Relationship between Money Supply, Income and Price Level in Nepal*#

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Abstract

Using the data from 1974/75 to 2017/18, this paper intended to find out the relationship between money supply, income and price level in Nepal. The paper has established the relationship between real money supply (both M1 and M2) with respect to real GDP, nominal money supply (both M1 and M2) with respect to price level and nominal GDP with respect to price level separately. The econometric tools such as ADF for unit root tests, SIC for lag length selection, bivariate Johansen Cointegration tests followed by VECM has been used for long-run causality. Further, VEC as well as VAR Granger Causality/Block Exogeneity Wald tests for short-run causality are used. The paper found bidirectional long-run causality between the real income with respect to both type of money supply in real terms. But there is no evidence of short run causation between these variables. Likewise, the study found the unidirectional long-run relationship runs from narrow money supply to consumer price. However, there is no short-run relationship from either side. Accordingly, there is no evidence of long-run as well as short-run relationship between broad money supply and consumer price level. Lastly, there is no evidence of long-run causality between nominal GDP and general price level. But the study found unidirectional short-run causality running from general price to nominal GDP. The results suggest that Nepal should focus on growth of time deposit component of broad money supply in long-run for economic growth and control of inflation.

Key Words: Broad and Narrow Money Supply, Price level, Short-run and Long-run Causality

JEL Classification: E51, E31, C32

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I. INTRODUCTION

The relationship between money, income and prices has been a subject of discussion among economists for a long time. Specifically, the role of money in determination of income and prices has been debated extensively over the decades. According to the classicists, the increase in money stock shifts the aggregate demand upwards without affecting the supply side (Ackley, 2007). This increment in money supply leads to increase in price level which just offsets the increase in nominal money, leaving the real money stock unchanged. Money, then, is completely neutral in the classical economy, real output, income and other real variables are completely left unchanged by change in the money supply (Branson, 2005).

Keynesians held the view that money does not play an active role in determining income and prices. They stress on the direction of causation running from income to money without any feedback (Coddington, 1976). According to their view, changes in the stock of money supply affects the interest rate and hence investment and consumption. The effect goes through the income at last. They say changes in the stock of money supply affects income only indirectly (Shapiro, 2001). Accordingly, changes in income cause changes in the stock of money supply through change in the demand for money, given sticky interest rates (Branson, 2005). This indicates a unidirectional causality from income to money supply. Similarly, according to the Keynesians, prices are determined by the demand and supply forces. From Keynesian point of view, inflation as a real phenomenon, is caused mainly by real factors (Blinder, 1988). The Keynesian economists negate the role of money in the price change. They are of the view that changes in prices are mainly due to structural factors.

Contrary to the Keynesians, the Monetarists led by Milton Friedman faithfully claim that money supply plays an active role in determining income and prices (Laidler, 1981). This indicates that both income and prices are mainly caused by changes in the stock of money supply in the short-run. Monetarists believe that the direction of causation runs from money to income without any feedback only in the short-run and the inflation is a monetary phenomenon in that changes in money supply cause changes of prices in both short-run as well as long-run (Mayer, 1975). In clear notation, the monetarists' proposition suggests that there is a unidirectional causality from money supply to income and a unidirectional causality from money supply to prices.

The new classical point of view totally ignored the association between money supply and income in both long-run and short-run because of rational expectation hypothesis (Froyen, 2014). Rather the overall effect of change in money supply

remains only in price level (Maddock & Carter, 1982). Their view coincides with the classical view.

The new Keynesians are giving the strong microeconomic foundation to the Keynesian system. So, their views support the Keynesian view of indirect association between money supply, income and price (Gordon, 1990). But they are not as rigid as Keynesians to believe the effectiveness of monetary policy (Froyen, 2014).

Despite this clear dispute, it is very crucial to understand the relationship between the variables such as; income, money and prices in an economy. Understanding this relationship is important, especially to the public policymakers, in conducting effective stabilization policies. The causal relationships between money and income as well as between money and prices have been an area of active research in Economics particularly after the publication of the influential paper by Sims (1972). Based on Granger causality, Sims (1972) developed a test of causality and applied it to data from the United States to examine the causal relationship between money and income. He found the evidence of unidirectional causal relationship running from money to income supporting the Monetarists' claim.

The money supply, income and price level have increasing tendency over the years in Nepal. The average increment rate of narrow money (currency plus demand deposit), broad money (narrow money plus time deposit), GDP and price level over the last 44 years are 15.69, 18.65, 4.35 and 8.19 percent respectively. Accordingly, the average growth rate of real narrow money and real broad money are 6.98 and 9.72 percent respectively. The time series macroeconomic variables are always in increasing trend. Therefore, there may be possibility of achieving the unidirectional or bilateral causal relationship between money, price and income in long-run as well as short-run. The relationship between these variables has significant importance because it traces out the nexus between these variables and provides policy implications to the policy makers. So, the main task of the study is to discuss and identify the casual relationship between these variables in the latest context of Nepal.

The problem of this study can be synthesized in the following research questions;

i. Is there any long-run and short-run relationship between these macroeconomic variables?

ii. Which variables are more appropriate for policy purpose?

The main objective of the study is to find out the long run and short run relationship between the money supply, income and the price level in Nepal.

Additional objective is to identify the more appropriate variables for policy purpose.

There are few limitations of the study. First, there is methodological limitation of this study. The paper used Johansen Cointegration tests followed by VECM or VAR model. So, the conclusions drawn by this study may not match with the conclusions drawn by the study using other methodology. Secondly, the quarterly or monthly data are usually needed for the dynamic analysis of the model, however such GDP data were not recorded in Nepal. This study is obliged to use the annual data which may provide the less dynamic results. Third limitation of this study is that it covers only the data from 1975-2018. The reason behind using the time period is because of availability of all data series for period.

II. REVIEW OF LITERATURE

Friedman and Schwartz (1963) found that the changes in the behavior of the money stock had been closely related with the changes in economic activity, money income, and prices in American economy during the period from 1867 to 1960. They also found that the interaction between monetary and economic change had been highly stable. However, they observed that monetary changes often had an independent origin; they have not been simply a reflection of changes in economic activity.

Al-Jarrah (1996) investigated the nature of the linkages between money, real income, and prices in Saudi Arabia. The study used multivariate Johansen technique, Granger-causality tests, and variance decomposition and impulse response functions to test for causal relationships among variables. The results indicated that real income contributes significantly in explaining changes in the money, while the reverse was not true. Consumer prices were also significant in predicting changes in money in the kingdom. The evidence of the contribution of money in explaining prices change, however, was weak.

Holod (2000) investigated the relationships between the money supply, exchange rate and prices in the Ukrainian economy by employing the monthly data from 1995:01 to 1999:06. The study used vector autoregression (VAR), vector error correction model and impulse response functions as its methodology to show how a shock in one of the variables influences the time behavior of others. The paper found some evidence that money supply shocks affected the price level behavior, but the effect was not very strong. On the other hand, the paper found that the money supply responded significantly to the shocks in the price level.

Ahmad, Asad and Hussian (2008) used the time series data of real GDP, nominal GDP, prices and money supply for the period of 1973 to 2007. The study used ADF to test the stationary of the data series and series were found integrated of

the order zero. The Granger causality test was used for causal relationship. The paper found the estimated coefficient between the growth of money supply and inflation to be positive and significant. The study accepted the Monetarist proposition that money supply determined the price levels and income. The authors suggested a tight monetary policy along with fiscal measures to control inflation in Pakistan.

Ishan and Anjum (2013) described the main role of money supply (M2) on GDP of Pakistan. The study used the secondary data of 12 years from 2000 to 2011. The paper found the excessive money supply (M2) by SBP (State Bank of Pakistan) entails high rate of inflation if the indicators i.e. CPI, interest rate are not controlled within the prescribed limits. The research found the evidence that high rate of inflation has adversely affected the economy of Pakistan because of excessive supply of money (M2) by SBP. The study revealed the impact of money supply (M2) on the GDP of Pakistan whereby the country has seen inflation rate in double digits. By using regression model, the paper has proved that interest rate and CPI have a significant relation with GDP. Thus, they have suggested that the money supply needs aggressive control to boost the economy.

Salih (2013) examined the relationship between the three macroeconomic variables money, income, and prices in the Saudi Arabian economy. The methodology used in the paper is cointegration, bivariate and trivariate Vector Autoregressive (VAR) models, and Granger Causality/Block Exogeneity tests. The author further supplemented the results with impulse response and variance decomposition. The results for Saudi Arabia for the period 1968-2011 indicated two-way causation between income and money supply. The results also showed that income Granger causes prices, and money Granger causes money prices.

Luo (2013) investigated the money supply behavior (endogeneity or exogeneity) of BRICS (Brazil, Russia, India, China, and South Africa) using quarterly data from 1982 to 2012. The author used the econometric methodologies like Chow Breakpoint Test, Unit Root Test, Johanson Cointegration Test, Granger causality Test, Vector Error Correction and Trivarite Vector Autocorrelation Matrix for the thesis. In four countries: Brazil, China, Russia (the period of 2004-2012) and South Africa (1982-1993), the study found money supply endogeneity evidence. Thus, this implies that bank loans cause the money supply, or there is bidirectional causality between these two. Regarding the other countries (India and the 1982-2003 period of Russia) the thesis found money supply to be exogenous which means money supply cause bank loans. The study concluded that in the short run; most of the countries share at least some degree of the monetarist view which envisages exogeneity of money supply.

Singh, Das and Baig (2015) examined the casual relationship between money supply, output and prices of India in the short and long-term both. Different metrics for money, output and prices were used to understand the relationship between each. The paper used ADF and PP test for unit root test, EG test and Johansen test for co-integration and Granger causality test for causal relationship among variables. The paper deployed quarterly as well as monthly data for analysis. Variables to understand food inflation was especially used because food prices are less income elastic and are viewed differently by citizens. The findings of the study indicated that the relationship is sensitive to the choice of variable which is relevant in the understanding of relationship between money, output and prices. Narrow Money was found to be a better policy variable than reserve money or Broad Money in India.

Koti and Bixho (2016) have presented different approaches and theories associated with money and inflation. The paper analyzed the theoretical links between money supply and the variables such as unemployment, trade and exchange rate, taxes and wages by occupying the data of Albania from 1994 to 2015. The study used the multiple regression analysis formulated with the guidance of the theories of money. The results of the study showed the strong relationship of the money supply with economic growth, interest rate and inflation, but it had a negative sign toward inflation showing that the case of Albania was special, because of the lack of optimum money supply from the banking system and outside. So, they found that all money supplied in the economy is fully absorbed by the individuals and private sector without increasing the inflation.

Khatiwada (1994) analyzed the causal relationship between money and money income as well as money and prices by deploying the regression, the Granger's causality test and Sim's test. The paper covered the annual Nepalese data from the FY 1965/66 to 1989/90. The study found a unidirectional causality running from money to money income. The test of causality between money and prices uniformly indicated that there is unidirectional casual relation from money to prices and no feedback from prices to money.

NRB (2001) examined the money-price relationship in Nepal. The study estimated the money-price relationship by using quarterly data from third quarter of 1975 to second quarter of 1999. The study showed the delayed impact of money on prices in Nepal disapproving the theory of money and price which suggests an instantaneous relationship between money and price. The study occupied ADF to test unit root and Engel- Granger co-integration test to check long run relationship among variables. The Almon lag model was applied to ascertain the sum effects of money supply on prices over the period. The study found that 10 percent changes in M1 bring about 4.5 percent changes in prices in

Nepal. M1 compared to M2 was found to have stronger relationship with prices in Nepal. The results of the paper also showed that there was no structural shift in money price relationship during the study period.

Gyanwaly (2012) analyzed the causal relationship between money, price and income in Asian countries by employing the annul data from 1964 to 2011. The paper used the Unit Root Test as well as the Granger's cointegration and causality test in its methodology. The study reached to the conclusion that money supply is an endogenous variable in all the countries though the extent of endogeneity in term of price and income variables slightly differs from on to another. The paper found that both narrow and broad money are unidirectionally causing the general price level in case of Nepal. The study found the bidirectional causality between broad money and GDP in Nepal. The study also found money supply in Nepal is not neutral because it is causing income and output of the economy at the cost of high inflation.

Travelling on the literature regarding the relationship between money supply and the macroeconomic variables such as income and price level, there are evidence of unidirectional as well as bidirectional causality depending on different countries. In Nepalese context, there are couple of studies done so far. These studies found unidirectional causality runs from money to price and income. So, this study is going to check the robustness of these findings. And this paper is going to use the Johansen cointegration test followed by VECM and VAR Granger causality which is purely new methodology regarding this topic in Nepalese context. And the time gap is another inspiration to study in this topic.

III. RESEARCH METHODOLOGY

This study is quantitative in nature and inferential research design has been used. To analyze the relationship between macroeconomic variables, the study has used the annual secondary data series from July 1975- July 2018 of Nepal. The data are collected from *Quarterly Economic Bulletin 2018 and Current Macroeconomic and Financial Situation 2018* published by Nepal Rastra Bank, and various *Economic Survey* published by Ministry of Finance of Nepal. This study has used the data in natural logarithm form rather than in original form for analysis. The use of logarithmic transformation generates Cobb-Douglas type model and subsequently permits to interpret the coefficients as elasticities.

3.1 Model Specification

The study uses narrow money supply (M1), broad money supply (M2), income (GDP), and general price level (NCPI) as variables. The study has separated former three variables into nominal as well as real form for the different model. The reason behind this is to find out the relationship of real money supply with

real income, nominal money supply with price level and price level with nominal income separately. The real variables are deflated on 2014/15 prices (By using GDP deflater instead of price level). The reason for using 2014/15 as base year is that the Household Budget Survey was conducted on 2014/15 and hence, the price level in Nepal is based on 2014/15 prices. The specific abbreviation in study would be RM1, NM1, RM2, NM2, RGDP, NGDP and NCPI for real M1, nominal M1, real M2, nominal M2, real GDP, nominal GDP and price level respectively.

Relationship between Macroeconomic Variables

Most of the theories and empirical studies suggest that the money supply causes the price level and income. The models are set as follows (Gujarati & Sangeetha, 2007).

$$RGDP = f(RM)$$

or, $$RGDPt = a1 + b1RMt + e1 \quad \ldots\ldots\ldots (1)$$

There are two models for this relationship with narrow and broad money supply.

And, $$NCPI = f(NM)$$

or, $$NCPIt = a2 + b2NMt + e2 \quad \ldots\ldots\ldots (2)$$

There are two models for the relationship between NCPI and two types of money supply as well.

Accordingly, the theory suggests that the price level causes the nominal income of a nation. So, the model is as follows.

$$NGDP = f(NCPI)$$

or, $$NGDPt = a3 + b3NCPIt + e3 \quad \ldots\ldots\ldots (3)$$

Hence, there are five bivariate models to illustrate relationship between variables in this paper.

3.2 Methods of Analysis

Time series econometrics has been used to estimate and analyze the coefficients. This paper intends to use the following methods of analysis.

