

Mitra Lal Devkota^{ORCID} and *Humnath Panta*^{ORCID}*

An Inquiry into the Effect of the Interest Rate, Gold Price, and the Exchange Rate on Stock Exchange Index: Evidence from Nepal

A b s t r a c t. This study examines the causal relationship between the Nepalese Stock Exchange (NEPSE) Index, the interest rate, gold price, and the USD exchange rate in Nepal. The monthly time series data from January 2006 to June 2018 are used. Time series properties of the data are diagnosed using the Ng-Perron unit root test and Johansen's cointegration test. Finally, the Granger causality test based on the Vector Error Correction Model (VECM) is used to find the direction of causation, and to model the short and long-run relationships between the variables. The findings suggest that there exists a feedback relationship between the NEPSE Index and the interest rate, and there exists a unidirectional causation from the gold price to both the exchange rate and the interest rate. There is also a unidirectional causation from the exchange rate to the NEPSE Index during the sample period. These findings have implications for government agencies, investors, researchers, stakeholders, and others interested in the topic.

K e y w o r d s: Causality; Cointegration; Exchange Rate; Gold Price; Interest Rate; NEPSE Index

J E L Classification: C22; E00; E44

Introduction

The relationship between the stock exchange index and macroeconomic variables including the gold price has received considerable attention in the

*Correspondence to: Mitra Lal Devkota, University of North Georgia, Department of Management and Marketing, Mike Cottrell College of Business, 82 College Circle, Dahlonega, GA 30597, United States, e-mail: mldevkota@ung.edu; Humnath Panta, Brenau University, College of Business and Communication, 500 Washington Street SE, Gainesville, GA 30501, United States, e-mail: hpanta@brenau.edu.

literature (Fama, 1981; Gunes, 2007; Pilinkus and Boguslauskas, 2009). Different researchers have used different set of variables in their studies. For example, Smyth and Nandha (2003) and Nieh and Lee (2001), among others, have studied the relationship between stock prices and exchange rates, whereas other researchers have used several macroeconomic variables in their study (Tursoy, Gonsel and Rjoub, 2008). The selection of variables, however, depends on the nature and structure of the economy as well as the size and significance of the stock market in the economy.

Empirical studies reveal that with financial deregulation, the stock market of a country has become more sensitive to both domestic and external factors (Mishra, Das, and Mishra, 2010). Several studies have examined the impact of macroeconomic variables on stock prices for developed as well as for developing countries. Alam and Uddhin (2009) document that stock prices and interest rate are the crucial factors which determine the economic growth of a country. The impact of the interest rate on stock prices provides important implications for monetary policy, risk management practices, financial securities valuation and government policy towards financial markets. Several researchers have investigated the relationship between gold prices and stock exchange indices. According to Sujit and Kumar (2011), gold provides high liquidity, and investment on gold can also be used as a hedge against inflation and currency depreciation. From an economic and financial point of view, movements in the price of gold are both interesting and important, and hence, it is necessary to validate the dynamic relationship of gold price with other variables under study periodically. Likewise, a number of empirical studies have investigated the relationship between stock prices and exchange rates. Likewise, a number of empirical studies have investigated the relationship between stock prices and exchange rates. According to Ratanapakorn and Sharma (2007), "For several reasons, foreign exchange rates should not be ignored when modelling stock prices. First, the money supply is used to stabilize foreign exchange rates. Second, the exchange rate movements may reinforce the link from money to inflation. Third, exchange rates may influence stock prices through interest rate effects. Finally, foreign exchange rates are important for investors deciding whether they should invest in the foreign exchange market or in the stock market." Ratanapakorn and Sharma (2007) are correct that some countries target exchange rates with monetary policy. Other countries target inflation rates with monetary policy, but, even so, monetary policy affects exchange rates, regardless of which target monetary authorities choose. Most of the studies in this area focus either on large economy such as India (Upadhyaya, Nag and Mixon Jr, 2018) or developed economies such as the USA (Ratanapakorn and Sharma, 2007). There is a relative dearth of such

studies in small countries like Nepal. The purpose of this study is to fill this void.

Using Nepalese data, our research work differs from the existing literature in several ways. First, we have used the fairly-recently developed unit root test that has better size and power properties than the widely used Phillips Perron (PP) test and the Augmented Dickey-Fuller (ADF) test. Second, our research uses recent data that covers a longer period of time than the existing literature and includes the exchange rate, the additional variable excluded in most of the existing papers in the context of Nepalese data. We have found that this variable has causal relationship with the gold price and the NEPSE Index. Finally, we examine both short and long-run causal relationships between the NEPSE Index, the interest rate, gold price, and the USD exchange rate.

The rest of the paper is organized as follows. A review of previous empirical studies is carried out in section 1. A detailed description of the data and the variables used in the study are presented in section 2. The econometric methodology used in the study and discussion of the empirical results are presented in section 3. The last section concludes the paper.

1. Literature Review

The study of the causal relationship between stock prices and macroeconomic variables has received considerable attention in the literature. These studies have used different macroeconomic variables and data from both developed and developing countries. In this section, we review a selected number of research articles from a plethora of publications.

