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**Determinants of Inflation in Nepal: An Application of ARDL
Bounds Testing Approach to Cointegration**

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ABSTRACT

This paper aims to examine the relationship between the price level and the macroeconomic variables namely, Indian CPI, government deficit, the nominal effective exchange rate, broad money supply, crude oil price, and real GDP from 1975 to 2018 by applying the ARDL approach to cointegration. Phillips-Perron test has been applied to test the stationarity of data series; all the variables considered are stationary at first difference, $I(1)$. VAR lag selection criteria have been deployed to select the optimal lag length. Bounds test (F-version) has been carried out to determine the existence of the long-run relationship between variables. The empirical results show that in the long-run, the major determinants of inflation in Nepal are Indian inflation (0.453), real income (0.347), and exchange rate (0.224). In addition, Indian inflation (0.286), the exchange rate (0.141), and government deficit (0.039) have significant effects in the short-run. Finally, the error correction term is found to be negative and statistically significant suggesting a correction of short-run disequilibrium within two years.

JEL Classification: C12, C22, E31, E51

Key Words: Inflation, Indian inflation, Money supply (M2), Government deficit, nominal exchange rate, Crude Oil Price, ARDL approach

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I. INTRODUCTION

Inflation is one of the major macroeconomic variables that influence other several macroeconomic variables such as real income, real interest rate, real investment, real saving, and the like. Likewise, several other macroeconomic variables influence inflation. Broad money supply, budget deficit, imported prices, inflation in the foreign economy, exchange rates, interest rate, crude oil price, and the like are the major factors that influence the price level in an economy. Inflation is the persistent upward movement of the general price level in an economy, which deteriorates the purchasing power of the consumers. Sporadic rise and fall in the price level are not termed as inflation. Consumer price index, producer price index, GNP implicit price deflator, and PCE implicit price deflator are the four major tools used to measure inflation (Shapiro, 1996).

The data reveals that the year-on-year consumer price inflation in Nepal stood at 6.95 percent in mid-August 2019 (Nepal Rastra Bank, 2019a). The data from 1975 to 2018 reveals that the broad money supply, budget deficit, and nominal effective exchange rate are rising exponentially, but this does not show the interlinkages between them. Apart from these variables, Indian inflation and international crude oil price also play a vital role in determining the price level in Nepal. This study attempts to measure the impact of major macroeconomic variables on inflation using the ARDL bounds testing approach to cointegration.

This paper is organized into five sections. Section I presents an introduction. Section II reviews the macroeconomic theories and related empirical studies. Chapter III presents the data and methodology. Chapter IV contains regression results and interpretation. Finally, Chapter V concludes the paper.

There are a few limitations to the study. First, the paper uses the ARDL approach to cointegration, so the conclusions drawn by this study may not match with the conclusion drawn by the study using other methodologies. Secondly, the study covers the data from 1975 to 2018 because of the unavailability of data prior to 1975. Despite wage and salary index being one of the influencing variables of the price level, the study has not included it because of the unavailability of data series from 1975, which is the third limitation of this study.

II. LITERATURE REVIEW

The literature review section is classified into two parts: a) review of macroeconomic thoughts and b) review of empirical studies. A review of macroeconomic theories deals with the quantity theory of money, demand-pull theory, monetary theory, cost-push theory, and rational expectation revolution. Similarly, under a review of empirical studies, the study has reviewed research papers by Mohammed, Benyamina, and Benhabib (2015), Lim and Sek (2015), Khatun and Ahamad (2012), and Pahlavani and Rahimi (2009) under the review of international empirical studies, and research papers by Chaudhary and Xiumin (2018), IMF (2014), and Poudyal (2014) under the review of national empirical studies. However, national empirical studies have not applied the ARDL approach.

2.1 Review of macroeconomic theories

The quantity theory of money is one of the oldest economic doctrines that survived despite the Great Depression followed by severe Keynesian criticism. The quantity theory of money, other being Say's Law of Market, are the founding pillars of classical macroeconomic thoughts. The classical quantity theory of money can be explained with a famous equation: $MV = PT$, where M = Money in circulation, V = velocity of money, P = price level, and T = volume of transaction. V is assumed constant. Classicist assumes that the economy is always in full employment, so transaction (T) is assumed constant. Consequently, an increase in the stock of money (M) brings about a proportionate rise in the price level (P).

The demand-pull theory of inflation emerged with the Keynesian effective demand. Keynes and his followers emphasized the increase in aggregate demand as the source of demand-pull inflation (Totonchi 2011). Aggregate demand comprises of consumption, investment, government expenditure, and net exports. Inflationary pressures pile up when the aggregate demand exceeds the aggregate supply, also known as the inflationary gap. The rapidity of price escalation depends upon the gap between aggregate demand and aggregate supply. Keynesian transmission mechanism states that the money supply is proportional to output at below full employment, while the money supply is proportional to the price level at full employment.

During the late 1940s and early 1950s, the waves of monetarism emerged with the works of Milton Friedman. Monetarism holds that stability in the growth of money supply is crucial for a stable economy and as such monetary policy is a more effective instrument than fiscal policy in economic stabilization (Froyen 2013). The monetarist emphasized the role of money and advocates that money supply influences the price, employment, and output in the short-run, but only influences price level in the long-run. Modern quantity theory led by Milton Friedman holds that "inflation is always and everywhere a monetary phenomenon (Totonchi 2011).

The rise in the efforts of a labour union to increase wages and employers to increase the profit was the principal cause of inflation, and emerged as Cost-Push inflation, also called "New Inflation" (Totonchi 2011). The basic cause of cost-push inflation is the rise in the money wage more rapidly than the productivity of the labour (Shapiro 1966). Another cause of cost-push inflation is known as profit-push inflation. Firms in imperfect markets rise the price of the product to offset the rise in wage and subsequent rise in the cost of production.

The new classical doctrine does not accept the difference between the short-run and long-run results in the Keynesian and monetarist analysis (Froyen 2013). The New Classical economist proposed that economic agents will form rational expectations. Economic agents form their expectations rationally based on all past and present information available, and also price expectations (Totonchi 2011).

2.2 Review of international empirical studies

Mohammed, Benyamina, and Benhabib (2015) examine the main determinants of inflation in Algeria using the ARDL model during the period 1980-2012. In this context, this paper focuses on the major sources to explain the inflation trend in Algeria (import price, oil price and money stock, government expenditure and effective nominal exchange rates of the Algerian Dinar). The results based on the ARDL model establish that a stable long-run relationship exists between inflation and its determinants. However, In the short run, only external factors (import price, oil price, and effective and nominal exchange rates) impact inflation in Algeria. Consequently, we may infer, as far as the impact on inflation is concerned, that fiscal and monetary policies cannot on their own be statistically significant.

Lim and Sek (2015) examine factors affecting inflation in two groups of countries (high inflation group and low inflation group) using annual data from 1970 to 2011. An Error Correction Model based on the Autoregressive Distributed Lag (ARDL) modeling has been used to explain the short-run and long-run impacts of each variable on inflation. The results respectively indicate that GDP growth and imports of goods and services have a significant long-run impact on inflation in low inflation countries. Results also indicate that money supply, national expenditure and GDP growth are the determinants of inflation which impose a long-run impact on inflation in high inflation countries. In the short run likewise, none of the variables are found to be significant determinants in high inflation countries. However, money supply, imports of goods and services and GDP growth have a significant relationship with inflation in low inflation countries.

Khatun and Ahamad (2012) investigate major determining factors of inflationary trends in Bangladesh during the period FY1981 to FY2009. An unrestricted error-correction model (UECM) version auto-regressive distributed lag (ARDL) bounds F-test has been employed to find out the short-run and long-run elasticities of the determinants of inflation. The empirical result reveals that domestic rice production affects inflation negatively in the short run to a significant extent. Conversely, domestic petroleum price and broad money (M2) supply have a low but positive impact on inflationary trends. This suggests that increased domestic rice production and effective fiscal-monetary integration are the crucial policy options to curb the inflationary pressure in Bangladesh.

