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Optimal Inflation Rate for Nepal

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ABSTRACT

This paper estimates the optimal inflation rate in Nepal based on the data of the period 1978–2016. The novelty of the analysis is that it probes possible nonlinearity of the hypothesized impact of inflation on economic growth using alternative specifications. The results suggest that there exists a threshold effect of inflation. The Ordinary Least Squares method estimates the turning point of inflation to be 6.25 percent while that of the Hansen (2000) method shows the threshold level to be 6.40 percent. The maximum impact on growth associated with the turning point, and at the mean levels of other explanatory variables is quite high at 4.59 percent.

JEL Classification: E31, E52, E58, O40

Key Words: Optimal inflation, threshold inflation, exchange rate overvaluation

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I. INTRODUCTION

The fundamental objective of monetary policy management in Nepal, is the attainment of high and sustainable economic growth accompanied with low level of inflation. As stipulated in the amended Nepal Rastra Bank (NRB) Act, 2016, NRB is entrusted with multiple objectives of ensuring price and financial stability and favorable balance of payments for sustainable development of the economy. Accordingly, NRB formulates necessary monetary, foreign exchange and financial sector policies focusing to control inflation, and to maintain financial and external stability. In its annual monetary policy statement, NRB also publishes the projected inflation figure for the coming fiscal year to anchor the inflation expectations at the targeted level.

High and persistent inflation and low economic growth have been major characteristics of Nepalese economy in recent years. In the last five years, the average inflation rate remained 8.8 percent in Nepal, which is higher than the projected inflation by 1.3 percentage point. Inter-country comparison of inflation in the South Asian Association for Regional Cooperation (SAARC) region shows that Nepal has the highest rate of inflation except Bhutan and Pakistan coupled with low economic growth. The average annual economic growth rate for last five years was 3.4 percent.

High inflation distorts the optimal allocation of resources and retards growth, weakens the external competitiveness, and lowers the domestic financial savings among others (RBI, 2014). It also exacerbates the inflation expectations and creating inflationary spiral in the economy. Therefore, there is a consensus now that high inflation is bad for the economy and central banks around the world strive to fight against the high inflation and maintain it at low level.

However, question arises; what is the low or the optimal level of inflation that does not adversely affect the economic activities? Is it zero, above zero or somewhat high numerical number? There is a widespread consensus that the economists and policymakers want to maintain inflation low, they have not typically aimed for zero inflation (Billi & Kahn, 2008).

In these regard, maintaining the optimal inflation rate both for short term and mid-term has the paramount importance because it would support the high and sustainable economic growth. The impact of alternative inflation objectives on the economic stability and overall economic well being should be understood clearly setting an appropriate inflation which maximizes welfare of the public (Billi & Kahn, 2008). Moreover, communication and making public aware of such optimal rate of inflation leads the central bank to focus all of its efforts to maintain inflation within this limit and enhance its policy effectiveness.

Nepal maintains a pegged exchange rate regime with India, and around two-third of its total trade takes place with India. Thus, Nepal's inflation is significantly influenced by inflation in India. Several empirical studies have shown that Nepal's inflation is largely determined by Indian inflation (Nepal Rastra Bank, 2007; Ginting, 2007; International Monetary Fund, 2011). In this context, the sustainability of the peg crucially depends on the keeping the inflation rate close to that of India. The adoption of the flexible inflation targeting by India has also necessitated to adopt a more proactive policy by the NRB in keeping inflation at a lower rate in Nepal.

In this regard, very few studies have been carried out in Nepal (Bhatta, 2015; Bhushal & Silpakar, 2011). Both of these studies use Khan and Shenhadji (2000) methodology which assumes the threshold level of inflation as exogenous. This study aims to contribute to the estimation of threshold inflation by adopting a more rigorous and alternative estimation techniques, where the threshold level is endogenous. Also, alternative estimation methods are used to assess the robustness of the results. The remainder of the study is organized as follows: the second section reviews the theoretical and empirical literature on the threshold effects of inflation and the third section discusses the alternative theoretical models and derives the results with concluding observations.

II. THEORETICAL UNDERPINNINGS AND EMPIRICAL EVIDENCE

This section provides the theoretical and empirical literature on the inflation and growth nexus. First, it discusses several theoretical postulates and major channels through which inflation affects growth. Second, it discusses the empirical literature on the optimal inflation rate focusing on developing countries.

There exists an extensive literature on the theoretical and empirical studies regarding inflation and growth nexus. Classical theory views savings as the major ingredient for investment and growth. The classical dichotomy between the real and nominal variables means that inflation only affects the price level, and only the real factors influence economic growth.

