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Causality and Long-Run Equilibrium among Money Supply, Inflation, and Indian Economic Growth: A VECM Study

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Abstract: The study examined the short-run and long-run relationship among inflation, money supply, and economic growth in India, covering the period from 1960-61 to 2023-24, using time series econometric models. The sources of data were collected from the Reserve Bank of India and World Bank Indicators. The results showed that GDP, CPI and BMS had upward trend and it implied that these variables were non-stationary during the study periods. The estimated Augmented Dickey-Fuller results showed that all the variables were stationary at their first difference. The co-integration test results revealed that there was an existence of co-integration and it implied that there was a long-run relationship between variables. The estimated results of the Vector Error Correction Model showed that that the past values of D (GDP (-1)) and D (CPI (-3)) had a significant negative effect on GDP. A negative effect of past values of GDP on GDP may be due to previous year GDP income had not been properly reinvested into the Indian economy. In the GDP equation, the coefficient of the error correction term had an appropriate negative sign with highly significant, indicating that about 4.37 per cent of the disequilibrium was corrected within the next period's change in GDP. The estimated adjusted R^2 value implied that 37.8 per cent of the variation in GDP explained by money BMS and CPI. The variance decomposition showed that the money supply contributed more to Indian economic growth than inflation. The Granger-causality test results indicated that a unidirectional causation between CPI and GDP, and between CPI and BMS. The findings highlighted the importance of inflation management, and it had less influenced on economic growth. The study believed that findings will be useful to the policymakers for developing effective economic strategies.

Keywords: Economic growth, Inflation Money supply, Cointegration, VECM, India

JEL Classifications: E31, E50, F43

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1. Introduction

1.1. Background of the Study

Economic growth level is the basis for socio-economic development and represents a key objective of an economy. Many economists had explored that a sustainable economic growth is closely related to money supply and inflation (Uche, 2018). Money supply and price stability were key determinants of an economic growth and standard of living of the people. Keynesians (1936) believed that an increase in money supply with lower interest rates could stimulate economic growth. However, excessive money supply could lead to inflation, which could negatively impact economic growth (Lucas, 1972). Supply of money and inflation were important macro variables which played a crucial role in an economy's growth. Most economists agreed that high and unstable inflation could lead to the reduction of consumers' purchasing power, increased uncertainty for businesses, discouraged investment, difficult financial planning, and inefficient resource allocation, all of which negatively impact economic growth (Fischer, 1993)

1.2. Purpose of the Study

India is one of the world's most populous nations with comprises 28 states and 8 union territories. After independence, the government of India formulated various development strategies based on the Harrod-Domar and statistician Mahalanobis growth models for future balanced economic growth, social justice, economic and social equality across Indian states. However, socio-economic disparities have continued across the Indian states up until now, and their impact is reflected at the aggregate level. The UN Human Development Report (2023-24) revealed that India ranked 134th out of 193 countries on the Human Development Index (HDI), with a value of 0.644, categorizing it as a medium human development country. A clear understanding of the interplay among money supply, inflation, and economic growth is essential to successfully elevating India's HDI and meeting the target of achieving developed nation status by 2047. The money supply referred to the total stock of money circulating in the economy. Inflation was referred to as a general increase in the price level, and it negatively affected lower-income households by making essentials like food, fuel, and healthcare more expensive, decreasing their purchasing power, standard of living, and savings, and increasing their debt. The relationship between inflation and economic growth was generally non-linear, meaning both very low and very high inflation could be detrimental, while a moderate level was often seen as conducive to economic growth. The study of the association among money supply, GDP, and inflation in developing and developed countries increased rapidly (Rami, 2010).

1.3. Research Significance

In view of the above, an empirical evaluation of the impact of money supply, inflation, and Indian economic growth will be essential to the policy makers in the following key aspects: (i) taking appropriate measures to avoid excessive economic fluctuations and thus maintain stable economic growth, (ii) better allocating or properly managing resources and improving economic efficiency, (iii) predicting business investment and making decisions and consumption plans, and (iv) formulating more rational and effective economic policies and social development strategies and other policies at the aggregate and disaggregated (states) levels in India.

The rest of the paper was organized as follows: Section 2 presented the review of literature. The sources of data and methodology were described in Section 3. The estimated analysis and discussions were explored in Section 4, and the final Section 5 gave the summary and conclusions. The following sections critically evaluated to a deeper understand of the research topic, study's relevance, key concepts, methodologies, and research gaps in current knowledge.