Pahlavani and Rahimi (2009) examine the major determinants of inflation in Iran using annual time series data (1971 to 2006) by applying the ARDL approach. An empirical model has been constructed which emphasizes the effects of liquidity, the exchange rate, GDP, the expected rate of inflation and imported inflation factors along with the dummy variable presenting the effect of the Iran/Iraq war on Iran's economy. The empirical results show that in the long-run, the main determinants of inflation in Iran are the liquidity, exchange rate, the rate of expected inflation and the rate of imported inflation. All these variables had significant effects on the inflation rate in the short run. Moreover, the destructive eight-year war with Iraq had a positive effect on the inflation rate in the Iranian economy. Finally, the error correction term (-0.3995) is found to be negative and statistically significant suggesting a quick adjustment process.

2.3 Review of national empirical studies

Chaudhary and Xiumin (2018) examine the impacts of macroeconomic variables on the inflation in Nepal during 1975-2016. The variables considered for the study are limited to the use of real broad money supply, real GDP, Indian prices. The results suggest that all variables considered are significant in the long-run implying that these variables are the determinants of inflation in Nepal. The results are consistent with the monetary theory. The results concluded that the money supply (0.197) and Indian prices (1.074) cause inflation in the long-run based on an Ordinary Least Squares regression model.

Poudyal (2014) examined short term and long-term effects of the macroeconomic variables on the inflation in Nepal during 1975-2011. The variables considered are budget deficits, Indian prices, real broad money supply, exchange rate, and real GDP. The regression results from the Wickens-Breusch Single Equation Error Correction model suggest that all variables considered are significant in the long run implying that these variables are the determinants of inflation in Nepal. However, only budget deficit, money supply, and Indian prices cause inflation in the short run.

IMF (2014) estimated the determinants of Nepalese inflation on the monthly series of Nepal's CPI, broad money, a nominal effective exchange rate (NEER), and Indian CPI using OLS. The coefficient of broad money supply and Indian inflation was 0.12 and 0.45 percent respectively; indicating a 1 percent increase in broad money supply will cause Nepalese inflation to rise by 0.12 percent whereas such an increase in Indian CPI will increase Nepalese inflation by 0.45 percent.

NRB (2007) estimated the impact of narrow money supply and Indian inflation in Nepal's inflation applying cointegration and error correction model on annual data from 1978 to 2006. The result revealed a significant short-run impact of M1 but did not find a long-run impact on inflation. Further, the findings suggest that a one percent increase in Indian price level changes Nepal's inflation by 1.09 percent in the short-run.

III. DATA AND METHODOLOGY

3.1 Data and variables

The study uses the annual data on the consumer price index of Nepal, broad money supply, Indian consumer price index, real GDP, Crude oil, Government deficit and nominal effective exchange rate. These data are obtained from the World Bank Open Data, and Nepal Rastra Bank covered the time period from 1975 to 2018.

Table 1
The description of variables

S.N.	Notation	Variable	Unit
1	CPIN	Consumer Price Index of Nepal	Log transformation; base year: 2010 = 100
2	M2	Broad money supply	Log transformation; values in million rupees
3	CPII	Consumer Price Index of India	Log transformation; base year: 2010 = 100
4	NEER	Nominal Effective Exchange Rate	Log transformation; base year: 2010 = 100
5	RGDP	Real GDP	Log transformation; Values in million rupees; Base year: 2010
6	COIL	Crude Oil Price	Log transformation; Value in US dollar
7	GD	Government Deficit	Log transformation; Value in Million rupees

According to the World Bank, the consumer price index reflects changes in the cost of the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals. Real GDP is the inflation-adjust monetary value of all goods and services produced within the political boundary of a country regardless of factors of production. The study calculated NEER considering indirect quotations, so the interpretation differs. The increase in the NEER index signifies the devaluation of the home currency and vice-versa. Hence, the study expects a positive coefficient of NEER. Government deficit refers to the excess of government expenses over government revenue for an accounting year. Broad money supply, though it is a monetary aggregate, only acts as a policy variable in this study as the government deficit causes the money supply to increase.

The formula used to calculate NEER is:

$$NEER = \sum_{i=1}^n TW_i \times NER_i$$

Where,

TW_i = Trade weight of country i

NER_i = Nominal Exchange Rate of country i

3.2 ARDL Approach to cointegration

Engle and Granger (1987) were first to propound the concept of cointegration, providing tests, and estimation procedures to ensure the existence of long-run relationships. Following the shortcomings of Engle and Granger (1987), Johansen (1999) and Johansen and Juselius (1990) proposed a new procedure for testing the cointegration of several, say k , $I(1)$ time series. This test permits more than one cointegrating relationship, so it is more applicable than the Engle and Granger (1987) test. However, when one cointegrating vector exists, Johansen (1988) and Johansen and Juselius (1990) cointegrating procedure cannot be applied (Nkoro and Uko, 2016). Thus, it is imperative to explore the ARDL bounds testing approach to cointegration developed by Pesaran and Shin (1999) and Pesaran et al. (2001).

Nkoro and Uko (2016), Bhatta (2013), and Narayan and Smyth (2006) have discussed numerous advantages of the ARDL approach. (i) Each of the underlying variables stands as a single equation endogeneity is less of a problem in the ARDL technique because it is free of residual correlation, (ii) When there is single long-run relationship, the ARDL procedure can distinguish between dependent and explanatory variables, (iii) The Error correction model (ECM) can be derived from ARDL model through a simple linear transformation, which integrates short-run adjustments with long-run equilibrium without losing long-run information, (iv) It can be applied on a time series data irrespective of whether the variables are $I(0)$ or $I(1)$, while Johansen cointegration technique requires all the variables in the system be of equal order of integration, nevertheless, ARDL cannot be applied if variables are $I(2)$, (v) ARDL procedure is statistically more significant approach to determine the cointegration relation in small samples, (vi) The ARDL technique allows the variables may have different optimal lags, (vii) The ARDL technique generally provides unbiased estimates of the long-run model and validates the t -statistics even when some of the regressors are endogenous.

Following the ARDL approach proposed by Pesaran and Shin (1999), the existence of a long-run relationship could be tested using equation (1) below:

$$\begin{aligned} \Delta \ln \text{CPIN}_t = & \alpha + \sum_{j=0}^p b_j \Delta \ln \text{CPIN}_{t-j} + \sum_{j=0}^q c_j \Delta \ln \text{CPII}_{t-j} + \sum_{j=0}^r d_j \Delta \ln \text{M2}_{t-j} + \\ & \sum_{j=0}^s e_j \Delta \ln \text{NEER}_{t-j} + \sum_{j=0}^u f_j \ln \text{RGDP}_{t-j} + \sum_{j=0}^v g_j \ln \text{COIL}_{t-j} + \sum_{j=0}^w h_j \ln \text{GD}_{t-j} + \\ & \gamma_1 \ln \text{CPIN}_{t-1} + \gamma_2 \text{CPII}_{t-1} + \\ & \gamma_3 \ln \text{M2}_{t-1} + \gamma_4 \ln \text{NEER}_{t-1} + \gamma_5 \ln \text{RGDP}_{t-1} + \gamma_6 \ln \text{COIL}_{t-1} + \gamma_7 \ln \text{GD}_{t-1} + \varepsilon \end{aligned} \quad \dots\dots\dots (1)$$

Here, all variables are as previously defined. $\gamma_1, \gamma_2, \gamma_3, \gamma_4, \gamma_5, \gamma_6$ and γ_7 are the long-run coefficients while $b_j, c_j, d_j, e_j, f_j, g_j$ and h_j represents the short-run dynamics and ε represents a random disturbance term. The orders of the lags in the ARDL model are selected by either the Akaike Information Criterion (AIC) or the Schwarz Bayesian Criterion (SBC) (Narayan, 2004). However, the study uses the SBC criterion in lag selection as ARDL-SBS estimators perform slightly better than ARDL-AIC in the majority of the experiments (Pesaran and Shin, 1995).

3.3 Hypothesis

To test whether the long-run equilibrium relationship exists between the consumer price index of Nepal, Indian consumer price index, broad money supply, crude oil price, government deficit, and nominal effective exchange rate, bounds test (F-version) for cointegration is carried out.

$H_0 : \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = \gamma_6 = \gamma_7 = 0$; No cointegration exists.

$H_1 : \gamma_1 \neq \gamma_2 \neq \gamma_3 \neq \gamma_4 \neq \gamma_5 \neq \gamma_6 \neq \gamma_7 \neq 0$; Cointegration exists.