The Keynesian apply the Aggregate Demand (AD) and Aggregate Supply (AS) to illustrate the output inflation relationship. According to this model, in the short-run, the AS curve is upward sloping which implies that stimulating the demand side of the economy affect both prices and output. Based on this concept, Keynesians advocate a positive relationship between inflation and output (Fabayo & Ajilore, 2006). The initial short- run trade-off between inflation and output results from the time inconsistent problem until it lures the producers into more output. However, in the long-run, the AS curve becomes vertical. The policy implication of vertical AS curve is that demand side policy is no longer increase the level of output but only the level of price.

The monetarists argued that inflation persists in the economy as the supply of money exceeds the growth rate of the economy. They challenged the Philips' argument of inflation and output trade-off and proposed wages adjust accordingly as the workers anticipate the future rate of interest.

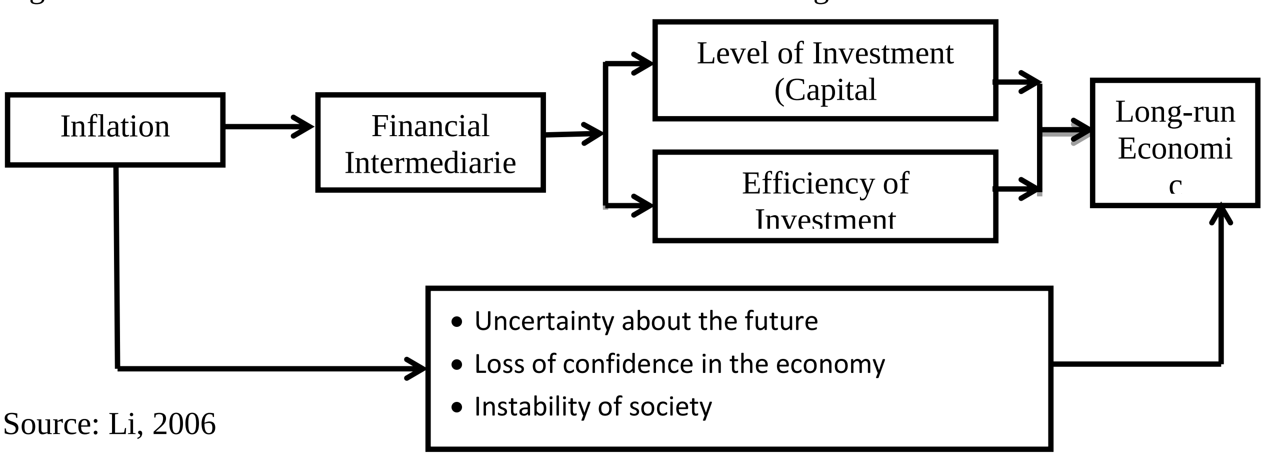
The neo-classical economists developed the portfolio management theory and propounded how individuals manage their wealth substituting current consumption for future consumption. Tobin (1965) suggested that inflation causes individuals to substitute out of money and into interest earning assets, which leads to greater capital intensity and promotes economic growth. It predicts the positive effect of inflation to economic growth.

On the other side, neo-Keynesian economists developed the concept of potential output also known as natural output and argued that inflation is determined by the actual level of output and level of unemployment. If the actual level of output is higher than its potential level and unemployment is below the natural rate, inflation accelerated that causes to shift in Philips curve to outward indicating higher inflation with higher unemployment (Gordon, 1997).

Endogenous growth theories endogenous factors namely economies of scale, increasing returns or induced technological change. According to this theory, rate of return of the capital determines the level of economic growth. Thus, inflation induces the goods to leisure substitutes which forces down to the return of human capital and then reduces the return on all capital and the growth rate (Gillman, Harris, & Matyas, 2001).

Inflation can affect growth through financial intermediaries and several transmission channels (Figure 1). First, high inflation can adversely affect the financial market development. Second, financial market development is associated with higher level and efficiency of investment (Li, Min, 2006).

Figure 1: Transmission mechanism from inflation to economic growth



Source: Li, 2006

Summarizing the theoretical literature, Drukker et al. (2005) provides the major alternative predictions regarding the impact of inflation on output and growth. 1) No effect—there is no effect of inflation on growth as money is super-neutral with money in the utility function (Sidrauski, 1967), 2) Positive effect—Money is a substitute for capital, hence inflation has a positive effect on long-term growth (Tobin, 1965), 3) Negative effect—Money is complementary to capital in the cash in advance model causing inflation to have a negative impact on growth (Stockman, 1981), 4) Threshold effect—the effect of inflation on growth depends on the threshold level. Beyond the threshold level, inflation has a negative effect on growth due to its impact on financial market efficiency arising from informational asymmetries and exacerbating financial market frictions (Huybens & Smith, 1998).

