# Monetary Neutrality in the Nepalese Economy during 1975-2008

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**Abstract**

*One of the methods of measuring the effectiveness of monetary policies is via inspection of monetary neutrality in the economy. It is a concept from classical economics and it suggests that changes in nominal variables do not have any impact on real variables. This paper studies the presence or absence of effective monetary policy in Nepal between 1975 and 2008 by observing money supply (nominal side), and real GDP (real). Results suggest that an increase in money supply immediately lowers the real GDP in the short run, but has no effect on real GDP in the long run. This evidence suggests that Nepal Rastra Bank's monetary policies between 1975 and 2008 may have been counter-productive in the short-run, but they were effective for long-run growth and stability of the Nepalese economy.*

## I. INTRODUCTION

Nations, through their central banks, apply monetary policies to achieve a desired level of growth and stability in the economy. Monetary policies control the flow of money supply, the availability of that money, and the rate of interest charged on borrowing or lending money. A monetary policy could, therefore, be either expansionary or contractionary. When an *expansionary* monetary policy is applied, money is infused into the economy, thus increasing the supply of money. On the other hand, a *contractionary* monetary policy results in the decrease of money supply in the economy.

The primary method of increasing or decreasing the money supply in any economy is by changing the interest rates. When the interest rate is lowered, it becomes cheaper to borrow money. Therefore, the supply of money in the economy increases. When the interest rate is raised, it becomes difficult for individuals and businesses to borrow money. Therefore, the supply of money in the economy decreases. The change in money supply via the application of different monetary policies aims to stabilize and grow an economy (Friedman, 2001).

The effectiveness of monetary policies in Nepal depend on factors like the authority's ability to control money supply, stable money demand, circulation of the Indian currency in the Nepalese market, and the development stage of financial markets (Acharya et. al.

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2003). But, these factors are very difficult to maintain control over. Despite legal prohibition, use of Indian currencies in the Nepalese market persists, even today, causing structural problems in the financial system. Also, the government authorities do not have absolute control over the balance of payments, and the government has lacked fiscal discipline at times. These factors, when combined, have resulted in a weaker monetary policy implementation in Nepal.

Like any other nation and its central bank, Nepal and Nepal Rastra Bank, have always had to work with monetary policies. However, extensive studies, on whether the monetary policies have been effective in Nepal, have been lacking. The objective of this paper is to study the effectiveness of monetary policies implemented by the Nepal Rastra Bank between 1975 and 2008. This effectiveness is examined by observing the classical economic concept of monetary neutrality held in Nepal during this period.

The rest of this paper is organized in the following manner: section 2 discusses the brief history of Nepalese monetary policies including pegging of Nepal currency to the Indian rupee; trends on the interest rate; the money supply section is also discusses the concept of monetary neutrality and why it needs to be looked into in the case of Nepal. Section 3 outlines the detailed research methodology employed in this research paper and presents a final economic model for the study. Section 4 shows the robustness check of the final model, and, finally, section 5 offers the conclusion of this research.

## II. EXCHANGE RATE, INTEREST RATE AND MONEY SUPPLY IN NEPAL

### *Pegging the Nepali Rupee to Indian Rupee*

When Nepal signed the Treaty of Peace and Friendship with India in 1950, the treaty resulted in a free flow of labor across the border between these two countries. In addition to this mobility of labor across the border, people were also free to convert Nepalese rupees into Indian rupees without any obstruction, and in an unlimited quantity. Until 1961, the Nepalese used both Indian rupees (IRs) and Nepalese rupees (NRs) within Nepal's border. The exchange rate would float and was determined by private money changers. While the ability to hold both types of currency was a definite plus point for the Nepali population, the frequent swings in the exchange rate due to availability or lack thereof of the Indian currency was causing problems (Acharya et. al. 2003).

When the Nepal Rastra Bank (NRB) was established in 1956, it promoted the use of the NRs within Nepal's borders. This essentially got rid of the dual currency system within Nepal's borders, and also helped the Nepalese government to stabilize the exchange rate between NRs and IRs according to its choice. To help the businesses and the general public, who were still doing businesses and making everyday purchases across the border, the NRB pegged the Nepalese rupee to the Indian rupee at 1.6:1, meaning NRs 1.6 was equal to IRe 1.

Although the Foreign Exchange Regulation Act of 1962 helped initiate the convertible exchange rates with currencies of other countries, the exchange rate between IRs and NRs stands the same today. There have been various attempts to get rid of the pegging system, but the high volume of every day cross-border purchases and trade between India and Nepal has posed a problem. Frequent adjustments between IRs and NRs are not possible given the massive amount of trade and purchases that occur daily. As a result, some modifications in terms of devaluation and revaluation between the IRs and NRs have been done in the past, but frequent exchange rate adjustments have seemed to be impossible to implement. Therefore, the IRs and NRs are still pegged today in the same ratio of 1:1.6.