The F-statistics is then compared with the critical values provided by Pesaran et al. (2001). If the computed F-statistics is higher than the appropriate upper bound of the critical value, the null hypothesis of no cointegration is rejected, if it lies within the lower and upper bounds, the result is inconclusive, and if it lies below the lower bound, the null hypothesis cannot be rejected.

$$\Delta \ln CPIN_t = \alpha + \sum_{j=0}^p \delta_1 \Delta \ln CPIN_{t-j} + \sum_{j=0}^q \delta_2 \Delta \ln CPII_{t-j} + \sum_{j=0}^r \delta_3 \Delta \ln M2_{t-j} + \sum_{j=0}^s \delta_4 \Delta \ln NEER_{t-j} + \sum_{j=0}^u \delta_5 \Delta \ln RGDP_{t-j} + \sum_{j=0}^v \delta_6 \Delta \ln COIL_{t-j} + \sum_{j=0}^w \delta_7 \Delta \ln GD_{t-j} + \delta_8 E(v_t) \dots \dots \dots (2)$$

The estimation of dynamic error correction will be carried out using equation (2) The coefficients $\delta_1, \delta_2, \delta_3, \delta_4, \delta_5, \delta_6,$ and δ_7 are the short-run dynamics of the model and δ_8 indicate the divergence or convergence towards the long-run equilibrium. A positive coefficient indicates a divergence, while a negative coefficient indicates convergence.

For the test of stability, CUSUM and CUSUMSQ test are carried out in this study. Besides these tests, a number of other tests are also carried out, such as Lagrange Multiplier (LM) test for serial correlation, Ramsey Reset test for functional form misspecification, Jarque-Berra test for normality, and KB test for heteroscedasticity. The study employs EViews 9 and Microfit 5.0 for calculation of econometric tests and ARDL model estimation.

IV. ECONOMETRICS TESTS

Nkoro and Uko (2016) proposed to test for unit roots since the ARDL cointegration technique requires underlying variables of I(0) or I(1) or a combination of both; integration of order I(2) leads to the crashing of the technique. Further, the ARDL error correction representation becomes relatively more efficient if the F-statistics (wald test) establishes that there is a single long-run relationship and the sample data size is finite (Nkoro and Uko, 2016). So, the study uses Phillips and Perron test for the stationary test as it is robust to serial correlation (Hudson, 2018). Table 2 depicts the results from the Phillips and Perron test at the level and first difference. Similarly, figure 1 depicts the trend with stationary.

Table 2
Phillips-Perron tests at the levels and at the first difference

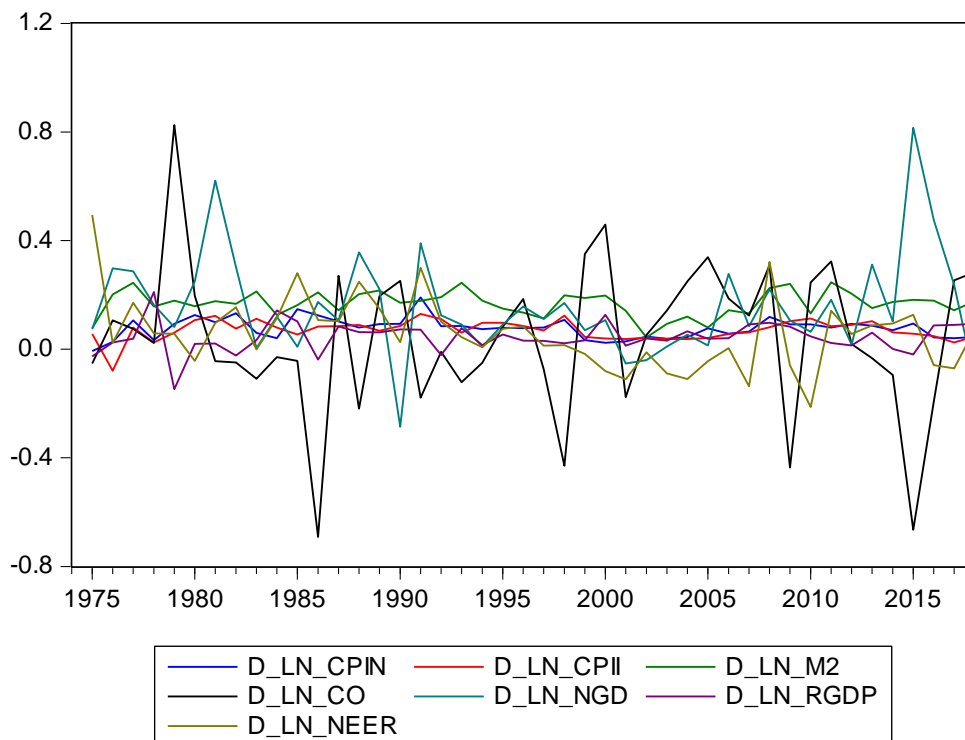
Variables	Level	First difference	Order of integration
CPIN	-0.7131	-4.9017*	I(1)
CPII	-0.1399	-4.6225*	I(1)
M2	-0.4606	-5.2417*	I(1)
NEER	-3.1300	-6.4770*	I(1)
RGDP	1.0678	-8.2164*	I(1)
COIL	-1.5744	-6.1290*	I(1)
GD	-0.0198	-5.3901*	I(1)

Note: The relevant critical value at a 1% level of significance is -3.5924.

* Significant at 1%.

Source: Author's own calculation using EViews9

Figure 1: Trend with stationary



Source: Author's own calculation using EViews9

Table 3
VAR lag length criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	123.7901	NA	6.87e-12	-5.839504	-5.543950	-5.732641
1	435.6570	498.9870*	1.40e-17	-18.98285	-16.61842*	-18.12794
2	488.5330	66.09503	1.45e-17	-19.17665	-14.74334	-17.57370
3	550.9026	56.13270	1.48e-17	-19.84513	-13.34295	-17.49415
4	657.0162	58.36247	4.87e-18*	-22.70081*	-14.12975	-19.60179*

Note: * indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

Source: Author's own calculation using EViews9

Table 4
Bounds test (F-version) result

Variables	F-statistics	Cointegration	Lag Optimal
F(CPIN CPII, M2, NEER, RGDP, COIL, GD)	4.52*	Cointegration	1,0,0,0,1,1,0
	Critical Value	Lower Bound (I0)	Upper Bound (I1)
	1%	3.15	4.43
	5%	2.45	3.61
	10%	2.12	3.23

Note: *, **, and *** shows 1%, 5%, and 10% level of significance respectively; ns: not significant at 10% level of significance.

Source: Author's own calculation using Microfit 5.0

F-statistics, presented in Table 4, lies above the upper critical value of 4.43, which rejects the null hypothesis of no cointegration. Also, a significantly negative coefficient obtained from ECMt-1 will support cointegration or convergence toward the long-run, which is considered more efficient for testing cointegration (Bahmani-Oskooee and Bahmani, 2015; Banerjee, Dolado and Mestre, 1998). This is indeed the case from Table 7.

The preliminary tests consisting of unit root test and bounds test confirms that all the variables are I(1), and the existence of a single long-term relationship respectively. Thus, it is imperative to apply the ARDL approach to cointegration.

V. ARDL REGRESSION RESULTS AND INTERPRETATION

Choosing the order of the distributed lag functions is one of the important issues in ARDL. The Schwarz Bayesian Criterion (SBC) is preferred to other model specification criteria as it often has more parsimonious specifications (Pesaran and Smith, 1998). The VAR lag length criteria have been deployed to choose the maximum lag length for the ARDL model. With the maximum lag length of 1, the optimal number of lags for each of the variables is shown as ARDL (1,0,0,0,1,1,0).