2. Review of Literature

This section briefly reviewed the closely related available international and national empirical studies on the relationships among money supply (MS), inflation (CPI), and economic growth (GDP). The following international studies investigated the relationships among GDP, MS, and CPI. For instance, Ahmed et al. (2011) examined the long-run relationships among macroeconomic variables real GDP, MS, and CPI for the Sudan economy using annual data over the period 1960 to 2005. The results of Granger Causality revealed that there was a unidirectional causation between MS and CPI. The direction of causation between MS and CPI ran from MS to CPI. There was no reverse causation from CPI movements to MS, and there was no reverse causation noted from prices to national income. Finally, no causation was found between real GD. Saatcioglu & Korap (2008) analyzed the long-run relationships between monetary aggregates, prices, and real output level using econometric models. Results revealed that the changes in the growth rate of M1 and M2 money supplies led to significant increases in the real output growth rate.

Available empirical studies in the Indian context, for instance, Rangarajan & Arif (1990) investigated the relationship between money supply, prices, and output covering the period 1961-62 to 1984-85 using a macro econometric model. The results revealed that an increase in credit led to monetary expansion, which gave rise to inflationary tendencies, and this inflationary impact of monetary expansion was neutralized by the extent of the additional output via the transmission mechanism with partial adjustment over time. Ramachandran & Kamaiah (1992) used cointegration and error correction models to analyze the long-run and short-run relationships between money and prices in India. They found that money supply led to price changes in India, which suggested prices led to money supply changes. Das (2003) examined the nature of the relationship among the price, money supply, and output in India covering the period 1992-2000 using the Vector Autoregression Moving Average (VARMA) model and Cointegration test. The results of the cointegration test suggested that money, price, and output were not cointegrated. The results VARMA of indicated that there was no long-run relationship among the three variables. Ramachandran (2004) investigated the stability of the relationship among M3 money, output, and prices in India using conventional stability tests, cointegration, and error correction models. The study found that the existence of a fairly stable relationship among these variables during 1951–1952 to 2000–2001, and also that there was a short-run dynamic adjustment among these variables.

This result went against the general belief of the existence of a long-run equilibrium relationship. Rami (2010) examined the relationship between narrow money (M1), broad money (M3), price level (WPI), and output (GDP at factor cost) covering the period 1951-2005 using pairwise Granger Causality test. The results test showed that M1 did not Granger cause WPI, WPI did not Granger cause M1, M1 did not Granger cause GDP, and GDP did not Granger cause M1. Manikandan et al. (2018) examined the causal relationship among the money supply, price level, and output variables during 1950-2013 using Johansen's co-integration test and Vector Error Correction Mechanism (VECM). Causal relationship among variables was observed using the Granger causality test. The VECM indicated there was an existence of long-run causalities from money supply to output and money supply to the general price level in the long run. However, in the short run, the bidirectional causality existed between money supply and price level, whereas unidirectional causality existed between output and price level.

2.1. Research Gap and Objective

The existing literature showed that the available few Indian empirical studies focused on the relationships among the inflation, money supply, and economic growth (GDP) covering the period 1961 to 2018, and they were out-dated. Therefore, this study filled this noticeable gap in the financial literature by providing an update (1960-61 to 2023-24) using appropriate advanced time series econometric techniques. This empirical analysis might be helpful for the policy makers to formulate and implement proper effective policies at the aggregate and disaggregated levels in India.

3. Econometric Methodology

3.1. Data Description

The study used secondary data covering time series data for 66 years, from 1960-61 to 2023-24, for three variables, namely Broad Money Supply (BMS), Inflation (Consumer Price Index (CPI)), and economic growth (GDP), in order to analyse the co-integration and causality relationship among them. The choice of the study period was due to the availability of balanced data set. The source of GDP was collected from the Reserve Bank of India, and Consumer Price Index and Broad money were collected from World Bank Indicators. GDP was the final value of the goods and services produced within the geographic boundaries of a country during a specified period of time, normally a year. The money supply was the totality of assets that households and businesses could use to make payments or to hold as short-term investments, such as currency, funds in bank accounts, and anything of value resembling money. CPI was a measure that examined the weighted average of prices of consumer goods and services, such as transportation, food, and medical care. It was calculated by taking price changes for each item in the predetermined basket of goods and averaging them. Changes in the CPI were used to assess price changes associated with the cost of living.

3.2. Econometric Tests & Techniques

According to the Classical Linear Regression Model (CLRM), the time series variables were said to be stationary if their mean, variance, and autocovariance were constant over time. Most of the time, series variables were non-stationary at a regular rate. The Ordinary Least Square (OLS) method could not be employed if the time series variables were non-stationary because the estimated OLS regression of a non-stationary variable on another time series variable resulted in the spurious regression problem (Muftaudeen & Bello, 2014). To avoid these problems, econometricians suggested the unit root test to estimate the OLS regression.

