inf} < \pi_1) + \delta_3 (\text{Inf}) \cdot I(\pi_1 \leq \text{Inf} \leq \pi_2)$$
$$+ \delta_4 (\text{Inf}) \cdot I(\text{Inf} > \pi_2) + \delta_5 (\text{INV}_{t-1}) + \varepsilon$$

Selection of threshold level is based on the similar procedure explained as above.

6 Model Estimation

6.1 Inflation and Economic Growth Nexus

The simple linear model of economic growth and inflation as defined in equation 3 has been estimated. The basic purpose of simple linear regression is to reveal the shape of the growth function relating the inflation with economic growth. A linear equation 3 is estimated by using data for Inflation and GDP growth and other control variables for 1961 to 2008 (Table 3). Result indicates that inflation has significant negative impact on
economic growth at second lag\(^2\). Investment has positive and significant impact on economic growth while population growth also has positive and significant impact on economic growth (Table 3). The coefficient of investment /GDP ratio is 0.65 which indicates that a 1 percentage point increase in investment will cause a 0.65 percentage point increase in growth. Other variable like M2 to GDP ratio and openness was also used in the regression equation and finally both variables were drop due to their insignificant relationship with economic growth.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-14.35769</td>
<td>-2.368223</td>
</tr>
<tr>
<td>Inflation</td>
<td>-0.198856</td>
<td>-3.274821</td>
</tr>
<tr>
<td>Investment</td>
<td>0.651056</td>
<td>3.573079</td>
</tr>
<tr>
<td>Population</td>
<td>0.036202</td>
<td>2.696865</td>
</tr>
</tbody>
</table>

R-Squared = 0.31; DW = 2.12; Jarque-Bera = 0.12; Ramsey RESET Test (1, 41) = 1.11 [0.30]

Nonlinear model has been estimated using equation 4. For estimation of \(\pi_1\) and \(\pi_2\), we apply the methodology given in previous section. Following steps are involved in estimation on non-linear model. At first step, we estimate the equation 3 with one threshold level. The estimation process of \(\pi_1\) is the same as given in section 5.

\[
d \log Y = \alpha_1 + \alpha_2 (\text{Inf}) * I(\text{Inf} \leq \pi_1) + \alpha_3 (\text{Inf}) * I(\text{Inf} > \pi_1) + \beta_1 (P) + \beta_2 (I) + \epsilon \ldots \ldots (7)
\]

We apply a range of threshold level ranging from 1 to 8 and choose the value that minimizes the error sum of square as mention by Hansen (2000). Finally, result indicates that the value of \(\pi_1\) is 6 and inflation below 6 has insignificant impact on economic growth. So the value of \(\pi_1\) is 6 in this case (Appendix Table 1-A & Table 1-B). These findings of first threshold level are also consistent with Singh (2003) for India and Hussain (2005) for Pakistan. Then, we carry out a significant test of no threshold against one threshold \(\pi_1\). The null hypothesis is \(H_0 = \alpha_2 = \alpha_3\) against the alternative of \(H_0 = \alpha_2 \neq \alpha_3\). The result indicates that null hypothesis is rejected at 5% level of significance which confirms the existence of one threshold level in inflation data.

The existence of second threshold in the relationship between growth and inflation is tested by using equation 4. By using same process we find the second threshold level which is 11 in this case (Table 4). Then, we carry out a significant test of one threshold against two thresholds. The null hypothesis is existence of only one

\(^2\) Mubarik (2005) and Hussain (2005) also found that inflation effect economic growth at second lag.
threshold against the alternative of existence of two thresholds. The result supports the existence of two thresholds against one at 5% level of significance.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-10.16507</td>
<td>-1.596767</td>
</tr>
<tr>
<td>Inflation &lt;6</td>
<td>0.183643</td>
<td>0.517296</td>
</tr>
<tr>
<td>Inflation &gt;=6 and Inflation &lt;=11</td>
<td>-0.322854</td>
<td>-2.611079</td>
</tr>
<tr>
<td>Inflation &gt; 11</td>
<td>-0.056985</td>
<td>-3.827330</td>
</tr>
<tr>
<td>Investment</td>
<td>3.449236</td>
<td>2.593879</td>
</tr>
<tr>
<td>Population</td>
<td>0.512724</td>
<td>2.622883</td>
</tr>
</tbody>
</table>