Table 5
Full information ARDL Estimate Results

Regressor	Coefficient	Standard Error	T-Ratio [Prob]
CPIN(-1)	0.369	0.165	2.239 [0.032]
CPII	0.286	0.152	1.874 [0.07]
M2	0.034	0.060	0.563 [0.577]
NEER	0.141	0.019	7.432 [0.000]
RGDP	0.038	0.072	0.528 [0.601]
RGDP(-1)	0.181	0.075	2.415 [0.021]
COIL	0.017	0.015	1.09 [0.284]
COIL(-1)	0.037	0.015	2.48 [0.018]
GD	0.039	0.015	2.54 [0.016]
INPT (Constant)	-3.243	0.797	-4.071 [0.000]
$R^2 = 0.99$; $\bar{R}^2 = 0.99$	DW-stat. = 1.93	F-stat. = 9908.9 [.0000]	
Diagnostic Tests			
Test Statistics	LM Version	F Version	
A: Serial Correlation	CHSQ (1) = .0094 [.923]	F (1,33) = .007 [.934]	
B: Functional Form	CHSQ (1) = 3.452 [.063]	F (1,33) = 2.79 [.104]	
C: Normality	CHSQ (2) = .7830 [.676]	Not applicable	
D: Heteroscedasticity	CHSQ (1) = 2.544 [.111]	F (1,42) = 2.57 [.116]	

Note: A: Lagrange multiplier test of residual serial correlation; B: Ramsey's RESET test using the square of the fitted values; C: Based on a test of skewness and kurtosis of residuals; D: Based on the Breusch-Pagan-Godfrey Test. *, **, and + shows the significance of coefficients at a 1%, 5%, and 10% level of significance respectively; ns: not significant at 10% level of significance

Source: Author's own calculation using Microfit 5.0

Table 5 indicates that the overall goodness of fit of the estimated ARDL regression model is very high with the result of adjusted R² = 0.99. The diagnostic test signifies that the model passes all of the tests. The critical values of χ^2 for one, and two degrees of freedom at a 5% significance level is 3.84, and 5.99 respectively. Thus, the null hypothesis of the normality of residuals, the null hypothesis of no first-order serial correlation, and the null hypothesis of no heteroscedasticity are accepted. However, the null hypothesis of no misspecification of functional form can be accepted at a 10% level of significance only.

Table 6
Estimated Long-run coefficients using the ARDL Approach

ARDL (1,0,0,0,1,1,0) selected based on Schwarz Bayesian Criterion

The dependent variable is CPIN

44 observations used for estimation from 1975 to 2018

Regressor	Coefficient	Standard Error	T-Ratio [Prob]
CPII	0.453*	0.161	2.821 [0.008]
M2	0.053 ^{ns}	0.091	0.585 [0.562]
NEER	0.224*	0.046	4.885 [0.000]
RGDP	0.347**	0.146	2.369 [0.024]
COIL	0.085**	0.033	2.530 [0.016]
GD	0.061**	0.028	2.204 [0.035]
INPT (Constant)	-5.141*	1.599	-3.215 [0.003]

Note: *, **, and *** shows the significance of coefficients at a 1%, 5%, and 10% level of significance respectively; ns: not significant at 10% level of significance

Source: Author's own calculation using Microfit 5.0

The estimated long-run model of the corresponding ARDL (1,0,0,0,1,1,0) is:

$$\ln \text{CPIN}_t = -5.209 + 0.453 \ln \text{CPII}_t + 0.053 \ln \text{M2}_t + 0.224 \ln \text{NEER}_t + 0.347 \ln \text{RGDP}_t + 0.085 \ln \text{COIL}_t + 0.061 \ln \text{GD}_t \dots\dots\dots (3)$$

The long-run coefficients are reported in Table 6. As expected, the coefficients of CPII, NEER, real income (RGDP), crude oil price, and government deficit are positive and significant. Quantitatively, the long-run elasticity of Indian CPI is 0.453, which is significant. This, in turn, shows that a one percent increase in Indian CPI leads to an increase in Nepalese CPI by 0.453%. Similarly, the long-run elasticity of NEER, real income, crude oil, and government deficit is 0.224, 0.347, 0.085, and 0.061 respectively. The result suggests that devaluation of the currency by 1% increases the price level by 0.224%. Similarly, an increase

in real income by 1% increase prices by 0.347%. Similarly, a 1% increase in crude oil price and government deficit increases the price level by 0.085% and 0.061% respectively. This result reveals that in long-term Indian inflation has a higher impact on inflation in Nepal. Accordingly, the result supports the presence of high trade dependency on India, and the consequent shifting of Indian inflation onto the Nepalese market. However, M2, which measures the policy effect on the price level, is positive but is not significant. Hence, the impact of policy on price level is less likely to be visible in annual data, which further confirms with the finding of Poudel (2019).

Table 7
Error Correction Representation for the Selected ARDL Model

ARDL (1,0,0,0,1,1,0) selected based on Schwarz Bayesian Criterion

The dependent variable is CPIN

44 observations used for estimation from 1975 to 2018

Regressor	Coefficient	Standard Error	T-Ratio [Prob]
Δ CPII	0.286***	0.152	1.874 [0.07]
Δ M2	0.034 ^{ns}	0.06	0.563 [0.577]
Δ NEER	0.141*	0.019	7.432 [0.000]
Δ RGDP	0.038 ^{ns}	0.072	0.528 [0.601]
Δ COIL	0.017 ^{ns}	0.015	1.090 [0.284]
Δ GD	0.039**	0.015	2.540 [0.016]
ECM _{t-1}	-0.631*	0.165	-3.826 [0.001]

Note: *, **, and *** show the significance of coefficients at a 1%, 5%, and 10% level of significance respectively. ns denotes not significant at 10% level of significance

Source: Author’s own calculation using Microfit 5.0

The estimated error correction model of the corresponding ARDL (1,0,0,0,1,1,0) is:

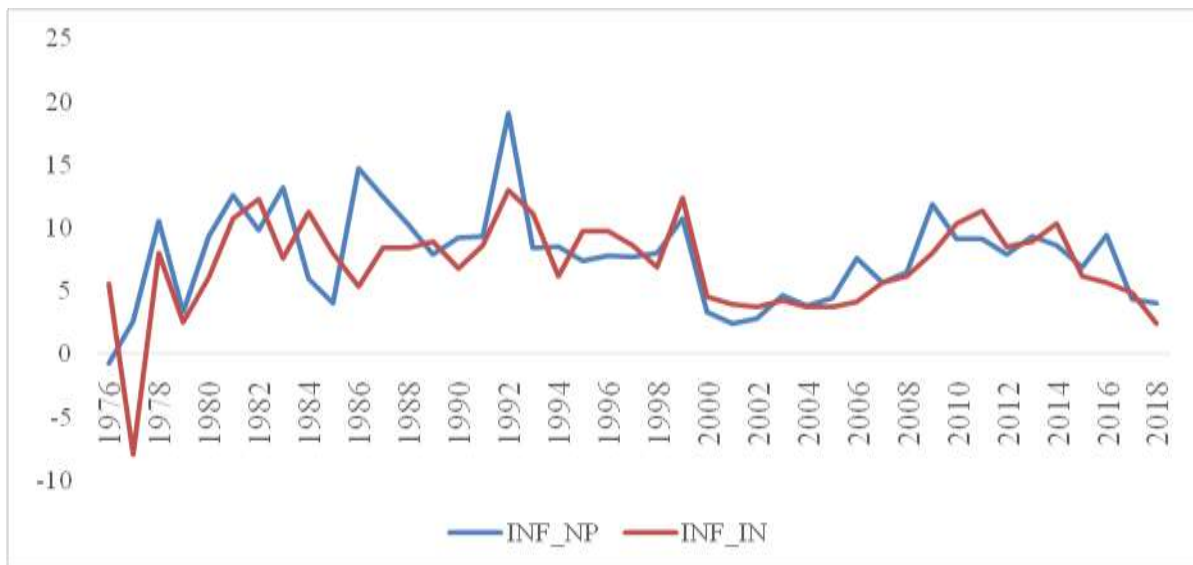
$$\Delta \ln \text{CPIN}_t = 0.286 \Delta \ln \text{CPII}_t + 0.034 \Delta \ln \text{M2}_t + 0.141 \Delta \ln \text{NEER}_t + 0.038 \Delta \ln \text{RGDP}_t + 0.017 \ln \text{COIL}_t + 0.039 \ln \text{GD}_t - 0.63.1 \text{ECM}_{t-1} \dots\dots\dots (4)$$

After estimating the long-term coefficients, we obtain the error correction version of the ARDL model. Table 7 reports the short-run coefficient estimates obtained from the ECM version of the ARDL model. As expected, Indian CPI, nominal effective exchange rate, and government deficit have a positive impact on Nepalese CPI in the short run. The short-run elasticity of Indian CPI is 0.286 and is significant 10%. This shows that a 1% increase in

Indian CPI results in a 0.286% increase in Nepalese CPI. Similarly, the short-run coefficients of NEER and Government deficit are 0.141 and 0.039 respectively, and both are significant at 1% and 5% respectively. Nevertheless, M2, real income, and crude oil prices are insignificant with a short-run elasticity of 0.034, 0.038, and 0.017 respectively. The error correction term ECM-1 indicates the speed of adjustment restoring the equilibrium in the dynamic model. The ECM coefficient shows how quickly/slowly the relationship returns to its equilibrium path, and it should have a statistically significant coefficient with a negative sign (Pahlavani and Rahimi, 2009). Also, a highly significant negative error correction term is proof of the existence of a stable long-term relationship. The ECM coefficient is -0.631 and is statistically significant at a 1% level of significance. This shows that short-run disequilibrium on the system converges to equilibrium at a speed of 63.1% per annum.