The study employed the appropriate time series econometric technique like Augmented Dickey Fuller (ADF (1979 & 1981)), Co-integration and Vector Error Correction Model (VECM) to investigate the causality between variables. The most popular method of ADF unit root test was employed to examine the stationarity of the time series variables. The estimated of results ADF indicated that all the variables used were stationary at their first difference I (1). The ADF unit root tests were specified as.

$$\Delta Y_t = \beta_1 + \alpha Y_{t-1} + \Sigma_{i=1}^{k} .\ \gamma i\ \Delta Y_{t-1} + e_t \text{ (Constant)} \quad (1)$$

$$\Delta Y_t = \beta_1 + \beta_{2t} + \alpha Y_{t-1} + \Sigma_{i=1}^{k} .\ \gamma i\ \Delta Y_{t-1} + e_t \text{ (Constant \& Trend)} \quad (2)$$

$$\Delta Y_t = \alpha Y_{t-1} + \Sigma_{i=1.}^{k}\ \gamma i\ \Delta Y_{t-1} + e_t \text{ (None)} \quad (3)$$

Where t denoted any time trend, k denoted the lagged differences, α, β, and γ were estimated parameters, e was the error term, Δ denoted by the difference operator (Y_t-Y_{t-1}), Y denoted all the time series variables, $\Delta Y_{t-1} = Y_{t-1} - Y_{t-2}$. Null Hypothesis ($H_0$): Data were non-stationary exists. Alternative Null Hypothesis (H_1): Data were stationary exist. If ADF test statistics exceeded the Mackinnon critical value, H_0 could be rejected, which meant that the series data were stationary at their first difference I (1). The estimated results of the ADF suggested that the Johansen's co-integration test (1988) and VECM were appropriate techniques to examine the long-run relationships among the variables in the short-run and long-run analyses.

Optimal Lag Length Criterion

The Akaike's Information Criterion (AIC), Schwarz's-Bayesian Information Criterion (SBIC) and Hannan's-Quinn Criterion (HQIC) were adopted to determine the optimum lag length of variables to be selected for the co-integration test and VECM analysis. The lag length criteria were specified as

$$AIC = -2T\ [\ln (\hat{R}^2 \rho)] + 2p \quad (4)$$

$$SBIC = \ln (\hat{R}^2 \rho) + [\rho \ln (T)] / T \quad (5)$$

$$HQIC = \ln(\hat{R}^2\rho) + 2\,T^{-1}\,\rho \ln[\ln(T)] \tag{6}$$

Where *p* represented the lag length to determine the time series model, $\hat{R}$ represented the estimation of the residuals from the model, and T represented the number of observations.

Co-integration Test

The Johansen's co-integration Trace statistic and Maximum Eigenvalue statistic test statistics were applied to determine the co-integration ranks (r), which were

$$_{\text{Trace (r)}} = -T\sum_{i=r+1}^{k} \ln(1-\lambda t) \tag{7}$$

$$\lambda_{Max}(r, r+1) = -T\ln(1-\lambda t) \tag{8}$$

Where λi denoted estimated Eigenvalues, T was the number of observations, and K denoted the number of endogenous variables. Trace Statistic: Null Hypothesis (H_0): The number of cointegrating vectors was at most r. Alternative Hypothesis (Ha): The number of cointegrating vectors was greater than r. Maximum Eigenvalue Statistic: Null Hypothesis (H_0): The number of cointegrating vectors was r. Alternative Hypothesis (Ha): The number of cointegrating vectors is r+1. The estimated results showed that the null hypothesis was rejected because the values were more significant than the test statistics and it meant that a long-run equilibrium relationship existed among the variables and then the VECM and Error Correction Mechanism (ECM) were used to examine dynamics relationship among the variables in the short-run and long-run.

VECM Framework

For the three variables, the VECM specified with L-1 lagged difference was a system of three equations

$$\Delta GDP_t = C_1 + \alpha_1 ECT_{t-i} + \sum_{i=1}^{L-1} \gamma_{11,i}\,\Delta GDP_{t-i} + \sum_{i=1}^{L-1} \gamma_{12,i}\,\Delta BMS_{t-i} + \sum_{i=1}^{L-1} \gamma_{13,i}\,\Delta CPI_{t-i} + e_{1t} \tag{9}$$

$$\Delta BMS_t = C_2 + \alpha_2 ECT_{t-i} + \sum_{i=1}^{L-1} \gamma_{21,i}\,\Delta GDP_{t-i} + \sum_{i=1}^{L-1} \gamma_{22,i}\,\Delta BMS_{t-i} + \sum_{i=1}^{L-1} \gamma_{23,i}\,\Delta CPI_{t-i} + e_{2t} \tag{10}$$

$$\Delta CPI_t = C_3 + \alpha_3 ECT_{t-i} + \sum_{i=1}^{L-1} \gamma_{31,i}\,\Delta GDP_{t-i} + \sum_{i=1}^{L-1} \gamma_{32,i}\,\Delta BMS_{t-i} + \sum_{i=1}^{L-1} \gamma_{33,i}\,\Delta CPI_{t-i} + e_{3t} \tag{11}$$