Alam and Uddin (2009) examined the relationship between stock prices and interest rates for fifteen developed and developing countries: Australia, Bangladesh, Canada, Chile, Colombia, Germany, Italy, Jamaica, Japan, Malaysia, Mexico, Philippine, South Africa, Spain, and Venezuela based on monthly data from January 1988 to March 2003. For all the countries in their sample, they found a significant negative relationship between interest rate and share price, and for six countries, they found a significant negative relationship between changes of interest rate and changes of share price. So, a considerable control in interest rate would be of a great benefit to these countries' stock exchange through a demand-pull mechanism, by way of more investors in share market, and supply-push mechanism, by way of more investment by companies.

Ratanapakorn and Sharma (2007) studied the long-term and short-term relationships among the US stock price Index (S&P 500) and macroeconomic variables from the first quarter of 1975 to the fourth quarter of 1999. They document that the S&P 500 average and long-term interest rates are negatively correlated while the money supply, industrial production index, inflation rate,

exchange rate, and short-term interest rates are positively correlated. Their causality analysis revealed that every macroeconomic variable considered caused the stock price in the long-run but not in the short-run.

Graham (2001) examined the relationship between the price of gold and stock price for the US over the period from January, 1991 to October, 2001 using four gold prices and six stock price indices. His analysis revealed an evidence of a unidirectional causality from stock price to returns on the gold price set in the London morning fixing and the closing price. However, for the price set in the afternoon fixing, his analysis shows an evidence of feedback relationship between the gold price and the stock price. Levin, Montagnoli and Wright, (2006) presented the short-run and long-run determinants of the price of gold using the theoretical framework of supply and demand. They revealed that total supply of gold is a function of the gold price. They also concluded that fluctuations in the gold price are caused by political stability, financial turmoil, changes in exchange rates and real interest rates. Smith (2001) investigated the short-term and long-term relationships between the gold price and stock exchange price index using daily, weekly and monthly time series data from 1991 to 2001. Four gold prices and six stock exchange indices were included in the study. He found no bilateral long-run relationship, or cointegration, between a gold price series and a stock market index. While there was some evidence of negative short-term Granger causality running from US stock index returns to gold returns, the reverse was not the case. Moore (1990) examined the link between anticipated inflation and gold returns, using a leading index of US inflation from 1970 to 1988 compiled by the Colombia University Business School. He found that gold price is negatively correlated with stock/bond markets. He further added that gold was an alternative investment tool for Turkish investors. This result is consistent with the finding of Buyuksalvarci (2010), who analyzed the effects of seven macroeconomic variables (the consumer price index, money market interest rate, gold price, industrial production index, oil price, foreign exchange rate, and money supply) on the Turkish Stock Exchange Market.

Tsoukalas (2003) studied the relationship between stock prices and the macroeconomic variables in Cyprus. The results of the study found a strong relationship between stock prices and exchange rates. This is because the Cypriot economy depends on services (import sector) such as tourism, off shore banking, etc. Vygodina (2006) examined the relationship between exchange rates and stock prices nexus for large cap and small cap stocks for the period from 1987 to 2005 in the USA. He found that large cap stocks Granger cause exchange rates. However, there was no causality for small cap stocks. Stock prices and exchange rates were affected by the same macroeconomic variables and changes in federal monetary policy in the USA had a significant effect on

the nature of these relationships. Smyth and Nandha (2003) examined the relationship between exchange rates and stock prices in Bangladesh, India, Pakistan and Sri Lanka using daily data over a six-year period from 1995 to 2001. They found that there is no long-run equilibrium relationship between the financial variables in any of the four countries. Also, the empirical results revealed unidirectional causality running from exchange rates to stock prices for only India and Sri Lanka, but no evidence of any causality was found between exchange rates and stock prices in Bangladesh and Pakistan. Nieh and Lee (2001) studied the relationship between stock prices and exchange rates for G-7 countries taking the daily closing stock market indices and foreign exchange rates for the period from October 1, 1993 to February 15, 1996. They found that there is no long-run equilibrium relationship between stock prices and exchange rates for each of G-7 countries. They did find a significant relationship between stock prices and exchange rates for a single day in some G-7 countries but found no significant correlation in the United States. These results might be explained by the difference between the countries' economic development stages, government policies, expectation patterns, etc.

Wongbampo and Sharma (2002) employed a VECM model to investigate the relationship between stock prices and five macroeconomic variables such as GNP, inflation, money supply, interest rate, and exchange rate in five Asian countries, namely, Malaysia, Indonesia, Philippines, Singapore and Thailand. They used monthly data for the period from 1985 to 1996, and found that, there exists both a short-term and long-term relationship between the stock prices and the macroeconomic variables. They also found a feedback relationship between the stock prices and the macroeconomic variables in all the countries in their study. Similarly, Mukherjee and Naka (1995) also employed a VECM model to examine the relationship between stock market returns and a set of six macroeconomic variables such as exchange rate, inflation, money supply, industrial production index, the long-term government bond rate, and call money rate in Japan. Their analysis suggests that there exists a long-run equilibrium relationship between the stock prices and the macroeconomic variables in Japan. On the other hand, Srinivasan (2014) used the Autoregressive Distributed Lag (ARDL) bounds testing approach and the Granger causality test on monthly time series data from June 1990 to April 2014 to investigate the causal nexus between the gold price, stock price, and the exchange rate in India. The results revealed that the gold price and stock price tend to have a long-run relationship with the exchange rate in India. However, there was no evidence of a stable long-run or short-run causal relationship between the stock price and gold price in India.