Unit Root Test

The classical regression model assumes that the both data series of dependent and explanatory variables be stationary, i.e., the errors have a zero mean and finite variance (Enders, 2010). But in the most cases, the macroeconomic time series are non-stationary (Asteriou & Hall, 2007). 'Whether the data is stationary or not?' we can find out by performing the unit root test. There are few methods of testing

unit root of the data. Here, the paper has performed the Augmented Dickey-Fuller (ADF) test for the test of stationarity of the data. There are three possible forms of the ADF test (Enders, 2010);

The equation for no intercept and no trend is,

$$\Delta Y_t = \gamma Y_{t-1} + \sum_{i=1}^{P} \beta_i \Delta Y_{t-1} + u_t \quad \ldots\ldots\ldots (4)$$

The equation for only intercept and no trend is,

$$\Delta Y_t = \alpha_0 + \gamma Y_{t-1} + \sum_{i=1}^{P} \beta_i \Delta Y_{t-1} + u_t \quad \ldots\ldots\ldots (5)$$

The equation for both intercept and trend is,

$$\Delta Y_t = \alpha_0 + \gamma Y_{t-1} + \alpha_2 t + \sum_{i=1}^{P} \beta_i \Delta Y_{t-1} + u_t \quad \ldots\ldots\ldots (6)$$

However, the paper has used last two equation to analyze the unit root in the data. The unit root is often denoted by order of integration I(n) (Asteriou & Hall, 2007). The order of integration refers the number of unit roots.

Schwarz Information Criterion (SIC)

The Johansen cointegration test requires the selection of appropriate lag length. There are many ways of selecting the lag length of the model. Some scholars prefer the ad-hoc methods (Gyanwaly, 2012) and some are employing different techniques developed by the econometricians. The one of the most popular methods of selecting the lag length is Schwarz Information Criterion (SIC), specially, when the sample size is smaller (Luo, 2013). In this criterion, the lower the value, the better the model (Gujarati & Sangeetha, 2007). This study has fixed the lag length of the model based on the SIC.

The SIC is given as (Gujarati & Sangeetha, 2007);

$$SIC = n^{k/n} \frac{\sum \hat{u}^2}{n} = n^{k/n} \frac{RSS}{n} \quad \ldots\ldots\ldots (7)$$

or, in log form

$$\ln SIC = \frac{k}{n} \ln n + \ln\left(\frac{RSS}{n}\right)$$

Johansen Cointegration Test

The cointegration refers the existence of a long-run equilibrium relationship between the variables in which an economic system converges over time (Bhusal,

2016). In general, for the cointegration test, the all data series used in the model should be integrated in same order. While testing the cointegration one cannot use the first difference data rather should use the level data. So, cointegration becomes an over-riding need for any econometric modelling occupying the non-stationary time series (Asteriou & Hall, 2007).

The most powerful and reliable method of testing the cointegration between the variables is Johansen Cointegration test. Cointegration only tells about long-run relationship between the series but it does not fix the direction of such relationship (Luo, 2013). For Johansen cointegration test, Trace statistics and Maximal Eigenvalue statistics are used which can be expressed as follows (Luo, 2013), (Asteriou & Hall, 2007);

$$\lambda\text{Trace}(r) = T\sum_{i=r+1}^{g}\ln\left(1-\hat{\lambda}_i\right) \quad \ldots\ldots\ldots (8)$$

$$\lambda\text{Max}(r, r+1) = -T\ln\left(1-\hat{\lambda}_{r+1}\right) \quad \ldots\ldots\ldots (9)$$

The bivariate Johnsen cointegration test has been performed in this study. When the data are found to be co-integrated, the study has performed the Vector Error Correction Method for long-run and short-run relation between variables. When the data are not co-integrated, the unrestricted Vector Autoregressive Model has been used for short-run relationship.

Vector Error Correction Method (VECM)

VECM is used for cointegrating model with first-difference stationary data. It can be used to test the short-run and long-run causality between a dependent and an explanatory variable: the long-run causality (from explanatory variable to dependent variable) can be identified in the test of the significance of the error-correction coefficient of the VECM by using ordinary least squares (OLS) estimation of the model (Luo, 2013). For instance, the VECM equation for the RGDP and RM is as follows (Asteriou & Hall, 2007);

For example, the bivariate error correction model as RGDP as dependent and RM as explanatory variable is given as:

$$\Delta\text{RGDPt} = \alpha_0 + \sum_{i=1}^{n}\alpha_{1i}\Delta\text{RGDP}_{t-1} + \sum_{i=1}^{n}\alpha_{2i}\Delta\text{RM}_{t-1} + \sum_{i=1}^{n}\alpha_{3i}\Delta\text{EC}_{t-n} + e_i \quad \ldots\ldots\ldots (10)$$

For the long run causality form RM to RGDP α_{3i} must be significant.

Unrestricted Vector Autoregressive (VAR) Model

The models which are not co-integrated has been tested short run causality under unrestricted VAR. As the data are integrated of first order, the first-difference data have been used for the VAR models. The equation of bivariate VAR models are as follows (Asteriou & Hall, 2007);

$$\Delta RGDPt = \beta 10 - \beta 12\ \Delta RMt + \gamma 11\ \Delta RGDPt{-}1 + \gamma 12\ \Delta RMt{-}1 + uyt \quad \ldots\ldots\ldots (11)$$

$$\Delta RMt = \beta 20 - \beta 21\ \Delta RGDPt + \gamma 21\ \Delta RGDPt{-}1 + \gamma 22\ \Delta RMt{-}1 + uxt \quad \ldots\ldots\ldots (12)$$

Granger Causality Test

The Granger causality/ block exogeneity Wald test has been performed under both VECM and VAR for the short-run causality between the variables. For instance, the Granger causality test between real income and real money supply is given as (Gujarati & Sangeetha, 2007);

$$\Delta RGDPt = \sum_{i=1}^{n} bi\ \Delta RM(t-i) + \sum_{j=1}^{n} ci\ \Delta RGDP(t-j) + e2t \quad \ldots\ldots\ldots (13)$$

$$\Delta RMt = \sum_{i=1}^{n} gi\ \Delta RM(t-i) + \sum_{j=1}^{n} hi\ \Delta RGDP(t-j) + e3t \quad \ldots\ldots\ldots (14)$$

Where e_{2t} and e_{3t} are disturbances and assumed to be uncorrelated to each other.

Unidirectional causality from RM to RGDP is indicated if $\Sigma b_i \neq 0$ and $\Sigma h_i = 0$. Conversely, unidirectional causality from RGDP to RM exists if $\Sigma b_i = 0$ and $\Sigma h_i \neq 0$. Feedback or bilateral causality is suggested if both coefficients $\Sigma b_i \neq 0$ and $\Sigma h_i \neq 0$. Finally, independence is suggested if $\Sigma b_i = 0$ and $\Sigma h_i = 0$. (Gujarati & Sangeetha, 2007).

The Granger causality test for other models are also same as above.

Residual Test

The serial correlation is tested by using Breusch- Godfrey Serial Correlation LM tests in this study. The heteroscedasticity is checked by using Breusch-Pagan Godfrey test. Accordingly, Jarque-Bera test is used to test the normality of residuals. Similarly, Cumulative Sum test and cumulative sum of square test are used to test the stability of the models.

IV. EMPIRICAL ANALYSIS

4.1 Results of Unit Root Test

The Augmented Dickey-Fuller (ADF) is used to test the unit root of the dependent and explanatory variables. Table 4.1 shows the results of Augmented Dickey-Fuller tests of the time series variables used in this study.

Table 4.1: Results of Augmented Dickey-Fuller Tests

Variable	Level		First Difference		Order of Integration
	Intercept without trend	Intercept with trend	Intercept without trend	Intercept with trend	
LNGDP	0.133 [0.9647]	-1.418 [0.8414]	-4.780* [0.0003]	-4.714* [0.0025]	I (1)
LRGDP	-0.484 [0.9841]	-3.236 [0.0911]	-6.557* [0.0000]	-6.525* [0.0000]	I (1)
LNCPI	-1.527 [0.5105]	-1.334 [0.8653]	-4.923* [0.0002]	-5.073* [0.0009]	I (1)
LNM1	-0.845 [0.7958]	-1.565 [0.7904]	-6.247* [0.0000]	-6.354* [0.0000]	I (1)
LRM1	-0.825 [0.8017]	-4.084 [0.0130]	-7.030* [0.0000]	-6.999* [0.0000]	I (1)
LNM2	-0.617 [0.8559]	-2.076 [0.5436]	-4.639* [0.0005]	-4.618* [0.0032]	I (1)
LRM2	-0.916 [0.7735]	-3.883 [0.0214]	-6.033* [0.0000]	-5.929* [0.0001]	I (1)

Source: writer's own calculation using e-views 9

Note:

1. *H0: has a unit root (non-stationary)*
   H1: does not has a unit root (stationary)
2. *Star * shows 1 percent level of significance*
3. *The p-values are based on MacKinnon (1996) one-sided p-values*

Table 4.1 shows that LNGDP, LRGDP, LNCPI, LNM_1, LRM_1, LNM_2 AND LRM_2 have unit root at 1 percent level of significance in both intercept with trend and without trend in the form of level data. So, the variables are not stationary at level. However, all these variables are stationary at 1 percent level of significance in first difference form in both intercept with trend and without trend. It means all the variables are integrated of order 1. i.e. I (1). Hence, the variables can be used for Johansen Cointegration test.

4.2 Lag Length Selection

Table 4.2 has presented the lag length selection of different models under Schwartz Information Criterion (SIC).

Table 4.2: Optimal Lag Length Selection for Johansen Cointegration Tests

Model		Lag length selection	
Dependent	**Explanatory**	**Lags**	**SIC**
LRGDP	LRM1	1	-7.781*
LRGDP	LRM2	1	-7.862*
LNCPI	LNM1	1	-6.869*
LNCPI	LNM2	1	-7.131*
LNGDP	LNCPI	1	-7.378*

Source: writer's own calculation using e-views 9
*Note: *shows the minimum SIC value, where the corresponding lag length is optimal for the model.*

Table 4.2 shows that all five models in this study can be tested by using lag length 1 which is suggested by Schwartz Information Criterion (SIC).

4.3 Results of Johansen Cointegration Tests

Since all the variables used are I (1), cointegration test can be done for the models. The lag length for all the models is uniformly one. There are five models in this study. Now, the next task is to perform Johansen Cointegration tests for all bivariate models in this study one by one.

Table 4.3: Results of Johansen Cointegration Tests for LRGDP and LRM1

Hypothesized No. of CE(s)	Trace Statistics	p-value for trace statistics	Max-Eigenvalue statistics	p-value for Max-Eigenvalue
None	26.936*	0.0006	26.846*	0.0003
At most 1	0.089	0.7651	0.089	0.7651

Source: writer's own calculation using e-views9
Notes:
1. *Star * denotes the rejection of hypothesis at 1 percent level of significance*
2. *The p-values are MacKinnon-Haug-Michelis (1999) p-values*

Table 4.3 presents the results of Johansen cointegration tests for the model 1 where there are two variables LRGDP and LRM1. The both trace statistic and max-eigenvalue tests show one cointegrating equation at 1 percent level of significance. It shows that there is long run association between real GDP and real narrow money supply. The VECM for model 1 is performed in the section 4.4.

Table 4.4: Results of Johansen Cointegration Tests for LRGDP and LRM2

Hypothesized No. of CE(s)	Trace Statistics	p-value for trace statistics	Max-Eigenvalue statistics	p-value for Max-Eigenvalue
None	14.242	0.0765	14.26*	0.0550
At most 1	0.241	0.6238	3.84	0.6238

Source: writer's own calculation using e-views9
Notes:
1. *Star * denotes the rejection of hypothesis at 10 percent level of significance*
2. *The p-values are MacKinnon-Haug-Michelis (1999) p-values*

Table 4.4 shows the results of Johansen cointegration tests for the model with LRGDP and LRM2. The Maximum Eigenvalue statistic suggests that there is one cointegrating equation at 10 percent level of significance. So, there can be a long run relationship between RGDP and RM2. The VECM for model 2 is performed in the section 4.4.

Table 4.5: Results of Johansen Cointegration Tests for LNCPI and LNM1

Hypothesized No. of CE(s)	Trace Statistics	p-value for trace statistics	Max-Eigenvalue statistics	p-value for Max-Eigenvalue
None	8.568	0.4068	5.818	0.6366
At most 1	2.749*	0.0973	2.749*	0.0973

Source: writer's own calculation using e-views9
Notes:
*1. Star * denotes the rejection of hypothesis at 10 percent level of significance*
2. The p-values are MacKinnon-Haug-Michelis (1999) p-values

The results of Johansen cointegration tests for the model with LNCPI and LNM1 have been shown in table 4.5. The both statistics suggest that there is one cointegrating equation at 10 percent level of significance. So, the study has found that there is a long run association between RGDP and RM2. The VECM for model 3 is performed in the section 4.4.

Table 4.6: Results of Johansen Cointegration Tests for LNCPI and LNM2

Hypothesized No. of CE(s)	Trace Statistics	p-value for trace statistics	Max-Eigenvalue statistics	p-value for Max-Eigenvalue
None	3.756	0.9222	3.515	0.9066
At most 1	0.240	0.6236	0.241	0.6236

Source: writer's own calculation using e-views9
Notes:
*1. Star * denotes the rejection of hypothesis at 10 percent level of significance*
2. The p-values are MacKinnon-Haug-Michelis (1999) p-values

In Table 4.6, the results of Johansen cointegration tests for the model with LNCPI and LNM2 has been shown. The both statistics suggest that there is no cointegrating equation at 10 percent level of significance. So, there is no long run relationship between NCPI and NM2. So, the unrestricted VAR Granger causality is performed for the short run causality of the model 4 in section 4.5.

Table 4.7: Results of Johansen Cointegration Tests for NGDP and NCPI

Hypothesized No. of CE(s)	Trace Statistics	p-value of trace statistics	Max-Eigenvalue Statistics	p-value for max-eigenvalue
None	9.431	0.3270	9.061	0.2811
At most 1	0.371	0.5426	0.371	0.5426

Source: writer's own calculation using e-views9
Notes:
*1. Star * denotes the rejection of hypothesis at 10 percent level of significance*
2. The p-values are MacKinnon-Haug-Michelis (1999) p-values

In Table 4.7, the results of Johansen cointegration test for the model with LNGDP and LNCPI is presented. The both statistics suggest that there is no long run association between NGDP and NCPI in Nepal. So, the unrestricted VAR Granger causality has been performed for the short run causality of the model 5 in section 4.5.

4.4 Results of VECM Results

The long-run causality of cointegrating variables has been tested with the help of Vector Error Correction Model (VECM) framework. It is found that the bivariate models with LRGDP and LRM1, LRGDP and LRM2 as well as LNCPI and LNM1 have the long-run cointegrating relationship.

Table 4.8: Results of VECM long run causality of the cointegrating model

Model	Dependent variable	Explanatory variable	Coefficient of CE	Standard error	t-statistics	p-value	Direction of causality
1	LRGDP	LRM1	-0.191*	0.0688	-2.7700	0.0070	Bi-directional long-run causality
	LRM1	LRGDP	-0.532*	0.1148	-4.6351	0.0000	
2	LRGDP	LRM2	-0.192*	0.0721	-2.6602	0.0095	Bi- directional long-run causality
	LRM2	LRGDP	-0.229**	0.0880	-2.6029	0.0111	
3	LNCPI	LNM1	-0.175***	0.0928	-1.8836	0.0635	Uni-directional long-run causality from NM1 to NCPI
	LNM1	LNCPI	-0.077	0.0812	-0.9425	0.3489	

Source: writer's own calculation by using e-views9

Note:

1. *Star * indicates the rejection of null hypothesis at 1% level of significance, ** indicates the rejection of null hypothesis at 5% level of significance and *** indicates the rejection of null hypothesis at 10% level of significance.*
2. *CE stands for cointegrating equation.*

Table 4.8 shows the results of the VECM long-run causality tests of the cointegrationg models. The coefficient of CE is negative in all three models. It means the cointegrating relationship between variables is convergent and valid for model 1, 2 and 3. In the model 1, the study found the bidirectional causal relationship between real GDP and the real narrow money supply in the long-run at 5 percent level of significance. Similarly, in the model 2, there is long-run bidirectional causal relationship between real GDP and real LRM2 at 5 percent level of significance. However, in the model 3, there is a unidirectional causal relationship between NCPI and the LNM1 in the long-run at 10 percent level of significance. It means RGDP causes RM1 and RM2 in the long-run with strong feedback effect. However, NCPI causes NM1in the long-run without any feedback.