Where, ΔGDP, ΔBMS and ΔCPI described the corresponding first difference series. C_1, C_2 and C_3 were the intercepts, the coefficients α_1, α_2 and α_3 were the adjustment speeds and represent how each variable adjusts in the short run to correct the deviation from the long-run equilibrium. e_1 e_2 and e_3 were the error terms (residuals), which are typically assumed to be a white noise process (multivariate normal). The value of α_j should be statistically significant and negative (or less than zero) for the system to converge back to equilibrium. Let's say, α_1 measures how much of the long-run error (ECT_{t-i}) will corrected in the current period's change in GDP. A high ECT value would imply a high speed of adjustment from short-run disequilibrium to long-run equilibrium. The γ_{ij} coefficients captured the short-run relationships among the variables, specifically the impact of past changes in all variables ΔGDP_{t-i}, ΔBMS_{t-i}, and ΔCPI_{t-i} on the current change in each variable (GDP_t, BMS_t, and ΔCPI_t).

Granger Causality Test

The Granger (Granger, 1988) causality was generally used to identify the pattern of causality relationship between variables used. A general specification of the causality test in a bivariate (X and Y) model could be tested as

$$\Delta X_t = \dot{\alpha}_X + \sum_{i=1}^{n} \alpha_i \, \Delta X_{t-i} + \sum_{i=1}^{n} \beta j \, \Delta Y_{t-j} + u_{1t} \quad (12)$$

$$\Delta Y_t = \dot{\alpha}_Y + \sum_{i=1}^{n} \lambda_i \, \Delta Y_{t-i} + \sum_{i=1}^{n} \gamma j \, \Delta X_{t-j} + u_{2t} \quad (13)$$

This analysis used two tests. The first test examined the null hypothesis that the X does not Granger-cause Y, and the second test examined the null hypothesis that the Y does not Granger-cause X. Unidirectional causality will occur between two variables if either null hypothesis of equation (12) or (13) was rejected. Bidirectional causality existed if both null hypotheses were rejected, and no causality existed if neither the null hypothesis of equation (12) nor (13) was rejected. The rejection or non-rejection of the null hypothesis was based on the probability values of F-statistics. Lastly, the variance decomposition method was employed to measure the strength of variance among the variables.

4. Estimated Empirical Results & Discussion

Descriptive Statistics

The estimated descriptive statistics of the variables under study were given in Table 1. The number of observations for all the variables were 66 as the time period of study was from 1960-61 to 2023-24. The estimated descriptive statistics showed the total observations, mean value, standard deviation, and range of the data (minimum value and maximum value), which helped in further estimation. The results showed that all the variables used exhibited negative skewness except for lnGDP. The estimated kurtosis of all the variables was less than 3. The descriptive results indicated that the mean of lnGDP was 31.03, average of lnBMS was 28.66 and mean of lnCPI was 3.21.and their means were almost identical to their medians. The standard deviation of the variables shows the spread of the values. GDP has the lowest standard deviation of 0.968.

Table 1: Descriptive Statistics

	lnBMS	*lnCPI*	*lnGDP*
Mean	28.66767	3.217058	31.03515
Median	28.76512	3.318880	30.89290
Maximum	32.89754	5.379261	32.78903
Minimum	24.38477	0.927225	29.62850
Std. Dev.	2.706640	1.387787	0.968239
Skewness	-0.060949	-0.088604	0.273971
Kurtosis	1.677874	1.710165	1.773251
Jarque-Bera	4.701001	4.520203	4.813742
Probability	0.095321	0.104340	0.090097
Sum	1834.731	205.8917	1986.250
Sum Sq. Dev.	461.5315	121.3351	59.06172
Observations	64	64	64

Source: Author’s calculation

Unit Root Test

All the time series variables used in this study were transformed into a natural logarithm. In general, figures were the most preliminary tools to get a rough idea about the stationarity of time series. Figures 1, 2 and 3 indicated the upward trend of GDP, CPI and BMS and it implied that these variables were non-stationary during the periods. The estimated results of ADF unit root test, were reported in Table 2, show that none of the variables was integrated at second-order differences.