The pegging of Indian and Nepalese currencies has proved to be very popular, and has contributed to the increasing cross-border trade between Indian and Nepal. However, this pegging system has resulted in some challenges, especially when it comes to monetary management and policies. The mere existence of Indian currencies inside Nepal has proved to be a hindrance while determining the demand of money in the Nepalese market. In addition, the easy substitution between these two currencies has resulted in a dampening effect when domestic money supply changes. Therefore, implementation of monetary policies in Nepal has had narrow coverage, and has not produced desired results (Acharya et. al. 2003). In other words, effectiveness of monetary policies in Nepal has been hampered due to the existence of ready supply of Indian currency in Nepalese market.

### *Interest Rates in Nepal*

Nepal Rastra Bank's intervention in the credit market started in 1966 through interest rate changes. However, the intervention was not to influence monetary policies but to facilitate credit flow and mobilize other financial resources. Different financial instruments and different kinds of loans carried different interest rates. Determination of the interest rates were based solely on the NRB's discretion due to the absence of market based instruments (Maskay and Pandit, 2010). Since 1975, the NRB started using the interest rate manipulations to influence credit and money supply.

Interest rates in Nepal have been high since the early 1970s. The primary reason for adopting high interest rates was to ensure that no savings from Nepal would shift to India with hopes of a higher return. With this in mind, in 1975, the NRB increased the interest rates all across the board. As a result, savings and fixed deposits increased while credit market slowed down. The exchange rate was devalued in 1985 by 14.7 percent, and was revalued by 5 percent in the 1990s during a period when interest rate on bank deposits in Nepal were lower than that in India (Acharya et. al. 2003).

In 1984/85, the balance of payments problems that started plaguing Nepal resulted in accepting to adopt the International Monetary Fund's economic stabilization program (Thornton 1987). Being under IMF's structural adjustment facility meant that the NRB had to be flexible in its interest rates determination, and as a result, would have to allow other commercial banks with limited powers to influence the interest rates. Therefore, commercial banks in Nepal were given permission to set their interest rates on savings

1.5% higher, and on time deposits 1% higher than the NRB's interest rates (Maskay and Pandit, 2010). This flexibility was further enhanced in 1986 when the NRB announced that commercial banks could not charge an interest above 15%. Such deregulation was the IMF's way of ensuring increased competition among financial and banking sectors. This was believed to increase efficiency and mobilization of resources.

On August 31, 1989, the NRB abolished any form of controlled interest rate, essentially granting banks and finance companies to set whatever interest rates they wished appropriate on deposits and lending. The post-democracy, post-1990, era fostered competition and resulted in a rapid increase in the number of banks and finance companies. So, the economic post-1990 liberalization fostered the banking and financial sectors resulting in rapid growth of these sectors. However, time and again, the NRB has been forced to issue directives aimed at curtailing the high interest rate spread between lending and deposits (Maskay and Pandit 2010).

### *Money Supply in Nepal*

Money supply in Nepal has always been affected by its balance of payments. Around 42 percent of the total money supply in Nepal during the 1980s was attributed to change in net foreign assets of the banking system (Acharya et. al. 2003). An improvement in the balance of payments during the 1990s meant that the foreign assets of the banking system had an increased contribution. However, net domestic assets of the banking system had declined during the same period, effectively neutralizing the expansionary contribution of foreign assets. After a brief decline in the balance of payment conditions during 1995/96, the situation improved after 1997. Till the end of 2008/09, there began a balance of payment surplus in Nepal.

There were attempts made to neutralize the impact of balance of payment surplus on the money supply in the country. In order to do this, the NRB issued the NRB bills between 1991 and 1994. However, the NRB resorted too much to the security instruments including the NRB bills, and as a result the interest rate on the NRB bills went up from 9.4 percent in 1992 to 11.1 percent in 1994. One of the reasons for this sterilization failure was the relatively inflexible exchange rate system in Nepal, mainly with regards to the Indian currency. If there were a rather flexible exchange rate system in Nepal, the effects would not have been so severe, and Nepal would not have experienced the high interest rates and excess monetary growth (Acharya et. al., 2003). However, if the NRB bills were not introduced, the money supply would have been even larger, even after accounting for inflation.

**Table 1: Financial Development Indicators**

| Phase | Period | Average M2/GDP ratio | Average Currency/M2 ratio |
|---|---|---|---|
| Pre-interest rate | pre-1955 | NA | NA |
| Controlled interes | 1956-1983 | 17.5 | 48.4 |
| Transition | 1984-1989 | 27.5 | 31 |
| Liberalized | 1990-present | 43.5 | 27.5 |

Source: NRB, CBS, GON, and calculations by Maskay and Pandit 2010

The growth in the financial sector, attributed to the financial deregulation by the NRB on the IMF's insistence, has been miraculous in Nepal. The growth can be examined by looking at the money supply in the economy (Table 1). The growth in the ratio of broad money (M2) to GDP shows that the money supply has grown significantly, and this in turn shows the development of financial sector in Nepal. The declining ratio of narrow money (currency) to broad money (M2) shows that use of currency has lowered significantly in Nepal, and this in turn, again, suggests the development of financial sector.