Now, the short-run causality between the variables in these three models is presented in Table 4.9 where the results of Vector Error Correction Granger Causality/ Block Exogeneity Wald tests have been shown.

Table 4.9: Results of VEC Granger Causality/ Block Exogeneity Wald tests for short-run causality

Model	Dependent variable	Explanatory variable	Chi-square statistics	p-value	Direction of causality
1	DLRGDP	DLRM1	0.8633	0.3855	No short-run causality
	DLRM1	DLRGDP	0.7725	0.3794	
2	DLRGDP	DLRM2	9.43E-05	0.9923	No short-run causality
	DLRM2	DLRGDP	0.5440	0.4608	
3	DLNCPI	DLNM1	0.3317	0.5647	No short-run causality
	DLNM1	DLNCPI	0.0601	0.8063	

Source: writer's own calculation by using e-views9
*Note: Star *** indicates the rejection of null hypothesis at 10% level of significance.*

Table 4.9 shows that there is no short-run causation between variables in all three cointegrating models. In this test, chi-square statistics is used and the p-values of the all models which are more than 10% suggest that the null hypothesis of 'there is no short-run causality' cannot be rejected. It means the growth rates of the variables in the model 1, 2 and 3 do not cause each other.

So, in a nutshell, the study infers that there is bidirectional causality between real GDP and both form of real money supply. And there is unidirectional causality runs from nominal money supply to NCPI. However, there is no causal relationship between growth rates of the variables used in model 1, 2 and 3.

4.5 Results of Unrestricted VAR Results

In this heading, the short-run causal relationship between the variables of the bivariate models which are found to be not cointegrated in the long-run are investigated. While testing the long-run association of the variables in the section 4.3, the model with NCPI and NM2 as well as NGDP and NCPI do not have the long-run relationship. However, it is mandatory task for this study to go for the short-run causality investigation of the variables.

Table 4.10: Results of VAR Granger Causality/Block Exogeneity Wald tests

Model	Dependent variable	Explanatory variable	Chi-square statistics	p-value	Direction of causality
4	DLNCPI	DLNM2	1.6980	0.1926	No short-run causality
	DLNM2	DLNCPI	1.4251	0.2326	
5	DLNGDP	DLNCPI	5.6933**	0.0170	Unidirectional short-run causality from NCPI to NGDP
	DLNCPI	DLNGDP	0.0651	0.7987	

Source: writer's own calculation by using e-views9
*Note: Star ** indicates the rejection of null hypothesis at 5% level of significance.*

In Table 4.10, the results of Vector Auto Regressive (VAR) Granger Causality/Block Exogeneity Wald tests for short-run causality has been performed. It is found that there is no short-run causal relationship between NCPI and NM2. However, the test shows that the unidirectional causality runs from NCPI to NGDP in the short-run at 5% level of significance. It means the growth rate of NCPI (inflation) and growth rate of NM2 do not have any association but the inflation causes growth rate of NGDP without any feedback.

4.6 Residual Diagnostic of the Models

Serial Correlation Test

The Breusch-Godfrey Serial Correlation LM Test shows that there is no any serial correlation problem in any model used in this study as the p-value are more than 5 percent.

Results of Heteroscedasticity Test

The Breusch- Pagan Godfrey test is used to detect heteroskedasticity. There is no any problem of Heteroskedasticity in any model used in this study as the p-values are more than 5 percent. So, the residuals have equal variance.

Results of Normality Test

The sample period is just 44 which may not be enough for time series analysis. So, the residuals are not found normally distributed except model 5. The Jarque-Bera statistics was used to test normality.

Results of Stability Test

The stability of the model is tested by using CUSUM and CUSUM square tests. The test shows that the models are stable though in some model the red line is crossed which violets the 5 percent critical bound.

V. CONCLUSIONS AND RECOMMENDATIONS

The study reveals that there is bidirectional long-run casualty between RGDP and RM1 as well as RGDP and RM2. So, it is to conclude that in the long-run the real money supply causes the real GDP and reciprocates (without causing in the short-run) in Nepal. In other words, the money supply causes the income in the long-run with strong feedback effect. But there is no evidence of short run causation between these two variables. It means the growth rate of real money supply and real GDP in Nepal is not associated.

Likewise, the study has found the unidirectional long-run relationship runs from NM1 to NCPI. However, there is no short-run relationship from either side. Here,

it is to conclude that, the NM1 causes the NCPI of the country in the long-run without any feedback. But there is no evidence of long-run as well as short-run relationship between NM2 and NCPI. It concludes that there is no association between NM2 and NCPI of Nepal in both short and long run. From the both short-run results between money supply and inflation, it can be inferred that there is no evidence of short-run causal relationship between the growth rate of money supply and inflation in Nepal.

Accordingly, there is no evidence of long-run causality between nominal GDP and NCPI. But the study found the unidirectional short-run causality running from general price to nominal GDP. It means that the growth rate of general price level affects the growth rate of nominal income of the nation.

The conclusions of the study do not support the monetarists' point of view which suggests that there is causal relationship runs from money supply to income and price in the short-run. They also postulate that the causality disappears in the long-run. Contrary to this, the paper found that the money supply causes national income with strong feedback effect and price level without feedback in the long-run.

This study also denied the early Keynesians' ignorance to the important role of money supply in the economy. However, this study supports the Keynesian view of indirect (long-run) relationship between the money supply, real income and prices. So, the conclusion of this study suggests that the money supply has significant role in the long-run rather than short- run for Nepalese economy.

This study intends to make some inferences which may be useful for the policymakers to design appropriate policies for the nation. The major recommendations of this study can be prescribed as follows;

- The study found that both real money supply causes the real income of the nation and real income also causes the both real money supply in the long-run. So, the policymakers should focus on growth rate of money supply in real term to achieve the real income growth.
- On the one hand, the main cause of the growth of nominal income of Nepal is growth rate of the general price level. On the other hand, the nominal narrow money causes the price level in the long-run. It means that the policymakers can infer that the nominal narrow money supply causes the nominal income of the nation indirectly. Hence, the narrow money supply can be instrumental to handle the inflation and nominal growth rate in the long-run.
- From the results of this study, the policymakers can see that the broad money supply is more appropriate than the narrow money supply because both causes the real income in the long-run but narrow money causes

inflation as well. The increment in broad money supply is found healthier than narrow money supply for overall Nepalese economy. Hence, the monetary policy should focus to increase the time deposit rather than the currency and demand deposit in the economy.

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Asymmetric Impact of Oil Price on Inflation: Evidence from Nepal

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Abstract

This paper investigates asymmetric oil price pass through on inflation in Nepal using time series data of 331 months from April 1987 to February 2018. The paper applies Nonlinear Autoregressive Distributed Lag (NARDL) model to estimate long run and short run asymmetric adjustment of refined petroleum products on Consumer Price Index (CPI). Finding shows presence of long run asymmetric adjustment between price of all petroleum products and CPI. However, when the model is controlled for monetary impact and price level of India, only the price of diesel is found to have long run asymmetric pass through into inflation. The long run cointegrating equation shows unit rise in price of diesel is accompanied by small contraction in CPI in long run by -0.048 units. Meanwhile unit fall in price of diesel is shown to have positive long run pass through in CPI by 0.431 units. This apparent anomaly could be attributed to fact that with rise in price of diesel, demand for cheaper adulterant like kerosene increases thus resulting in fall in CPI Similarly, fall in unit price of diesel could have overall increased industrial demand and other resources which in turn led to significant increase in CPI. Meanwhile, study didn't find any significant asymmetry in short run between CPI and petroleum products. However, in short run a significant impact on the CPI by actual size of increased price of Petrol and Diesel has been found. Hence, in short run, it shows that it is the size of price increase in Petrol and Diesel; not the price itself that has significant effect on the CPI. Since petroleum products in Nepal are not priced by market, these findings can provide guidelines for future oil pricing in reducing the spillover impact on general price level.

Key Words: oil prices, inflation, NARDL, asymmetric cointegrating relationship, symmetric oil price adjustment

JEL Classification: E31, Q43, C12, C13, P44

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I. INTRODUCTION

Inflation erodes purchasing capacity of people. Especially for fixed income households, inflation reduces the wealth and is often considered as negative tax. The main cause of inflation can be broadly distinguished into cost push and demand pull. However, it is pertinent that the underlying cause behind both is analyzed and its impact be assessed. In case of impoverished country like Nepal ills of inflation can be hardly understated. According to Shrestha and Chaudhary (2012), 10 percent rise in food price is likely to increase overall poverty by 4 percentages. This finding is very alarming as recent multidimensional poverty index report by national planning commission has found 28.6% of Nepal's population is multidimensionally poor (National Planning Commission, 2018). Besides poverty, high level inflation also is found to have negative impact in growth of economy. As per Bhusal and Silpakar (2011) the optimal threshold inflation for Nepal is 6 percent beyond which can jeopardize the economic growth. More recent study by NRB (2017) suggests that Nepal should target inflation around 6.4%. Therefore it is very important that inflation be controlled in order to address poverty as well as economic growth.

In this situation it is important to analyze what factors actually leads to rise in inflation especially in Nepal. Most of the study shows that demand side factor and monetary factor plays a major role in Nepalese inflation. For instance, Mathema (1998) using granger bivariate causality has shown that carpenter's wage in Kathmandu and agricultural labors wage in terai was found to exert significant pressure on national price level. Meanwhile Bhattarai and Joshi (2009) have shown that stock return is used as long term hedge against the inflation. On the other hand, inflow of remittance is also found to increase the inflation in the country (Dahal, 2014). Besides these demand side factors, Paudyal (2014) found that in period of 1975 to 2014 budget deficit, Indian prices, broad money supply, exchange rate and real GDP were long run determinant of the inflation in Nepal. Further, Koirala (2008) has shown inflation expectation can contribute towards the inflation itself.

However, the analysis of inflation in Nepal through supply side factors seems lacking. According to Osmani and Bajracharya (2008), global oil crisis of 1970s did put inflationary pressure in Nepalese economy and Paudyal (2014) did attempted to isolate effect of oil price surge during 1979/80 oil price rise but was found to be insignificant. Meanwhile, International Monetary Fund (2011) has shown that international oil price and Indian inflation are impactful factors to Nepealese inflation. Despite these studies, actual role of supply factors within country influencing the inflation hasn't been investigated. Therefore it is necessary that a detailed study to analyze the effect of supply factors in Nepalese inflation be carried out.

Nepal is landlocked country and its supply chain is heavily dependent on imported fuel. Nepal has signed a bilateral agreement with India in 1974 making Indian Oil Corporation sole supplier of fuel to Nepal prohibiting it to import oil from other countries; though revised version allows for buying crude oil from third country but it still needs to be refined in India (Bhattarai, 2017). This petro-politics thus further complicates oil price situation in Nepal. Besides, in Nepal the sole distribution of oil is done by Nepal Oil Corporation. (NOC) and hence price of oil is not determined by market forces. In addition to price control by NOC, apparent monopolist, also practice cross subsidy among the products. Furthermore, the presence of syndicates of dealers and retailers has added burden to general consumer (Sapkota, 2015). Therefore, it is important to assess the impact of oil price in inflation of the country. Further, study in industrial countries have shown that oil has asymmetric pass through into inflation (Chen, 2009) as it is generally perceived that the subsequent increase in inflation by increased fuel price remains sticky and does not diminish when oil price decreases. Thus, it is important to determine whether such phenomena also exist in Nepal considering its unique petro-economy. Since each petroleum product has different target market with petrol being consumed by high income bracket, kerosene by low income bracket and diesel by industries and transportation, it is interesting to analyze whether they have same level of impact. Based on this policy maker can decide which fuel pricing can help for sound economy. This paper, thus, attempts to analyze the impact of changes in oil price on consumer price of Nepal in both long and short term and further verify whether the impact is asymmetrical using Nonlinear ARDL model.

II. REVIEW OF LITERATURE

Macroeconomist in general holds consensus that global oil price shock in 1970s as a source for subsequent economic downturn as documented in seminal paper by Bruno and Sachs (1985). Despite this, there are debates on whether oil prices themselves are main cause of recession (Bohi, 1990; Bohi, 1991). Also two oil price shocks since 1990s didn't have substantial impact on the GDP growth and inflation (Blanchard & Gali, 2007). However, it is widely accepted that oil price can at least in some degree impact the inflation. For instance, Hamilton (1996) opines that impact of oil price increase on subsequent inflation depends on past experience. Meanwhile Lee, Ni and Ratti (1995) opine that the effect of oil price increase is a function of their size relative to their current degree of variability. Further, Mork (1989) indicated asymmetric effect of oil price such that its rise matter more than its fall. This asymmetric pattern in oil price fluctuations is further corroborated by Lown & Rich (1997). Chen (2009) using time varying pass through have found that appreciation of domestic currency, active monetary policy and openness in trade can explain decline in oil price impact on inflation.

According to Hooker (2002) these varied description of oil price impact on macroeconomic variable such as inflation can be attributed to the fact that oil price are a time series data without an underlying theoretical framework to explain its interplay which is further complicated by monetary policy. However, Bernanke et al. (1997) and Hamilton and Herrera (2004) have questioned the efficacy of monetary policy in eliminating recessionary consequences of oil shock inflation rates. Further, several studies have shown unstable relationship of oil prices especially in recent data. Lee et al. (1995) and Hamilton (1996) have suggested usages of complicated nonlinear and asymmetric filters to avoid the misspecification in relationship. This structural issue is not only in the case of data from US alone but among several countries as well. For example, DeGregorio et al. (2007) applying rolling VAR and Phillip Curve model in data of 34 developed and developing countries found declining oil pass through. This declining impact is also witnessed in a study by Chen (2009). Using data of 19 industrial countries, Chen (2009) found degree of oil price pass through varies across countries and is positively correlated with the energy imports.

Literature appears to segregate the impact of oil price pass through in varying degree among oil importing nation and exporting one. For instance, in a study of nine oil importing Southern and Southeastern countries by Jongwanich and Donghyun (2011) concludes that the magnitude of oil price pass-through is limited. The major reason behind such can be attributed to the price control and subsidy that has been provided to mitigate the impact of oil price rise. For example, Tang, Wu and Zhang (2010) shows that in China despite oil price surge reducing interest rate, overall output and rising inflation, the long term impact is curbed by price control. Meanwhile, reverse was seen in Kenya, where a 10 percent rise in oil price was followed by meager 0.5 percent increase in inflation while in long run impact reached up to 1 percent (Kiptui, 2009). Similarly, Akcelik and Ognuc (2016) applying vector autoregressive model showed that 10 percent change in international crude oil contributed to 0.42 percent change in consumer inflation in Turkey, which is a major oil importing nation. Despite the several study across oil importing nation a strict consensus on oil price pass through hasn't been established.

Similarly, among the oil exporting nations too the diversity on impact of oil price pass through can be seen. Castro et al. (2017) in a study of four major European economies Germany, France, Spain and Italy found diverse pattern across disaggregate economy. Karimili et al. (2016) has found oil price shock significantly affecting domestic inflation in Russia, Azerbaijan and Kazakasthan. A study conducted in Indonesia by Adam et al. (2015) using difference equation model shows that unit increase (decrease) in world crude oil prices caused the inflation rate to go up (fall) by 0.33 percent. The impact is varied as Ju et al. (2014) has reported positive effect of oil price on inflation in China whereas

Ahmed and Wadud (2011) found a negative association in Malaysia and Iwayemi and Fowowe (2011) and Roeger (2005) shows no association between oil prices and inflation in Nigeria and EU respectively. Meanwhile Adeniyi et al. (2011) applying ARDL in Phillp curve found high price sensitivity to oil price volatility in Nigeria. Sek et al. (2015) has suggested these varied findings perhaps could be explained by differences in the economic conditions of the countries under investigation. These well documented studies have been limited and all of them have so far focused only in developed and developing economy hence similar studies in context of least developed country like Nepal is hitherto lacking.