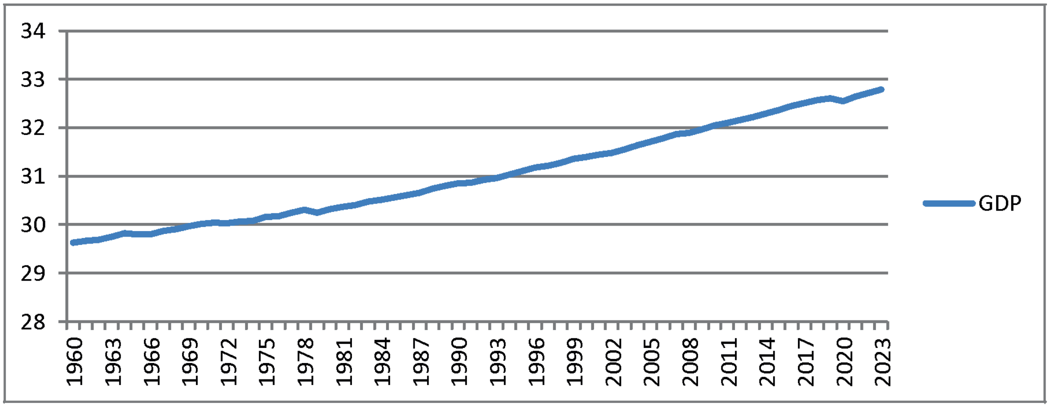

Figure 1: Estimated trends of GDP

Source: Author's calculation

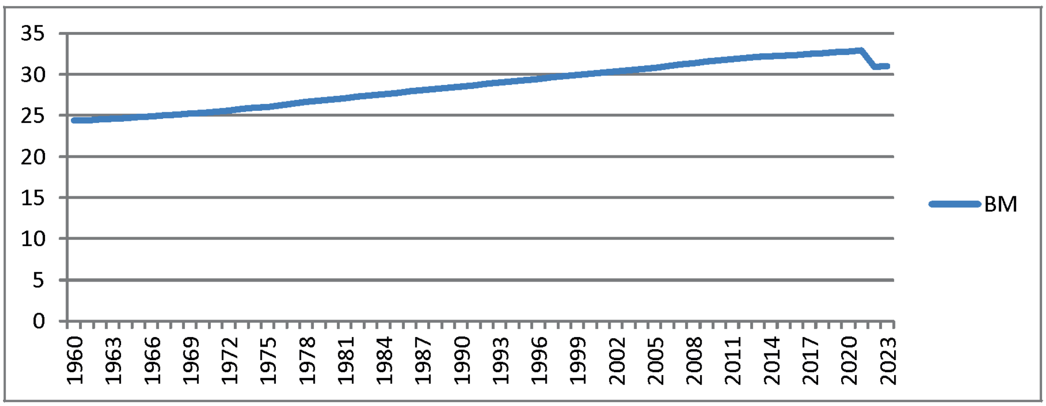

Figure 1: Estimated Trends of BM

Source: Author's calculation

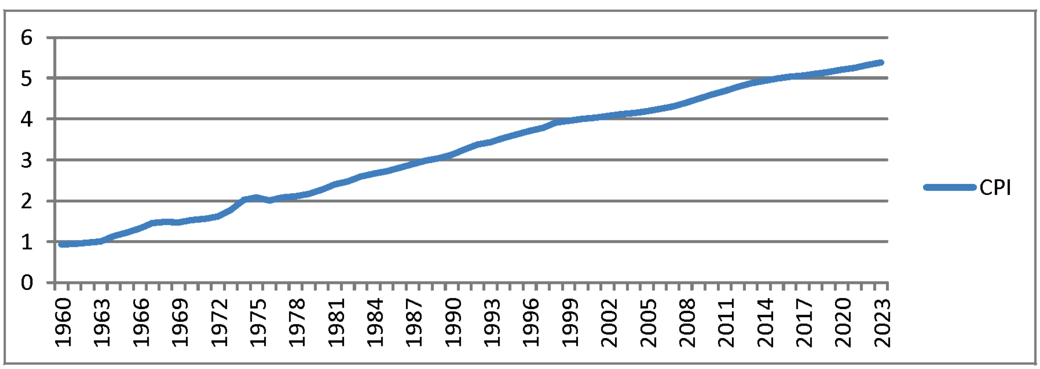

Figure 1: Estimated Trends of CPI

Source: Author's calculation

All the variables were not stationary at their level. However, they become stationary after taking the first difference at 5 percent levels of significance and therefore, are integrated of order 1 that is, the variables are I(1), the null hypothesis is rejected indicating that the series is stationary implying that there was a long-term relationship between the variables. Therefore, the results of ADF test suggested that the VECM approach was a suitable model to explore this relationship further.

Table 2: Estimated results of ADF unit root test

Variables	*Models*	*At their Level*			*Decision*	*At their First difference*			*Decision*
		ADF Statistics	*CV@ 5 Per cent*	*P-Value*	*Non- Stationary*	*Statistics*	*CV@ 5 Per cent*	*p-value*	*Stationary*
GDP	(1)	2.3205	-2.908	1.000	I (0)	-7.638	-2.908	0.000	I (1)
	(2)	-1.7220	-3.482	0.729	I (0)	-8.397	-3.482	0.000	I (1)
	(3)	12.905	-1.946	1.000	I (0)	0.1566	1.946	0.000	I (I)
CPI	(1)	-0.9256	-2.908	0.773	I (0)	-5.819	-2.908	0.000	I (1)
	(2)	-2.4015	-3.482	0.375	I (0)	-5.895	-3.482	0.000	I (1)
	(3)	2.9673	-1.946	0.999	I (0)	-1.359	1.946	0.000	I (I)
BMS	(1)	-1.5732	-2.908	0.490	I (0)	-7.224	-2.908	0.000	I (1)
	(2)	1.7854	-3.482	1.000	I (0)	-7.524	-3.482	0.000	I (1)
	(3)	2.9598	-1.946	0.999	I (0)	-0.859	1.946	0.000	I (1)