## *Monetary Neutrality in the Nepalese Economy*

Monetary neutrality or the neutrality of money is a concept in classical economics. It suggests that change in money supply does not have any effect on real variables like GDP and employment; it only affects nominal variables like price, wage and exchange rate.

Therefore, the monetary neutrality concept suggests that if the changes in money stock and changes in real variables are independent, then money is neutral. This phenomenon, called the *classical dichotomy*, is a widely accepted notion in economics. Furthermore, it is widely accepted in economic theory that there is long-*term monetary neutrality* if the change in money stock does not have a long-term impact in the real variables such as real GDP (Lucas 1995).

Some researchers have shown that money supply, M2, has predictive content for subsequent movement in prices or income (Miyao, 2004). Because of this reason, money supply is often used as a guiding tool when it comes to making monetary decisions and policies. In some countries, like Japan, the money supply lost this predictive capacity during the 1990s, probably due to the failure of banks and the unreliable movement of bank loans.

There have been issues raised on whether money neutrality holds in the short-run or not. Economists have argued that even in cases where money neutrality holds in the long-run, it might not hold in the short-run. The one common example is the case of wages and prices remaining sticky in the short-run despite a change in money supply (Cripps, 1977). Therefore, many nominal variables remain unaffected in the short-run by a change in money supply, thus suggesting no monetary neutrality. However, economists do agree that monetary neutrality gives a good enough approximation of the behavior of any economy in the long run.

An effort to study the neutrality of money in Nepal, therefore, starts with the investigation of the long-term impact on the output level when there are changes in the money supply. From aforementioned discussions about the monetary policies of Nepal, it is difficult to ascertain if the Nepalese monetary policies have been sound and "tight". This research intends to observe whether the monetary policies of Nepal had any impact on its real output. That is, this research will investigate whether there was monetary neutrality present in the Nepalese economy.

## III. DATA AND METHODOLOGY

### *Data*

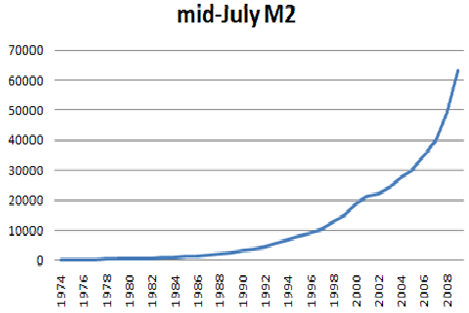


Figure 1: Money Supply

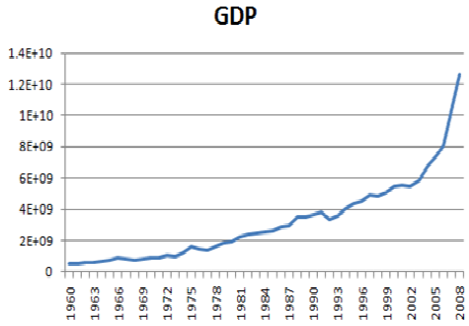


Figure 2: Real GDP

The time-trend graph of money supply, M2, shows that the money supply has kept increasing since early 1980s (Fig. 1). The time-trend graph of GDP shows that the GDP has moved in an increasing direction since 1960, albeit with a few hiccups every now and then (Fig. 2). The first significant drop can be noticed after 1975 when the GDP dropped due to the high oil prices resulting from the Second Oil Crisis. Like any other nation in the world dependent on oil for economic development, Nepal too suffered due to the crisis. Another significant drop in GDP occurred after 1991, right after the democracy of 1990. The revolution of the 1990 could have been the reasons for the drop. This reasoning seems to hold given how the economy bounces back in 1993, and the GDP starts growing again. Other than these two significant drops, the GDP of Nepal has maintained an increasing trend.

### *Methodology*

Research since the late 1980's on the subject of monetary neutrality has focused on verification via vector autoregression modeling (Jacobson et. al., 1999). This study aims to test the theory of monetary neutrality in the Nepalese economy using tests on the order of integration of the money stock and real GDP, as well as with a vector autoregression model to determine the historical impact of a money supply shock on the level of real gross domestic product. Verification of monetary neutrality is a vital component in the

identification of business cycles, as it is often used as a restriction in structural equation models seeking to forecast macroeconomic fluctuations.

The long-run relationship between the money stock and real output is dependent on the order of integration of each variable. Order of integration of each variable is tested using unit root tests, specifically the standardized Augmented Dickey-Fuller test. Because of the low power of this test, Phillips-Perron test can be used as an alternative to test the autocorrelation and partial autocorrelation functions in order to investigate the stationarity of the time series in question (Elliott et. al., 1996). Robustness of the results against each of these measures helps to come to more definite conclusions about the order of integration.