Nepal especially poses a unique case as it doesn't have crude oil sources to meet rapidly growing demand for petroleum products. According to a study, petroleum products constitute about 15 percent of total energy consumption in Nepal. Further, Nepal has no oil refinery and hence has to depend entirely on oil imports from India for meeting its energy needs. Similarly, Nepal Oil Corporation (NOC) is a sole monopolist to import and distribute petroleum products in Nepal. In 2002, a provision of petroleum import arrangement agreement was signed between NOC and IOC, which required Nepal to import crude oil from international market and hand over to IOC which in turn would supply equivalent volume of refined petroleum products to Nepal. As a part of agreement, Haldiya Refinery Transfer Price was to be used as export price to NOC. Meanwhile, since February 2006, government adopted a wholesale pricing system that requires announcing wholesale prices. With this structural rigidity the oil pricing doesn't follow free market dynamics. Hence, Nepal's case poses a unique picture in the context of oil pricing and its eventual impact on the national economy. A comparative study of inflation in Nepal and India conducted by Nepal Rastra Bank suggests that price of petroleum products pushes the cost of freight, carriage and cost of other goods service eventually causing inflation (NRB, 2011). It further points out that trying to contain inflation at certain level despite food surplus has witnessed challenge from supply side management due to rising fuel price. Further, International Monetary Fund (2011) states that using both stylized analysis and econometric analysis; applying VAR indicates India's inflation and international oil price as main driving force behind Nepalese inflation. This means increase in fuel prices increases cost of production and transportation that ultimately raise the general price level of goods and services. Besides, it suggests that the food price inflation might be because of correlation between oil price and fertilizers required for crop production.

III. METHODOLOGY

Data and Variables

The monthly oil price data from April 1987 to February 2018 has been downloaded from official website of Nepal Oil Corporation. The data contains price list of petrol, diesel, and kerosene and LPG gas individually. Further, price of LPG cooking gas is available only from April 1996. Figure 1, Figure 2 and Figure 3 show the date and price changes of petrol, diesel and kerosene respectively.

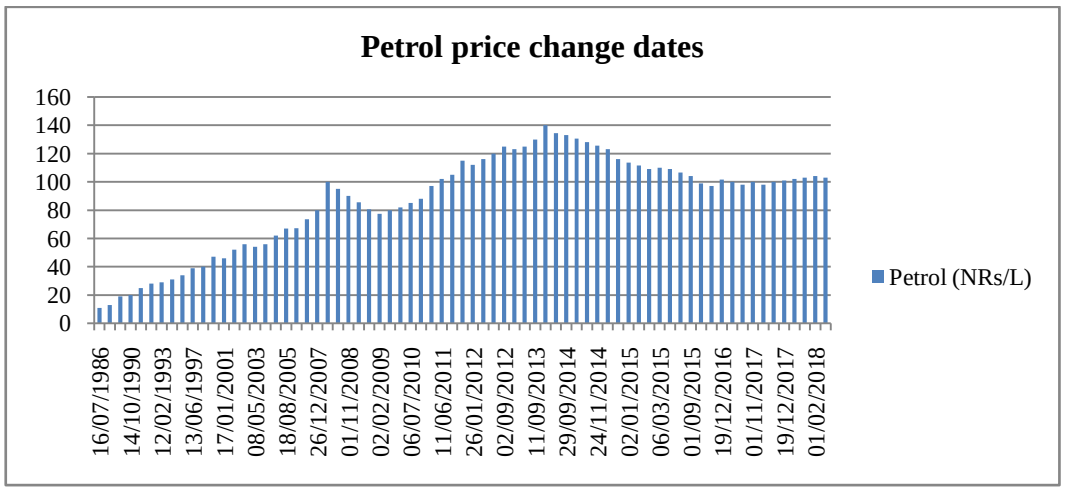

Figure 1: Petrol price and change date

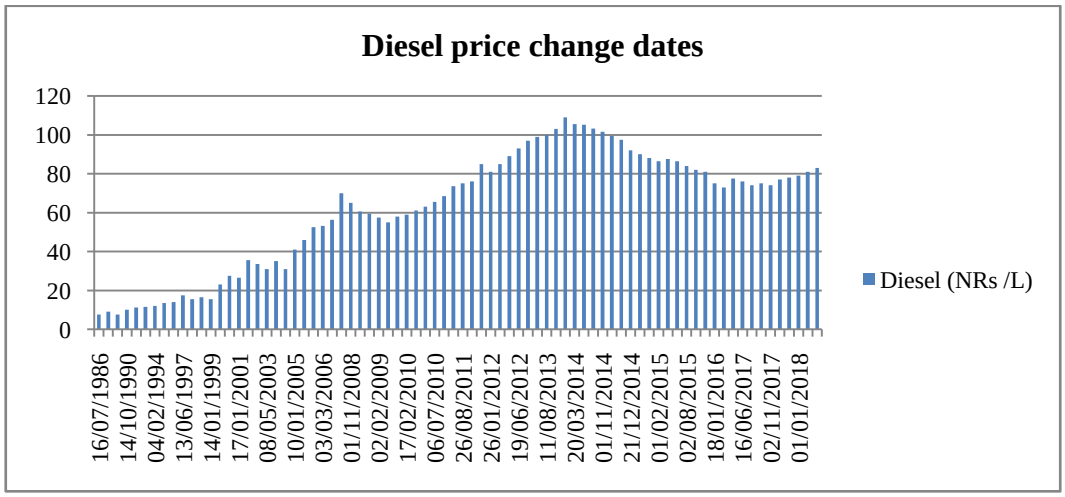

Figure 2: Diesel price and change date

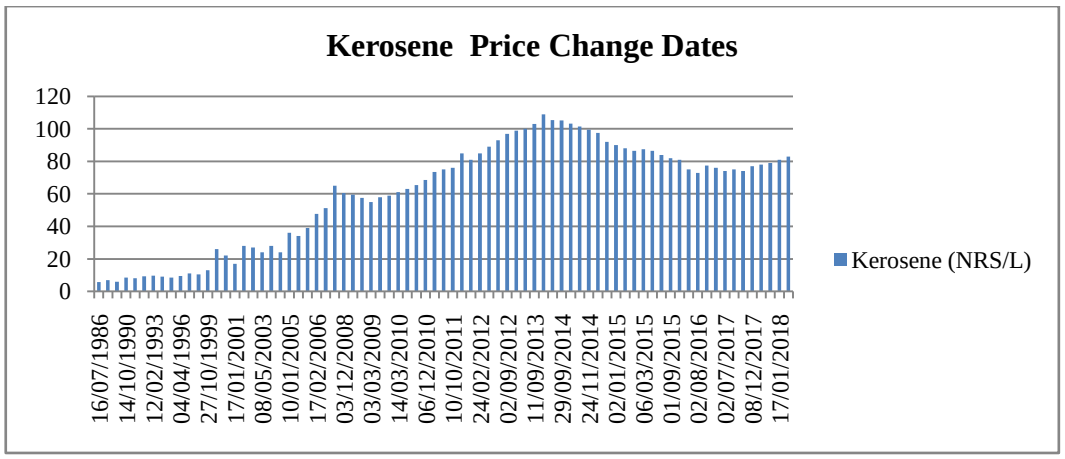

Figure 3: Kerosene Price and Change Date

Table 1 provides the brief description about how the price has varied among petrol, diesel and kerosene since 1987 to 2018. It shows that price of diesel has changed more than other products. Since the start Petrol is priced higher than diesel and kerosene. Also form November 1, 2008 the price of diesel and kerosene has been equalized.

Table 1: Description of Price Change

	No. of times change	Minimum		Maximum	
		Price	Price set Date	Price	Price set Date
Petrol	70	12.9	4/1/1987	140	3/14/2014
Diesel	78	7.5	7/16/1986	109	3/14/2014
Kerosene	77	5.5	7/16/1986	109	3/14/2014

Meanwhile, corresponding monthly CPI index of Nepal with October 2014 as base month is obtained from official website of Nepal Rastra Bank. The month to month growth of CPI is shown in Figure 4. It shows that there was a high volatility during 1987 to 2010 and the fluctuations abated in recent times. The average month to month growth during 371 month period is found to be positive 0.59 percent while standard deviation is found to be 0.03.

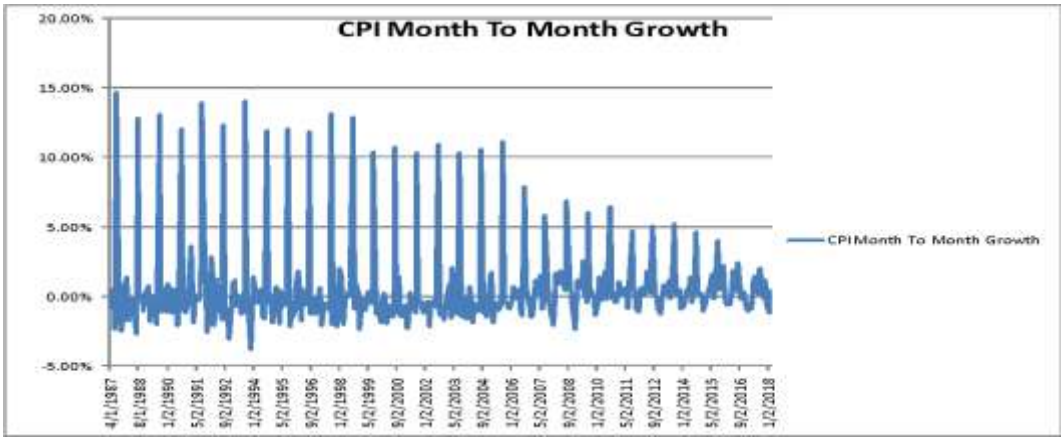

Figure 4: Month to Month CPI growth in percent

Figure 5, on the other hand, shows the movement of price of Petrol, Diesel, Kerosene and LPG gas in the given time period.

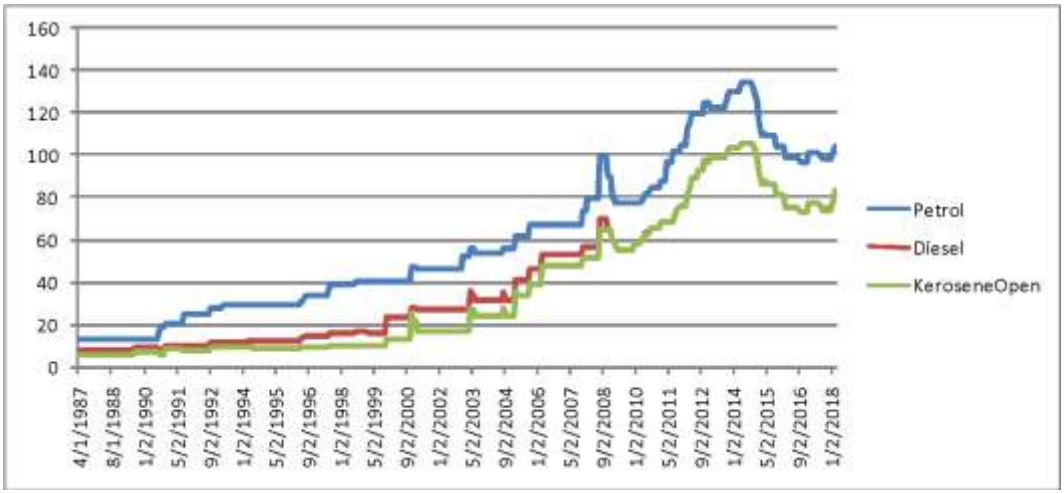

Figure 5: Movement of Price of Petrol, Diesel and Kerosene

The plot indicates high correlation between three which is substantiated by following Karl Pearson correlation table2.

Table 2: Correlation between Petrol, Diesel and Kerosene

	Petrol	Diesel	Kerosene
Petrol	1		
Diesel	0.9887	1	
Kerosene	0.9812	0.9961	1

Since it is difficult to actually pinpoint which oil product among three refined petroleum products, viz- petrol, diesel and kerosene, mainly contribute to inflation. The study uses all three of them separately. The intuition behind the usage is that all three products cater to different market segment. For instance, petrol is generally consumed for cars and private vehicles and hence it is demanded by high income market segment. Meanwhile, diesel is used by heavy vehicles like bus and trucks and hence mainly used for transportation affecting supply chain. Besides, it is also highly demanded by industries as fuel. On the other hand, kerosene is used by low income household for mainly cooking purpose. The price of all three products along with the CPI is plotted in Figure 3 below.

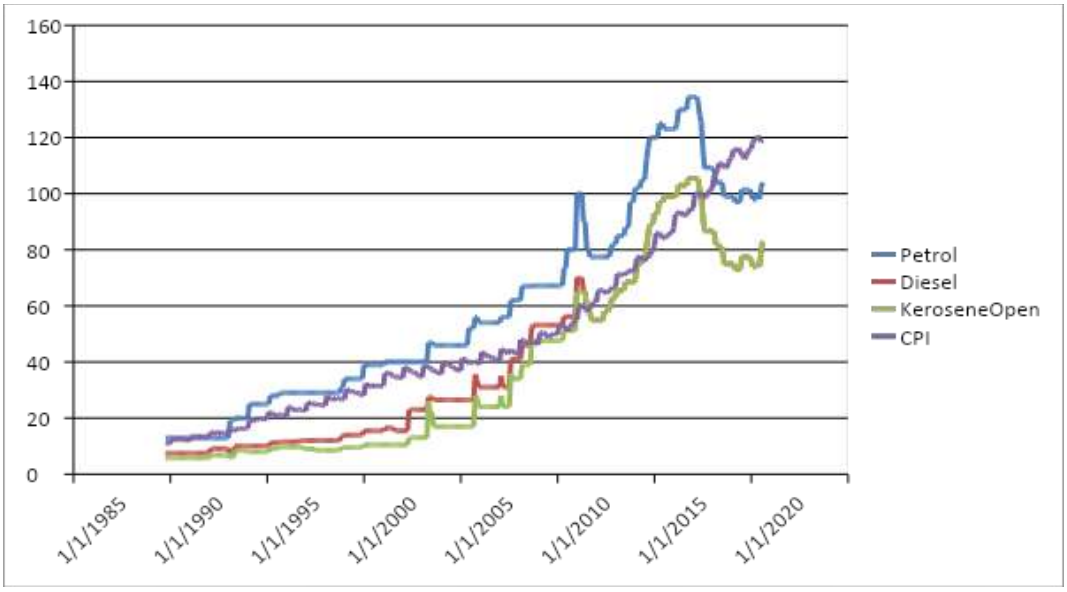

Figure 6: Oil Price and CPI Movement

The image shows that there had been relatively slow growth in all four variables gentle rise from 1987 to late 90s followed by accelerated growth after turn of millennium. Scatter plot between CPI and all three petroleum product is shown in figure 7.