R-Squared = 0.37; DW = 2.02; Jarque-Bera = 0.09; Ramsey RESET Test (1, 39) = 0.34 [0.56]

Final estimation results of equation 4 are presented in table 4. An interesting finding is that for the low inflation, the coefficient of inflation (0.1836) is positive. This result shows that 1 percentage increase in inflation will cause a 0.18 percentage point increase in economic growth. However, this positive impact is not significant. This implies that in Pakistan, low inflation up to 6 is not harmful for the country. In the middle inflation group (inflation between 6 and 12), the coefficient of inflation (-0.322854) is negative and significant at one percent level. Results suggest that an increase in one percentage point inflation per year is associated with a reduction of the growth rate of real GDP by 0.32 percentage point. When inflation rate is exceeding the 11 percentage point, the coefficient of inflation is still negative and significant. However, this negative effect is smaller than that when inflation is in the range of 6 to 11. A one percentage increase in inflation, when inflation rate is more than eleven percentage point, a reduction of 0.06 percentage point is occur in real GDP growth rate.

The existence of two threshold levels implies that inflation can be divided into three parts. As inflation rises from zero to six percentage point, the effect on economic growth is negligible or even positive. As inflation crosses the low threshold level, it has significant and negative impact on the GDP up to a certain level. When inflation crosses second threshold level, the marginal adverse impact of inflation on growth diminishes. The smaller negative coefficient illustrate that the inflation growth relationship flattens when the economy has high inflation. Intuitively, we can say that once inflation exceeds a threshold level, all of the damage to the financial system has already been done, and then

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3 Mubarik (2005) found that in Pakistan, inflation up to 7 is not harmful while Hussain (2005) found that the low range of inflation is 5.
perfect foresight dynamics comes into being. When these occur, further increases in inflation have no additional detrimental effects on economic growth (Li, 2006).

6.2 Inflation and Investment Nexus

Theoretical literature has suggested that investment might be the channel that link inflation to economic growth. The linear model is estimated by using equation 5 to uncover the relationship between inflation and investment. Result indicates that inflation has significant and negative impact on investment/GDP ratio. The coefficient of inflation (-0.0842) shows that a 1 percentage point increase in inflation will cause a 0.08 percentage point reduction in investment. The first lag of investment is used to control the economic conditions in the last period which has significant and positive impact on current investment (Table 5). This linear analysis confirms the inflation-investment/GDP nexus like inflation and GDP growth. Further relationships between inflation and investment with threshold effects by using the same techniques described for inflation and economic growth will be estimated.

Table 5: Linear Estimation Results
(Dependant Variable is Investment/GDP Ratio)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>7.682031</td>
<td>3.179267</td>
</tr>
<tr>
<td>Inflation</td>
<td>-0.084268</td>
<td>-1.940828</td>
</tr>
<tr>
<td>Lag of Investment</td>
<td>0.589304</td>
<td>4.515194</td>
</tr>
<tr>
<td>Dummy from 1973 to 1981</td>
<td>-0.945999</td>
<td>-1.699239</td>
</tr>
</tbody>
</table>

R-Squared = 0.55; DW = 1.80;
Jarque-Bera = 0.08;
Ramsey RESET Test (1, 40) = 1.13 [0.32]

Nonlinear model estimation started by estimating the equation 6. By applying same process as given for inflation and growth, a single threshold at 7% is estimated because we cannot reject the null hypothesis of one threshold against 2 threshold. Table 6 presents the estimation results of the inflation-investment relationship with threshold effects. The coefficient of inflation (0.048) is insignificantly positive when inflation is below the threshold level. However, as inflation rates exceed the threshold level, the effect of inflation on the level of investment is negative and significant. The evidence suggests that during a period of high inflation, the level of investment be adversely affected by inflation.

