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Relation Between Inflation and Capital Market in India

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Abstract. *Capital market has significant influence on the inflationary situation in an economy both in the short run and in the long run. The general determinants which affect capital market are share indices, stock prices, prices of gold and silver, interest rate, exchange rate and even money supply can be treated as influencing variable when money is treated as capital. In this paper the author examined the impact of capital market on inflation in India during 1980-2022 taking CPI and WPI as the indicators of inflation and gold price, silver price, BSE index, BSE market capitalization, money supply and rupee dollar nominal exchange rate are considered as the indicators of capital market. Augmented Dickey-Fuller test was applied to verify unit root for all variables including break unit roots and the author calculated growth rates during 1980 – 2022 using the simple semi-log linear trend model. Author applied Johansen cointegration test and vector error correction models among the variables in both the cases of CPI and WPI and calculated short run causality through Wald test and long run causality through cointegrating equation. In VECM, the paper found one significant cointegrating equation in case of CPI and found three significant cointegrating equations in WPI. The paper found that CPI has long run causal relationships with BSE index, BSE market capitalisation, money supply and rupee dollar exchange rate and WPI has long run cointegrating relationships with BSE market capitalisation, money supply and rupee dollar exchange rate respectively. Rupee dollar exchange rate has short run causal relationships with CPI and again CPI and BSE index has bidirectional short run causality. According to impulse response functions,* the *responses of CPI to gold price, BSE market capitalization and money supply have been approaching towards equilibrium but finally diverged away from equilibrium. There are significant short run causalities from BSE index and money supply to WPI. The impulse response of WPI to gold price, silver price, BSE index, BSE market capitalisation and exchange rate of rupee have been converging towards equilibrium many times although diverged finally. The model can be modified by including interest rate, share prices, bond prices under monthly data analysis.*

Keywords-CPI, WPI, gold price, silver price, BSE index, BSE market capitalization, money supply, exchange rate, cointegration, vector error correction, short run causality, long run causality.

JEL Classification: C22, C32, E30, E31, E52, E62, F31.

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Introduction

The stock market performance is directly proportional to the inflation rate where investors on shares behave as a hedge against inflation in the long run because economic and financial theories argued that stock prices are affected by macroeconomic variables. As a result, value of stock or share portfolio can appreciate over the inflationary period because stock market investors are subject to inflation illusion as explained by Modigliani and Cohn (1979). But, in the short run as inflation rises, stock prices fall due to falling revenue

and profits, unfavorable macro-economic indicators, and higher short term interest rate induced from monetary policy. In emerging capital market, high inflation rate affects stock prices (Apergis et al.,1996). It was also found by cointegration analysis using quarterly data on non-financial firms listed in DJIA30 and NASDAQ100 during 1999-2016 that inflation rates are negatively associated with stock prices (Eldomiaty, et al.,2020). Evidence suggests that international stock prices, recession, financial crisis might have impact on stock market vis-à-vis inflationary tendencies.

The increase supply of gold and silver might boost output but the increase in their prices have several economic implications depending on exchange rate regimes and convertibility and hedging in the capital market. The gold might not be a perfect hedge against inflation in the short run, but it works well as a long-term hedge against price inflation caused by the devaluation of fiat currencies from money printing. Again, the gold and silver prices are significantly affected by each other, and generally gold and silver prices are positively correlated in India.

Indian stock market returns are highly volatile and inflation rate and stock market returns are negatively correlated, on the other hand, stock market return is positively related with exchange rate (Sreenu,2016). The nominal exchange rate represents an offsetting factor to changes in relative prices. Higher inflation rate provokes currency exchange rate to be depreciated which has adverse impact on the economy in spite of higher export growth. It also creates exchange rate volatility. It was observed that inflation performance is generally better under pegged exchange rates than floating or freely floating exchange rates where a floating nominal exchange rate represents, at least from a theoretical standpoint, a requirement for a pure inflation targeting regime. Even, inflation brings high bond yield which begun unfavourable effects in capital market (Homer,1969).