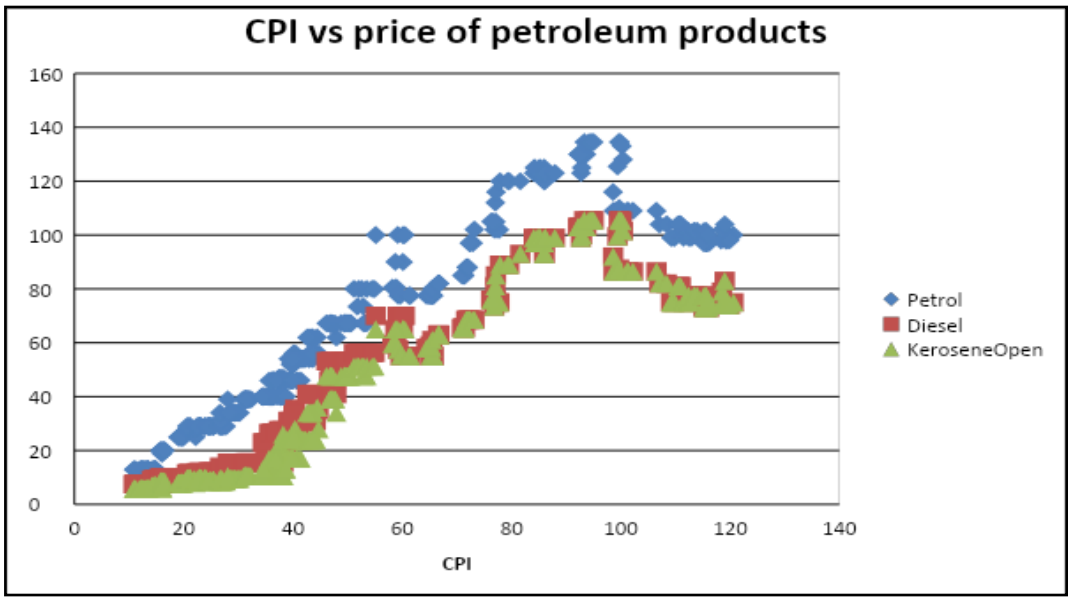

Figure 7: Scatter Plot between CPI and Petroleum Products

In addition to CPI and Petroleum Products this study uses money supply of Nepal (M2) and Wholesale Price Index (WPI) of India as the control variables. The reason for controlling money supply is because literature shows that money supply has strong effect in the general price level (Hamburger & Zwick, 1981). According to Milton Friedman, inflation is always and everywhere monetary phenomenon (Barro, 2007). This provides the growth of money supply as well as financial deepening (Levine & Zervos, 1998). The yearly data was obtained from World Development Indicators. In order to convert it to monthly, standard cubic spline interpolation was applied (Suits, Mason, &Chan, 1978). Similarly, wholesale price index of India has been chosen as an another control variable as India and Nepal share open border and Nepal has more than two-third trade size with India alone. So, any price movement in India can have spillover effects on Nepal. The WPI was obtained from the website of Reserve Bank of India (RBI)

Econometric Tools

The paper primarily uses cointegration analysis to determine the long run and as well as the short-run interactions between oil price and CPI. The entire method has been outlined in the following steps:

1. Unit Root Test

Cointegration analysis helps to solve the spurious regression problem that appears in time-series data due to presence of non-stationarity (Hendry & Juselius, 2000). Therefore, it is imperative that unit root check is to be applied in both time series

to determine integrated order of both time series. But, before applying the unit root test it is important to determine the appropriate lag to take for both time series. The most common approach for model order is to minimize one or more information criteria that include Akaike Information Criterion (AIC), Schwarz-Bayes Criterion (SBIC), Akaike's Final Prediction Error Criterion (FPE), and Hannan-Quinn Criterion (HQIC). The comparative analysis of all these information criteria is given in Lütkepohl (2005).

2. Granger Causality

To check the direction of relationship between CPI and fuel price the paper checks for Granger Causality (Granger, 1969). If any time series signal X granger causes another signal Y then it implies past values of *X* should contain enough information that can predict *Y* beyond the information contained in past values of Y.

3. Johansen Test of Cointegration

Johansen (1988) test is applied to determine the number of possible co-integrating equation between two variables. Johansen test actually produce two statistics: maximal eigenvalue of the stochastic matrix and the trace of the stochastic matrix. The maximum eigenvalue test conducts separate tests on the individual eigenvalues and the null hypothesis is number of cointegrating vectors is equal to 'r' where as the trace test is a joint test where the null hypothesis is that the number of cointegrating vectors is less than or equal to 'r'. Here 'r' is some arbitrary value (Ghimire et al., 2015).

4. NonLinear Autoregressive Distributed Lag Model (NARDL)

After establishing the number of possible co-integrating equations usually, Error Correction Model such as Vector Error Correction Model is employed to determine the long run relationship (Anderson et al., 2002). However, the VECM model assumes symmetry in the relationship among both dependent and explanatory variables that is the response of dependent variable will be same for both rise and fall of explanatory variables. Since the study deals on asymmetry of oil prices impact on inflation it applies Nonlinear Autoregressive Distributed Lag Model (NARDL) for analysis (Atil, Lahiani, & Nguyen, 2014). The model developed by Shin et al. (2014), Shin (1998) and Pesaran et al. (2001), has been used determining the asymmetric long and short run dynamics between oil price and CPI. In this study, the long run relation between CPI and petroleum products along with control variables is given by following equation.

$$CPI = \beta_0 + \beta_p X + Z\beta + \epsilon \quad \text{..... (i)}$$

Where,

X= [Petrol^{+},Petrol^{-},Diesel^{+},Diesel^{-}, Kerosene^{+},Kerosene^{-}]

Z= [M2 to GDP, WPI_India]

$\beta_p = [\beta_{petrol+}, \beta_{petrol-}, \beta_{diesel+}, \beta_{diesel-}, \beta_{kerosene+}, \beta_{kerosene-}]$ are the co-integrating vectors of long run

β=[$\beta_{M2toGDP}$, $\beta_{WPI\ india}$]

and finally if K$\in \{Petrol, Diesel, Kerosene\}$ thenK^+ and K^- are the partial sums of positive and negative change in any arbitrary independent variable given by

$$K_t^{+} = \sum_{i=1}^{t} \Delta K_t^{+} = \sum_{i=1}^{t} max(\Delta K_t, 0) \quad \text{……. (ii)}$$

$$K_t^{-} = \sum_{i=1}^{t} \Delta K_t^{-} = \sum_{i=1}^{t} min(\Delta K_t, 0) \quad \text{……. (iii)}$$

If the cointegrating coefficients $\beta_{k+} \neq \beta_{k-}$ then it can be shown that the asymmetric adjustment of Kth variable on CPI does exist in long run

The ARDL equivalent formulation of short run relationship as explained in Shin et al. (2014), can be framed as following

$$\Delta CPI_t = \alpha + \gamma_p X_{t-1} + Z_{t-1}\gamma + \sum_{i=1}^{p} \emptyset_i \Delta CPI_{t-1} + \sum_{j=1}^{q} \varphi_j \Delta X_{t-j} + \epsilon \quad \text{……. (iv)}$$

Where,

$\gamma_p = [\gamma_{petrol+}, \gamma_{petrol-}, \gamma_{diesel+}, \gamma_{diesel-}, \gamma_{kerosene+}, \gamma_{kersoene-}]$ are short run adjustment coefficients of independent variable on change in CPI;

γ= [$\gamma_{M2toGDP}$, $\gamma_{WPI\ india}$] are short run adjustment coefficients of control variable on change in CPI;

p and q are the lag orders;

$\sum_{i=1}^{p} \emptyset_i$ is short run impact of previous CPI change lag;

$\sum_{i=1}^{q} \varphi_j$ are the short run impact of increase and decrease in independent variable on CPI respectively and significance of all the coefficients are determined using the Wald F test .

It should be however noted that the NARDL can be applied on time series containing both I(0) and I(1) series. But the entire assumption will become invalid if any of variable is of I(2). This is the reason why unit root test is important.

IV. EMPIRICAL RESULTS AND DISCUSSION

As both variables oil price index and CPI shows a trend it is always intuitive to check for the presence of unit root. However, before applying the unit root test it is important to see what is the appropriate lag to take for both time series.

Table 3: Lag Selection Criteria for CPI

Lag	FPE	AIC	HQIC	SBIC
0	931.203	9.67435	9.67858	9.685
1	1.37968*	3.15973*	3.16819*	3.18101*
2	1.38703	3.16504	3.17773	3.19697
3	1.38633	3.16504	3.18145	3.2071
4	1.39259	3.16904	3.19018	3.22225

As shown in table 3, for CPI the significant lag based on four metrics final prediction error (FPE), Akaike's information criterion (AIC) and the Hannan Quinn Information Criterion (HQIC) and SBIC is lag 1 meanwhile as shown in Table 4 for Oil price the best lag according to FPE, AIC and HQIC is VAR lag 3.

Table 4: Significant Lag Selection Criteria for Oil Products

Criteria	Petrol		Diesel		Kerosene	
	Lag	Value	Lag	Value	Lag	Value
FPE	3	4.1176	2	2.86795	1	3.51382
AIC	3	4.25315	2	3.89147	1	4.09458
HQIC	3	4.27006	1	3.90364	1	4.10304
SBIC	1	4.2995	1	3.91647	1	4.11586

As the table shows, for petrol the 3 lag selection is most appropriate while for diesel the optimum lag selection appears to be either 2 or 1. Meanwhile for kerosene the appropriate lag appears to be 1. In such circumstances since there is no majority we follow democratic process and make model parsimonious by using the average lag order of 2 (Nielsen, 2006).

Following the lag selection for determining unit root Augmented Dickey-Fuller test (Dickey and Fuller, 1976) is applied to test for the presence of unit root. The result of which is tabulated in Table 5:

Table 5: ADF test for CPI, CPI (-1), Oil Index, Oil Index (-1)

Series	Test Statistics	p-value	Decision
Z(t) of CPI	2.211	0.9989	Unit Root Exist
Z(t) of CPI (-1)	**- 19.049**	**0.0000**	Unit Root is Absent
Z(t) of Petrol	-0.582	0.8749	Unit Root Exist
Z(t) of Petrol (-1)	**-17.395**	**0.0000**	Unit Root is Absent
Z(t) of Diesel	-0.107	0.9487	Unit Root Exist
Z(t) of Diesel(-1)	**-17.279**	**0.0000**	Unit Root is Absent
Z(t) of Kerosene	-0.018	0.9570	Unit Root Exist
Z(t) of Kerosene (-1)	**-18.707**	**0.0000**	Unit Root is Absent

Since calculated Z score of CPI is 2.211 whose magnitude is less than the tabulated value hence we cannot reject null hypothesis of presence of unit root. Meanwhile for first difference of CPI the tabulated values comes to -19.382 which is greater in magnitude we cannot accept null hypothesis. Hence, the CPI can be considered to be integrated process of order one I (1). Similarly, the tables shows all oil products (petrol, diesel and kerosene) are also process of order one I(1). Since all variables are non-stationary time series data we cannot apply direct OLS estimation as it always gives spurious relationship.

In addition to the unit root, the granger causality test has been performed to see if we can establish a direction of causality between CPI and dependent variable. Since all the variables are integrated in the order I(1), Stock and Watson (1988) and Park and Phillipes (1988) have suggested that the conventional granger causality of vector auto regression (VAR) cannot be applied as Wald test statistics doesn't follow asymptotic chi-square distribution due to presence of nuisance parameter in order I(1). Thus, the paper utilizes the method suggested by Toda and Yamamoto (1995) that allows computing Granger causality on non-stationary process by augmenting the unrestricted VAR model by (k+d) th order where k is optimal number of lag length and d is the integrated order. Table 6 shows the result of test according to which all three petroleum products granger causes CPI but no other way around.

Table 6 : Granger Causality Test/Block exogenity wald test

Null Hypothesis	Chi-square	p-value	Decision
Petrol does not Granger Cause CPI		0.0104	Reject Null
CPI does not Granger cause Petrol	0.513377	0.9722	Do not reject Null
Diesel does not Granger Cause CPI	7.381062	**0.0607**	Reject Null at 90 percent
CPI does not Granger cause Diesel	0.360891	0.9482	Do not reject Null
Kerosene does not Granger Cause CPI	7.284720	**0.0634**	Reject Null at 90 percent
CPI does not Granger cause Kerosene	0.131994	0.9877	Do not reject Null

To see if there is a long run stable relationship Johansen Test is applied. The summary of various functional form of possible co-integrating equation based on critical value given by Mackinnon-Haug-Michelis (1999) is shown in Table 7 which suggest that under assumption data has no trend based on both Trace Statistics and Maximum Eigenvalue test at least one co-integrating equation exist for functional form of no intercept and no trend as well as for with intercept and no trend. Meanwhile under assumption of data having trends the result was insignificant. Thus, the Johansen test indicates presence of at least one co-integrating equation without any specific trend.

Table 7 : Summary of Possible of Co-Integrating Equation Based on Johansen Test

	CE Form						Rank Test		Max-Eig Test		Decision
Data Trend	Intercept	Trend	No Of CE*	Eigen Value	Trace Stat	Max-Eigen Stat	Critical Value	p-value	Critical Value	p-value	No. of CE
			0	0.116869	56.80627	45.48691	40.17493	0.0005	24.15921	0.0000	
None	No	No	1	0.022188	11.31936	8.212075	24.27596	0.7598	17.79730	0.6827	1
			0	0.117055	63.44054	45.56419	54.07904	0.0059	28.58808	0.0002	
None	Yes	No	1	0.024834	17.87634	9.204123	35.19275	0.6405	9.1645	0.6405	1
			0	0.055205	34.86493	20.78426	47.856	0.4511	27.58434	0.2895	
Linear	Yes	No	1	0.024158	14.08066	8.950405	29.79707	0.8361	29.13162	0.8364	0
			0	0.0411	21.1074	16.1338	25.8721	0.1750	19.3870	0.1396	
Linear	Yes	Yes	1	0.0135	4.9736	4.9736	12.5180	0.6002	12.5180	0.6002	0
			0	0.0231	9.5283	8.5250	18.3977	0.5267	17.1477	0.5447	
Quadratic	Yes	Yes	1	0.0027	0.9933	0.9933	3.8415	0.3189	3.8415	0.3189	0

** CE: Cointegrating Equation*

Once the number of cointegrating vector established the paper applies standard nonlinear autoregressive distributed lag (NARDL) model to analyze the impact of oil price on CPI. The intuition is to see the impact with and without controlling the possible endogenous variables.

a. Without Control Variables

Table 8 shows the long run relationship of CPI with Petrol, Diesel and Kerosene without other control variables.