Source: Author's calculation

Note: * indicates significance, i.e.: rejection of null hypothesis at 5 percent

Co-integration Test

In order to test for the existence of long-run relationships among variables, the Johansen and Juselius (1990) methodology was utilized. The null hypothesis assumed that there was no cointegration relationship between the variables. The estimated results of the co integration test were reported in Table 3. The results indicated that trace tests points out there existence of one co integrating equation at 5percent level of significance. The trace and Max-Eigen statistics were lesser than their respective critical values at 5 per cent level of significance. So it cannot be rejected the null hypothesis. It implied that the dependent and independent variables were co integrated (a long-run relationship between GDP, BMS and CPI) in India. Overall these two results indicated that the variables were co integrating and a long-run relationship exists among the variables for all countries. Thus the effect of BMS and CPI on economic growth was explored by the estimation of VECM.

The lag order selection criteria were helped in determining the optimal lag length to be used in VECM. The estimated results of criteria were reported in Table 4 and results indicated that the optimal lag length was 4 as indicated by LR, FPE, AIC criteria. This suggests that each variable was lagged by 4 periods and the equation for each endogenous variable was regressed on 4 lags of itself and other endogenous variables in the system.

Table 3: Estimated results of Johansen co-integration test

Variable	*Tests*	*Hypothesized No. of CE(s)*	*Eigen-value*	*Trace statistic*	*Critical Value @ 0.05 %*	*P-Value*	*Co-integration*
GDP, CPI & BMS	Trace statistic	None*	0.278*	44.76*	42.915	0.0322	No
		At most 1	0.2179	24.831	25.872	0.0670	No
		At most 2	0.1488	9.8345	12.517	0.1349	Yes
	Eigen statistic	None	0.2787	19.935	25.823	0.2468	Yes
		At most 1	0.2179	14.997	19.387	0.1938	Yes
		At most 2	0.1488	9.8345	12.517	0.1349	Yes

Source: Author's calculation

Note: * indicates significance at 5percent level

Table 4: Estimated results of optimum lag selection criterion for the VECM model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-92.44806	NA	0.005102	3.235528	3.341165	3.276764
1	227.7525	596.9840	1.34e-07	-7.313642	-6.891092*	-7.148696
2	244.6227	29.73741	1.03e-07	-7.580431	-6.840968	-7.291775
3	257.7603	21.82181	8.99e-08	-7.720689	-6.664314	-7.308323
4	271.3815	21.23974*	7.78e-08*	-7.877338*	-6.504050	-7.341262*
5	277.8464	9.423442	8.65e-08	-7.791403	-6.101203	-7.131617

Source: Author's calculation

Note: *Optimal lag length order selected by the criteria at a 5 per cent level.

AIC: Akaike Information Criterion, SIC: Schwarz-Gideon Information Criterion,

HIC: Hannan-Quinn Information Criterion, LR: Sequential Modified test statistic,

FPE: Final prediction error and endogenous.

Results of VECM

The estimated results in Table 5 provided an analysis of the short-run and long-run relationships among three variables namely GDP, CPI, and BM using a VECM. The co-integrating equation established the long-run relationship between the variables. When GDP (-1) was normalized to 1.0000, the coefficient for CPI (-1) was estimated at 15.552, and the coefficient for BMS (-1) was 0.5431 was statistically significant at the conventional levels. The constant terms for D (GDP) and D (BM) were significant at the1 per cent level. This suggests there was a non-zero drift or deterministic trend in the D (GDP) and D (BM) equations. The ECT revealed the speed of adjustment back to the long-run equilibrium. In the D (GDP) equation, the ECT coefficient was -0.043673 and was found to be highly significant. This negative and highly significant value confirmed a cointegration relationship and indicated that roughly 4.37 per cent of the disequilibrium was corrected within the next period's change in GDP. For the D (BM) equation, the ECT coefficient was 0.3256 and was significant at the 10 per cent level. This suggested a 32.57 per cent adjustment speed for BMS. In contrast, the D (CPI) equation had a positive ECT coefficient of 0.0208, which was not statistically significant, suggesting CPI did not play a significant role in adjusting to the long-run equilibrium.

The short-run dynamics were captured by the coefficients of the lagged differenced variables. In the GDP equation, the estimated results showed that the past values of D (GDP (-1)) and D (CPI (-3)) were significant negative effect on GDP at 5 per cent level. The results are similar to the study of Gatawa et al (2017) who found that there was a negative connection between the past values of GDP and economic growth of Nigeria. A negative effect of past values of GDP on GDP may be due to previous year GDP income had not been properly reinvested into the Indian economy.

The estimated lagged coefficients of D (BMS (-4)) was found to be positive and statistically significant and this coefficient has led to an increase in economic growth (GDP). The results suggested that one per cent increase in BMS lagged by four period D (BMS (-4)) increase GDP by 0.27 per cent. This finding was dissimilar with study of Suleiman (2010) and similar to Saatcioglu & Korap (2008).The results suggest that 1 per cent increase in D (CPI (-3)) lagged by two period increase GDP by 0.206 per cent. However, Osuala, (2013) carried out the impact of inflation on economic growth over a period of thirty-one years using the VAR and its results revealed a statistically significant positive impact of inflation on economic growth in Nigeria which disagreed with the findings of the present study.

In the D (CPI) equation, D (CPI (-1)) was significant positive effect at 5 per cent level. In the D (BMS) equation, D (GDP (-2)) and D (GDP (-2)) were significant positive effect on BMS. Furthermore, a significant constant term was found for both the D (GDP) and D (BMS) equations at 1 per cent level. Finally, the Diagnostic Tests offered insight into the model's fit. The D (GDP) equation exhibited the best fit, having the highest R^2 of 0.517927 and adjusted R^2 value 0.378661 implied that 38 per cent of variation in GDP explained by money BMS and CPI. The D (CPI) equation had the lowest Adjusted R^2 0.210898. The F-statistics of 3.7189, 2.1924, and 3.1822 for (GDP), D (CPI), and D (BMS) respectively suggested that all three equations, as a whole, were statistically significant. The results were derived from 64 observations for each equation. Akaike AIC and Schwarz SC are information criteria used for model selection, where lower values are preferred.

Table 5: Estimated results of Cointegrating & VECM

Variables	*CointEq1*		
GDP(-1) CPI(-1) BM(-1) Constant	1.000000 -15.55250	0.047404 (0.05258)	0.543103 (-1.21228)
Error Correction	D(GDP)	D(CPI)	D(BMS)
Constant	0.0677*** (2.574)	0.0054 (0.134)	-0.8628*** (-3.713)
ECT	-0.0436**** (-3.885)	0.0208 (1.2040)	0.3256* (3.2832)
D(GDP(-1))	-0.1233 (-0.963)	-0.2490 (-1.262)	-0.6092 (-0.539)
D(GDP(-2))	-0.2286** (-1.935)	-0.0907 (-0.498)	5.2454**** (5.0315)
D(GDP(-3))	-0.1546 (-1.045)	0.1987 (0.871)	2.7099** (2.075)
D(GDP(-4))	-0.3241** (-2.163)	0.3098 (1.3420)	1.6776 (1.268)
D(CPI(-1))	0.1425 (1.528)	0.3419** (2.379)**	1.3177 (1.6009)
D(CPI(-2))	-0.1561 (-1.482)	-0.3089 (-1.903)	-0.1877 (-0.201)
D(CPI(-3))	0.2061** (2.010)	0.1572 (0.995)	0.5368 (0.593)
D(CPI(-4))	0.0274 (0.301)	-0.2189 (-1.559)	0.6432 (0.7999)

D(BMS(-1))	-0.0253* (-1.707)	-0.0017 (-0.077)	0.0351 (0.2684)
D(BMS(-2))	0.0054 (0.033)	0.0739 (0.292)	-0.5220 (-0.3604)
D(BMS(-3))	-0.2012 (-1.297)	0.1039 (0.434)	1.9636 (1.4346)
D(BMS(-4))	0.2746* (1.668)	0.2473 (0.975)	1.0283 (0.7076)
Constant	0.0677*** (2.574)	0.0054 (0.1342)	-0.8628*** (-3.713)
Diagnostics Test			
R-squared	0.517927	0.387766	0.478982
Adj. R-squared	0.378661	0.210898	0.328466
F-statistic	3.718988	2.192408	3.182262
Akaike AIC	-4.308247	-3.443621	0.047172
Schwarz SC	-3.815272	-2.950646	0.540147
Observations	64	64	64

Source: Author's calculation
Note: **** indicated highly significance *** indicated significance at 1 % level,
** indicated significance at 5 % level & * indicated significance at 10 % level
Number in parenthesis indicated t-ratios

Granger causality

The Granger-causality test exhibited the relationship between the variables, which may be unidirectional (one-way) (or) bidirectional (two-way) relationship (or) no relationship. The estimated results of granger causality test among the macro economic variables were reported in Table 6. The null hypothesis for GDP does not Granger Cause CPI and also CPI does not Granger Cause BMS. These hypotheses

Table 6: Results of Pair-wise Granger Causality Test

Null Hypothesis	*Pair*	*F-Statistic*	*P-value**	*Decision*
CPI does not Granger Cause GDP	1	2.88633	0.0640	Rejected Null Hypothesis
GDP does not Granger Cause CPI	2	2.37710	0.1020	Accepted Null Hypothesis
BMS does not Granger Cause GDP	3	4.17291	0.0204	Rejected Null Hypothesis
GDP does not Granger Cause BMS	4	2.99472	0.0580	Rejected Null Hypothesis
BMS does not Granger Cause CPI	6	3.71592	0.0304	Rejected Null Hypothesis
CPI does not Granger Cause BMS	6	0.30788	0.7362	Accepted Null Hypothesis

Source: Author's calculation
Note: * indicates significance at 5percent level

were not rejected meaning that accepted null hypotheses showing a unidirectional causation between inflation and GDP, and between inflation and BMS.