On this scenario, the paper endeavours to verify the relationships between Indian inflation (explaining by CPI and WPI) and the determinants of Indian capital market such as gold price, silver price, BSE index, BSE market capitalisation, money supply and rupee dollar nominal exchange rate respectively during 1980-2022 using Johansen's cointegration and vector error correction models.

Some relevant research

In India, capital market has close association with the inflation rate represented by CPI and WPI. Kumar (2008) established that Sensex has strong positive relation with wholesale price index in India and negative relation with the rupee dollar exchange rate during $1998m_7$-$2008m_3$ through regression analysis, but it was found that there is no cointegration between Sensex and WPI. Rajkumar (2018) examined the relationship between WPI and BSE market capitalization, BSE Sensex 30 and trading turnover-both value and volume during $2000m_4$ to $2014m_3$ in India and found that Johansen cointegration revealed one cointegrating equation which explained that inflation is significant in explaining the changes in BSE market capitalisation in the long run inversely. There is no short run relationship. A negative relationship may threaten the stock market predictions.

Garg and Kalra (2018) examined the relationship between Sensex, average inflation rate and gold price in India during 1991-2017 and found that the correlation between Sensex and gold price is 0.918, and the relation between Sensex and average inflation rate is negative.

Sreenu (2018) discussed the use of the co-integration ARDL approach to determine the relationship between the Yuan rate and the Chinese stock market returns. They found the positive relationship between them. Kedia and Vashist (2020) used a linear regression analysis between CPI and BSE index in India and observed that a rise in inflation will lead to the downfall of the BSE Sensex index proportionately during $2016m_4$ to $2019m_{10}$.

Bhowmik (2020) examined the VEC model in China during 1990-2019 and found that there is association between REER, NEER and capital market in which there exists a significant long run negative causality between Shanghai Composite Index, REER and NEER of RMB.

Sreenu (2023) used GARCH, ARDL and ECM models on returns of the stock market and inflation and exchange rates which affects the stakeholder expected returns in India during $2010m_1$- $2020m_6$. In the short run, the relationship among the variables shows the existence of a significant impact on stock market returns and there is long-term association among them. There exists a significant relationship, in terms of co-

integration and causality, between market returns, inflation rate and exchange rate. Hence, increases in the exchange rate (In Indian Currency) drive investors to upsurge stock prices to sojourn in the stock market.

In the capital market, the role of gold price and silver price have significant influence on the inflation rate. Fisher (1930) examined that the gold and silver are expected to hedge against inflation. The so-called Fisher hypothesis is generalised to other investment assets. It implies that the expected nominal return on any investment asset should be equal to its real return plus the expected inflation rate. The post-Keynesian theory of asset price inflation suggests that an increase in share market or property values can itself contribute more to general inflationary pressures (through the wealth effect on consumer expenditures), which require a higher base interest rate from the central bank and entail greater economic hardship for those who subsequently lose their jobs. Mahdavi and Zhou (1997) found that gold and silver prices could effectively gauge inflation expectations since, commodity prices are generally considered to be able to incorporate new information faster than consumer prices.

Baur and Lucey (2010) examine the time-varying relationships between US, UK and German stocks and bonds returns and gold returns. Those authors' aim was to probe the existence of gold as a hedge and a safe haven. Their findings suggest that gold is a hedge against stocks but is not a safe haven for bonds in any market situations. Wang et al. (2011) observes that time and market selection are the keys to inflation hedge. They employ a threshold cointegration framework and find that the low cross elasticity, the incomplete price adjustment and the short-run rigidity of the price adjustment between gold price and CPI might eliminate the inflation hedge ability of gold. Batten et al. (2014) provided estimates from co-integration test for a sample of data from 1985 to 2012 in the US market and found that there would be no dynamic relationship between inflation and gold prices if the volatile period of the 1980s was excluded from the series. Bampinas and Panagiotidis(2015) examined the long-run hedging ability of gold and silver prices against alternative measures of consumer price index for the UK and the US during 1791 to 2010 and found that gold can at least fully hedge headline, expected and core CPI in the long-run. The inflation hedging ability of gold is on average higher in the US compared to the UK. Hoang et al. (2016) analysed the role of gold by conducting non-linear autoregressive distributed lag and showed that there is no long-run equilibrium between gold prices and CPI in China, India and France. Duong (2022) investigated both the short- and the long-run relationships between gold prices and inflation in Vietnam during $2001m_{12}$- $2020m_{7}$ and found that consumer price inflation has no impact on gold price inflation in the short run, but a long-run equilibrium exists between these two variables. VECM causality analysis indicates a unidirectional causality between gold price inflation and consumer price inflation in the short run. This means that gold price inflation temporarily causes consumer price inflation, but the impact of CPI on the gold price index is permanent and negative.

Money supply and exchange rate mechanism in the capital or money market have strong impact on the pressure on inflation rate. Ghosh, Ostry, Gulde and Wolf (1996) verified that there is a strong link between the choice of the exchange rate regime and macroeconomic performance. Adopting a pegged exchange rate can lead to lower inflation, but also to slower productivity growth. Pegged exchange rates are associated with significantly better inflation performance (lower inflation and less variability), and there is at least some evidence of a causal relationship. Timothy, Ada and Chigozie (2016) used VAR and GARCH model in Nigeria from 1970 to 2014 and found that there is a uni-directional causality running from inflation to real exchange rate volatility which is a proxy for domestic inflation and from imported inflation to real exchange rate and there is no causality running from inflation to real exchange rate. Purnomo (2017) verified that inflation reduced exports, slowed growth, world crude oil price, coal price, palm oil price and rubber price and currency exchange rate depreciated in Indonesia during 2012-2016.Monfared and Akın (2017) used VAR model and concluded that both the money supply and the exchange rate affect the inflation in the positive direction during 1976-2012 in Iran. Tom, Rincy and Ajina (2021) used Dickey Fuller (ADF) Test, Johansen's Co-integration Maximum Likelihood Test and Vector Error Correction Model (VECM) and found that exchange rate and inflation are found to have positive impact on export performance in India from 1995 to 2020.Bhowmik(2021) examined that after the entry of Chinese RMB into SDR basket Yuan per SDR has significant long run causality with inflation rate from $2017m_{1}$ to $2021m_{8}$. Kumar et al. (2022) established by cointegration test that IIP numbers with Nifty returns has long run relation with inflation rate, unemployment rate and GDP in India during $2000m_{12}$-$2019m_{12}$. Citci and Kaya (2023) used panel data of

149 countries during 1980–2017 and found that the uncertainty of the exchange rate has a significant and positive effect on inflation and the effect of exchange rate uncertainty on inflation is nonlinear. As the exchange rate uncertainty increases, the size of its effect on inflation decreases.

Yet, more future research are necessary to clarify the influence of capital market on inflationary pressure whether it is in micro or macro level which might be theoretical or empirical. Even, the fundamental research is relevant to find out the multi-dimensional indicators of inflation.

Objective of the paper

In this paper, the author examined the influence of Indian capital market on Inflation from 1980 to 2022 applying the Johansen cointegration test and vector error correction analysis taking the determinants of capital market as gold price, silver price, BSE index, BSE market capitalisation, money supply and rupee US dollar nominal exchange rate respectively and CPI and WPI with 2010=100 were considered as the indicators of inflation in India where both short run and long run relationships have been analysed clearly.

Source of data and methodology

Data on India's CPI (2010=100), WPI (2010=100) and rupee US Dollar nominal exchange rate from 1980 to 2022 were collected from the World Bank. Money supply (Broad money) in Rs Crore was collected from the RBI. The data on the gold price (in Rs 24 carat per 10 gram) and silver price (in Rs per kg) were collected from the website, www.alerttax.in and the data on BSE index and BSE market capitalisation were collected from www.bseindia.com respectively.