In the Nepalese context, the study of Gaire (2016) is the only one in the area of our interest. He examined cointegration and causality between NEPSE

Index with regard to short-term interest rates and gold prices in Nepal. He analyzed monthly time series data from January 2006 to December 2016. He found that there is a long-run equilibrium relationship between the NEPSE index, short-term interest rate, and gold price in Nepal. He further added that the short-term interest rate could be one of the predictors of stock prices in the secondary market of Nepal. Although a pioneering study in the Nepalese context, his research suffers from some weaknesses in the adopted methodologies. For instance, he used the augmented Dickey Fuller (ADF) test which is known to have low power and size properties. In addition, the ADF test is known to have a severe size distortion (in the direction of over-rejecting the null when it is true) when the series has a large negative moving average root. Moreover, our research uses more recent data that covers a longer period of time and includes the exchange rate. We have found that the exchange rate, the variable excluded in his paper, has a causal relationship with the gold price and the NEPSE Index.

2. Data

This study is based on secondary data for the period between January, 2006 to August, 2018. These are obtained from various sources including Nepal Rastra Bank (NRB), the central bank of Nepal, Nepalese Stock Exchange (NEPSE) Limited, and Nepal Gold and Silver Dealers' Association (NEGOSIDA). It consists of monthly time series data with the variables NEPSE Index, interest rate, gold price, and exchange rate (USD exchange rate expressed as the amount of Nepalese rupees per unit of USD). Statistical software packages R and EViews are used for arranging the data and conducting econometric analysis.

NEPSE Index: The transaction index published at the end of the day by the Nepal Stock Exchange. The NEPSE Index data are collected from various reports of Nepal Stock Exchange Ltd and Current Macroeconomic and Financial Situation dataset from the NRB. The NEPSE Index on the last day of the month is considered for the analysis.

Interest Rate: The Interest Rate, also known as Interbank Rate, is the rate of interest for short-term lending/borrowing among commercial banks. The monthly average interest rate data are obtained from the quarterly economic bulletin of NRB.

Gold Price: End of month's gold prices per 10-gram data are obtained from the website of Nepal Gold and Silver Dealers' Association (NEGOSIDA).

Exchange Rate: The exchange rate is monthly average rate of exchange between US dollars (USD) and Nepalese Rupees (NPR). The exchange rates

data are obtained from the NRB website and are computed by taking the average of the buying rates and selling rates.

These were the only variables with sufficient monthly data available to the authors for the time period under study. For example, even though we wanted to include variables such as industrial production index and consumer price index, the unavailability of the data on a monthly basis prevented us from including them into our analyses.

3. Methodology and Empirical Results

3.1 Test of Correlation and Multicollinearity

The correlation coefficients between the variables are summarized in Table 1. The figures indicate that the NEPSE Index has a negative correlation with the interest rate, but positive correlation with the gold price and the exchange rate. We also observe that there is a very strong correlation between the exchange rate and the gold price. This suggests that multicollinearity might be an issue in the time series data.

Table 1. Correlation Matrix

	NI	IR	GP	ER
NI	1			
IR	-0.15	1		
GP	0.22	-0.36	1	
ER	0.57	-0.53	0.79	1

Note: NI, GP, ER, and IR stand for NEPSE Index, gold price, exchange rate, and interest rate, respectively.

Wooldridge (2011) states that multicollinearity is likely to exist if the *t*-statistics corresponding to the parameter estimates of independent variables in an ordinary least square (OLS) regression model are not statistically significant, whereas the overall *F* statistic is statistically significant. Wooldridge (2011) further adds that multicollinearity is a serious problem if the VIF is greater than 10. In this regard, an OLS regression model is fitted using NEPSE Index as the dependent variable and the interest rate, gold price, and exchange rate as independent variables and the results are reported in Table 2. Furthermore, the variance inflation factors (VIF) for the coefficients of each variable are estimated and the results are reported in Table 3. The OLS results indicate that all the parameters as well as the overall *F* statistic of the regression model are statistically significant at 5% level of significance.

Table 2. Results from ordinary least squares regression model

	Estimate	Standard Error	<i>t</i> -ratio	Pr (> <i>t</i>)
Intercept	-0.675	0.400	- 1.687	0.094
IR	0.115	0.030	3.914	0.000*
GP	-0.789	0.116	-6.826	0.000*
ER	3.642	0.310	11.764	0.000*

Residual standard error: 0.1586 on 146 degrees of freedom
Multiple R-squared: 0.5153, Adjusted R-squared: 0.5053
F-statistic: 51.74 on 3 and 146 DF, p-value: <2.2e-16

Note: * – statistical significance at 5% level of significance.

In addition, the VIF results in Table 3 suggest that the VIFs for all the variables are smaller than 10. These results suggest that multicollinearity is not an issue in the time series data.