The structural VAR estimation will be used to test for an endogenous relationship between the money supply and the real output. This gives a testable statistical measure of money neutrality hypothesis. After estimation of the model, monetary neutrality will be investigated in two ways:

***Impulse response analysis*** will determine the effect of a shock to money on GDP and the effect of a shock to GDP on money. At this point, it can be seen how each variable evolves over time in response to shocks on the other, given constant exogenous factors (Mitchell, 2000).

***Granger Causality Tests*** on the lagged factors of each variable will determine if one variable is a statistically significant "cause' of the other. This is accomplished via block F-tests on the coefficients of the accompanying lagged values of each variable.

### *Identification of Long Term Relationship*

The first step is to determine whether shocks to money stock result in permanent changes to real output. For this purpose the long term rate of change of real output with respect to the money stock must be determined. Mathematically, this can be represented by:

$$\lim_{k \to \infty} \frac{\partial y_{t+k} / \partial u_t}{\partial m_{t+k} / \partial u_t}$$

That is, the long term derivative of real output with respect to the money stock must be determined. If the value of this expression is zero, then the effect of changes in money decays to zero as time moves forward, and monetary neutrality holds. If the money stock is stationary, no permanent shocks to the money stock exist, making this long term derivative divergent; monetary neutrality in this context is not testable.

### *Possible Relationship Cases*[1]

The expression for monetary neutrality as the long-term derivative of real output with respect to the money supply yields five possible cases for the long-term relationship between money and real output.

***Money supply is integrated of order zero (i.e. stationary):*** As stated above, if money is I(0) then long-term monetary neutrality cannot be tested, as shocks to the money supply are non-permanent by the property of the data series. This is due to the fact that the decay of the denominator of the long-term derivative results in divergence of the expression.

***Money is integrated at order one or greater, but at a lower order than GDP:*** In this case long term monetary neutrality holds. Because GDP is integrated at a higher order, shocks to the money stock do not influence the growth rate of real output, yielding no permanent impact on GDP.

***Money and GDP are integrated of the same order:*** This case requires determination of shocks to the money stock orthogonal to real output, requiring estimation of a structural model.

***Money is integrated at order one or greater, but at a higher order than GDP:*** If money is integrated at an order higher than that of real output, then monetary neutrality holds, as changes to the money stock result in no permanent change to GDP. This is because the numerator of the long term derivative above converges to zero if the real output is stationary.

***Money and GDP are co-integrated:*** Cointegration implies that there is some linear combination of money and GDP which is stationary. The relationship will converge to this linear combination, which may contain a constant and trend. Because of this "moving target," monetary neutrality cannot be tested with these methods in the event of cointegration.

### *Modeling Design and Procedure*

While tests on the order of integration can determine the permanence of effects of monetary supply shocks on real output, demonstrating the evolutionary relationship between these variables requires the estimation of vector autoregression model. Modeling and testing for an endogenous relationship enables in finding short term effects, in addition to the tests for permanent effects yielded by the unit root tests. For this purpose, the following system of equations can be estimated:

$$Log(m_t)\Delta^x = a + \sum_{i=1}^{q} \alpha_i Log(y_{t-i})\Delta^z + \sum_{i=1}^{q} \beta_i Log(m_{t-i})\Delta^x \quad \text{.....equation 1}$$

$$Log(y_t)\Delta^z = a + \sum_{i=1}^{q} \lambda_i Log(y_{t-i})\Delta^z + \sum_{i=1}^{q} \gamma_i Log(m_{t-i})\Delta^x \quad \text{.....equation 2}$$

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[1] For a detailed review, see Walter Enders' *Applied Econometric Time Series 2nd edition.*

In these expressions, 'y' represents real output, 'm' represents money stock, 'delta' is the difference operator and 'x' and 'z' represent the order of integration of each variable.

### *Tests for the Order of Integration*

Identification of the order of integration of each variable and comparison of these will determine which of the four cases the Nepalese economy falls under. Since co-integration is only possible in the event that the variables are integrated of the same order, this test is only required in the event that the variables do, in fact, have the same order of integration. However, this test will be performed regardless of the unit root test results to determine the robustness of the result.

***Money Stock:*** The Augmented Dickey Fuller test does not have high power, and is sometimes sensitive to the number of lags in the estimation. Also, previous researches have shown that when the sample size is small, as in the case of this study where data ranges from 1975 to 2008, the ADF test is not very convincing (Hu et. al., 1992). Therefore, for convincing conclusions, the autocorrelation function and partial autocorrelation function will also be observed.

The ADF test on the log of M2 for a wide variety of lag specifications is presented in *Appendix A*. For each lag specification the test fails to reject the null hypothesis of a unit root. This suggests that the money stock is not stationary in level. A quick scan of the partial autocorrelation function (PACF) and autocorrelation function (ACF), shown in Figure 3, reveals slow decay in the autocorrelation pattern, an indication of non-stationarity.