Table 8: NARDL Asymmetry Statistics without Control Variable

Variables(K)		Long Run Effect of K on CPI		Asymmetry (F-stat)	
		Effect (+)	Effect(-)	Long Run	Short Run
Petrol	Coeff	**0.515**	0.162	7.571***	0.2502
	F-stat	**28.38*** **	0.4179		
Diesel	Coeff	**1.288**	-0.581		
	F-stat	**14.02*** **	1.38	1.575***	0.0857
Kerosene	Coeff	**-1.305**	**0.912**		
	F-stat	**23.91*** **	**14.48*** **	1.589	0.4477
Bound Test of nonlinearity	F-stat	0.047911***			
		t_BDM = -5.2720 F_PSS = 5.6554***			
		[above 99% LB=3.88 and 99% UB=5.30 as per PESARAN (2001)]			
Adj. R square: 0.0824					

*Note: *** and ** denotes significant at 1% and 5% significance level, respectively*

The analysis shows that long run asymmetry exist among Petrol and Diesel in impacting inflation. Further, the rise in price of petrol appears to have significant positive impact on CPI with 1 unit rise accompanied by 0.515 units. Meanwhile unit fall in petrol price shows 0.162 unit rise on CPI suggesting upward stickiness of inflation to petrol price. However, the result is insignificant hence this assertion cannot be validated. Similarly, impact of diesel appears to have more elastic effect with one unit increase in it followed by 1.2 unit rise in CPI. This well explains how increase in diesel price affects the heavy vehicles like buses ferrying passengers and trucks transporting goods. This obviously creates supply shock and has pronounced effect on inflation. Meanwhile fall in Diesel price shows unit fall is followed by 0.581 unit decline in CPI however this result is also statistically insignificant hence we are unable to reject the hypothesis that fall in diesel price has no effect on CPI. In case of kerosene though long run asymmetry appeared to be lacking, the impact however shows that Kerosene price has negative effect on CPI with unit rise in Kerosene price is accompanied by a decline in CPI by -1.3 unit. This can be explained as Kerosene is demanded by the low income household and they may resort to other fuels like firewood for energy purpose. This can be corroborated through Rao (2013) in a study in Kerosene subsidy in Maharastra India has shown that the kerosene is used by poor household who do not have access to biomass. Further, a recent survey in Nigeria and Bangladesh have shown that with rise in oil price poor household's bio mass consumption increases (Durotoluwa, 2019). On the other hand, fall in kerosene price appears to have significant positive impact on CPI suggesting that Kerosene might be used as adulterant in Diesel a very well-known practice (Yadav et al., 2005). In fact when

kerosene and diesel price was equalized in Nepal, there was immediate 40 percent increase in sale of diesel accompanied 60 percent decline in sale of kerosene. This suggests that diesel was earlier adulterated with kerosene when latters price was low (Kojima, 2009). The impact of adulteration is reduced life of vehicle and higher maintenance cost especially of cargo vehicles (Gawande & Kaware, 2013). These maintenances cost and break down of transport vehicle disrupts supply and ultimately increase the price level.

However the overall long run impact of the three petroleum products on CPI appears to be very poor as the adjusted coefficient of determination indicates only 8 percent of variance in CPI is explained by these variables. This apparent poor fit calls for controlling of other extemporaneous variables that could have somehow impacted the CPI. In this regards, since inflation is considered to be always and everywhere a monetary phenomenon, it is intuitive to control monetary impact in the model. Further, as Nepalese currency is pegged to Indian currency and Nepal shares open border with India, co-movement has been observed between inflation of two countries (Ginting, 2007). Therefore, controlling the effect of inflation of India is again intuitive. Following section reevaluates the model by controlling for the possible monetary impact and impact of India's inflation.

b. With Control Variables

Table 9 details the long run proxied by M2/GDP and price level of India proxied by Wholesale Price of India.

Table 9: NARDL Asymmetry Statistics with Control Variable

Variables (K)		Long Run Effect of K on CPI		Asymmetry	
		Effect (+)	Effect(-)	LongRun	Short Run
Petrol	Coeff	0.003	-0.098	1.353	0.6348
	F-stat	.004352	1.803		
Diesel	Coeff	-0.048	**0.431**	**5.278*** **	1.277
	F-stat	0.1215	**8.09*** **		
Kerosene	Coeff	-0.008	-0.114	1.769	0.6342
	F-stat	.004287	1.363		
M2 to GDP	Coeff	0.0312628			
	F-stat	**2.04** **			
WPI of India	Coeff	0.4294646			
	F-stat	**0.047911*** **			
Cons	Coeff	-0.87067			
	F-stat	0.5731782			
Bound Test of nonlinearity		t_BDM = -10.7626 F_PSS = 17.9240*** *[above 99 percent LB=3.07 and 99 percent UB=4.44 as per PESARAN (2001)]*			
Adj. R square: 0.2636					

*Note: *** and ** denotes significant at 1 percent and 5 percent significance level, respectively*

The NARDL test after introduction of control variable shows an entirely different picture than the one obtained without control in earlier section. First, the result shows that the value of adjusted R2 has improved to 0.2636. However, the analysis has found negligible impact of petrol on CPI in the long run. Further, there was no significant asymmetry in CPI due to change in petrol price. This can be probably explained as petrol is only demanded by high income group whose purchasing power doesn't change with rise or fall in its price. Nevertheless, petrol price rise has negligible but positive impact on CPI with 0.003 unit rise and fall in petrol price is followed by 0.098 unit fall in CPI. This shows that petrol price and CPI have same directional changes. On the other hand, kerosene shows no significant asymmetry in long run. In long run though insignificant, the rise in kerosene by a unit is accompanied by fall in CPI by 0.008. This could be because as kerosene is generally used by low income group and people might have substituted it for fire woods. The insignificance of kerosene in CPI shows that its impact has fallen in long run as probably consumer has switched to cooking gas. Meanwhile the CPI is found to be most impacted by the diesel with significant asymmetry in its rise and fall in long run. First, rise in diesel though insignificant, is followed by -0.048 unit fall in CPI. This appears to be very counterintuitive as diesel is mainly used by heavy vehicle used for supplying goods and ferrying people. And its increased price should have increased impact in long run. This anomaly could probably be explained as diesel is generally mixed with kerosene and hence rise in diesel might have made users resort to cheaper fuel like kerosene (Yadav et al., 2005). This claim is supported by Kojima (2009) that found when kerosene and diesel price were equalized in Nepal there was 60 percent drop in kerosene and 40 percent increase in diesel consumption. Similarly, fall in diesel price by one unit has significant positive impact on CPI by 0.431 units. This apparent anomaly can be explained intuitively as diesel is the main fuel used by industries for production. Further, during the load shedding period diesel was used mainly for generator. Decrease in diesel price seems to have spurred the industry production which eventually increases the growth thus increasing general price level (Selden, 1959). This assertion is consistent with the literature as according to Parikh and Khedkar (2013) decline in diesel price creates better economic environment for industry. Further, in a study of 18 Eurozone countries, Bayar and Kilic (2014) has shown that with falling fuel price industrial output rises. With rise in industrial output the economic growth ensues that leads to rise in inflation as entailed by Phillip Curve (Mankiw, 1990). Another possible explanation of this could be attributed to fact that as per NRB, transportation that is mainly affected by oil price comprises only 5.34 percent in CPI weight. This finding is extremely interesting as it indicates how attempting to reduce cost push inflation can spillover to demand pull. The long run cointegration however appears to be more impacted by the wholesale price of India and money supply as both are found to be significant determinants of CPI. The cumulative effect of rise and fall in CPI in

long run because of individual oil products is depicted in the figure 8. The graph shows that fall in petroleum product across all three items have more impact on CPI than its rise.

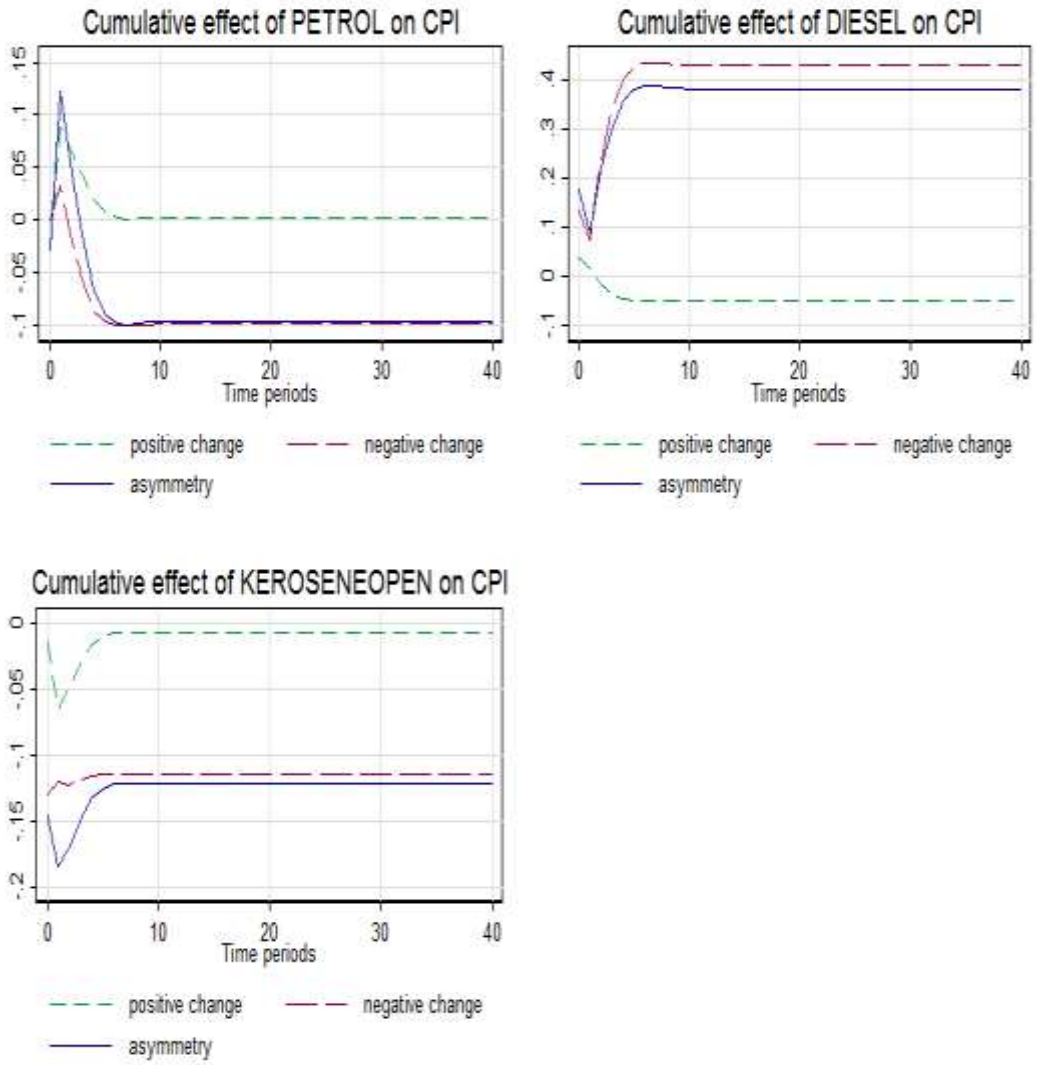

Figure 8: Long Run cumulative impact on CPI by Petrol, Diesel and Kerosene

Meanwhile short run analysis using NARDL is tabulated in table 10.

Table 10: Short Run NARDL Dynamics

Δ CPI	Coeff	p-value
Cons	-.8706784	0.130
CPI(-1)	**-.4405832**	**0**
$Petrol^{+}$(-1)	.0012158	0.947
$Petrol^{-}$(-1)	.0433095	0.188
$Disel^{+}$(-1)	-.0211023	0.727
$Disel^{-}$(-1)	**-.1898633**	**0.006**
$Kerosene^{+}$(-1)	-.0034793	0.948
$Kerosene^{-}$(-1)	.0504165	0.241
Δ CPI(-1)	**.14353**	**0.004**
Δ CPI(-2)	.1071631	0.227
Δ $Petrol^{+}$	-.0283891	0.538
Δ $Petrol^{+}$(-1)	**.1071631**	**0.022**
Δ $Petrol^{-}$	-.0002473	0.998
Δ $Petrol^{-}$(-1)	-.076688	0.535
Δ $Disel^{+}$	**.0411442**	**0.072**
Δ $Disel^{+}$(-1)	.0079936	0.949
Δ $Disel^{-}$	-.1362581	0.549
Δ $Disel^{-}$(-1)	.2105717	0.334
Δ $Kerosene^{+}$	-.0148427	0.884
Δ $Kerosene^{+}$(-1)	-.0517161	0.639
Δ $Kerosene^{-}$	.1307077	0.383
Δ $Kerosene^{-}$(-1)	-.0227118	0.866
WPI India	**.4294646**	**0.000**
M2 to GDP	**.0312628**	**0.043**

The standard Error Correction Model (ECM) shows that a clear short run asymmetry is lacking. However in short run, it is found that unit change in lagged difference of petrol price significantly deviates the CPI by 0.1 units from its long run equilibrium. This suggests that a change in size of price of petrol in previous period increases the CPI. Meanwhile in case of diesel, the fall in price is followed by 0.19 unit fall in CPI bringing the CPI towards convergence. While similar to petrol the unit rise price differential of Diesel deviates the CPI by 0.04 unit from its equilibrium

Thus the findings shows that in short run, it is not the increase in price but the actual size of increase for both diesel and petrol that impacts CPI. This finding has a big policy implication suggesting that modest price rise in petrol and diesel is better than the abrupt hike which may cause disequilibrium in CPI.

V. CONCLUSION AND RECOMMENDATION

This paper has examined the impact of oil price pass through into the inflation of Nepal. Though there has been several studies in oil price pass through into inflation across the globe, Nepal presents a unique case for research as it is landlocked and is entirely dependent on India for fuel. Further, the distribution of

petroleum within the country is done solely by Nepal Oil Corporation. Since inflation has been one of the major factors creating economic hardships especially for fixed income earning groups, NRB needs to formulate monetary policy with an aim to contain it. In view of the fact that monetary policy instruments can address the demand side of inflation, it is important to determine the empirical relationship between inflation and change in oil price

This study shows considerable long run impact of all three petroleum products on the CPI. However, the impact remains consistent only with Diesel after controlling for the monetary component and apparent effect of India's inflation. Meanwhile petrol and kerosene do not appear to exhibit such asymmetry.

Further, study does not find any significant asymmetry in oil price pass through in short run. But the short run increase in CPI can be attributed to size of increase in prices of diesel and petrol rather than the price itself. Since this study employs nonlinear asymmetric model as per the suggestion of Lee et al. (1995) and Hamilton (1996); it can provide guideline for similar future studies as well. Especially since many economic variables such as price, wage are sticky this methodological approach can be employed for their investigation.

The main finding of this study however is the apparent fall in diesel price in long run followed by increase in CPI by 0.44 which can be attributed to increased industrial demand as explained by Bayar and Kilic (2014). This could be explained by fact that the decrease in oil price generates income effect influencing industries to channel their surplus into buying additional raw materials or hiring new labors. Since supply of raw materials and labors do not depend upon oil price, they have apparent constant supply. This increased demand of both raw material and labor eventually could have increases the CPI through demand pull channel. This explanation is aligned with Lemieux (2015), which by applying production possibility frontier curve has shown that in US after the price of crude oil dropped with discovery of fracking, the demand for other goods and service has increased. Thus spawning a long chain effect of change in oil price in consumption, production and eventually into inflation. Another study on US data by Baumeister and Kilian (2016) has shown that decline in price of gasoline has produced 0.7 percentage of real GDP growth by raising private real consumption.

Hence, findings of this study particularly the difference in short run and long run effect of diesel price in CPI opens door for future research on how fall in diesel price apparently has spillover effects into industry and translating it to demand pull inflation. Besides, this study also indicates that the inflation cannot be explained only by oil price alone as suggested by Mankiw (2007); as we have seen significant effect of M2 to GDP and Wholesale Price of India.

Finally, further studies are recommended to see the interplay of other macroeconomic and monetary indicators along with oil price in influencing the CPI of Nepal. This study, however, shows that since oil price in Nepal is not determined by market mechanism, so pricing authorities should be cautious about the size of price change especially in case of petrol and diesel. Further, this research provides a policy prescription for government to make pricing of diesel more scientific as it has a long run impact on CPI through both industrial demand and through supply chain mechanism.