Table 3. Variance Inflation Factor

Interest Rate	Gold Price	Exchange Rate
1.4133	2.6958	3.2663

For the econometric analyses of the time series data, the Ng-Perron Test (Ng and Perron, 2001) is used to test the stationarity both at the levels and the first differences. Then the Johansen cointegration method is used to investigate the long-term relationship among the variables and to determine the number of cointegrating vectors. The Granger causality test based on the Vector Error Correction Model (VECM) is used to find the direction of causation and to model the short and long-run relationships between the variables.

3.2 Unit Root Test for Testing Stationarity (Ng-Perron Test)

According to Ng-Perron (2001), the widely used ADF test suffers from low power, especially when the moving-average polynomial of the first differenced series has a large negative root. The ADF test seems to over-reject the null hypothesis when it is true and fails to reject the null hypothesis when it is false. To overcome this issue, they proposed a new test known as the Ng-Perron Test. Compared to the ADF and PP unit root tests, this test possesses better power and size properties, so its results are more reliable when applied to small data sets (Harris and Sollis, 2003). The Ng-Perron test has the null hypothesis of non-stationarity of the time series. There are four test statistics, (MZ_{α} , MZ_t , MSB, MPT) associated with this test. The first two test statistics (MZ_{α} , MZ_t) are efficient versions of the Z_{α} and Z_t test statistics, and are usually reported more often for interpretation of empirical results (Gregorioui, Kontonikas and Montagnoli, 2006; Cuestas and Harrison, 2008; Cuestas and Staehr, 2013; Raihan et al., 2017). These statistics are given by:

$$MZ_{\alpha} = \frac{T^{-1}(y_T)^2 - f_0}{2k} \tag{1}$$

$$MZ_t = MZ_{\alpha}MSB \tag{2}$$

where $k = \sum_{t=2}^T \left(\frac{y_{t-1}}{T}\right)^2$, $MSB = \left(\frac{k}{f_0}\right)^{1/2}$, f_0 is the spectral density at frequency zero, and y_T is the generalized least squares (GLS) de-trended value of the variable. These statistics are based on a specification for x_t and a method for estimating f_0 . The test uses a GLS detrended series to improve the power properties and uses modified lag selection criteria to address the size distortion.

We use the Ng-Perron test to test the stationarity of the variables in logarithmic scales at levels, and their first differences. We considered intercept as well as intercept and trend while testing at levels and their first differences. This analysis is performed using EViews 10. As reported in Table 4 and Table 5, each series is non-stationary at levels, and then stationary at the first differences, suggesting that all the variables are individually integrated of order 1, that is $I(1)$. After establishing the stationarity of the time series data, we proceed to conduct the test for cointegration.

3.3. The Johansen Test for Cointegration

To further investigate the long-term relationships, the Johansen (1988, 1991, 1992) and Johansen and Juselius (1990) maximum likelihood cointegration technique is used. This technique also determines for the number of cointegrating vectors and is based on Granger’s (1981) ECM representation. The multivariate cointegration test can be expressed as follows:

$$y_t = K_0 + K_1\Delta y_{t-1} + K_2\Delta y_{t-2} + \dots + K_{p-1}\Delta y_{t-p} + \Pi y_{t-p} + \epsilon_t \tag{3}$$

where:

$y_t = (\text{NEPSE Index, Interest Rate, Gold Price, Exchange Rate})'$ and are cointegrated of order one [i. e., $I(1)$],

$K =$ a 4×4 matrix of coefficients,

$\Delta =$ a difference operator,

$\Pi =$ a 4×4 matrix of parameters, and

$\epsilon_t =$ a vector of normally and identically distributed error terms.

Table 4. Ng-Perron Test Results-Levels

Variable	Intercept		Intercept and Trend	
	MZ_{α}	MZ_{T}	MZ_{α}	MZ_{T}
NI	-0.176	-0.127	-2.529	-1.124
GP	-0.682	-0.763	-4.453	-1.414
IR	-1.929	-0.307	-9.971	-2.131
ER	-0.329	-0.021	-9.146	-0.214
Critical value	-8.100	-1.980	-17.3	-2.910

Note: Critical values are for 5% level of significance; NI, GP, ER, and IR stand for NEPSE Index, gold price, exchange rate, and interest rate, respectively.

Table 5. Ng-Perron Test Results-First Differences

Variable	Intercept		Intercept and Trend	
	MZ_{α}	MZ_{T}	MZ_{α}	MZ_{T}
NI	-21.170*	-3.163*	-37.446*	-4.321*
GP	-73.886*	-6.078*	-72.906*	-6.036*
IR	-9.574*	-2.16*	-73.185*	-6.048*
ER	-65.761*	-5.733*	-67.054*	-5.790*
Critical value	-21.170*	-3.163*	-37.446*	-4.321*

Note: * – statistical significance at 5% level of significance; NI, GP, ER, and IR stand for NEPSE Index, gold price, exchange rate, and interest rate, respectively.

The presence of r cointegrating vectors between the elements of y implies that Π is of rank r ($0 < r < 4$).