Figure 3: ACF /PACF of LogM2

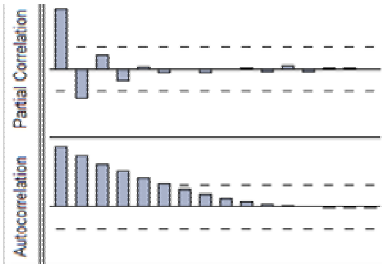
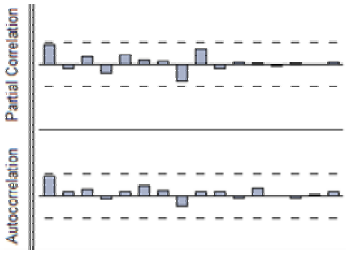



Figure 4: ACF/PACF of difference of LogM2




The ADF tests on the difference of the log of M2 for a variety of lag specifications to determine the stationarity is presented in *Appendix B*. The test rejects the null hypothesis of a unit root for shorter periods, but fails to reject the possibility of a unit root beyond the fourth lag. This suggests that difference of the log of the money stock i.e. growth of money supply, is stationary. Observing the ACF and PACF, shown in Figure 4, reveals a sharp decay in the autocorrelation pattern, thus suggesting stationarity. Also, prominent spike in the first lag, shown by the PACF, suggests that money supply is I(1).

***Real GDP:*** The ADF test on the log of GDP for a wide variety of lag specifications is presented in *Appendix C*. For each lag specification the test fails to reject the null hypothesis of a unit root. This suggests that the GDP is not stationary in level form. Slow decay in the autocorrelation pattern, shown in Figure 5, is indication of non-stationarity.

Figure 5: ACF/PACF of Log GDP

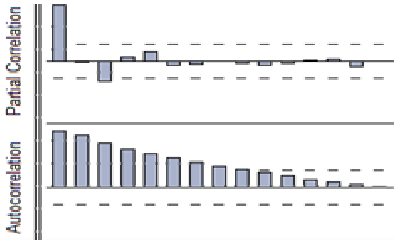
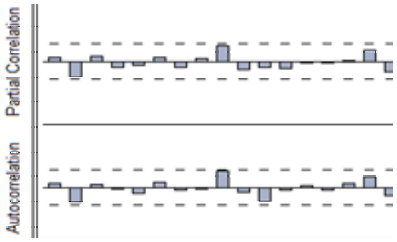



Figure 6: ACF/PACF of difference of Log GDP




The ADF tests on the difference of the log of GDP for a variety of lag specifications to determine the stationarity is presented in *Appendix D*. The test rejects the null hypothesis of a unit root for both shorter and longer periods. This suggests that difference of the log of the GDP, i.e. growth rate of GDP, is stationary. Observing the ACF and PACF, shown in Figure 6, reveals a sharp decay in the autocorrelation pattern, thus suggesting stationarity. The prominent spike in the first lag shown by the PACF suggests that GDP is I(1).

### *Test of Co-integration*

The tests to determine the order of integration of money supply and GDP suggest that both these variables are integrated of order one i.e. I(1). This gives two possible cases: money and GDP are co-integrated, or money is integrated at an order higher than GDP. The second case supports money neutrality, whereas the first case asks for a structural model. A test for the endogenous relationship between GDP and money supply can confirm which of these two cases is applicable here.

The strong probability of both of these variables being integrated of order one means a test of co-integration is desirable. In order to test the co-integration, the number of lags that will be used has to be determined. The appropriate lag structure is suggested by a variety of information criterion, mainly the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC). The AIC tends to overestimate the order of lag selection, while the BIC tends to underestimate (Lutkepohl, 1991). So, both of these are used to come to a general consensus in order to avoid any bias in the selection of the lag structure. *Appendix E* shows the lag suggestions given by various criteria, and most of these criteria agree that a single lag should be used.

The test of co-integration between money supply and GDP is shown in *Appendix F*. It shows two types of tests for co-integration: the Johansen Trace test, and the Maximal

Eigenvalue test. The null hypothesis for the test of co-integration is that there is *no cointegration.* Both the tests fail to reject the null hypothesis, suggesting that there is no co-integrating relationship between money supply and GDP. While failure to reject *no cointegrating relationship* should not be interpreted as evidence in favor, the failure to detect *a co-integrating relationship* is evidence against its presence (Engel, 1987).

### *Vector Auto Regression (VAR) Estimate*[2]

This study is a multivariate time series analysis, meaning there are at least two variables that are of time-series nature that are being analyzed in order to build an economic model. When it comes to describing and analyzing the dynamic nature of financial and economic time-series, and forecasting such series, the VAR model is superior to univariate forecasting models and simultaneous equation models. It is also useful when conducting a structural analysis to determine the impact on a particular variable in the model when there is an unexpected shock.