2.1 Empirical Evidence on Threshold Inflation and Economic Growth

The optimal rate of inflation can be estimated on the basis of the threshold effects in the relationship between inflation and growth. Inflation below the threshold level supports economic growth and inflation above the threshold retards the economic growth. While the theoretical discussions point out the detrimental effects of 'very' high inflation, the empirical evidence on the appropriate or the optimal level of inflation is mixed. The empirical literature on the optimal inflation rate can be broadly classified into two groups. One group of literature analyses the cross-country data to estimate the average optimal inflation. The second group focuses on a specific country to derive the threshold rate of inflation. The literature also tends to distinguish between the optimal inflation rate in developing countries and advanced economies. For the advanced economies, there is a consensus that inflation rate between 1 to 3 percent corresponds to price stability while for the emerging and transition economies inflation in the range of 4 to 5 percent would be desirable (Reserve Bank of India, 2014).

Based on these theoretical underpinnings, a large number of empirical studies have been carried out. Several cross country and single country studies have demonstrated both the linear and nonlinear relationship between inflation and economic growth. The non-linear nexus depicts the threshold effects i.e., structural break point of inflation which has the important policy implication to the central banks (Fisher, 1993).

A recent report by the RBI summarizes the various empirical studies estimating the threshold inflation in India (Reserve Bank of India, 2014). Various studies using different methodologies and time periods suggest the threshold inflation in India between 4 to 7 percent. The latest estimation for the threshold effect in India using the logistic smooth transition (LSTR) model suggests the upper bound for India at around 6 percent (Reserve Bank of India, 2014). Based on this seminal study, India adopted the flexible inflation targeting, with the objective of gradually reducing inflation and fixing the inflation target of 4 percent with a band of +/- 2 percent.

One of the most often cited and replicated studies by Khan and Senhadji (2001) estimates the threshold inflation using a balanced panel data from 1970 to 2003 for both developing and advanced countries. The authors estimate the threshold inflation for developing countries to be between 10.62 percent and 11.38 percent beyond which inflation significantly slows growth. The threshold inflation for advanced countries is estimated to be much lower between 0.89 percent and 1.11 percent.

There are several empirical studies focusing on the threshold inflation for an individual country. These studies employ various time periods and methodology to estimate the threshold inflation. Table 1 provides a summary of literature review on the empirical estimates of inflation.

There are very few empirical studies in Nepalese case to understand the relationship between inflation and output growth. Using the time series data of growth rate of GDP and inflation for the period of 1975 to 2010, the study by Bhusal and Silpakar (2011) have estimated 6 percent inflation as the threshold inflation level for Nepal. This study includes inflation as a single independent variable in the growth equation. However, the overall model is not robust and it has not examined the significance of the existence of the threshold. Bhatta (2015) estimates the threshold level of inflation employing the methodology of Sarel (1996) and Khan and Senhadji (2001). This study estimates 6 percent inflation as a threshold for Nepal.

Table 1 Summary of literature review

Study	Country	Period	Variables	Threshold	Methodology
Hosny Amr Sadek and Mohtadi Hamid (2014)	Egypt	1981-2009	Log of: GDP growth, Inflation, Inflation2, Gross fixed capital formation, Credit to the private sector, Trade, openness, Govt. consumption expenditure, Nominal exchange rate, Population growth rate.	12%	Threshold regression by Hansen (2000)
Khan Mohsin S. and Senhadji Abdelhak S. (2001)	140 countries comprising both industrial and developing countries	1960-1998	Log of: GDP growth rate, CPI inflation, GDP percapita, ratio of gross domestic investment to GDP, Population growth, growth rate of the TOT, five year std.dev. of TOT.	1-3 percent for Industrial countries and 11-12 percent for developing countries	
Bhatta Siddha Raj (2014)	Nepal	1975-2014	Real GDP, Inflation, Population growth, Export income, total investment	6 percent	Threshold regression by Khan and Senhadji (2001)
Yabu Nicas and Kessy Nicholsus J. (2015)	Kenya, Tanzania and Ugands	1970-2013	Growth rate of real GDP, Inflation, Population growth rate, Investment to GDP ratio, Credit to GDP ratio, Total trade to GDP ratio, FDI to GDP ratio and one dummy variable which takes zero during price contr5ol and one elsewhere.	Kenya 6.77 percent, Tanzania 8.80 percent, Uganda 8.41 percent.	Pollin and Zhu (2005)
Leshoro Temitope L.A. (2012)	South Africa	1980:Q2 - 2010:Q3	Growth rate of real GDP, Inflation, Investment to GDP ratio, percentage change in the TOT.	4 percent	Threshold regression by Khan and Senhadji (2001)
Frimpong Joseph Magnus and Oteng-Abayie Eric Fosu (2010)	Ghana	1960-2008	Growth rate of gross domestic investment as percentage of GDP, Growth rate of aggregate labour force, growth rate of TOT, and growth rate of money supply.	11 percent	Threshold regression model developed by Khan and Senhadji (2001)