To determine the number of cointegrating vectors, there are two likelihood ratio tests available. These are trace test (λ -trace) and maximum eigenvalue test (λ -max). We conducted the Johansen cointegration test with all the variables in their logarithmic scales and used both the λ -trace and λ -max statistics options in Eviews. For both the directions, 3 lags were used which is consistent with Bhattacharjee, et al., (2014). The results for both the λ -trace and λ -max statistics are summarized in Table 6. We see that the λ -trace statistic identified one cointegrating relationship among the NEPSE Index and the three macroeconomic variables, while the λ -max statistic identified no cointegrating relationship among the variables at $\alpha = 0.05$ level of significance. Since the trace statistic takes into account all of the smallest eigenvalues, it possesses more power than the maximum eigenvalue statistic (Kasa, 1992; Serletis and King, 1997). Furthermore, according to Cheung and Lai (1993), the λ -trace statistic is more robust than the λ -max statistic, and hence, we conclude that there is at least one cointegrating relationship between NEPSE Index, the interest rate, gold price, and the USD exchange rate in Nepal. In other words, there exists a long run equilibrium relationship between the variables. Furthermore, Bruesch-Godfrey Serial correlation LM Test results in a chi-square test statistic of 3.741 with a p-value of 0.154. This suggests that the

null hypothesis of no serial correlation is not rejected at 5% level of significance, and thus, the adequacy of the model is confirmed.

Table 6. Johansen Cointegration Test Results (Trace and max. eigenvalue)

Null Hypotheses	λ_{trace} Stat	5% Critical Value	p-value	λ_{max} Stat	5% Critical Value	p-value
$r = 0$	56.62	47.86	0.006*	27.37	27.58	0.0532
$r \leq 1$	29.25	29.80	0.058	20.43	21.13	0.062
$r \leq 2$	8.81	15.49	0.383	6.97	14.26	0.492
$r \leq 3$	1.84	3.84	0.175	1.84	3.84	0.175

Notes: *: Statistically significant at 5% level of significance; r =hypothesized number of cointegrating equations; the cointegration model is based on the vector autoregression model (VAR) with 3 lags as determined by the likelihood ratio test; the critical values for Trace and Max-Eigen statistics are calculated by EViews (10).

3.4 Granger Causality and Vector Error Correction Model (VECM)

The results from the Johansen test for cointegration indicate that causality exists between the cointegrated variables. The Granger causality test (1987) is a statistical procedure used to determine if one time series is helpful in forecasting another. According to Engle and Granger (1987), if two variables x_t and y_t are cointegrated, there exists an error correction model given by

$$\Delta x_t = \gamma_1 + \theta_1 ECT_{t-1} + \sum_{i=1}^m \delta_1 \Delta x_{t-i} + \sum_{i=1}^n \tau_1 \Delta y_{t-i} + \epsilon_{1t} \quad (4)$$

$$\Delta y_t = \gamma_2 + \theta_2 ECT_{t-1} + \sum_{i=1}^m \delta_2 \Delta y_{t-i} + \sum_{i=1}^n \tau_2 \Delta x_{t-i} + \epsilon_{2t} \quad (5)$$

where Δ is the difference operator, m and n are the lag lengths of the variables, ECT refers to the error correction term(s) derived from the long-run cointegration relationship via Johansen maximum likelihood procedure, γ , θ , δ , τ are the parameters to be estimated, and ϵ_{1t} and ϵ_{2t} are the white opens up an additional channel for Granger causality to emerge that is completely ignored by the standard Granger and Sims tests. The Granger causality can be tested by examining the statistical significance of the lagged ECTs using a t-test or by a joined test applied to significance of the sum of the lags of each explanatory variable by an F-or Wald χ^2 test¹.

The Johansen test of cointegration in section 3.3 shows that there is cointegration between the NEPSE Index, the interest rate, gold price, and the USD

¹ We tested the long-run causality through the statistical significance of each error correction term by an individual T-test, and the short-run Granger causality through the joint significance of the lags of each explanatory variable by a Wald χ^2 test. A variable X is said to Granger cause a variable Y, if addition of lagged values of X in the regression model describing Y can improve quality of the model and/or forecasts (see, Syczewska, 2014; Osinska, 2011).

exchange rate. We now proceed to fit the VECM model to test the existence of short and long-run causal relationships. VECM includes lags of the dependent variables, in addition to its own lags (Upadhyaya, Nag and Franklin Jr, 2018). In addition to indicating the direction of causality amongst the variables, the VECM allows us to distinguish between short-run and long-run Granger causality because it can capture both the short-run dynamics between time series and their long-run equilibrium relationship (Mashi and Mashi, 1996)².

Table 7. The Long-run and Short-run Granger Causality

Null Hypotheses	ECT (t -stat)	χ^2 -stat	Nature of causality	Direction of causality
GP \Rightarrow NI	-0.420	0.522	None	None
NI \Rightarrow GP	0.923	1.826	None	
GP \Rightarrow ER	2.666**	3.704**	Short and long-run	Unidirectional
ER \Rightarrow GP	-0.800	0.041	None	
GP \Rightarrow IR	-2.844**	0.434	Long-run	Unidirectional
IR \Rightarrow GP	0.713	0.030	None	
ER \Rightarrow IR	0.076	0.408	None	None
IR \Rightarrow ER	-0.484	0.333	None	
NI \Rightarrow IR	0.040	2.980**	Short-run	Feedback
IR \Rightarrow NI	-1.787*	0.128	Long-run	
ER \Rightarrow NI	1.969*	3.420**	Short and long-run	Unidirectional
NI \Rightarrow ER	-0.219	0.360	None	

Notes: H_0 : $X \Rightarrow Y$ represents the null hypothesis that X does not granger cause Y; ** – statistically significant at 1% level of significance, * – statistically significant at 10% level of significance; NI, GP, ER, and IR stand for NEPSE Index, gold price, exchange rate, and interest rate, respectively.