Table 6: Estimation with Thresholds Effect
(Dependant Variable is Investment/GDP Ratio)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>7.878550</td>
<td>3.277259</td>
</tr>
<tr>
<td>Inflation &lt;7</td>
<td>0.047665</td>
<td>0.608740</td>
</tr>
<tr>
<td>Inflation &gt;=7</td>
<td>-0.067759</td>
<td>-1.949206</td>
</tr>
</tbody>
</table>
Lag of Investment | 0.579052 | 4.459827  
Dummy       | -0.991533 | -1.795522  
R-Squared = 0.57; DW = 1.81;  
Jarque-Bera = 0.06;  
Ramsey RESET Test (1, 40) = 0.11 [0.74] 

7 Conclusion and Policy Options

The objective of the present study has been twofold. Firstly, the impact of the inflation rate on economic growth with the possibility of two threshold level for Pakistan using annual data from 1961 to 2008 has been examined and secondly, nonlinear relationship between inflation and investment is also investigated.

Inflation and growth model supports the existence of a nonlinear relationship with two thresholds (6% and 11%). Existence of double threshold, divide the inflation range into three categories i.e. low inflation, moderate inflation and high inflation. Inflation below the first threshold (6%) effects economic growth insignificantly and positively; at moderate rates of inflation, between the two threshold levels (6% to 11%), the effect of inflation is significant and strongly negative and at high rates of inflation, above the second threshold (above 11%), the marginal impact of additional inflation on economic growth diminishes but is still significantly negative. The existing literature emphasizes only one threshold level beyond which inflation impedes growth, but below which inflation has no significant or even positive effects on growth, whereas this study has detected a second threshold level for Pakistan. The finding of first threshold level is also consistent with Singh (2003) for India and Hussain (2005) for Pakistan.

The second objective of the study is to explore the mechanism through which inflation affects long-run economic growth in a nonlinear fashion. Investment is one of the possible channels through inflation hit economic growth and analysis indicates the nonlinear relationship between these two variables with only one threshold at 7%. Rate of inflation below the threshold level has positive but insignificant impact, while above the threshold has strong negative and significant impact on the investment.

These findings provide some policy implications. On the basis of this study, it is desirable to keep the inflation below than 6 percent and therefore central bank should concentrate on those policies which keep the inflation rate below the first threshold because it may be helpful for the achievement of sustainable economic growth. Low inflation is also helpful for minimizing the uncertainties in the financial market which in turn boost the investment in the country.
Appendix:

Appendix Table 1-A: Estimation of One Threshold Level
(Dependant Variable is GDP Growth Rate)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-13.94929</td>
<td>-2.110006</td>
</tr>
<tr>
<td>Inflation &lt;6</td>
<td>0.240981</td>
<td>0.924573</td>
</tr>
<tr>
<td>Inflation &gt;=6</td>
<td>-0.203435</td>
<td>-3.087819</td>
</tr>
<tr>
<td>Investment</td>
<td>0.639304</td>
<td>3.232172</td>
</tr>
<tr>
<td>Population</td>
<td>0.035727</td>
<td>2.572852</td>
</tr>
</tbody>
</table>

R-Squared = 0.32; DW = 2.14; 
Jarque-Bera = 0.11; 
Ramsey RESET Test (1, 40) = 1.19 [0.28]

Appendix Table 1-B: Estimation of One Threshold Level
(Dependant Variable is GDP Growth Rate)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-10.90925</td>
<td>-1.748677</td>
</tr>
<tr>
<td>Inflation &lt;=6</td>
<td>-0.561443</td>
<td>-2.596820</td>
</tr>
<tr>
<td>Inflation &gt;6</td>
<td>-0.249473</td>
<td>-3.786838</td>
</tr>
<tr>
<td>Investment</td>
<td>0.515003</td>
<td>2.651303</td>
</tr>
<tr>
<td>Population</td>
<td>0.035711</td>
<td>2.725498</td>
</tr>
</tbody>
</table>

R-Squared = 0.36; DW = 2.01; 
Jarque-Bera = 0.08; 
Ramsey RESET Test (1, 40) = 1.08 [0.30]

References:


