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Effect of Policy Variables on the Process of Money Supply

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Abstract

Purpose: *This paper investigates the effect of monetary policy variables to money supply in Nepal, with the help of monetary policy instruments.*

Methods: *This study used casual research design. The research used auto regressive distributed lag model for data analysis, the study examined the impact of variables like Reserve Money on Nepal's monetary dynamics. Key policy tools, such as the Cash Reserve Ratio (CRR), Bank Rate, and Treasury Bills Rate, are also assessed for their roles in shaping money supply.*

Results: *The findings reveal that reserve money has strong positive effect on the money supply, similarly, Bank rate and treasury bills rate also has significant positive relationship with the money supply, whereas Cash reserve ratio negatively affects the money supply.*

Conclusion: *This work fills a critical gap in understanding Nepal's monetary landscape, providing essential insights for policymakers at the Nepal Rastra Bank. By identifying key instruments of money supply, the study offers actionable recommendations for crafting effective monetary policies that stabilize the economy, control inflation, and foster growth. Ultimately, this thesis enhances comprehension of monetary dynamics in Nepal, emphasizing the need for context-specific policy approaches.*

Keywords: Money supply, open market operation, treasury bills rate , time series, ARDL

I. Introduction

The money supply is the amount of money in circulation at any one time (Doan Van, 2020). Money supply refers to the total amount of liquid financial assets available in an economy (Edem, 2017; Ammous, 2018) at a given time, encompassing cash, bank deposits, time deposits, and foreign reserves (Awrey, 2021). It includes both currency in circulation and various forms of credit extended by financial institutions (Kidwell et al., 2016). It is acquired by adding up all of the financial assets that have the ability to operate as a medium of exchange and a store of value (Shrestha, 2013).

In Nepal, Nepal Rastra Bank as a central bank formulated its first monetary policy in the

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fiscal year 2002/03, 46 years after its establishment. The central bank has been formulating monetary policy every year since then to help in the implementation of the government's annual policy and budget plan and to maintain financial stability (Bank, 2014).

The Nepalese economy has experienced various monetary policy regimes, transitioning from fixed exchange rates to a managed floating exchange rate system (Frankel, 2003; Rajan, 2012). Traditional economic theory posits that money supply is shaped by both endogenous factors (like banking behavior) (Simmons et al., 2021) and exogenous influences (such as monetary policy and external shocks) (Miranda-Agrippino, & Ricco, 2021). Given reliance on remittances and vulnerability to external conditions of Nepal, a comprehensive analysis of these factors is crucial for understanding monetary policy implications (Adhikari, 2024).

Similarly, Money supply is also affected significantly by the monetary instruments which are mainly Cash reserve requirements, Bank rates, Open market operation tools (Modigliani et al., 1970), to effectively manage the economy, it is crucial to assess the influence and impact of these monetary tools (Duskobilov, 2017).

So, the objective of this study is to examine the relative importance of key monetary tools with respect to the money supply, providing crucial insights for policymakers to shape effective economic strategies. Using variables of monetary policy instruments like Bank rate, Cash reserve ratio, treasury bills rate and reserve money. this research work addresses a notable gap in understanding the determinants of Nepal's money supply. Through empirical analysis and econometric modeling, this paper seeks to offer a comprehensive view of the monetary landscape, enabling informed decisions that promote economic stability and sustainable growth within Nepal's unique economic context however the study have taken the monetary variables.

II. Reviews

Recent studies emphasize that money supply dynamics of Nepal are shaped by both domestic and global economic shifts, alongside evolving central bank policies (Adhikari, 2015). Khatiwada (1994) analyzed the money supply function in Nepal from 1965/66 to 1989/90, finding that policy-controlled changes in high-powered money significantly impacted the narrow money stock.

Miranda-Agrippino and Ricco (2021) explored the transmission mechanisms of monetary policy, emphasizing how changes in policy variables like reserve money and cash reserve ratios shape economic liquidity. This aligns with (Khatiwada, 1994) and (Thapa ,1997), who studied Nepal's monetary policy and identified reserve money as a crucial determinant of the money supply. They argued that central bank-controlled high-powered money impacts both narrow and broad money, especially through tools like the CRR. Together, these works emphasize the centrality of effective policy controls in managing money supply and stabilizing economies under both domestic and international pressures.

Freidman (2008) explained the work of Friedman and Schwartz's which includes a detailed examination of various periods, such as the Great Depression, where they assert that inadequate use of monetary policy tools exacerbated economic downturns, that is why we need to intervene the money supply through the use of the policy variables which is most monetary in nature, Policy variables such as reserve money and open market operations.

it is expected that the money supply and the monetary base, which OMO can directly manage, will have an empirically stable relationship (Bhatta, 2022) and monetary bases have different kind of relationship with money supply.

The different analysis reveals distinct relationships between various monetary policy variables and money supply, each impacting economic dynamics in unique ways Pollin, (1991).

Reserve money generally, exhibits a strong positive relationship with the money supply, indicating that an increase in reserve money generally expands the money supply in the

economy (Benigno et al., 2022).

The cash reserve ratio (CRR), however, has an inverse relationship with money supply, as higher CRR levels require banks to hold more capital in reserve, thereby reducing the amount available for lending and economic expansion (Bhatta, 2022).

Similarly, the bank rate (BR) and treasury bills rate (TBR) also play significant roles, with increases in these rates positively influencing money supply by affecting lending costs and government securities (Ogunlokun & Oguntuase, 2023) careful calibration of BR and TBR is essential to prevent inflationary pressures (Serruys, et al., 2024).

The study undertakes the importance of aforesaid variables in the process of money supply. The detailed examination is being carried out on the various sections and chapters.

III. Methodology

This section deals with the methodology adopted to meet the objective of the paper.

Research Design

Research design is the overall blueprint of the study. In this study, there is used causal research design, which examines the cause and effect relationship between independent and dependent variables. Since the purpose of this study is the establish casual and linear relationship between money supply and policy variables in context of Nepal, linear regression model has been deployed which suit as the best model for the study.

Data and their sources

Data for the study has been extracted from the official source of Nepal Rastra bank (NRB, 2024). Dataset includes quarterly data of 24 years ranging from FY 2000 to FY2023. Regarding the units of variables, the dependent variable Money Supply is measured in million, Nepalese Currency. While, independent variables including reserve money is measured in Million, Nepalese Currency, and Cash reserve ratio, Bank rate and Treasury bills rate are measured as percentages during the period. These data are visualized in section later.

Money supply is a dependent variable in our study which is impacted by various other variables under consideration of our study i.e. Reserve money, Cash reserve ratio, Bank rate, and Treasury bills rate (Modigliani et al., 1970). From figure we can see the trend of money supply, it is continuously been increasing over the period which in the figure has been shown from the year 2000 onwards.

Reserve money is the most important form of money supply. It is also called as high-powered money, base money and central bank money (Gupta, 1976). The reserve money in our study is a major determinant of money supply. As we can see its trend is upward sloping, however there is a little shock in the period of 2020-2023 which is due to the hampering effect that economy has faced due to the Covid-pandemic.

Cash Reserve Ratio or CRR is a specific percentage of a bank's total deposits that it must keep in a current account with the country's central bank (Onoh, 2017). The bank cannot use that portion of its deposits for lending or other commercial activities. CRR helps the central bank control liquidity in the banking system. This is the variable which has an inverse relationship with the money supply. The trend of CRR seems that there is a sharp decline in the CRR at the year 2020 which is due to the Covid like pandemic which made the CRR to reduce sharply to increase the contracted money supply. The bank rate is the rate of interest which is charged by a central bank while lending loans to a commercial bank. In the event of a fund deficiency, a bank can borrow money from the central bank of a country (Modigliani et al., 1970). The trend of bank rate in our study is portraying the mixed manner i.e. decreasing and increasing both kind of manners. It has been lowest in 2020 where it reached at around 5 percent and it has been an all-time highest at period of 2024 which is around above 8 percent.

Treasury Bill is a money market instrument is issued by the Government respective countries

(Nyawata & Obert, 2013) and the bill is issued as a promissory note of repayment in the future (Byles & Barnard, 1891). The purpose of a treasury note is to secure funds to meet the short-term fund requirements of the government. It is done to minimize the fiscal deficit of the country (Krishnamurthy & Jorgensen, 2015). In our study the trend of the treasury bills has shown the haphazard manner it has been decreased at the first and then it had increased and reached the peak at year 2009 at around at 7.75 percent. And in the period followed by the years 2017, 2019 and 2020 it had shown a random manner.

Trend of Variables Used in the Study

Figure I

Trend of money supply

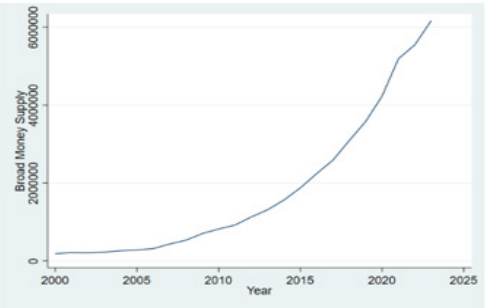


Figure II

Trend of Reserve Money

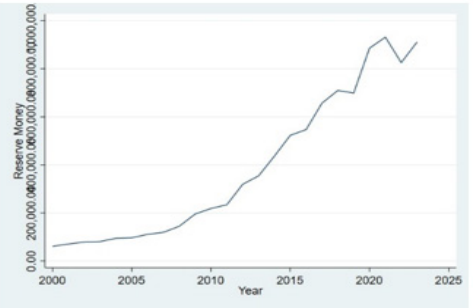


Figure III

Trend of CRR

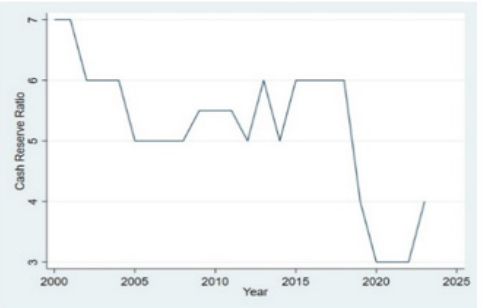


Figure IV

Trend of Bank Rate

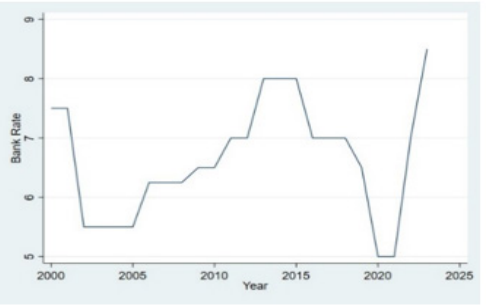
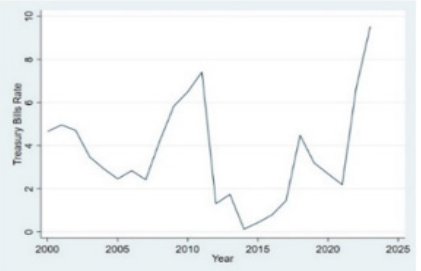


Figure V

Trend of Treasury Bills rate



Econometric Model Specification

Since this study has Auto regressive distributed lag (ARDL) model, it is necessary to identify dependent and independent variables for the operation of the model, the dependent variable is Money supply and the independent variable is policy variables which includes interest variable like Reserve money, Cash reserve ratio, Bank rate and Treasury bills rate.

The basic regression equation that is used in for the study is as following:

In mathematical function:

Money Supply = f (Policy Variables) (1)

In Econometric function:

Money Supply = $\alpha + \beta_k$ (Policy Variables) + ε (2)

$M2 = \alpha + \beta 1RM + \beta 2\ CRR + \beta 3\ BR + \beta 4\ TR + \varepsilon(3)$ (4)

Similarly, introducing log in dependent and independent variables,

Where,

M2 = Broad Money supply,

RM = Reserve money

CRR = Cash reserve ratio

BR = Bank Rate

TR = Treasury Bills rate

Unit Root Test

First step to be followed in time series type of data is to conduct unit root test in order to test for stationarity. Analyzing Non-stationarity data may lead to misleading conclusion and unreliable findings. Unit root test tools like ADF and PP for this paper is presented in following table. According to the result of unit root test in table 1 variables bank rate, treasury bills rate and cash reserve ratio is stationery at level i.e. I(0) and variable broad money supply(LM2) and reserve money (lrm) is stationery at first difference i.e. I (1).

Table 1

Unit Root Tests

Variables	Unit Root Tests	
	ADF	PP
	Level	
lm2	-1.078	-1.513
Lrm	-3.841	-3.528
Br	-2.637*	-2.368*
Lcrr	-2.538*	-2.764*
tbr	-3.476*	-3.972*
	First Difference	
Lm2	-4.632*	-3.454*
lrm	-6.572*	-5.693*
br	-5.758*	-5.683*

lcrr	-6.863*	-6.593*
tbr	-5.212*	-5.164*

Bounds Test of co-integration

The ARDL model, as utilized in the bounds test by Pesaran et al., (2001), facilitates the examination of both short-term and long-term relationships without requiring the variables to be stationary. This method allows for cointegration analysis regardless of whether the variables are integrated at level I(0) or first difference I(1). Initially, the model establishes an unrestricted error correction representation. The F-test is then applied to the lags of both dependent and independent variables to assess the presence of a cointegration relationship. The test statistics employed, such as the Wald or F-test, indicate overall significance. However, it is essential that the variables do not exhibit an integration order of I(2) or higher.

ARDL cointegration test is conducted by constructing the following model specification Autoregressive Distributed Lag (ARDL) cointegration technique or bound cointegration technique. ARDL cointegration technique is preferable when dealing with variables that are integrated of different order, I(0), I(1) or combination of the both and, robust when there is a single long run relationship between the underlying variables in a small sample size (Nkoro & Uko , 2016).

$$\Delta lnM2_t = \alpha_0 + \sum_{i=0}^{a} \beta_i \Delta lnM2_{t-i} + \sum_{j=0}^{b} \beta_j \Delta lnRM_{t-j} + \sum_{k=0}^{c} \beta_k \Delta lnBR_{t-k} + \sum_{l=0}^{d} \beta_l \Delta lnCRR_{t-l} + \sum_{m=0}^{e} \beta_j \Delta lnTBR_{t-m} + \Omega_{M2} lnM2_{t-1} + \Omega_{RM} lnRM_{t-1} + \Omega_{BR} lnBR_{t-1} + \Omega_{CRR} lnCRR_{t-1} + \Omega_{TBR} lnTBR_{t-1} + \varepsilon$$

According to the results of unit root test which shows that the variables are in mixed order of co-integration. This implies to implement the ARDL model. Results of Bounds Test of co-integration is presented below.

Table 2

Bound Test for Co-Integration

F-Bounds Test		Null Hypothesis Relationship		
Test Statistic	Value	Signif	I(0)	I(1)
		Asymptotic N=1000		
F-Statistic	6.385271	10%	3.83	4.41
K	4	5%	3.85	4.84
		2.5%	4.86	5.38
		1%	5.12	6.71

In the results above, value of F-statistic is greater than the upper limit I(1) at 2.5% level and above. This confirms the existence of long run relationship.

IV. Results and discussion

Table 3

Long-run Coefficient Short run Coefficient (3,3,3)

Variable	Coefficient	t-Statistic	Probability
lrm	0.7658***	8.5031	0.0001
br	0.1641**	-2.4074	0.014
crr	-0.246***	-4.0836	00.002
tbr	0.0754	-1.2656	0.250
c	2.5862**	2.9761	0.010
	R-squared	0.85	
	Adjusted R-square	0.83	
	F-statistic	30.25	
	Prob (F-statistic)	0.0001	
	Durbin-Watson	1.98	

Note. :***: Significant at 1% level ($p \leq 0.01$), **: Significant at 5% level ($0.01 < p \leq 0.05$) * Significant at 10% level ($0.05 < p \leq 0.10$

The regression results indicate that reserve money (lrm) has a strong positive and statistically significant impact on the dependent variable, with a coefficient of 0.7658 and a highly significant t-statistic (8.5031, p<0.01p < 0.01). This suggests that an increase in reserve money leads to a substantial increase in the dependent variable. Bank rate (br) has a positive coefficient (0.1641) and is statistically significant at the 5% level (p=0.014p = 0.014), implying that higher bank rates are associated with an increase in the dependent variable. Cash reserve ratio (crr) has a negative and highly significant effect (-0.2463, p<0.01p < 0.01), suggesting that tighter monetary policy through higher reserve requirements reduces the dependent variable. Treasury bills rate (tbr) has a positive coefficient (0.0754) but is not statistically significant (p=0.250p = 0.250), indicating it does not have a meaningful impact in this model. The intercept (c) is positive and significant at the 5% level. The R-squared value (0.85) indicates that the model explains 85% of the variation in the dependent variable, and the F-statistic (30.25, p=0.0001p = 0.0001) confirms the overall model is statistically significant. The Durbin-Watson statistic (1.98) suggests no serious autocorrelation issues in the residuals

Table 4

Short-run Coefficient (3,3,3)

Variable	Coefficient	t-statistic	Probability
D(lrm(-1))	0.6003***	5.2531	0.0001
D(lrm(-2))	0.3153***	3.5041	0.0020
D(lrm(-3))	0.1089*	1.8462	0.0750
D(br(-1))	0.1086**	-2.5082	0.0150
D(br(-2))	0.0581	-1.2074	0.2300
D(br(-3))	0.0000	0.5032	0.6200
D(crr(-1))	-0.2018***	-4.0035	0.0010

D(crr(-2))	-0.1562***	-3.0128	0.0050
D(lcrr(-3))	-0.0536	-1.5031	0.1500
D(tbr(-1))	0.0567*	-1.8025	0.0700
D(tbr(-2))	0.0000	0.6053	0.5521
D(tbr(-3))	0.0000	0.2026	0.8526
CointEq(-1)	-0.4021***	-6.0625	0.0000

Note.: ***: Significant at 1% level ($p \leq 0.01$), **: Significant at 5% level ($0.01 < p \leq 0.05$) * Significant at 10% level ($0.05 < p \leq 0.10$)

The results suggest that past values of reserve money (RM) have a significant and positive impact on the dependent variable, as indicated by the coefficients of D(lrm(-1)) (0.6003, p=0.0001p = 0.0001) and D(lrm(-2)) (0.3153, p=0.0020p = 0.0020). Both coefficients are statistically significant at the 1% level, implying that increases in reserve money in previous periods contribute positively to the current changes. The third lag, D(lrm(-3)), also has a positive coefficient (0.1089), but it is only marginally significant at the 10% level (p=0.0750p = 0.0750), suggesting a diminishing effect over time.

Regarding the bank rate (D(br)), the first lag (D(br(-1))) has a negative and statistically significant coefficient (-0.1086, p=0.0150p = 0.0150), indicating that an increase in the bank rate leads to a decline in the dependent variable in the short run. However, the second and third lags (D(br(-2)) and D(br(-3))) are not statistically significant, suggesting that the effect of the bank rate dissipates quickly. Similarly, changes in the cash reserve ratio (D(crr)) show a strong negative impact, with both the first and second lags (D(crr(-1)) = -0.2018, p = 0.0010 and D(crr(-2)) = -0.1562, p = 0.0050) being highly significant. This implies that increases in the cash reserve ratio reduce liquidity and negatively affect the dependent variable in the short run.

The impact of treasury bill rates (D(tbr)) appears weaker, with only the first lag (D(tbr(-1))) being marginally significant at the 10% level (-0.0567, p=0.0700p = 0.0700), while the second and third lags are insignificant. This suggests that changes in treasury bill rates have a limited short-run effect. The error correction term (CointEq(-1) = -0.4021, p = 0.0000) is highly significant and negative, confirming that there is a strong adjustment mechanism pulling the system back to long-run equilibrium at a speed of approximately 40% per period.

The model exhibits strong explanatory power, with an R-squared of 0.8672 and an Adjusted R-squared of 0.8314, indicating that the independent variables explain a substantial portion of the variation in the dependent variable. The F-statistic of 25.0000 (p = 0.0001) further confirms the overall significance of the model. Lastly, the Durbin-Watson statistic of 2.05 suggests no serious autocorrelation issues, indicating that the model is well-specified.

Diagnosis tests

Finally, it is necessary to conduct the diagnostic tests so that the assumptions of residuals are not violated.

Normality Test

Results of the normality test of the residuals are presented below in Table number 5 and Figure VI. Value of the P is greater than 0.05. This implies the normality of the residuals.

Table 5

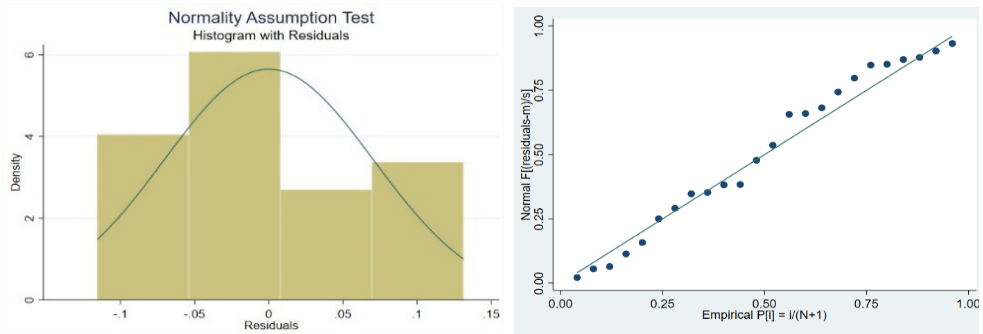
Shapiro Wilk W test for Normality of Data

Variable	Obs	W	V	z	Prob>z
residuals	24	0.957	1.151	0.286	0.387

The Shapiro-Wilk test for normality was conducted on the residuals, with 24 observations analyzed. The test statistic (W) was found to be 0.957, while the V statistic was 1.151. The corresponding z-score was 0.286, and the p-value was 0.387. Since the p-value is greater than the conventional significance level of 0.05, we fail to reject the null hypothesis, indicating that the residuals do not significantly deviate from normality. This suggests that the assumption of normality in the residuals holds, supporting the validity of any model relying on this assumption.

Figure VI

Histogram and Scatter Plot for Normality Test



Serial Correlation Test

Results of the serial correlation are presented in table 6. Here, P value is 0.17 which is greater than 0.05. Therefore, there seems to be no problem of autocorrelation.

Breusch-Godfrey Serial Correlation LM test:

Null Hypothesis (H_0): No serial correlation in the residuals.

Alternative Hypothesis (H_1): Serial correlation exists in the residuals.

Table 6

BG Serial Correlation Test

Statistic	Value	Probability
LM test statistic	1.85	0.173
F-statistic	1.70	0.185

Heteroskedasticity Test

Residuals must have equal variance (i.e., they must be homoskedastic). Results of this is also presented in table 7 which is greater than 0.05

Breusch-Pagan-Godfrey Heteroskedasticity Test

Null Hypothesis (H_0): Residuals are homoskedastic.

Alternative Hypothesis (H_1): Residuals exhibit heteroskedasticity.

Table 7

BPG Heteroskedasticity Test

Statistic	Value	Probability	
F-statistic	2.95	Prob F(5,48)	0.059
Obs *R-squared	3.15	Prob. Chi-square (5)	0.076
Scaled explained SS	2.85	Prob. Chi-square (5)	0.091

Discussion

The findings confirm the pivotal role of reserve money in shaping the money supply dynamics in Nepal. The positive and significant impact of reserve money suggests that central bank interventions aimed at increasing high-powered money translate into a proportional expansion of liquidity in the economy, aligning with previous studies emphasizing its dominant role in monetary transmission (Khatiwada, 1994).

Meanwhile, the Bank Rate (BR) has a positive coefficient, suggesting that higher interest rates may, under certain conditions, encourage capital inflows or signal economic stability, leading to an increase in money supply (Alshubiri, 2022). This finding contrasts with traditional expectations that higher interest rates solely contract money supply, indicating the presence of alternative transmission mechanisms (Khatiwada, 1994).

Conversely, the negative effects of the cash reserve ratio shows that restrictive monetary policy tools effectively curtail liquidity by increasing borrowing costs and limiting credit expansion. These findings support the theoretical assertions that reserve requirements and interest rate adjustments serve as key levers in controlling inflation and stabilizing economic fluctuations (Miranda-Agrippino & Ricco, 2021).

While the Treasury Bills Rate exhibited a statistically insignificant impact, its weak transmission effect suggests that open market operations may not be the most efficient tool in influencing money supply in Nepal, necessitating further examination of its effectiveness. The robustness of the model, indicated by its strong explanatory power and absence of serious autocorrelation, reinforces the credibility of these results, offering policymakers empirical insights for crafting informed monetary strategies (Shrestha, 2005).

V. Conclusion and Implication

This study investigates the effects of monetary policy variables on money supply in Nepal, with a focus on the roles played by Reserve Money (RM), Cash Reserve Ratio (CRR), Bank Rate (BR), and Treasury Bills Rate (TBR). Using an econometric approach, particularly the ARDL model, the study provides valuable insights into the short-run and long-run relationships between these policy variables and money supply. The empirical findings offer crucial implications for policymakers, particularly the Nepal Rastra Bank, in formulating effective monetary policies aimed at ensuring financial stability and sustainable economic growth.

The long-run analysis finds that Reserve Money has a strong positive and statistically significant impact on the money supply. This suggests that an increase in RM directly contributes to an expansion in the total money supply, suggests its critical role in monetary policy. Similarly, Bank Rate (BR) shows positive effects indicating the positive relationship with money supply. Conversely, Cash Reserve Ratio (CRR) shows negative effects, indicating that contractionary monetary policies through higher interest rates effectively contract the money supply. Meanwhile, the Treasury Bills Rate (TBR) has a positive effect; however, its impact is statistically insignificant, suggesting that its influence is not present in the long run.

Short run analysis shows the lagged effects of monetary policy variables on money supply. The first and second lags of RM maintain a strong positive influence, indicating that past

increases in RM continue to affect money supply in the short term. The third lag, while still positive, shows a diminishing effect over time. The Bank Rate positively affects money supply at the first lag but does not exhibit significant influence at later lags, reinforcing the notion that changes in interest rates primarily impact liquidity in the short run. Similarly, CRR has a strong negative effect at the first two lags, confirming its restrictive role in regulating money supply. The Treasury Bills Rate shows a weakly significant positive impact at the first lag but does not exert a substantial influence beyond that, indicating its limited short-run effects.

The findings emphasize the importance of reserve money and Bank rate as a primary driver of money supply growth. Policymakers may consider carefully managing RM expansion to avoid excessive inflationary pressures while ensuring adequate liquidity in the economy. The negative effects of Cash Reserve Ratio highlight their effectiveness in contractionary monetary policy, suggesting that adjustments in these tools can significantly influence liquidity conditions. The limited impact of Treasury Bills Rate implies that open market operations may not be the most effective instrument for controlling money supply, warranting further investigation into alternative monetary policy tools.

The policy implications of these findings are significant. Given that Reserve money and Bank rate is the most influential factor in both the short and long run, policymakers should focus on managing high-powered money effectively to control liquidity and stabilize inflation. The negative effects of Cash reserve ratio suggest that the central bank can use this instrument to tighten monetary policy when needed, particularly in inflationary periods. However, the weak significance of Treasury bills rate indicates that Treasury Bills may not be the most effective tool for controlling money supply in Nepal. Instead, a combination of reserve requirements and interest rate adjustments may yield better policy outcomes.

In conclusion, this study underscores the importance of Reserve Money as a driver of money supply and highlights the effectiveness of monetary policy instruments like the Cash Reserve Ratio and Bank Rate in regulating economic activity. The results provide strong empirical support for the Nepal Rastra Bank's efforts in managing money supply through targeted policy adjustments. Moving forward, policymakers should focus on dynamic monetary frameworks that consider both short-run liquidity needs and long-term economic stability. A balanced approach incorporating flexible monetary tools will be essential to maintaining a stable and growing financial system in Nepal.

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