The short and long-run causality results from Table (7) indicate that there are two short and long-run causal relationships between the NEPSE Index, the interest rate, gold price, and the exchange rate. These causal relationships run from the gold price to the exchange rate, and from the exchange rate to the NEPSE Index. In addition, there are two long-run causal relationships between the variables. These causalities run from the gold price to the interest rate, and from the interest rate to the NEPSE Index. There is only one short-run causal relationship. This runs from the NEPSE Index to the Interest rate. There is one feedback relationship between the NEPSE Index and the interest rate. Thus, we can conclude that, for our dataset, there is unidirectional causality running from the gold price to the exchange rate and the interest rate,

² Number of lags of the VECM estimation was selected using the likelihood ratio test.

and from the exchange rate to the NEPSE Index³. It means that the gold price Granger causes both the exchange rate and the interest rate, and finally, both the interest rate and the exchange rate Granger cause the NEPSE Index. No causality exists between the rest of the pairs.

Summary, Conclusions and Discussion

The present study investigated the causal relationships between the NEPSE Index, the interest rate, gold price, and the USD exchange rate in Nepal. The analysis used the monthly data for the period between January, 2006 to August, 2018 which are obtained from various sources including Nepal Rastra Bank (NRB), the central bank of Nepal, Nepalese Stock Exchange Limited, and Nepal Gold and Silver Dealers' Association (NEGOSIDA). The NEPSE Index is used to represent the Nepalese stock market index. It is believed that, the selected variables, among others, represent the state of the economy of Nepal.

We used the Ng-Perron unit root test to check the stationarity of the variables. This test possesses better power and size properties, due to which the results are more reliable when applied to small data sets. Our results indicate that each series is non-stationary at levels, and then stationary in the first differences. To further investigate the long-run relationship among the variables, we used the Johansen cointegration test to determine the number of cointegrating vectors. We conducted this test with all the variables in their logarithmic scales and used both the λ -trace and λ -max statistics options. We find that there is only one cointegrating relationship between the variables. In other words, there exists a long run equilibrium relationship between the variables.

We then employed Granger causality test based on VECM framework to determine the existence of both short and long-run causal relationships between the variables. Our results indicate that there are two short and long-run causal relationships which run from the gold price to the exchange rate, and from the exchange rate to the NEPSE Index. In addition, there are two long-run causal relationships which run from the gold price to the interest rate, and from the interest rate to the NEPSE Index. There is only one short-run causal relationship which runs from the NEPSE Index to the Interest rate. Also, there is a feedback relationship between the NEPSE Index and the interest rate. Thus, for our dataset, there is a unidirectional causality running from the gold

³ If the null hypothesis that x does not cause y is rejected, but y does not cause x is not rejected, it is called a unidirectional causation. However, if both tests are rejected, then a feedback or a bidirectional relationship is established between x and y . If both tests fail to reject the null hypothesis, then a contemporaneous relationship is established.

price to the exchange rate and a unidirectional causality running from the gold price to the interest rate, and from the exchange rate to the NEPSE Index. It means that the gold price Granger causes both the exchange rate and the interest rate, and finally, both the interest rate and the exchange rate Granger cause the NEPSE Index. No causality exists between the rest of the pairs.

Our finding is in line with Smyth and Nandha (2003) who concluded that the exchange rate Granger causes stock price in India and Sri Lanka, and with Abdalla and Murinde (1997) who found that the exchange rate Granger causes stock market prices in Pakistan. Similarly, our finding of no causality (in either direction) between the gold price and the NEPSE Index is consistent with the finding of Mishra et al., (2010) and of Gaire (2016). Thus, while our finding is consistent with that of most previous studies, it is contrary to the result of Gaire (2016) with respect to causality from the gold price to the interest rate, as he concluded that there is no causality from the gold price to the interest rate. In addition, he found a unidirectional causality from the interest rate to the NEPSE Index, which is also contrary to our finding of a feedback relationship between the two variables. In addition to his research, we included an additional macroeconomic variable-exchange rate, and concluded that there exists a unidirectional causality from the gold price to the exchange rate, and from to the exchange rate to the NEPSE Index.

As the study pertains to Nepal, where capital account transactions are not open, our results are more relevant in countries where capital account transactions are not open. In addition, inflation and economic growth, the other fundamental macroeconomic variables, are not directly included in the study, except as they interact with our chosen variables. For future studies, we suggest including these variables to understand their effect and direction of causality with the ones included in this paper. According to Ratanapakorn and Sharma (2007), one should have at least 30 years of data to use cointegration analysis. Clearly, our data does not cover a long enough time period for the analysis of cointegration. Similar to those authors, our objective is to investigate a shorter time period, and hence, the results should be viewed with caution.