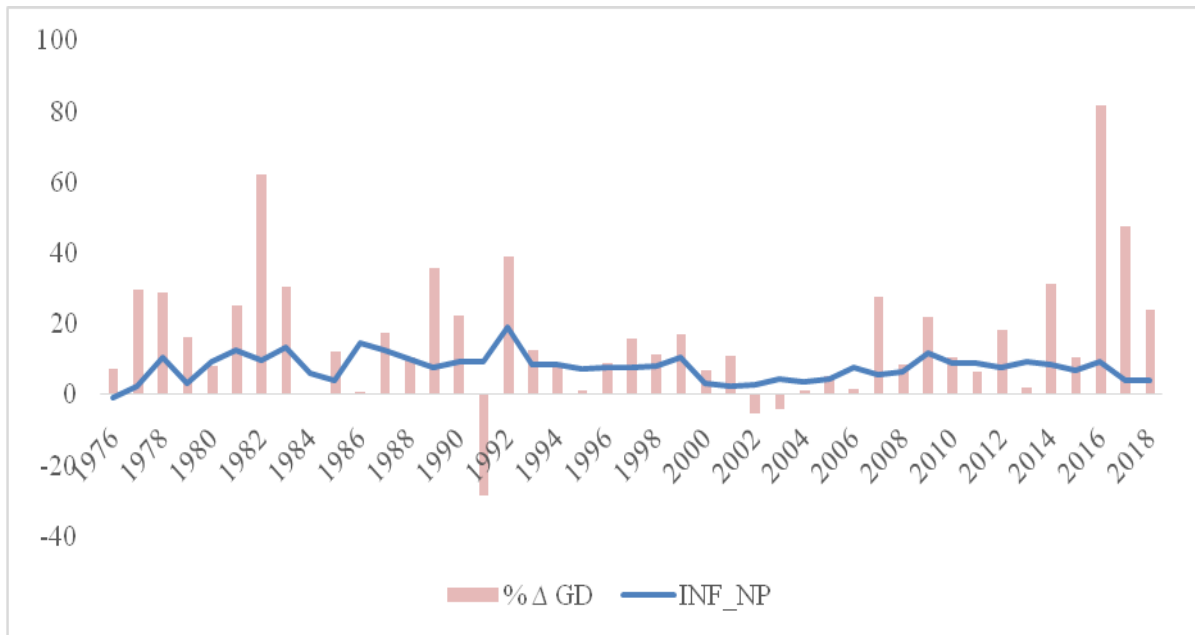
The study presents the movement of inflation and other macroeconomic variables in graphs. Figure 1 to Figure 5 shows the trend of inflation and other macroeconomic variables from 1975 to 2018.

Figure 2: Trend of Inflation in Nepal and India



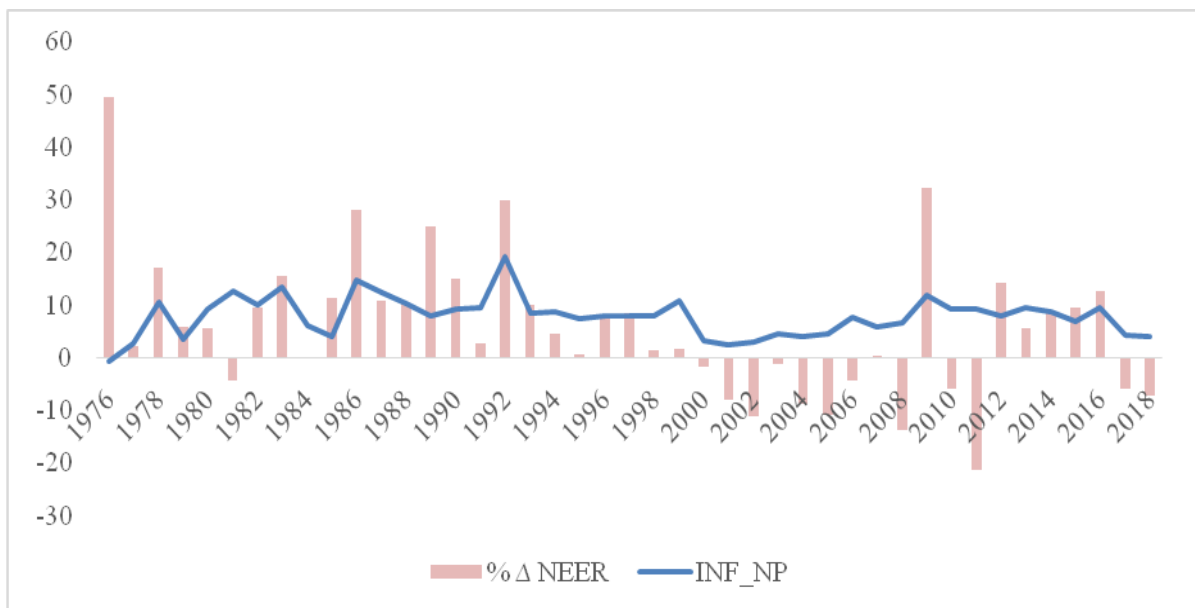
Source: World Bank, 2018; Nepal Rastra Bank, 2019; Base year: 2010 = 100

Figure 3: Trend of Nepalese inflation and change in the government deficit



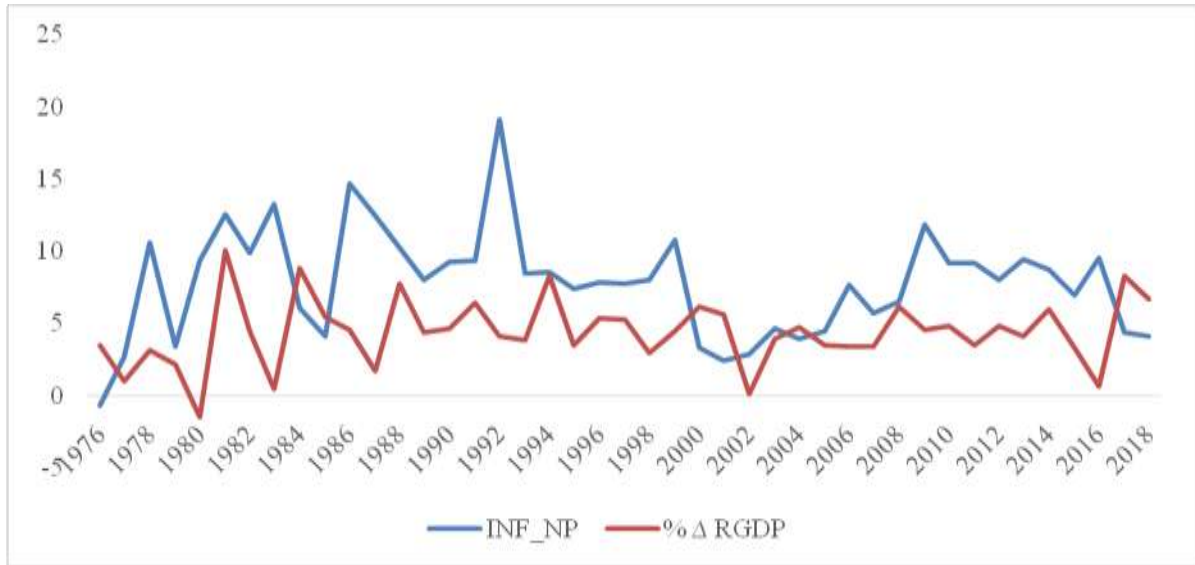
Source: Nepal Rastra Bank, 2019

Figure 4: Trend of Nepalese inflation and change in the nominal effective exchange rate