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Macroeconomic Influence on the Nepalese Stock Market

Mukti Bahadur Khatri [*]

Abstract

This study examines the dynamic relationship among the stock market and macroeconomic factors such as nominal domestic variables (inflation, money supply, and interest rate), real economic activity (gross domestic product) and foreign variable (exchange rate and foreign direct investment) of Nepal. It has used Johansen and Juselius (1990) method of multivariate cointegration for the period Mid-July 1994 to Mid-July 2015. The finding of this study shows that the stock prices are positively and significantly related to money supply. Real economic activity and interest rate have insignificant and negative relationship with the stock prices. Similarly, foreign direct investment, inflation (CPI) and exchange rate with US dollar have a positive and insignificant relationship with the Nepalese stock market. Accordingly, the VEC estimates suggest that there is no significant effect of macroeconomic variables to the Nepalese stock price in the short run. In general, the presence of cointegration and causality suggest that Nepalese stock market is not efficient in both the short run and the long run.

Key Words: Stock Market, Macroeconomic Variables, Cointegration, VEC Estimates, Causality Test

JEL Classification: G10, E44, C32

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I. INTRODUCTION

The history of Nepalese stock market begins with Biratnagar Jute Mills and Nepal Bank Limited who floated their shares in 1937 AD, even though Nepalese stock market institutionalized only after the establishment of Securities Market Centre in 1976. Later on, it was changed into Securities Exchange Center (SEC) in 1984 AD. Further, the modernization begin in 1992 under the Enhanced Structural Adjustment Program (ESAP) converted SEC into Nepal Stock Exchange (NEPSE) with the sole objective of carrying out secondary market services for stocks. On January 13, 1994, NEPSE opened a trading floor introducing an 'open outcry system' which was replaced by 'automated trading system' beginning August 24, 2007.

NEPSE is the only organized stock exchange (secondary market) in Nepal operating under Securities Act, 2006. It turned itself into a profit seeking organization in May 2008 from its initial not for profit organization. The recent developments in NEPSE includes provision of real time information (live trading activity) to investors from November 2, 2008 and introduction of the over-the-counter (OTC) market from June 4, 2008 which provides the market for trading of shares that are de-listed and that are not listed in NEPSE for failing to meet the listing criteria. The historical performance of the NEPSE for the period of Mid-July 1994 to Mid- July 2015, number of companies listed and number (paid up value) of listed securities both have increased from 66 in 1994 to 232 in 2015. In the same time market capitalization ratio (ratio of market capitalization on nominal GDP at market price) is also (in million) increased from 13872 to 989404 million (NRB, 2017).

There are various empirical research that examines the influence of macro-economic factors on the stock market. These studies are based on the asset valuation model which argues that macroeconomic factors can affect stock price in two distinct ways. Firstly, they can change expected cash flows of the firm and by this means change firm's stock price. Secondly, they can change the discount rate or required rate of return used by the market participants (Crowder, 2006). For this purpose nominal domestic variables (inflation, money supply, interest rate), real domestic activity (gross domestic product, unemployment rate) and foreign variables (exchange rate, oil price and international stock exchange index) reflecting the real, monetary and financial sectors of an economy.

The existence of macroeconomic influence on the stock market suggests that stock price can be predicted using the publicly available information on macroeconomic variables. The occurrence of which contradicts with Fama's (1970) Efficient Market Hypothesis (EMH). According to him "A capital market is efficient if all the information in some information set ϕ_t is "fully reflected" in

security prices" Fama distinguished three versions of the efficient markets based on this set of information ϕ_t reflected[1] in security prices:

(i) **The Weak Form of the Efficient Market Hypothesis:** It refers to the information based on historical series of prices, which is just the past price (or returns).

(ii) **The Semi-Strong Form of the Efficient Market Hypothesis:** It refers to the publicly available information based on speed of price adjustment to other obviously available information such as statement of stock openings, new security issues, annual reports etc.

(iii) **The Strong Form of the Efficient Market Hypothesis:** It refers to private information based on all information of market participants or any investor or groups (e.g., management of mutual funds) have monopolistic access to any information relevant for the formations of prices have just appeared.

On the basis of above discussion, this study analyzes relationships between a group of macroeconomic variables and the Nepalese stock market index. The objective of this study is to investigate whether stock prices may serve as a leading indicator for macroeconomic variables in Nepalese economy or a group of macroeconomic variables may serve as a leading indicator for stock returns in Nepal. Granger causality tests have been employed to estimate the relationships on the basis of data from 1994 to 2015 (i.e. 22 years).

II. REVIEW OF LITERATURE

The stock market has been historically analyzed as a reliable tool to indicate economic progress. The theoretical approach to studying the relationship between the macroeconomic factors and stock market is provided by the financial theory, the so called present value model which is used to describe the valuation of assets. The model suggests that the stock price is equal to the present discounted value of the future expected cash flows (Humpe and Macmillan, 2007). This is expressed as

$$P_t = \sum_{j=1}^{k} E_t \left(\frac{CF_{t+j}}{(1+R_t)^j} \right) \qquad \ldots\ldots\ldots (1)$$

[1] The set of information ϕ_t reflected in security prices at t time period distinguished three versions of the efficient markets (Fama, 1970). This classification has been widely adopted in the literature on financial markets for convenience.

Where,

P_t is the current asset (stock) price or intrinsic value of asset (stock)

E_t is the conditional expectations operator based on the information available to market participants at time t

CF_t is the cash flows at time t

R_t is the discount rate or rate of return used by the market participants to discount future values

k is the investor's time horizon or holding period

From equation (1), it can be seen that macroeconomic factors can affect stock price in two distinct ways. First, they can alter expected cash flows of the firm and thereby alter firm's stock price. Second, they can alter the discount rate or required rate of return used by the market participants.[2] The asset pricing theory (such as Arbitrage Pricing Theory) is silent about which macroeconomic variables are likely to influence all assets (Chen, Roll and Ross, 1986). The study hypothesizes these factors to be comprising of nominal domestic variables (inflation, money supply and interest rate), real domestic activity (real economic activity) and foreign variables (such as exchange rate between US dollars and Nepalese Rupees, FDI) have influence on Nepalese stock market.

Shrestha and Subedi (2014) examined the determinants of stock market performance in Nepal and based on stock market index of monthly data of 2000 to 2014, and using OLS estimations of behavioral equations. According to their study, there is strong positive relationship with inflation and growth of money supply along with negative response to interest rate.

Joshi (2009) examined the dynamic relationship among the stock market and macroeconomic factors represented by nominal domestic variables (inflation, money supply and interest rate), real economic activity (gross domestic product) and foreign variable (exchange rate) for a stock market of Nepal. This study has also used Johansen and Juselius (1990) method of multivariate cointegration for the period Mid-July 1995 to Mid-June 2006. This study has acknowledged dynamic relationship among stock index and macroeconomic variables. Similarly the presence of cointegration and causality of the study suggests that Nepalese stock market is not efficient in the short run and also in the long run.

Pilinkus (2009) examined the relationships between a group of macroeconomic variables and the Lithuanian stock market index, i.e. OMX Vilnius index. The

[2] Required rate of return consists of nominal risk free rate and risk premium (for inflation, default, maturity). Nominal risk free rate in turn compromises of real risk free rate and inflation premium for expected inflation.

study revealed a group of macroeconomic variables may offer as a leading indicator for stock returns in Lithuania. Granger causality tests have been employed to estimate the relationship on the basis of data from December 1999 to March 2008. The research signifies that some macroeconomic variables (e.g., GDP deflator, net export, FDI etc.) guide Lithuanian stock market returns, some macroeconomic variables (e.g., GDP, material investment, construction volume index, etc.) are led by the OMXV index and, finally, some macroeconomic indices (e.g., money supply, BOP, etc.) and the stock market returns Granger cause each other.

Humpe and Macmillan (2007) examined under the framework of a standard discounted value model whether a number of macroeconomic variables influence stock prices in the USA and Japan. A cointegration analysis is used in order to model the long term relationship between macroeconomic variables such as industrial production, the consumer price index, money supply, long term interest rates and stock prices in Japan and the USA. This study found the data are consistent with a single cointegrating vector for the USA, where stock prices are positively related to industrial production and inversely associated to both the CPI and a long term interest rate. It also finds an insignificant (although positive) relationship between stock prices of USA and the money supply. However, for the Japanese data it finds two cointegrating vectors i.e. stock prices & industrial production. Where, stock price are positively subjective by industrial production and negatively by the money supply along with the industrial production is negatively subjective by the CPI and a long term interest rate. These contrasting results may be due to the fall in the Japanese economy during the 1990s and consequent liquidity trap.

Gay (2008) argues that the relationship between share prices and macroeconomic variables is well acknowledged for the United States and other major economies, however, what is the relationship between share prices and economic activity in emerging economies, is less researched. The goal of this study was to investigate the time series relationship between stock market index prices and the macroeconomic variables such as exchange rate and oil price for Brazil, Russia, India, and China (BRIC) using the Box-Jenkins ARIMA model. Although no significant relationship was found between particular exchange rate and oil price on the stock market index prices of either BRIC country due to other domestic and international macroeconomic factors on stock market returns, deserving further research. This study also found no significant relationship between present and past stock market returns, signifying the markets of Brazil, Russia, India, and China show evidence of the weak-form of market efficiency.

Tursoy, Nil and Husam (2008) empirically tested the Arbitrage Pricing Theory (APT) in Istanbul Stock Exchange (ISE) for the period of February 2001 up to

September 2005 on a monthly base. In this paper, various macroeconomic variables representing the basic indicator of an economy employed money supply (M2), industrial production, crude oil price, consumer price index (CPI), export, import, price of gold, interest rate, exchange rate, GDP, unemployment rate, foreign reserve and market pressure index (MPI). This study tested 13 macroeconomic variables against 11 industry portfolios of Istanbul Stock Exchange to examine the effects of those variables on stocks' returns. Using ordinary least square (OLS) technique and it observed that there are some differences among the industry sector portfolios.

Gan & et al. (2006) examined the relationships between a set of seven macroeconomic variables and the New Zealand Stock Index from January 1990 to January 2003 using cointegration tests. Particularly, this study employed the Johansen Maximum Likelihood and Granger-causality tests to find out results. In addition, this study examines the short run dynamic linkages between NZSE40 and macroeconomic variables by using innovation accounting analyses. Finally, this study found the NZSE40 is consistently influenced by the money supply, interest rate and real GDP. There is no evidence that the New Zealand Stock Index is a leading indicator due to change in macroeconomic variables.

Arnold & Vrugt (2006) examine empirical evidence on the link between stock market volatility and macroeconomic uncertainty. The findings that US stock market volatility is significantly related to the dispersion in economic forecasts from survey of professional forecaster (SPF) survey participants over the period from 1969 to 1996. This link between stock market volatility and macroeconomic uncertainty is much stronger than that between stock market volatility and the time-series measures of macroeconomic volatility, but disappears after 1996.

The seminal work in this aspect is that of Chen, Roll and Ross (1986) for US. They examine a range of business conditions variable that might be related to stock returns because they are related to shocks to expected future cash flows or discount rates. They show that the variables, such as the growth rate of industrial production, inflation (expected and unexpected), the spread between long and short interest rates (Term Structure Spread), and the spread between high and low-grade bonds a bond (Default Risk Premium), systematically affect stock returns. More specifically, they conclude that the default and term premia are priced risk factors that Industrial Production is a strong candidate for being a risk factor, and that weaker evidence supports Inflation's claim to that status (Flannery and Protopapadakis, 2002). Followed by this, many empirical studies have emerged focusing mostly on developed markets; for instance, Lee (1992), Darrat and Dickens (1999), Park and Rati (2000), Laopodis (2006), Patra and Poshakwale (2006), Ratanapakorn and Sharma (2007) among others and few on emerging

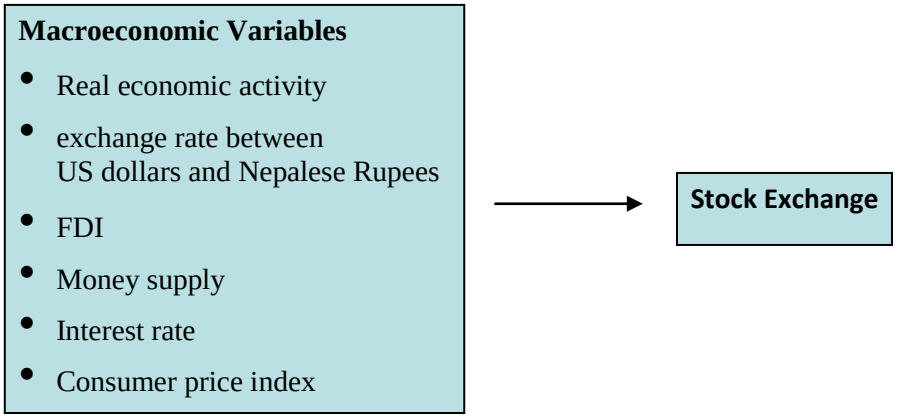
equity markets[3] (e.g., Mookerjee and Yu, 1997; Lee, 1997; Tsoukalas, 2003; Al-Khazali, 2003; Gunasekarge, Pisedtalasai and Power, 2004; Wickremasinghe, 2006), all of which documented relationship between stock market and at least one of the macroeconomic variables.

III. CONCEPTUAL FRAMEWORK

This study primarily focuses on stock prices. Six non-equity macroeconomic variables such as inflation, money supply, interest rate, real economic activity, exchange rate and foreign direct investment are used in an attempt to examine the relationship between these variables and stock prices. The relationship between stock prices and macroeconomic factors is based on the two theoretical models- the Efficient Markets Hypothesis (Fama, 1970) and the present value model (Humpe and Macmillan, 2007 and Allen et al., 2004).

It is widely accepted that increase in future levels of real economic activity, as measured by GDP will affect the future cash flows in the same direction. Stock returns being a function of future cash flows, there is positive relationship with the real economic activity.

Conceptual Framework



[3] According to the International Finance Corporation, a unit of the World Bank, an emerging equity market is an equity market from a developing country. A developing country is one that has a low income (US$ 783 or less per capita in 1997) or middle income (US$ 783 to 9656 per capita in 1997).

Therefore, this relationship can be explained as the following model:

$$LNEPSE = f (LGDP, LEXR, LFDI, LM1, LTBR, LCPI)$$

In equation form this can be written as:

$$LNEPSE = \beta 0 + \beta 1\ LGDP + \beta 2\ LXER + \beta 3\ LFDI + \beta 4\ LM1 + \beta 5\ LBTR + \beta 6\ LCPI$$

Where, variables LNEPSE, LGDP, LEXR, LFDI, LM1, LTBR and LCPI denote log values of Nepal stock exchange index, real gross domestic product, NRs/US dollar exchange rate, foreign direct investment, narrow money supply, 91-days Treasury bill rate, and consumer price index. The expected signs of the coefficients of the variables are:

$\beta 1 > 0$, $\beta 3 > 0$, $\beta 5 < 0$ and others are determined empirically.

IV. DATA AND ANALYSIS

4.1 Nature of Data

The time series data of secondary nature compromising of stock prices and six non-equity macroeconomic variables such as inflation, money supply, interest rate (weight average treasury bills rate -TBR), real economic activity, FDI and exchange rate has been used for the study. In this study annual data for the period 1994 to 2015 on the Nepal Stock Exchange (NEPSE) index and the macroeconomic variables were obtained from Annual Report of Nepal Stock Exchange and Quarterly Economic Bulletin of Nepal Rastra Bank. The NEPSE index is a broad based value weighted index and is available from July 1994. The choice of the macroeconomic variables is based on the prior empirical findings in the developed and emerging stock markets and their relevance and importance to the Nepalese economy.