In this study, the VAR estimate will serve two purposes. First, the tests for stationarity indicated that both variables are I(1). So, this model estimation helps determine long-run monetary neutrality because the unit root tests are insufficient when variables are integrated of the same order. Second, this model will assist in quantifying the effect of a shock on the money supply to real output, giving an idea of the relative speed of the reaction and the rate of convergence.

The number of lags used in the VAR estimation is determined by the suggestion of various lag selection criteria shown in *Appendix E*. The selection criteria suggests that only one lag should be used. Although the selection criteria is unanimous in their suggestion to use only one lag, two lags will be used in the VAR estimation in order to avoid any bias resulting from omission.

The VAR estimation result, with two lags, is shown in *Appendix G*. The value of the t-statistics for the impact of money supply on GDP is low. The t-statistics for the impact of GDP on money supply is also low, but it is a little higher when compared to the first case. This evidence suggests that the impact of these two variables on one another is generally insignificant. For the sake of completeness, Appendix G also shows the VAR estimation result with only one lag. Once again, the t-statistics suggest that GDP has a slightly higher impact on money supply. However, their net impact on one another is insignificant.

## IV. ROBUSTNESS OF THE MODEL

### *Structural Analysis of the VAR Estimate*

Due to complex interactions between variables in a VAR estimation model, the dynamic properties of a VAR model is studied through structural analysis summaries, mainly the Granger Causality test and the Impulse Response Function.

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[2] For a detailed review, Walter Enders (2003).

***Granger Causality test:*** If a variable is found to be helpful in predicting another variable, then the first variable is said to *Granger-cause* the second variable. It is important to note that this notion does not imply true causality, and only implies the forecasting ability of the first variable to forecast the second variable (Granger 1969).

Block F-tests, in the form of Granger Causality test, carried out on the coefficients of each series to observe the statistical causality is shown in *Appendix H*. For GDP's impact on money supply, the null hypothesis is that *GDP has no impact on money supply.* Similarly, for money supply's impact on GDP, the null hypothesis is that *money supply has no impact on GDP.*

The Granger Causality tests in this study fail to reject both the null hypotheses. Therefore, GDP does not *Granger-cause* money supply, and money supply does not *Granger-cause* GDP. In other words, GDP and money supply have no causal impact on one another. This holds true when either two or one lag is selected in the VAR estimate.

***Impulse Response Function (IRF):*** The Impulse Response Function shows how a dynamic system responds when a sudden exogenous impulse or a 'shock' is applied to the system (Lutkepohl, 2008). The IRF in this study shows the response of the two endogenous variables at the time of the shock and over subsequent time periods. *Appendix I* shows the impulse responses of GDP and money supply to a Cholesky one standard deviation shock in either GDP or money supply.

The response of GDP to a one standard deviation positive shock to money supply shows that GDP responds negatively to growth in money supply. Immediately, the GDP decreases and this continues for the next couple of periods, and then GDP increases again to converge to its pre-shock level. This suggests that a shock in money supply does produce a significant reaction in the real sector as shown by the immediate decline of the GDP. Similarly, GDP responds negatively to a one standard deviation positive shock in GDP. The GDP declines for the next couple of periods, and then starts increasing again until it converges to its pre-shock level.

The response of money supply to a one standard deviation positive shock to money supply shows that money supply responds negatively to its growth. This suggests that if money supply increases this period, then it starts to decline in the next period, and so on, until it converges to the pre-shock level. However, money supply does not respond immediately to a one standard deviation positive shock in GDP. But, money supply increases for a couple of periods thereafter, until it falls again and converges again to its pre-shock level. The fact that money supply increases when there is a positive shock in GDP suggests that policymakers in Nepal, essentially the Nepal Rastra Bank, have not followed tight monetary policies.

## V. CONCLUSION

The VAR estimation result shows the notion that money supply has a permanent effect on real GDP is rejected. The evidence suggests that changes in money supply do not have a permanent effect on real GDP. However, the Cholesky one standard deviation positive shock suggests that in the short-run an increase in money supply immediately lowers the GDP, thus showing a negative response. This responsiveness of the real GDP to a change in money supply suggests that in the short-run, real variables in the Nepalese economy do get affected by changes in monetary policies.

However, the Cholesky shock test suggests that the effects are in the short run only. Both the Cholesky shock test and Granger causality test confirm that in the long-run, monetary policies do not affect the real variables. Therefore, in the long-term, the concept of monetary neutrality has held true in the Nepalese economy between 1975 and 2008. This, in turn, suggests that monetary policies practiced by the Nepal Rastra Bank may have been counter-productive in the short run, but have been effective for the long run growth and stability of the economy.