Study	Country	Period	Variables	Threshold	Methodology
Mubarik Yasir Ali (2005)	Pakistan	1973-2000	Growth rate of real GDP, Inflation, Population growth rate, Investment growth rate.	9 percent	Threshold regression model developed by Khan and Senhadji (2001)
Fabayo and Ajilore (2006)	Nigeria	1970-2003		6 percent	Threshold regression by Khan and Senhadji (2001)
Kannan and Joshi (1998)	India	1981/82-95/96	real GDP growth, total investment to GDP ratio, real agricultural growth, net terms of trade and WPI inflation	6 percent	Threshold regression by Sarel (1997)
Study	Country	Period	Variables	Threshold	Methodology
RBI (2014)	India	NA	NA	4± 2 percent	NA
Bhusal Tara Prasad and Silpakar Sajana (2011)	Nepal	1975-2010	Growth rate of GDP, Inflation	6 percent	Threshold regression by Khan and Shenhadji (2001)
Kannan R. and Joshi Himanshu (1998)	India	1981/82-1995/96	Real GDP growth, total investment to GDP ratio, real agricultural growth, net terms of trade and WPI inflation.	6 percent	Threshold regression by Sarel (1997)
Mohanty, Deepak, Chakraborty, A. B., Das, Abhiman and John, Joice (2011)	India	Q1:1996-97 to Q3: 2010-11	GDP growth and Inflation	4.5-5.5 percent	Three different methods proposed by Sarel (1996), Khan and Senhadji (2001) and Espinoza et al. (2010)

III. EMPIRICAL ESTIMATION OF THRESHOLD INFLATION

This section undertakes the empirical estimation of the threshold inflation in Nepal. First, based on the theoretical underpinnings of the growth model, an empirical model is postulated. Second, the model is estimated using the ordinary least squares (OLS) method and recently developed threshold estimation technique by (Hansen, 2000).

3.1 Model and Estimation Method

The model specification is based on the augmented Solow-Swan growth model (Mankiw et al. 1992). The model incorporates the human capital, apart from the inputs of labour and physical capital in the neo-classical growth model (Mankiw, Romer, & Weil, 1992; Spolaore & Wacziarg, 2013).

In recent times the empirical literature on growth has moved from the 'proximate' determinants to 'deep' determinants which impact on the resource endowment and productivity growth (Spolaore & Wacziarg, 2013; Rodrik, 2003). 'Deep' determinants of growth focus on various factors such as : (a) geography; (b) trade integration; and (c) institutions (Rodrik, 2003). However, due to unavailability of the data on geographic and institutional variables, I confine the analysis to trade integration only.

The next important question is concerning the choice of the other explanatory variables. The empirical studies on the determinants of growth utilize a host of explanatory variables including inflation rate (Barro, 1997; Bosworth & Collins, 2003; Sala-i-Martin). The choice of the explanatory variables in this study is chosen both based on the empirical growth literature and data availability in Nepal. The reduced form of growth equation to be estimated is as follows:

$$gdppcg_t = \alpha y_{t-1} + \gamma_1 inf_t + \gamma_2 inf_t^2 + \beta_1 sav\_gdp_t + \beta_2 life_t + \beta_3 open_t + \beta_4 over\_exch_t + dummy + \varepsilon_t \quad \text{..... (1)}$$

Where $gdppcg_t$ = real GDP per capita growth. The explanatory variables are as follows (with the postulated signs of the regression coefficients of the corresponding variables in parentheses): inf_t (+ or -) =percentage change of Consumer Price Index in Nepal ; y_{t-1} (-) = lagged real GDP per capita (in log); sav_gdp_t (+) = savings to GDP (per-cent); $life_t$ (+) = life expectancy at birth; $open\_gdp_t$ (+ or -) = trade openness (total trade to GDP); $over\_exch_t$ (-) = exchange rate overvaluation, $dummy$ represents the dummy variables to capture the episodes of devaluation of Nepalese rupees and political events that contributed to high inflation (that is, the years 1981, 1986, 1987, 1992 and 2009).

The initial or the lagged level of per capita GDP captures the conditional ‘convergence effect’ or the catch-up effect. The coefficient of initial per capita GDP is expected to be negative because convergence hypothesis postulates that poorer countries tend to grow faster compared to richer countries. Another explanatory variable, savings-to-GDP ratio is regarded as a crucial determinant of growth. According to the seminal Harrod-Domar growth models increasing the savings rate will increase the growth of output by increasing investment (Harrod, 1939; Domar, 1946). Moreover, savings attract foreign investors by permitting the domestic investors for equity participation in the joint venture (Aghion et al. 2009). Trade openness has also been widely used in the empirical literature as one the determinants growth as a proxy for trade liberalization. Nepal embarked on a journey to liberalize the economy in the late 1980s, with major reforms on trade fronts. Consequently, total trade gradually increased, which helped to spur productivity growth. Similarly, life expectancy captures the level of human capital.1