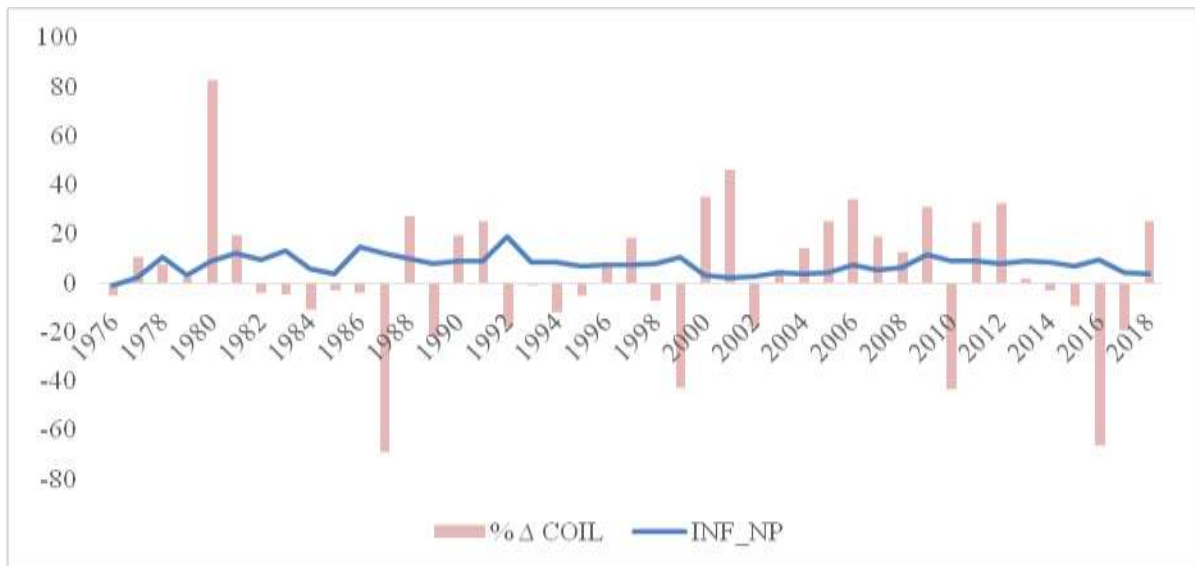
Source: World Bank, 2018; Nepal Rastra Bank, 2019

Figure 5: Trend of Nepalese inflation and real GDP growth rate



Source: Nepal Rastra Bank, 2019

Figure 6: Trend of Nepalese inflation and change in crude oil price



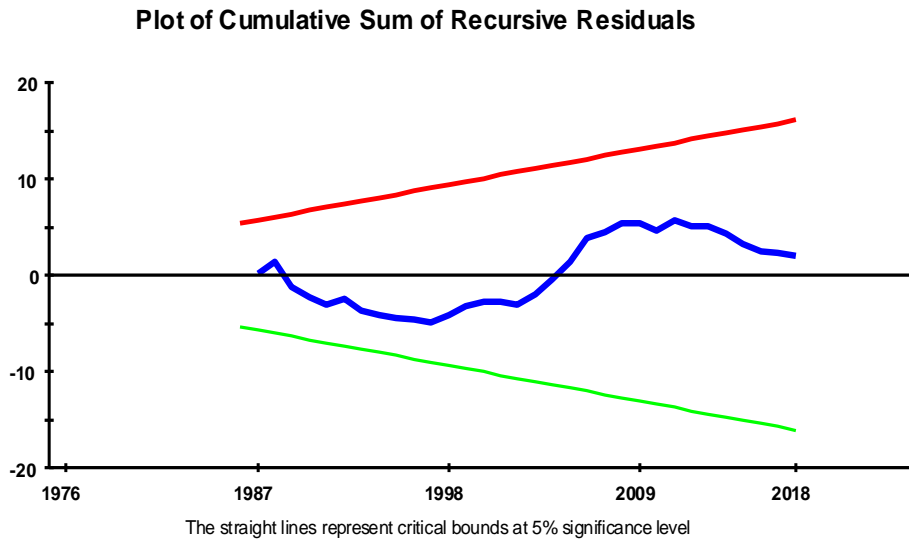
Source: Nepal Rastra Bank, 2019; OPEC basket price

VI. STABILITY TEST

Eventually, the stability of the long-run coefficients together with the short-run dynamics is explained. The CUSUM and CUSUMSQ tests proposed by Brown, Durbin, and Evans (1975) have been applied to test the stability of the model. The CUSUM test makes use of the cumulative sum of recursive residuals based on the first set of n observations and is updated recursively and plotted against breakpoints (Bhatta 2013). If the plot of CUSUM statistics lies within the critical bounds of a 5% significance level represented by a pair of straight lines drawn at the 5% level of significance, the null hypothesis that all coefficients in the error

correction model are stable cannot be rejected. If either of the lines is crossed, the null hypothesis of coefficient constancy can be rejected at the 5% level of significance. The CUSUMSQ test, which is based on the squared recursive residuals, is carried out with a similar procedure.

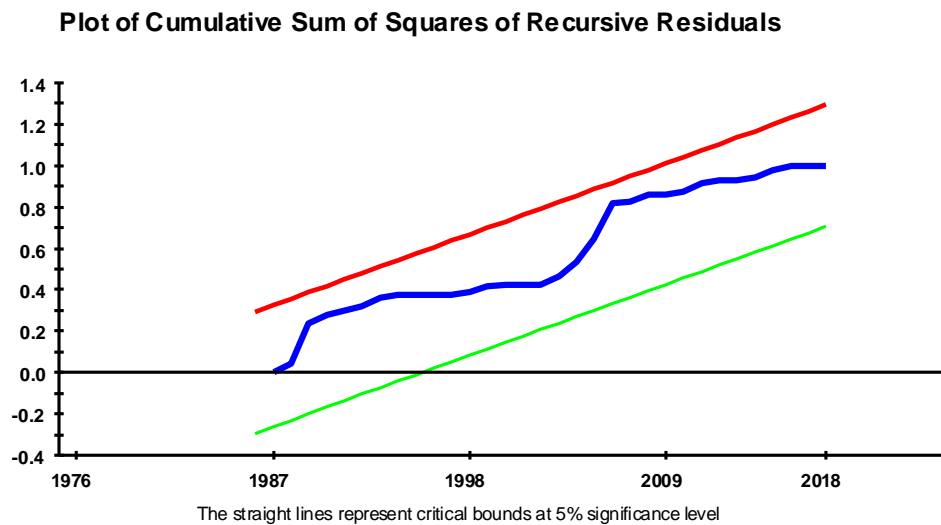
Figure 7: Plots of CUSUM Statistics



Source: Author's own calculation using Microfit 5.0

Figure 5 presents the plot of the cumulative sum of recursive residuals. The result clearly indicates the absence of any instability of the coefficients during the investigated period because the plot is within the 5% critical bounds.

Figure 8: Plots of CUSUMSQ Statistics



Source: Author's own calculation using Microfit 5.0

Figure 6 provides the plot of the cumulative sum of squares of recursive residuals. Similar to the previous test, the plot is within the 5% band supporting the stability of the model.

VII. CONCLUSION

This paper investigates the relationship between inflation and other macroeconomic variables affecting it. The study finds Indian inflation to be the most significant factor influencing the Nepalese inflation. This evinces that Indian inflation gets instantly transferred to the Nepalese market and this immediate shift of Indian inflation supports the fact of a weaker supply of domestic production supplemented by the increased imported goods from India. This result also supports the fact that Nepal imports 65.38% of total imports from India alone (Nepal Rastra Bank, 2019b). Similarly, the exchange rate has a positive impact on prices in both the long-run and short-run. This clarifies that imported goods become expensive as exchange rate devaluates, which exert pressure on domestic prices. Further, the government deficit has a positive impact on the price level in both the short-run and long-run. This suggests that government deficit causes an increase in the money supply, which exerts pressure on price. Lastly, the short-run disequilibrium converges to the long-run equilibrium at a speed of 63.1% per annum signifying a very quick adjustment process. Based on the above results, the study makes the following recommendations: (i) to establish mechanism for monitoring price developments in Indian market, (ii) to promote import substitution industrialization by providing appropriate incentives, (iii) to administer porous border, and (iv) to study the implication of capital mobility between India and Nepal.