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## APPENDIX A: The ADF test on the Log of Money Supply

Null Hypothesis: LM has a unit root
Exogenous: Constant
Lag Length: 1 (Fixed)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.393906 | 0.5737 |
| Test critical values: | 1% level | -3.639407 | |
| | 5% level | -2.951125 | |
| | 10% level | -2.614300 | |

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LM has a unit root
Exogenous: Constant
Lag Length: 2 (Fixed)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -0.997554 | 0.7426 |
| Test critical values: | 1% level | -3.646342 | |
| | 5% level | -2.954021 | |
| | 10% level | -2.615817 | |

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LM has a unit root
Exogenous: Constant
Lag Length: 3 (Fixed)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -0.482263 | 0.8821 |
| Test critical values: | 1% level | -3.653730 | |
| | 5% level | -2.957110 | |
| | 10% level | -2.617434 | |

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LM has a unit root
Exogenous: Constant
Lag Length: 4 (Fixed)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.179185 | 0.6706 |
| Test critical values: | 1% level | -3.661661 | |
| | 5% level | -2.960411 | |
| | 10% level | -2.619160 | |

*MacKinnon (1996) one-sided p-values.

## APPENDIX B: The ADF test on the Difference of the Log of Money Supply

Null Hypothesis: D(LM) has a unit root
Exogenous: Constant
Lag Length: 1 (Fixed)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -3.067745 | 0.0390 |
| Test critical values: | 1% level | -3.646342 | |
| | 5% level | -2.954021 | |
| | 10% level | -2.615817 | |

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LM) has a unit root
Exogenous: Constant
Lag Length: 2 (Fixed)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -2.465437 | 0.1331 |
| Test critical values: | 1% level | -3.653730 | |
| | 5% level | -2.957110 | |
| | 10% level | -2.617434 | |

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LM) has a unit root
Exogenous: Constant
Lag Length: 3 (Fixed)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -2.646691 | 0.0948 |
| Test critical values: | 1% level | -3.661661 | |
| | 5% level | -2.960411 | |
| | 10% level | -2.619160 | |

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LM) has a unit root
Exogenous: Constant
Lag Length: 4 (Fixed)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.915913 | 0.3209 |
| Test critical values: | 1% level | -3.670170 | |
| | 5% level | -2.963972 | |
| | 10% level | -2.621007 | |

*MacKinnon (1996) one-sided p-values.

## APPENDIX C: The ADF test on the Log of GDP

Null Hypothesis: LGDP has a unit root
Exogenous: Constant
Lag Length: 1 (Fixed)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | 0.263878 | 0.9738 |
| Test critical values: | 1% level | -3.577723 | |
| | 5% level | -2.925169 | |
| | 10% level | -2.600658 | |

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LGDP has a unit root
Exogenous: Constant
Lag Length: 2 (Fixed)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | 0.336260 | 0.9778 |
| Test critical values: | 1% level | -3.581152 | |
| | 5% level | -2.926622 | |
| | 10% level | -2.601424 | |

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LGDP has a unit root
Exogenous: Constant
Lag Length: 3 (Fixed)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | 0.273122 | 0.9743 |
| Test critical values: | 1% level | -3.584743 | |
| | 5% level | -2.928142 | |
| | 10% level | -2.602225 | |

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LGDP has a unit root
Exogenous: Constant
Lag Length: 4 (Fixed)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | 0.327316 | 0.9772 |
| Test critical values: | 1% level | -3.588509 | |
| | 5% level | -2.929734 | |
| | 10% level | -2.603064 | |

*MacKinnon (1996) one-sided p-values.

## APPENDIX D: The ADF test on Difference of Log of GDP

Null Hypothesis: D(LGDP) has a unit root
Exogenous: Constant
Lag Length: 1 (Fixed)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -5.560754 | 0.0000 |
| Test critical values: | 1% level | -3.581152 | |
| | 5% level | -2.926622 | |
| | 10% level | -2.601424 | |

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LGDP) has a unit root
Exogenous: Constant
Lag Length: 2 (Fixed)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -3.552777 | 0.0109 |
| Test critical values: | 1% level | -3.584743 | |
| | 5% level | -2.928142 | |
| | 10% level | -2.602225 | |

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LGDP) has a unit root
Exogenous: Constant
Lag Length: 3 (Fixed)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -3.128085 | 0.0317 |
| Test critical values: | 1% level | -3.588509 | |
| | 5% level | -2.929734 | |
| | 10% level | -2.603064 | |

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LGDP) has a unit root
Exogenous: Constant
Lag Length: 4 (Fixed)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -2.971989 | 0.0456 |
| Test critical values: | 1% level | -3.592462 | |
| | 5% level | -2.931404 | |
| | 10% level | -2.603944 | |

*MacKinnon (1996) one-sided p-values.