The degree of exchange rate overvaluation is also included as an explanatory variable in growth model2. In an influential paper, Rodrik (2008) argues that undervaluation of the currency stimulates economic growth and overvaluation is associated with slow growth. He derives the index of undervaluation by taking the difference between the actual real exchange rate and the Balassa-Samuelson-adjusted rate. Due to large number of out migrants in Nepal, per capita income can not capture the productivity gain. I therefore, adjust the formula for undervaluation/overvaluation by using net foreign assets as a proxy of productivity of labour force working abroad. The degree of overvaluation/undervaluation is defined as the the portion of real effective exchange rate that is not explained by the GDP per capita growth and the growth in the net foreign assets.

$$growth\_reer_t = \alpha + \beta GDPPC\_growth_t + NFA\_growth_t + \varepsilon_t \quad \text{….. (2)}$$

Where, $growth\_reer_t$ =growth rate of real effective exchange rate index, $GDPPC\_growth$ =GDP per capita growth, NFA_growth =growth in net foreign assets. Thus, the degree of over/undervaluation is obtained by the difference between the actual and the predicted values (that is the residuals) of real effective exchange rate. We expect the sign of this variable to be negative.

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[1] The Penn World Table Version 9 estimates the “Human Capital Index”. However, the data are not available for the recent two years.

[2] I am thankful to Madhav Dangal for suggestion to include this variable.

The model includes the quadratic term for inflation to examine the possible non-linear and threshold effect of inflation on growth. Low level of inflation can be beneficial to growth as it provides an incentive to producers, but once it surpasses a certain threshold it might have negative effect on growth due to uncertainty and distortion of the price signals for efficient allocation of resources.

Then the turning point implied by the inflation-growth relationship is estimated using the formula for the quadratic equation. Specifically, the turning point is estimated as by setting the first partial derivative of Equation 1 to zero:

$\frac{\partial(gdppcg_t)}{\partial(inf_t)} = 0$, which implies, $inf^* = -\frac{\gamma_1}{2\gamma_2}$.

The significance of the turning point is estimated based on the Wald test for confidence interval using the delta method (Cameron & Trivedi, 2009). Due to the presence of squared inflation term, the main effect or the marginal effect of inflation and its significance is also reported in the regression estimations.

The growth rate associated with the estimated inflation turning point is also important as statistical significance of the turning point may not be economically significant. Thus, the maximum growth rate is also estimated at the turning point of inflation and mean values of the other explanatory variables. The significance of the maximum impact is also tested using the delta method.

The ordinary least squares (OLS) method is used to estimate the model. Augmented Dickey Fuller test, Phillips Perron test and Dickey-Fuller Generalized Least Squares (DFGLS) tests are used to test for the unit roots of the variables before estimating the regression. In order to avoid the spurious regressions, appropriate transformation of the variables is performed to make the variables free from unit roots. In order to account for the time series nature of the data, the standard errors are adjusted using the heteroskedasticity and autocorrelation consistent (HAC) Newey-White estimator upto some lag (Newey & West, 1987).3 The rule of thumb to choose the optimal lag is given by 0.75*T^(1/3), where T denotes the number of observations used in the regression (Stock & Watson, 2011).

In addition to the Ordinary Least Squares (OLS) estimation of model 3.1, I estimate a modern threshold regression approach based on Hansen (2000). The relationship between inflation and growth within Hansen (2000) framework can be expressed as follows4:

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[3] The formula for the Newey-West correction of standard errors is a bit involved and is not reproduced here.

[4] This discussion of the Hansen (2000) methodology draws from Hosny and Mohtadi (2014), pp. 10-11.

$$y_t = \widehat{\theta_1} x_t + e_t, \; q_t \leq \gamma \qquad \text{….. (3)}$$

$$y_t = \widehat{\theta_2} x_t + e_t, \; q_t > \gamma \qquad \text{….. (4)}$$

Where y_t denotes the real GDP growth rate at time t, x_t is the vector of explanatory variables including inflation, and e_t is the error term. The variable q_t represents the threshold variable that splits the sample into two regimes depending on the value of γ. Equations 3 and 4 can be rewritten as a single equation as follows:

$$y_t = \theta' x_t + \delta' x_t(\gamma) + e_t \qquad \text{….. (5)}$$

Where $\theta = \theta_2, \delta = \theta_2 - \theta_1, \; x_t(\gamma) = x_t d_t(\gamma)$, and the dummy variable $d_t(\gamma) = \{q_t \leq \gamma\}$