4.2 Description of Stock Price and Macroeconomic Variables

Concerned macroeconomic variables are defined as follows:

Table 1: Description of Variables

Symbol	Variable	Definitions
LNEPSE	Stock Prices	Natural log of NEPSE Stock Prices Index
LM1	Money supply	Natural log of Narrow Money Supply
LCPI	Inflation	Natural log of National Consumer Price Index
LTBR	Interest Rate	Natural log of weighted average 91-days Treasury Bills Rate
LGDP	Real Economic Activity	Natural log of Real Gross Domestic Product
LFDI	Foreign Direct Investment	Natural log of Foreign Direct Investment
LEXR	Exchange Rate	Natural log of NRs/US Dollar Exchange Rate

Here, the first differences of variables are indicated by Δ which represents change rates or instance, ΔLNEPSE indicates growth of NEPSE stock price index which is also called as stock returns. Accordingly other variables are also defined.

4.3 Summary Statistics

It represents summary report of Mean, Standard Deviation, Maximum, Minimum, Skewness, and Kurtosis, which explain synopsis about the distribution, variability, and central tendency of a variable.

Table 2: Summary Statistics

Variables	No. of Obs.	Mean	Min.	Max.	Std. Dev.	Skew	Kurt	Jarque-Bera Test
ΔLNEPSE	22	0.03	-0.45	0.57	0.31	0.19	-0.93	0.73
ΔLGDP	22	0.04	0.001	0.08	0.02	0.39	0.43	0.57
ΔLEXR	22	0.02	-0.08	0.17	0.07	0.33	-0.72	0.69
ΔLFDI	22	0.02	-2.64	1.54	0.94	-1.06	2.23	6.70**
ΔLM1	22	0.12	0.04	0.24	0.05	0.55	-0.09	0.88
ΔLTBR	22	-0.10	-1.73	0.69	0.58	-1.38	1.99	8.28***
ΔLCPI	22	0.07	0.02	0.12	0.03	0.03	-1.09	0.85

Note: This table displays the summary statistics of concerned variables for the sample period Mid-July 1994 to Mid-July 2015. The concerned variables ΔLNEPSE, ΔLCPI, ΔLM1 and ΔLTBR, ΔLGDP, ΔLFDI and ΔLEXR denote first difference of log values of Nepal Stock Exchange index, consumer price index, narrow money supply, 91-days Treasury Bill Rate, real gross domestic product, foreign direct investment and NRs/US dollar exchange rate.

***Significant at the 1-percent level,

**Significant at the 5-percent level

For the ΔLNEPSE the mean is 0.03 and the standard deviation is 0.31. The largest and lowest value for this is -0.45 and 0.57. The variable shows positive skewness indicating the higher probability of very large positive stock prices. Similarly the kurtosis shows that it is platykurtic (fat or short tailed) with lower than normal kurtosis (that is K>3), which means that there is a higher probability than usual

for extreme values (very good or very bad returns) to occur. The combination of these presents the normal distribution of the variable as indicated by the JB test of normality, where p value of JB test is reasonably high.

For the macroeconomic variables, the mean is the highest for LM1 and the lowest for LTBR. The figures in the standard deviation column indicate that LFDI is highly volatile while LGDP is less volatile.

4.4 Correlation Matrix

Table 3 shows that there is moderate correlation between the ΔLNEPSE and most of the macroeconomic variables. However, the macroeconomic variables except ΔLGDP, ΔLEXR and ΔLCPI demonstrate strong correlation with each other.

Table 3: Correlation Matrix

Correlation Matrix	ΔLNEPSE	ΔLGDP	ΔLEXR	ΔLFDI	ΔLM1	ΔLTBR	ΔLCPI
ΔLNEPSE	1.0000						
ΔLGDP	-0.1270	1.0000					
ΔLEXR	-0.0314	0.1822	1.0000				
ΔLFDI	0.2700	0.2969	-0.3780	1.0000			
ΔLM1	0.1921	0.0175	0.1187	0.2742	1.0000		
ΔLTBR	0.4385	0.0486	-0.3315	0.7025	0.5123	1.0000	
ΔLCPI	-0.2466	0.5228	0.4345	-0.1558	0.1391	-0.2009	1.0000

Note: This table displays the correlation of concerned variables for the sample period Mid-July 1994 to Mid-July 2015. The concerned variables ΔLNEPSE, ΔLCPI, ΔLM1 and ΔLTBR, ΔLGDP, ΔLFDI and ΔLEXR denote first difference of log values of Nepal Stock Exchange index, consumer price index, narrow money supply, 91-days Treasury Bill Rate, real gross domestic product, foreign direct investment and NRs/US dollar exchange rate.

4.5 Cointegration

A linear combination of log of Nepal Stock Exchange (LNEPSE) index, consumer price index (LCPI), narrow money supply (LM1), three months Treasury bill rate (LTBR), nominal gross domestic product (LGDP), US dollar exchange rate (LEXR), and foreign direct investment (LFDI) time series can be stationary despite being individually non-stationary. The cointegration of two (or more) time series implies that there is a long-run, or equilibrium, relationship between them. So it was employed to examine the dynamic relationship between NEPSE and macroeconomic variables. The following steps were followed in this regard:

4.5.1 Unit Root Test

Before testing for the relationship between the seven variables in the system of equations, unit root test is carried out for each variable. Table 4 displays the results of the Augmented Dickey-Fuller (ADF, 1981) test for unit roots. The results suggest that all the variables are non stationary in their levels. These results are consistent when an intercept and linear trend are included as deterministic components in the test equations.

Let us observe the ADF test of level and first difference of Nepalese stock market index and macroeconomic variables (time series). According to ADF results of first difference, absolute calculated value of 'T' is more than absolute value of T at 1%, 5% and 10%. So, the null Hypothesis is rejected at 1%, 5% and 10%. It implies that there is no Unit Root problem. Therefore, there is no Unit Root (i.e. stationary). On the contrary, ADF results of level shows an Unit Root Problems. They are given detail as follows.

Table 4: Augmented Dickey-Fuller Test for Unit Root Test

Variables	For Level			For First Difference		
	Estimated Value	Test Statistic: tau	P-Value	Estimated Value	Test Statistic: tau	P-Value
LNEPSE	-0.164437	-1.19011	0.6531	-0.460616	-1.98222	0.2906
LGDP	-0.0438757	-1.92266	0.3149	-0.76179	-3.25899	0.03508
LEXR	-0.291533	-2.57604	0.1168	-1.1273	-4.17686	0.00613
LFDI	-0.731407	-3.14514	0.04207	-1.35212	-3.91872	0.01003
LM1	0.000179651	0.00834831	0.947	-0.764153	-2.7207	0.09222
LTBR	-0.553044	-2.04721	0.266	-0.921956	-2.45061	0.1448
LCPI	0.0251975	1.07566	0.9953	-0.471456	-2.02287	0.275

Note: This table displays ADF test for the unit roots for the sample period Mid-July 1994 to Mid-July 2015 Significant at the 5-percent level. The variables LNEPSE, LCPI, LM1 and LTBR, LGDP, LFDI and LEXR denote log values of Nepal Stock Exchange index, consumer price index, narrow money supply, 91-days Treasury Bill Rate, real gross domestic product, foreign direct investment and NRs/US dollar exchange rate.

4.5.2 Vector Autoregression (VAR) system of maximum lag order

For the Johansen's cointegration tests the relevant order of lag of VAR model should be specified. For this purpose, the study used AIC, BIC and HQC. Table 5 shows that the results of the optimal lag selection. It suggests at least five lags. The information below indicates the best (that is, minimized) values of the respective information criteria.

Table 5: Vector Autoregression system of lag order

Lags	Loglik	p(LR)	AIC	BIC	HQC
1	2.24518		0.959137	1.282408	0.839451
2	11.59705	0.00002	-0.432842	-0.069162	-0.567489
3	25.03530	0.00000	-2.505883	-2.101794	-2.655491
4	28.93831	0.00521	-2.989719	-2.545221	-3.154288
5	365.26336	0.00000	-58.877227*	-58.392320*	-59.056756*

Notes: * indicates lag order selected by the standard

AIC = Akaike criterion,BIC = Schwarz Bayesian criterion and HQC = Hannan-Quinn measure.

4.5.3 Johansen Test for Cointegration

This study has used a model to examine long run relationships between macro variables and the stock market. For this purpose cointegration analysis is considered to be an ideal tool. So it uses the Johansen (1991) procedure. For the VECM this study first determine the order of integration of the variables.

Table 6: Johansen Test for Cointegration

Rank	Eigenvalue	Trace Test	P-Value	λmax Test	P-Value
0	0.96582	171.33	0.0000	54.019	0.0038
1	0.90280	117.32	0.0006	37.295	0.0985
2	0.86080	80.020	0.0053	31.550	0.0908
3	0.74659	48.470	0.0420	21.964	0.2292
4	0.59115	26.506	0.1172	14.310	0.3537
5	0.40959	12.196	0.1490	8.4309	0.3444
7	0.20968	3.7651	0.0523	3.7651	0.0523

Notes: This table displays the time series cointegration tests using the Johansen's method for the sample period Mid-July 1994 to Mid-July 2015 Significant at the 5-percent level.

The two Johansen tests for cointegration namely Eigenvalue Test and Trace statistics, have been used to establish the rank of β. In other words, how many cointegration vectors the system has can be ascertained by the Johansen tests for cointegration.

The above table shows that the trace and λmax tests reject the null hypothesis that the smallest eigenvalue is not 0, thus it concludes that the series are in fact stationary. However, the study considered only the cointegrating vector represented by largest eigenvalue (stock prices). The cointegrating vector

normalized on the stock prices (with the largest eigenvalue) is given by β1= (1.000, 121.71, -25.208, -1.8152, -15.835, 1.4989, and -36.529).

These cointegrating vectors represent the long-run equilibrium relationship among the variables and values are the coefficients of LNEPSE (normalized to one), LGDP, LEXR, LFDI, LM1, LTBR and LCPI a linear trend, and are long term elasticity measures due to logarithmic transformation. The above vector can be explained as:

LNEPSE = -121.71LGDP + 25.208LEXR + 1.8152LFDI + 15.835LM1 - 1.4989LTBR+ 36.529LCPI

(4.7183)*** (-1.4119) (1.0025) (0.4963) (1.7685)* (1.3073) (0.3466)

*Significant at the 5-percent level,

***Significant at the 10-percent level

The above estimated cointegration relationship of equation shows that real economic activity has insignificant and negative relationship with the stock prices. It is inconsistent to the results provided by Fama (1981); Chen, Ross and Roll (1986), Kaul (1987); Lee (1992); Ratnapakorn and Sharma (1997) in the US, by Mukherjee and Naka (1995) in Japan, by Naka, Mukherjee and Tufte, (1999) in India and by Joshi (2008) in Nepal. So, there is no direct relationship between them.

The result of this study also implies that a positive and insignificant relationship between exchange rate and the Nepalese stock market. This is consistent to findings of Mukherjee and Naka (1995) for Japan; Maysami, Howe, and Hamzah (2004) for Singapore; Phylaktis and Ravazzolo (2005) for Pacific Basin countries (Hong Kong, Malaysia, Singapore, Thailand and the Philippines); Ratnapakorn and Sharma (2007) for US and Joshi (2008) for Nepal.

Similarly, foreign direct investment and stock returns have a positive and insignificant relationship means if FDI increases then it leads to industrial growth and thereby increases stock prices. Tarzi (2005) investigates the flow of both foreign portfolio equity investments (FPEI) and foreign direct investment (FDI) to rising markets. Between 1986 and 1995 stock market capitalization in emerging countries grew ten-fold from $171 billion to 1.9 trillion and market share held in capitalization increased from 4 percent to 11 percent, mostly to the nine major up-and-coming markets together with Brazil, India, and Hong Kong (now a province of China).

There is evidence that stock prices are positively and significantly related to money supply. This finding is similar to positive relationship examined by Shrestha and Subedi (2014) for Nepal; Mukherjee and Naka (1995) for Japan; Naka, Mukherjee and Tufte (1999) for India; Mayasami, Howe and Hamzah

(2004) for Singapore, Ratnapakorn and Sharma (2007) for US. This finding implies that monetary policy in Nepal has positive impact on stock prices, since central bank in Nepal uses the credit control (Control money supply) as an intermediate targets in monetary policy framework. The positive relationship may be because increase in money supply increases cash in hand and growth, ultimately earnings and dividends and thereby increasing stock prices.

Interest rate has negative and insignificant relationship with stock prices. The negative relationship is similar to our hypothesis and is consistent with the present value model. This is however consistent to the findings of Shrestha and Subedi (2014) for Nepal; Mukherjee and Naka (1995) for Japan and Ratnapakorn and Sharma (2007) for USA who argue that short term interest rate are positively related to stock prices (at Short-Term Analysis and Granger Causality). One of the reasons may be increasing in interest rate decreases the lending rate. With the high interest rate spread individuals will expect decrease investment in future, which ultimately decreases profit of banking and financial institution which has predominance in the Nepalese stock market thus decreasing the stock price.

Finally inflation (CPI) has insignificant influence over the stock prices in the cointegrating vector against the hypothesis of relationship. Humpe and Macmillan (2007) also find similar result for Japan and Joshi (2008) in Nepal. However, this result is consistent to Fisher's model which expect a positive relationship and the empirical findings in Chen, Ross and Roll (1986); Lee (1992), Canada (Darrat, 1990), Japan (Mukherjee and Naka, 1995), India (Naka, Mukherjee and Tufte, 1999). One reason for such existence may be because Nepalese inflation is driven by Indian inflation rather those other domestic factors such as real economic activity or money supply in the long run.

4.5.4 Short-Term Analysis and Granger Causality

As the Granger explaination, when given variables are cointegrated, then error correction model (ECM) help to explain the short-run dynamics or adjustments of the cointegrated variables towards their equilibrium values along with one-period lagged cointegrating equation and the lagged first differences of the endogenous variables. This also provides the causal relationship among the stock prices and the macroeconomic variables which can be determined by estimating VEC model of equation. Equation presented as below explains the empirical estimates from the VEC model for stock price equation only.

$$\Delta LNEPSEt = 0.289122 - 1.78982\ \Delta LGDPt\text{-}i + 1.18777\Delta LEXRt\text{-}i + 0.0134174\ \Delta LFDIt\text{-}i -$$

(t-ratio) (0.8674) (-0.3141) (0.7808) (0.09331)

$$0.496141\Delta LM1t\text{-}i + 0.267571\Delta LTBRt\text{-}I - 1.91727\Delta LCPIt\text{-}I$$

(-0.2407) (1.127) (-0.4843)

The VEC estimates show that one-period lagged error correction term is statistically significant at 5 percent level but positive. The constant term is 0.289122 which suggests a slow speed of adjustment back to the long run equilibrium. Moreover, this indicates that about 28 percent of disequilibrium exerted by a short run shock is corrected each year following the shock. At this rate, it takes around three years to come back to the long run equilibrium. The estimates suggest that there is no significant effect of macroeconomic variables to the Nepalese stock prices. The estimates also suggest that immediate past changes in inflation, money supply and gross domestic activity negatively affect stock returns while exchange rate, foreign direct investment and interest rate have positive impact on stock returns.

V. CONCLUSION

This study examines the interaction of share returns and the macroeconomic variables as a subject of interest among academics, investor and practitioners. It is found that stock prices are determined by some fundamental macroeconomic variables such as the interest rate, the exchange rate and the money supply. Similarly, the financial pressure indicates that the investors generally believe that monetary policy and the macroeconomic events have a large influence on the volatility of the stock price. This implies that macroeconomic variables can influence investors' investment decision and motivates as a previous study of the relationships between share returns and macroeconomic variables of many researchers. Similarly, there is no data significant except money supply in the long run analysis while no significant in the short run analysis. But overall, the presence of cointegration and causality suggests that Nepalese stock market is not efficient in both the short run and the long run. It causes that, it is driven by economic fundamentals and hence publicly available information on macroeconomic variables can be potentially used in predicting stock prices.

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