REFERENCES

- Bahmani-Oskooee, Mohsen, and Sahar Bahmani. 2015. "Nonlinear ARDL Approach and the Demand for Money in Iran." *Economics Bulletin* 35 (1): 381-391.
- Banerjee, A.J., J. Dolado, and R. Mestre. 1998. "Error-correction mechanism test for cointegration in single-equation framework." *Journal of Time Series Analysis* 19 (3): 267-283.
- Bhatta, Siddha Raj. 2013. *Stability of Money Demand Function in Nepal*. Accessed 12 11, 2019. <https://nepjol.info/index.php/bj/article/view/7508>.
- Brown, R. L., J. Durbin, and J. M. Evans. 1975. "Techniques for testing the constancy of regression relationships over time." *Journal of the Royal Statistical Society. Series B (Methodological)* 37 (2): 149-192.
- Chaudhary, Sunil Kumar, and Li Xiumin. 2018. "Analysis of the determinants of Inflation in Nepal." *American Journal of Economics* 8 (5): 209-212.
- Engle, and Granger. 1987. "Cointegration and error correction: representation, estimation, and testing." *Econometrica* 55: 251-276.
- Fischer, S. 1993. "The role of macroeconomic factors in growth." *Journal of Monetary Economics* 32: 45-66.

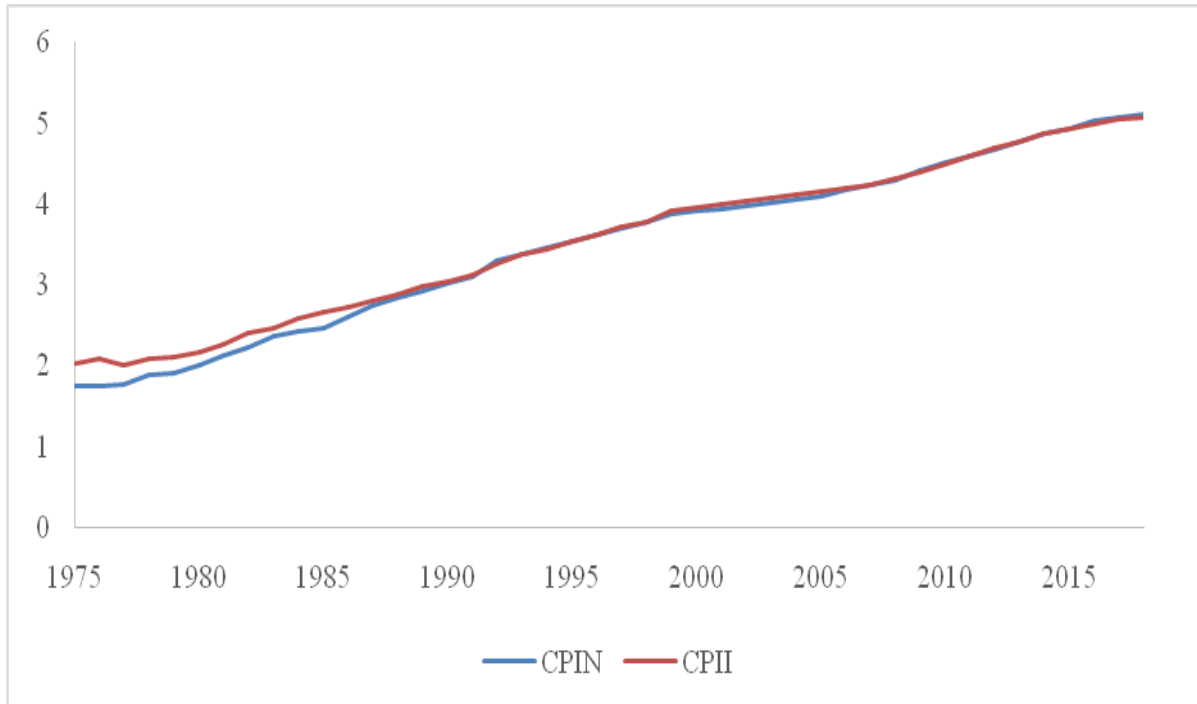
- Froyen, Richard T. 2013. *Macroeconomics: Theories and Policies*. Noida: Pearson Education.
- Hudson, John. 2018. Phillips-Perron (PP) Unit Root Tests. <https://people.bath.ac.uk/hssjrh/Phillips%20Perron.pdf>.
- IMF. 2014. IMF Country Report No. 14/214. Washington D.C.: IMF.
- Johansen, Søren. 1988. "Statistical analysis of cointegration vectors." *Journal of Economic Dynamics and Control* 12 (2-3): 231-254.
- Johansen, Soren, and Katarina Juselius. 1990. "Maximum likelihood estimation and inference on cointegration--with applications to the demand for money." *Oxford Bulletin of Economics and Statistics* 52 (2): 169-210.
- Khatun, Fahmida, and Mazbahul Golam Ahamad. 2012. "Investigating the determinants of inflationary trends in Bangladesh: An ARDL bounds F-Test approach." March 12. <https://mpira.ub.uni-muenchen.de/42572/> accessed on 12/14/2019.
- Lim, Yen Chee, and Siok Kun Sek. 2015. "An examination on the determinants of Inflation." *Journal of Economics, Business and Management* 3 (7): 678-682.
- Mohammed, Kamel Si, Kheira Benyamina, and Abderrezzak Benhabib. 2015. "The main determinants of inflation in Algeria: An ARDL Model." *International Journal of Management in Education* 5 (8).
- Narayan, Paresh Kumar. 2004. Reformulating critical values for the bounds F statistics approach to cointegration: An application to the tourism demand model for Fiji. Discussion Paper No 02/04, Victoria: Monash University.
- Narayan, Paresh Kumar, and Russell Smyth. 2006. "Dead Man Walking: An empirical reassessment of the deterrent effect of capital punishment using the bounds testing approach to cointegration." *Applied Economics, Taylor & Francis Journals* 38 (17): 1975-1989.
- Nepal Rastra Bank. 2019a. Current macroeconomic and financial situation of Nepal. Kathmandu: Nepal Rastra Bank.
- Nepal Rastra Bank. 2007. Inflation in Nepal. Nepal Rastra Bank, Research Department, Kathmandu.
- Nepal Rastra Bank. 2019b. Quarterly Economic Bulletin. Kathmandu: Nepal Rastra Bank.
- Nkoro, Emeka, and Aham Kelvin Uko. 2016. "Autoregressive distributed lag (ARDL) cointegration technique: application and interpretation." *Journal of Statistical and Econometric Methods* 5 (4): 63-91.
- Pahlavani, Mosayeb, and Mohammad Rahimi. 2009. "Sources of inflation in Iran: An application of the ARDL approach." *International Journal of Applied Econometrics and Quantitative Studies* 6 (1): 61-76.
- Paudyal, Shoor B. 2014. "Determinants of inflation in Nepal: An empirical assessment." *NRB Economic Review* 26 (2): 61-82.

- Pesaran, M. H., and R. Smith. 1998. "Structural analysis of cointegration VARs." *Journal of Economic Surveys* 12: 471-505.
- Pesaran, M. Hashem, and Yongcheol Shin. 1995. "An autoregressive distributed lag modeling approach to co-integration analysis." *Cambridge Working Papers in Economics* 9514.
- Pesaran, M. Hashem, Yongcheol Shin, and Richard J. Smith. 2001. "Bounds testing approaches to the analysis of level relationships." *Journal of Applied Econometrics* 16 (3): 289-326.
- Poudel, Sushil. 2019. "Price and Wage Rigidity in Nepal." NRB Working Paper No. 47 1-20.
- Shapiro, Edward. 1966. *Macroeconomic analysis*. New York: Galgotia Publication.
- Thapa, Nara Bahadur. 2002. "An econometric analysis of the impact of real effective exchange rate on economic activities in Nepal." *Economic review, Nepal Rastra Bank* 14: 17-36.
- Thapa, Nara Bahadur. 1997. "The money supply function in Nepal." *Economic Review, Nepal Rastra Bank* 9: 44-65.
- Totonchi, Jalil. 2011. "Macroeconomic theories of inflation." *International Conference on Economics and Finance Research*. Singapore: IACSIT Press. 459-462.
- World Bank. 2019. Consumer Price Index (2010=100). <https://datacatalog.worldbank.org/consumer-price-index-2010-100-2> accessed on 12/14/2019