Hansen (2000) derives the asymptotic distribution of the least squares estimate of $\hat{\gamma}$ of the threshold parameter. Thus, this method is an improvement over the popular Khan and Shenhadji (2001) method as it endogenizes the threshold parameter and provides its statistical significance. Equation 5 can be expressed in matrix form as :

$$Y = X\theta + X_\gamma \delta_n + e \qquad \text{….. (6)}$$

Where the regression parameters $(\theta, \delta_n, \gamma)$ are estimated by the OLS or Maximum Likelihood Estimator, when e_t is iid and $N \sim (0, \sigma^2)$. Hansen (2000) shows that the threshold parameter $\hat{\gamma}$ can be obtained by minimizing the concentrated sum of squared error function, $S_n(\gamma)$:

$$S_n = S_n(\hat{\theta}(\gamma), \hat{\delta}(\gamma), \gamma) = Y'Y - Y'X_\gamma^* \left(X_\gamma^{*\prime} X_\gamma^*\right)^{-1} X_\gamma^{*\prime} Y \qquad \text{….. (7)}$$

The threshold value can now be uniquely defined as:

$$\hat{\gamma} = \arg\min S_n(\gamma) \qquad \text{….. (8)}$$

The significance of the threshold variable can be tested under the null hypothesis $H_0 = \theta_1 - \theta_2$. However, the parameter $\hat{\gamma}$ is not identified under the null, and hence the classical t-test or Wald test is not applicable. Hansen (2000) derives the asymptotic distribution of the likelihood test variable using the bootstrap method:

$$LR = (S_0 - S_1)/\hat{\sigma}^2,$$

Where S_0 is the residual sum of squares (RSS) under the null , S_1 is the RSS under the alternative hypothesis (H1), and $\hat{\sigma}^2$ is the residual variance under H1 .

3.2 Data Sources

The data covers the annual data from the fiscal year 1978 to 2016.[5] The choice of the time period is dictated by the data availability from the earliest period. The main data source is various issues of Economic Survey published by the Ministry of Finance. The data for the per capita GDP is taken from the World Development Indicators.

The summary statistics of the data used for estimation is presented in Table 2. The table reports only the summary statistics of 38 observations omitting the 'outliers' of inflation greater than 20 percent and negative economic growth.

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[5] Though the initial data starts from 1976, due to the transformation of variables (that is, taking the lag or growth and differencing resulted in a loss of observations.

Table 1: Summary statistics

VARIABLES	Mean	Standard Deviation	Minimum	Maximum
Real GDP growth	4.292	2.398	-1.500	10
Inflation	8.846	3.820	2.400	21.10
Life expectancy	59.09	8.048	45.20	70.70
Trade/GDP growth (in %)	1.784	7.198	-18.50	18.23
Saving/GDP growth(in %)	-0.730	20.75	-45.20	53.06
Exchange rate overvaluation	0	10.77	-32.32	23.62
Difference of lagged log per capita GDP	0.0494	0.0722	-0.169	0.208

Figure 2 depicts the real GDP growth and inflation against the time. There does not seem to be a discernible relationship between economic growth and inflation. Figure 3 plots the economic growth against inflation rate in order to inspect the relationship between these variables. The quadratic trend seems to better fit the data than the linear trend. However, the relationship does not include the effects of other explanatory variables.

Figure 2: Inflation and Real GDP Growth

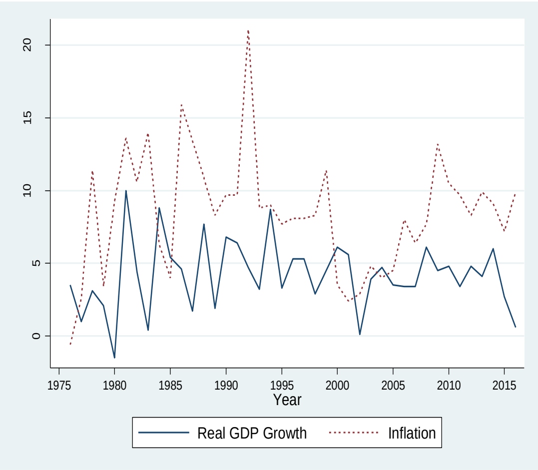
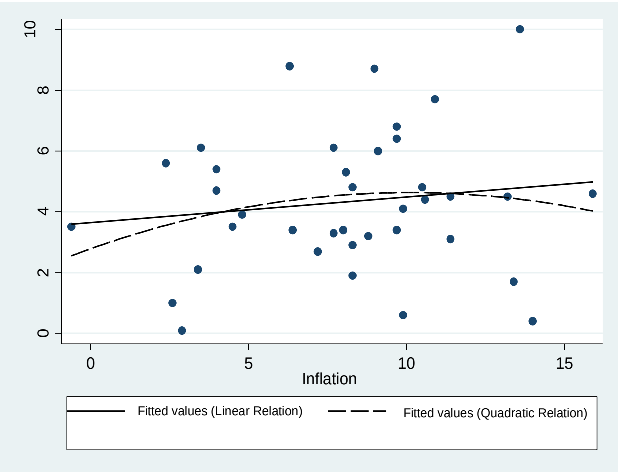