## APPENDIX E: Determination of the lag length for the VAR

Sample: 1960 2010
Included observations: 29

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -32.27859 | NA | 0.036456 | 2.364041 | 2.458337 | 2.393573 |
| 1 | 88.52158 | 216.6072* | 1.16e-05* | -5.691143* | -5.408254* | -5.602546* |
| 2 | 91.11487 | 4.292341 | 1.28e-05 | -5.594129 | -5.122647 | -5.446467 |
| 3 | 92.39245 | 1.938404 | 1.57e-05 | -5.406376 | -4.746302 | -5.199649 |
| 4 | 96.12467 | 5.147884 | 1.63e-05 | -5.387908 | -4.539242 | -5.122116 |
| 5 | 97.95397 | 2.270860 | 1.97e-05 | -5.238205 | -4.200946 | -4.913348 |
| 6 | 101.6370 | 4.064012 | 2.13e-05 | -5.216344 | -3.990492 | -4.832422 |

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

## APPENDIX F: Test of Co-integration between Log of Money Supply and Log of GDP

Sample (adjusted): 1976 2008
Included observations: 33 after adjustments
Trend assumption: Linear deterministic trend
Series: LM LGDP
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None | 0.268315 | 11.32355 | 15.49471 | 0.1924 |
| At most 1 | 0.030266 | 1.014199 | 3.841466 | 0.3139 |

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

| Hypothesized No. of CE(s) | Eigenvalue | Max-Eigen Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None | 0.268315 | 10.30935 | 14.26460 | 0.1924 |
| At most 1 | 0.030266 | 1.014199 | 3.841466 | 0.3139 |

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

## APPENDIX G: The VAR Estimate

Sample (adjusted): 1976 2008
Included observations: 33 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| | DLM | DLGDP |
|---|---|---|
| DLM(-1) | 0.320972 | -0.010321 |
| | (0.17689) | (0.31976) |
| | [ 1.81448] | [-0.03228] |
| DLGDP(-1) | 0.038464 | 0.049319 |
| | (0.10106) | (0.18268) |
| | [ 0.38060] | [ 0.26997] |
| C | 0.111716 | 0.061506 |
| | (0.03216) | (0.05814) |
| | [ 3.47348] | [ 1.05794] |
| R-squared | 0.099738 | 0.002898 |
| Adj. R-squared | 0.039721 | -0.063576 |
| Sum sq. resids | 0.060538 | 0.197808 |
| S.E. equation | 0.044921 | 0.081201 |
| F-statistic | 1.661822 | 0.043595 |
| Log likelihood | 57.14146 | 37.60493 |
| Akaike AIC | -3.281300 | -2.097268 |
| Schwarz SC | -3.145254 | -1.961222 |
| Mean dependent | 0.166075 | 0.063034 |
| S.D. dependent | 0.045841 | 0.078737 |

| | |
|---|---|
| Determinant resid covariance (dof adj.) | 1.31E-05 |
| Determinant resid covariance | 1.09E-05 |
| Log likelihood | 94.95009 |
| Akaike information criterion | -5.390915 |
| Schwarz criterion | -5.118822 |

Sample (adjusted): 1977 2008
Included observations: 32 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| | DLM | DLGDP |
|---|---|---|
| DLM(-1) | 0.413026 | -0.172200 |
| | (0.19534) | (0.32906) |
| | [ 2.11440] | [-0.52331] |
| DLM(-2) | -0.022857 | -0.177370 |
| | (0.18794) | (0.31660) |
| | [-0.12162] | [-0.56023] |
| DLGDP(-1) | -0.003171 | 0.183009 |
| | (0.10945) | (0.18437) |
| | [-0.02898] | [ 0.99262] |
| DLGDP(-2) | 0.096694 | -0.250126 |
| | (0.11058) | (0.18627) |
| | [ 0.87444] | [-1.34279] |
| C | 0.095347 | 0.128661 |
| | (0.04075) | (0.06865) |
| | [ 2.33963] | [ 1.87416] |
| R-squared | 0.169335 | 0.120783 |
| Adj. R-squared | 0.046273 | -0.009471 |
| Sum sq. resids | 0.054813 | 0.155541 |
| S.E. equation | 0.045057 | 0.075900 |
| F-statistic | 1.376015 | 0.927285 |
| Log likelihood | 56.50710 | 39.81927 |
| Akaike AIC | -3.219194 | -2.176204 |
| Schwarz SC | -2.990173 | -1.947183 |
| Mean dependent | 0.164984 | 0.067544 |
| S.D. dependent | 0.046137 | 0.075543 |

## APPENDIX H: Granger Causality Test

Sample: 1960 2010
Lags: 1

| Null Hypothesis: | Obs | F-Statistic | Probability |
|---|---|---|---|
| DLGDP does not Granger Cause DLM | 33 | 0.14486 | 0.70618 |
| DLM does not Granger Cause DLGDP | | 0.00104 | 0.97447 |

Sample: 1960 2010
Lags: 2

| Null Hypothesis: | Obs | F-Statistic | Probability |
|---|---|---|---|
| DLGDP does not Granger Cause DLM | 32 | 0.38850 | 0.68180 |
| DLM does not Granger Cause DLGDP | | 0.43811 | 0.64976 |

## APPENDIX I: Impulse Response Function