However, even considering these limitations, our results have important policy implications. The present study has concluded that the interest rate and the USD exchange rate could be the important determinants of the Nepalese stock exchange index. As such, understanding the stock market reaction to these variables over time should provide insight to practitioners, researchers, government agencies, and others interested in the topic.

References

- Abdalla, I. S., Murinde, V. (1997), Exchange Rate and Stock Price Interactions in Emerging Financial Markets: Evidence on India, Korea, Pakistan and the Philippines, *Applied Financial Economics*, 7(1), 25–35, DOI: <http://dx.doi.org/10.1080/096031097333826>.
- Alam, M., Uddin, G. (2009), Relationship Between Interest Rate and Stock Price: Empirical Evidence from Developed and Developing Countries, DOI: <http://dx.doi.org/10.5539/ijbm.v4n3p43>.
- Bhattacharjee, K., Bang, N. P., Mamidanna, S. (2014), Transmission of Pricing Information Between Level III ADRs and Their Underlying Domestic Stocks: Empirical Evidence from India. *Journal of Multinational Financial Management*, 24, 43–59, DOI: <http://dx.doi.org/10.1016/j.mulfin.2013.12.001>.
- Buyuksalvarci, A. (2010), The Effects of Macroeconomics Variables on Stock Returns: Evidence from Turkey, *European Journal of Social Sciences*, 14(3), 404–416.
- Cheung, Y. W., Lai, K. S. (1993), Finite-Sample Sizes of Johansen's Likelihood Ratio Tests for Cointegration, *Oxford Bulletin of Economics and Statistics*, 55(3), 313–328, DOI: <http://dx.doi.org/10.1111/j.1468-0084.1993.mp55003003.x>.
- Cuestas, J. C., Harrison, B. (2008) Testing for Stationarity of Inflation in Central and Eastern European Countries (No. 2008/13).
- Cuestas, J. C., Staehr, K. (2013), Fiscal Shocks and Budget Balance Persistence in the EU Countries from Central and Eastern Europe, *Applied Economics*, 45(22), 3211–3219, DOI: <http://dx.doi.org/10.1080/00036846.2012.703316>.
- Engle, R. F., Granger, C. W. (1987), Co-integration and Error Correction: Representation, Estimation, and Testing, *Econometrica: Journal of the Econometric Society*, 251–276, DOI: <http://dx.doi.org/10.2307/1913236>, <https://www.jstor.org/stable/1913236>.
- Fama, E. F. (1981), Stock Returns, Real Activity, Inflation and Money, *American Economic Review*, 71, 545–565, DOI: <https://www.jstor.org/stable/1806180>.
- Gaire, H. (2016), Stock Index, Interest Rate and Gold Price of Nepal: Cointegration and Causality Analysis, Retrieved From <https://nrb.org.np/ecorev/articles/2.NEPSEIndex20180206.pdf>.
- Granger, C. W. (1981), Some Properties of Time Series Data and Their Use in Econometric Model Specification. *Journal of Econometrics*, 16(1), 121–130, DOI: [http://dx.doi.org/10.1016/0304-4076\(81\)90079-8](http://dx.doi.org/10.1016/0304-4076(81)90079-8).
- Gregoriou, A., Kontonikas, A., Montagnoli, A. (2006), Euro Area Inflation Differentials: Unit Roots, Structural Breaks and Nonlinear Adjustment, *University of Glasgow, Department of Economics, Working Paper*, (2007_13).
- Gunes, S. (2007), Functional Income Distribution in Turkey: A Cointegration and VECM Analysis, *Journal of Economic and Social Research*, 9(2), 23–36.
- Harris, R., Sollis, R. (2003), *Applied Time Series Modelling and Forecasting*, Wiley.
- Johansen, S. (1988), Statistical Analysis of Cointegration Vectors, *Journal of Economic Dynamics and Control*, 12, 231–254, DOI: [http://dx.doi.org/10.1016/0165-1889\(88\)90041-3](http://dx.doi.org/10.1016/0165-1889(88)90041-3).
- Johansen, S. (1991), Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models, *Econometrica*, 59, 1551–1580, DOI: <https://www.jstor.org/stable/2938278>.
- Johansen, S. (1992), Determination of Cointegration Rank in the Presence of a Linear Trend. *Oxford Bulletin of Economics and Statistics*, 54(3), 383–397, DOI: <http://dx.doi.org/10.1111/j.1468-0084.1992.tb00008.x>.