Figure 0: Relationship Between Inflation and Growth



3.3 Results

Before estimating the models we need to ensure that the dependent variable (real GDP growth) and the explanatory variables are integrated of the same order (Enders, 2004). Augmented Dickey Fuller test, Phillips Perron test and Dickey-Fuller Generalized Least

Squares (DFGLS) tests are used to test for the unit roots of the variables. The tests reveal that the inflation variable is stationary while other variables are non-stationary. Since, the dependent variable is stationary, all the non-stationary variables are converted into growth form to ensure that all variables are stationary. The latter transformation possibly results into the loss of information and renders the interpretation of the regression coefficients of those variables a bit difficult. However, since our main interest is the estimation of quadratic inflation-growth relationship, this transformation is unlikely to affect our results.

The OLS estimations of the model 3.1 are reported in Table 3. The first column of the Table 3.2 shows that there is no statistically significant relationship between inflation and growth when we have a basic set of conditioning variables.

However, with the full set of conditioning variables in columns 2–4 (Table 3), the quadratic term of inflation becomes significant at 5 percent level. Moreover, the joint test of significance of both the linear and squared inflation term shows that the combined effect is significant at 5 percent level. The negative coefficient of the squared inflation terms suggests that there is possibly an inverted relationship between inflation and growth.

Table 0 : OLS Results

VARIABLES	**(1) Model 1**	**(2) Model 2**	**(3) Model 3**	**(4) Model 4**
Inflation	-0.03	0.33**	0.30**	0.41***
	(0.074)	(0.151)	(0.144)	(0.128)
Inflation Squared		-0.02**	-0.02**	-0.03***
		(0.010)	(0.010)	(0.011)
Difference of lagged log per capita GDP			-6.88	-7.56
			(6.820)	(6.209)
Saving/GDP growth (in %)	0.01	0.01	0.01	0.01
	(0.011)	(0.015)	(0.015)	(0.014)
Trade/GDP growth (in %)	0.12***	0.14***	0.13***	0.12**
	(0.040)	(0.039)	(0.045)	(0.045)
Life expectancy		0.00	0.01	0.02
		(0.056)	(0.058)	(0.045)
Exchange rate overvaluation				-0.06*
				(0.031)
Dummy variable		1.96	2.35	3.06
		(2.497)	(2.591)	(2.854)
Constant	4.34***	2.98	2.92	2.13
	(0.811)	(4.081)	(3.855)	(2.805)
Observations	39	39	39	39
P-value of Joint Test		0.053	0.065	0.0096

Note. Dependent variable is real GDP growth. Newey-West corrected standard errors with lags 3 in parentheses. P-value of joint test refers to the probability of rejecting the null that both inflation and square of inflation are zero.
*** p<0.01, ** p<0.05, * p<0.1

The turning point implied by the inflation-growth relationship on Model 4 (Table 3) is given in Table 4. The turning point of inflation occurs at 6.25 percent which is significant at 1 percent level. However, the standard error is quite large resulting in a wide confidence interval. The growth impact associated with this level of inflation depends on the value of other covariates. If we fix the values of other covariates at means, the maximum real GDP growth impact associated with the 'optimum' level of inflation is 4.59 percent. The confidence interval of the maximum impact is small compared to the threshold inflation.

Table 4 : Turning Point of Inflation and its Maximum Impact

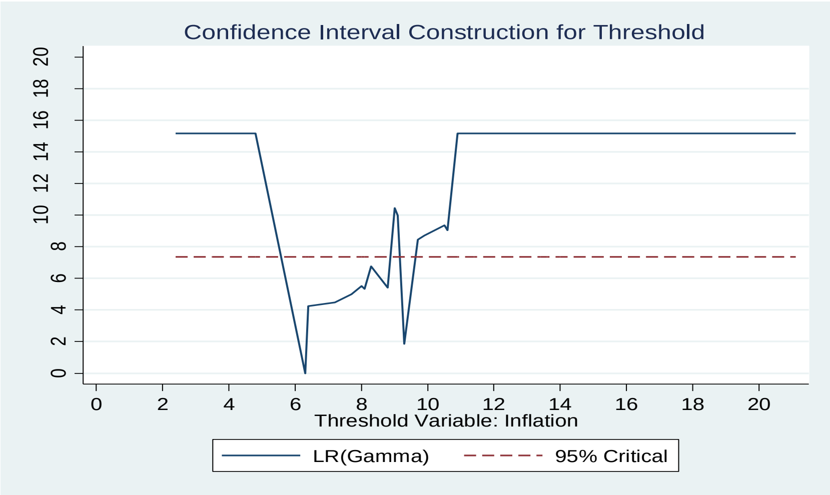
	Point estimate	Standard error	95 percent confidence interval
Turning point (inflation)	6.25	1.599	[3.12 9.38]
Maximum growth impact at means	4.59	0.276	[4.04 5.13]

Threshold regression

As an alternative estimation of threshold inflation, Model 3.4 is estimated using Hansen (2000) methodology. First, the null hypothesis of no threshold effect is tested using 10,000 bootstrap replications, the p-value for the threshold model using inflation rate is marginally significant at 0.011. The test suggests that there is a sample split based on the threshold level of inflation at 5 percent level of significance.