Appendix

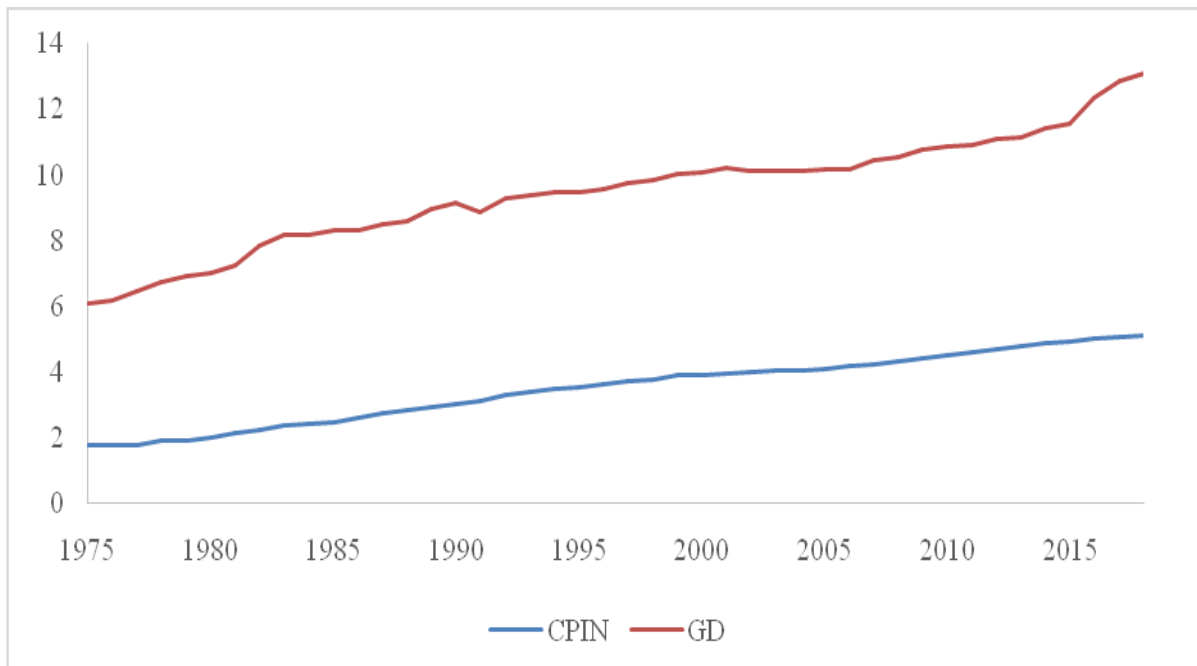
The trend of macroeconomics variables and Nepalese CPI

Figure A1: Trend of Nepalese CPI and Indian CPI



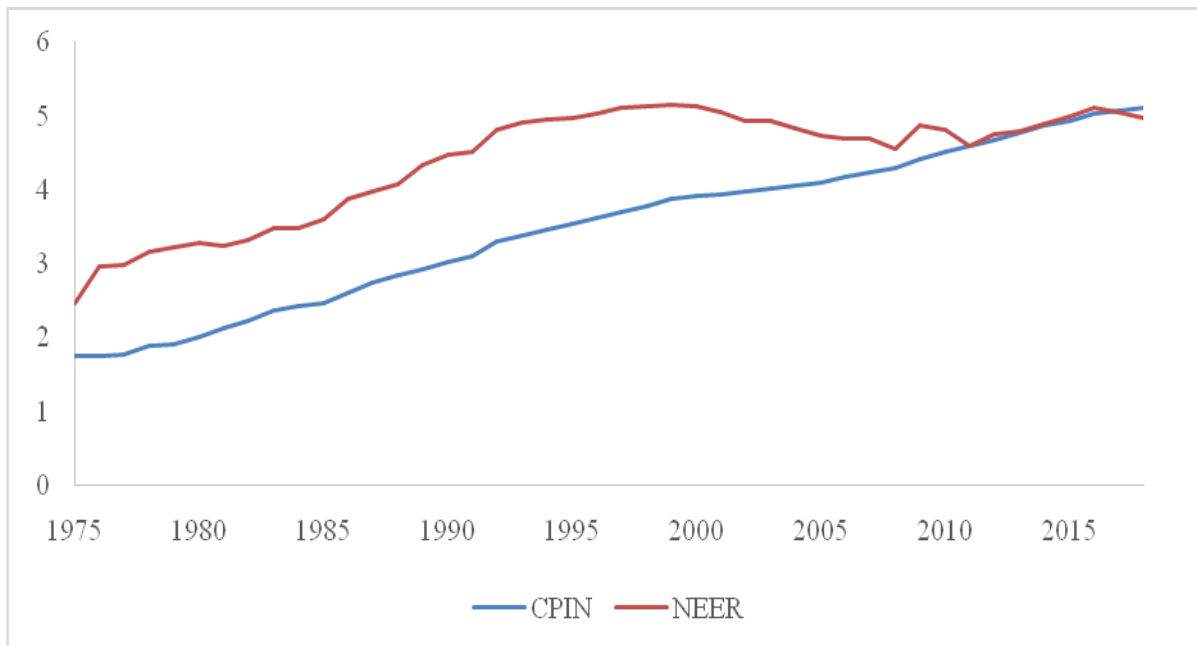
Source: World Bank, 2019; Nepal Rastra Bank, 2019

Figure A2: Trend of Nepalese CPI and Government deficit



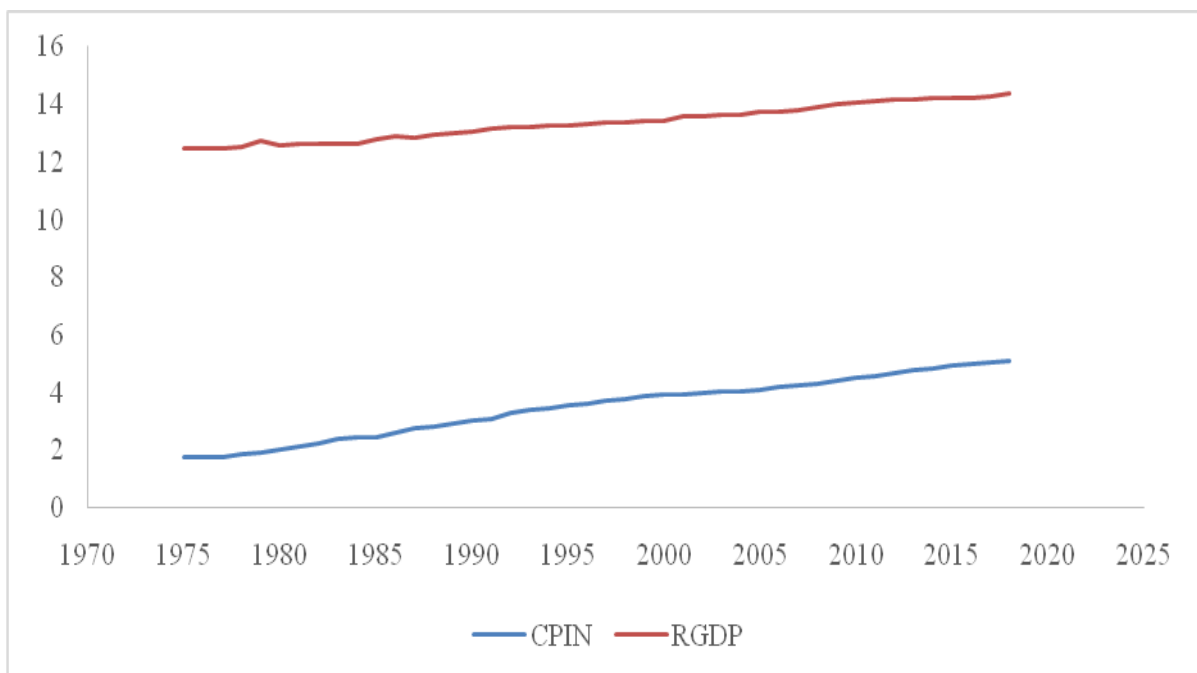
Source: Nepal Rastra Bank, 2019

Figure A3: Trend of Nepalese CPI and Nominal effective exchange rate



Source: Nepal Rastra Bank, 2019

Figure A4: Trend of Nepalese CPI and Real GDP



Source: Nepal Rastra Bank, 2019