- Johansen, S., Juselius, K. (1990), Maximum Likelihood Estimation and Inference on Cointegration—with Applications to the Demand for Money, *Oxford Bulletin of Economics and Statistics*, 52, 169–210, DOI: <http://dx.doi.org/10.1111/j.1468-0084.1990.mp52002003.x>.
- Kasa, K. (1992), Common Stochastic Trends in International Stock Markets, *Journal of Monetary Economics*, 29(1), 95–124, DOI: [http://dx.doi.org/10.1016/0304-3932\(92\)90025-W](http://dx.doi.org/10.1016/0304-3932(92)90025-W).
- Levin, E. J., Montagnoli, A., Wright, R. E. (2006), Short-Run and Long-Run Determinants of the Price of Gold.
- Mishra, P. K., Das, J. R., Mishra, S. K. (2010), Gold Price Volatility and Stock Market Returns in India. *American Journal of Scientific Research*, 9(9), 47–55.
- Moore, G. H. (1990), ANALYSIS: Gold Prices and a Leading Index of Inflation. *Challenge*, 33(4), 52–56, DOI: <http://dx.doi.org/10.1080/05775132.1990.11471444>.
- Mukherjee, T. K., Naka, A. (1995), Dynamic Relations between Macroeconomic Variables and the Japanese Stock Market: An Application of a Vector Error Correction Model, *Journal of Financial Research*, 18, 223–237, DOI: <http://dx.doi.org/10.1111/j.1475-6803.1995.tb00563.x>.
- Ng, S., Perron, P. (2001), Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power. *Econometrica*, 69(6), 1519–1554, DOI: <https://www.jstor.org/stable/2692266>.
- Nieh, C. C., Lee, C. F. (2001), Dynamic Relationship Between Stock Prices and Exchange Rates for G-7 Countries, *The Quarterly Review of Economics and Finance*, 41(4), 477–490, DOI: [http://dx.doi.org/10.1016/S1062-9769\(01\)00085-0](http://dx.doi.org/10.1016/S1062-9769(01)00085-0).
- Osińska, M. (2011), On the Interpretation of Causality in Granger Sense, *Dynamic Econometric Models*, 11, 129–140, DOI: <http://dx.doi.org/10.12775/DEM.2011.009>.
- Pilinkus, D., Boguslauskas, V. (2009), The Short-Run Relationship Between Stock Market Prices and Macroeconomic Variables in Lithuania: An Application of the Impulse Response Function. *Engineering Economics*, 65(5).
- Raihan, S., Abdullah, S. M., Barkat, A., Siddiqua, S. (2017), Mean Reversion of the Real Exchange Rate and the Validity of PPP Hypothesis in the Context of Bangladesh: A Holistic Approach.
- Ratanapakorn, O., Sharma, S. C. (2007), Dynamic Analysis between the US Stock Returns and the Macroeconomic Variables, *Applied Financial Economics*, 17(5), 369–377, DOI: <http://dx.doi.org/10.1080/09603100600638944>.
- Serletis, A., King, M. (1997), Common Stochastic Trends and Convergence of European Union Stock Markets. *The Manchester School*, 65(1), 44–57, DOI: <http://dx.doi.org/10.1111/1467-9957.00042>.
- Smith, G. (2001), The Price of Gold and Stock Price Indices for the United States, *The World Gold Council*, 8(1), 1–16.
- Smyth, R., Nandha, M. (2003), Bivariate Causality Between Exchange Rates and Stock Prices in South Asia. *Applied Economics Letters*, 10(11), 699–704, DOI: <http://dx.doi.org/10.1080/1350485032000133282>.
- Srinivasan, P. (2014), Gold Price, Stock Price and Exchange Rate Nexus: The Case of India. *Romanian Economic Journal*, 17(52).
- Sujit, K. S., Kumar, B. R. (2011), Study on Dynamic Relationship Among Gold Price, Oil Price, Exchange Rate and Stock Market Returns. *International journal of applied business and economic research*, 9(2), 145–165.
- Syczewska, E. M. (2014), The EURPLN, DAX and WIG20: The Granger Causality Tests Before and During the Crisis, *Dynamic Econometric Models*, 14, 93–104, DOI: <http://dx.doi.org/10.12775/DEM.2014.005>.

- Tsoukalas, D. (2003), Macroeconomic Factors and Stock Prices in the Emerging Cypriot Equity Market, *Managerial Finance*, 29(4), 87–92,
DOI: <http://dx.doi.org/10.1108/03074350310768300>.
- Tursoy, T., Günsel, N., Rjoub, H. (2008). Macroeconomic Factors, the APT and the Istanbul Stock Market. *International Research Journal of Finance and Economics*, 22, 49–57.
- Upadhyaya, K. P., Nag, R., Mixon Jr, F. G. (2018). Stock Market Capitalization and the Macroeconomics of Transition Economies: The Case of India. *Dynamic Econometric Models*, 18, 35–47, DOI: <http://dx.doi.org/10.12775/DEM.2018.002>.
- Vygodina, A. V. (2006), Effects of Size and International Exposure of the US Firms on the Relationship Between Stock Prices and Exchange Rates. *Global Finance Journal*, 17(2), 214–223, DOI: <http://dx.doi.org/10.1016/j.gfj.2006.05.001>.
- Wongbangpo, P., Sharma, S. C. (2002), Stock Market and Macroeconomic Fundamental Dynamic Interaction: ASEAN-5 Countries, *Journal of Asian Economics*, 13, 27–51, DOI: [http://dx.doi.org/10.1016/S1049-0078\(01\)00111-7](http://dx.doi.org/10.1016/S1049-0078(01)00111-7).
- Wooldridge, M. (2011). *Modern Econometrics*. McGraw Hill.