Figure 4 shows the graph of the normalized likelihood ratio sequence $LR_n^*(\gamma)$ as the function of threshold inflation. The LS estimate of γ is the value that minimizes this graph, which occurs at $\hat{\gamma} = 6.40\ \%$. The 95 % critical value of 7.35 is also plotted, so we can read off the asymptotic 95 % confidence set $\hat{\Gamma}*$ =[6.40, 9.30] from the graph where $LR_n^*(\gamma)$ crosses the dotted line. These results suggest that there is an evidence of two-regime specification, though there is considerable uncertainty about the value of the threshold.

Figure 4: Threshold inflation



The comparison of the threshold estimates from the OLS and the threshold estimations show that there is some of evidence of threshold effect of inflation. The confidence intervals also overlap in these cases, showing the robustness of the result. Thus, the results broadly suggest that the threshold inflation falls within the range of around 6 to 9 percent. The wide confidence intervals of these estimations may also be a result of few observations available for estimation.

The estimations of threshold inflation suggest that there is a sample split of two regimes based on inflation rate. We assume the sample split level of 6.5 percent and re-run the regressions. Table 5 indicates that below the 6.5 percent threshold, inflation has a might have a positive impact on growth. When inflation exceeds 6.5 percent, it seems to have negative impact on growth, though the result is not statistically significant. Due the sample split, the number of observations in both samples reduced, and the regression coefficients obtained may not very reliable.

Table 5: OLS Results on Sample Split

VARIABLES	Sample Split 1	Sample Split 2
Inflation	0.23	-0.37
	(0.506)	(0.315)
Difference of lagged log per capita GDP	-59.67	-6.61
	(26.699)	(7.350)
Saving/GDP growth(in %)	0.14	0.00
	(0.087)	(0.021)
Trade/GDP growth (in %)	-0.03	0.11
	(0.113)	(0.074)
Life expectancy	-0.10	0.03
	(0.067)	(0.054)
Exchange rate overvaluation	0.08	-0.06
	(0.069)	(0.051)
Dummy variable		2.84
		(3.501)
Constant	12.86	5.86
	(6.254)	(4.255)
Observations	10	29

Note. Dependent variable is real GDP growth. Newey-West corrected standard errors with 3 lags in parentheses. Sample 1 and Sample 2 refer to the observations when inflation rate is below and above 6.5 percent respectively.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

IV. CONCLUSION

From the regression results, there is some evidence to suggest the existence of a threshold level of inflation in Nepal. The OLS method estimates the turning point of inflation to be 6.25 percent while that of the Hansen (2000) method shows the threshold level to be 6.40 percent. However, the confidence intervals of the threshold level are large in both estimations suggesting the uncertainty of the estimates. This optimal range of inflation, however, is consistent with earlier findings in the literature on developing countries (Khan and Shenhadji, 2001). The maximum impact on growth associated with the turning point, and at the mean levels of other explanatory variables is quite high at 4.59 percent.

The large standard errors associated with the threshold estimations may be due to the low number of sample size, data limitations and short-run developments exerting a significant impact on inflation – such as failure of agricultural crops, high prices of imported products and depreciation in the exchange rate. Several previous studies have also argued that the inflation in Nepal is significantly affected by other non-economic structural and political factors. Moreover, the above threshold estimates are based on past data, and a more forward-looking approach is needed to assess the appropriate level of inflation. The uncertainty in the level of threshold level of inflation also suggests that it is better to adopt a 'target' range or band of inflation instead of point estimate in Nepal. A range also enhances transparency and predictability in the monetary policy by signaling the maximum tolerance levels of monetary policy to accommodate unanticipated shocks (RBI, 2014).

Given the pegged exchange rate regime and about two-third of total trade with India, Nepal's inflation is mostly influenced by India. Thus, the sustainability of the peg crucially depends on maintaining the inflation close to that of India to prevent the misalignment of exchange rate. The average annual inflation differential of Nepal with India since 1976 has been around 1.5 percent. With the adoption of flexible inflation targeting by Reserve Bank of India, inflation has come down significantly in India, and the RBI has committed to target the inflation level to 4 percent with +/- 2 percent band. Thus, Nepal should also adopt an inflation target range around the computed optimal inflation rate to lower the inflation expectation and enhance economic growth.

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