Variance Decomposition

The estimated results of the variance decomposition were presented in Table 7. The results indicated that in the fifth year lag period of 53.44 per cent of the variance in GDP was explained by 42.06 per cent of the variance in BMS and 4.99 per cent of the variance in CPI.

Table 7: Results of Variance Decomposition

Variance Decomposition of GDP				
Period	*S.E.*	*GDP*	*BMS*	*CPI*
1	0.026568	100.0000	0.000000	0.000000
2	0.034172	99.01070	0.904139	0.085160
3	0.056432	45.04469	53.10764	1.847670
4	0.061119	39.12369	55.40702	5.469290
5	0.070238	53.44544	42.06338	4.491180
6	0.128921	16.09106	82.47548	1.433459
7	0.138100	14.07661	83.55488	2.368509
8	0.155475	28.37224	68.97550	2.652251
9	0.318779	8.765307	90.54960	0.685090
10	0.410648	5.425239	92.09994	2.474820

Source: Author's calculation

In the tenth lag period, 5.42 per cent of the variance in GDP was explained by 92.09 per cent of the variance in BMS and 2.47 per cent of the variance in inflation (CPI) in India. The results revealed that variance in GDP are mostly explained by BMS and less by Inflation. The results show that the money supply plays a significant role than inflation in the composition of GDP in India.

Summary & Conclusions

The study's key findings were summarized**.** The results indicated that GDP, CPI, and BMS had upward trends and were non-stationary during the study periods. The estimated ADF results showed that all the variables were stationary at their first difference. The cointegration test showed that there was a long-term stable relationship among the variables. The estimated results of the VECM showed that the previous years' values of D (GDP (-1)) and D (CPI (-3)) had a significant negative effect on GDP. This was attributed to previous year GDP income not having been properly reinvested into the Indian economy. In the D (GDP) specification, the error correction term (ECT) was statistically significant with an appropriate negative sign, showing that about 4.37 per cent of the disequilibrium was corrected within the next period's change in GDP. The estimated adjusted^2 revealed that 37.8 per cent of the variation in GDP was explained by BMS and CPI. The variance decomposition showed that the money supply contributed more than inflation to Indian economic growth. The Granger-causality test results indicated a unidirectional causation between CPI and GDP, and between CPI and BMS.

Policy recommendations

The above findings were expected to be helpful to policymakers to formulate relevant policies at disaggregate and aggregate levels in India. Since the lagged GDP term (GDP (-1)) had a significant negative effect on current GDP, policymakers were advised to focus on measures to ensure a higher re-investment rate of current income.

- (a) Direct public expenditure towards high-multiplier infrastructure projects that maximize long-term returns.
- (b) Encourage productive private sector investment in economic activities.

2. The significant negative effect of lagged CPI (CPI (-3)) on GDP and the unidirectional causality from CPI to GDP suggested that managing inflation was crucial for economic growth.
    - (c) Implement supply-side policies (e.g., improving agricultural productivity, logistics) to address core inflationary pressures, rather than relying solely on demand-dampening measures.
    - (d) Monitor and manage price stability as a key input for sustainable long-run economic growth.
3. Strategic Money Supply (BMS) Management: The finding that money supply (BMS) contributed more than inflation to Indian economic growth supported a focus on strategic monetary policy.
    - (e) Maintain an adequate and stable money supply to support credit flow for productive sectors.
    - (f) Ensure that increases in money supply translated into real economic activity and not primarily into asset price bubbles or high inflation.

The study opened avenues for the following future research:

(i) Disaggregated analysis of Money Supply: While the aggregate money supply (BMS) showed a strong contribution to growth, future studies could decompose BMS into its components (e.g., M1, M3, credit to commercial sector) to identify which component had the most potent and stable effect on GDP.

(ii) Expanding the VECM model to include other potential determinants of GDP, such as interest rates, exchange rates, foreign direct investment (FDI), and government debt, could provide a more comprehensive view of the long-run and short-run dynamics.

(iii) Applying time-varying parameter models or regressions could assess if the cointegrating relationship and the magnitude of the VECM coefficients (like the ECT and the effects of lagged variables) had changed over different policy regimes or economic cycles in India. Research could explore asymmetric effects by using non-linear models (e.g., NARDL) to see if positive shocks and negative shocks in CPI or BMS had different impacts on GDP.

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