Author assumes, y_1=CPI, y_2=WPI, x_1=gold price, x_2=silver price, x_3=BSE index, x_4=BSE market capitalisation, x_5=money supply and x_6=rupee US dollar nominal exchange rate.

Johansen (1988) cointegration and vector error correction were done among $y_1,x_1,x_2,x_3,x_4,x_5,x_6$ and among $y_2,x_1,x_2,x_3,x_4,x_5,x_6$ respectively for India during 1980-2022 to find out long run association and short run causality including cointegrating relationship. The causality was found out by applying the Wald test (1943). Dickey and Fuller, W. A. (1979) test was applied to verify unit root for all variables. The simple semi-log linear trend model was applied to get growth rates of all variables from 1980 to 2022.

Growth rate can be computed from semi-log linear trend regression model which can be written as follows:

$Log(x_i)=c+bt+u_i$ where x_i is dependent variable, t is time, c and b are constants and u_i is random error.

ADF test (1979) can be applied in the following model,

$\Delta y_t=\alpha+\beta t+\gamma y_{t-1}+\delta_1\Delta y_{t-1}+\ldots\ldots\ldots+\delta_{p-1}\Delta y_{t-p+1}+e_t$

Where y is the variable, α is constant, β is the coefficient of time trend, p is the lag order, γ is the higher order regression process, i.e., the lag length p has to be determined when applying the test. The unit test is then carried out under H0=Null hypothesis γ=0 against H1=alternative hypothesis γ<0. When $DF\tau = \frac{\hat{\gamma}}{SE(\gamma)}$. If the calculated test statistic is less (more negative) than the critical value, then the null hypothesis γ=0 is rejected and no unit root is present.

Johansen cointegration test (1988) is shown below.

If the mx1 vector time series Y_t contains more than 2 components, each being I (1), then there may exist k(<m) linearly independent 1xm vectors $\alpha_1, \alpha_2\ldots\ldots\alpha_k$ such that $\alpha' y_t \sim$ I (0) kx1 vector process where $\alpha= (\alpha_1, \alpha_2\ldots\ldots\alpha_k)$ is a k x m cointegrating matrix.

Let VAR(p) [Vector Auto Regressive] model is given below,

$Y_t=\delta D_t+\phi_1 Y_{t-1}+\ldots\ldots\ldots\ldots+\phi_p Y_{t-p}+\varepsilon_t$

Where Y_t is a time series mx1 vector of I(1) variables. The VAR(p) model is stable if

Determinant $(In-\phi_1 z - \ldots\ldots\ldots\ldots - \phi_p z^p) =0$

If there are roots on the unit circle then some or all the variables in Y_t are I(1) and they may be cointegrated. If cointegration exists the VAR model is transferred to VECM (Vector Error Correction Model) which is given below.

$\Delta y_t=\Gamma_0 D_t+\Pi Y_{t-1}+\sum_{j=1}^{p-1} \Gamma j \Delta Y_{t-j} +\varepsilon_t$

Where D_t=vector deterministic variables (constants, trends, and/or seasonal dummy variables)

$\Gamma j=-I+\phi_1+\ldots\ldots\ldots\phi_j$, for all values j=1, 2, …….. p-1 are mxm matrix.

$\Pi=\gamma A$ is the long run impact matrix, A and γ are mxk matrices,

ε_t are Nm (0, Σ) errors.

Determinant $(1-\sum_{j=1}^{p-1} \Gamma j B^j)$ has all its roots outside the unit circle.

Assume VECM errors are independent Nm (0, Σ) distribution, then given CI restrictions on the trends/drift/no drift parameters, the likelihood $L_{max}(k)$ is a function of the CI rank k.

The Trace test is based on log-likelihood ratio (LR).

$LR=2\ln[L_{max}(\text{unrestricted})/L_{max}(\text{restricted})]$ for k=m-1,……..1,0.

The Test H_0:CI rank ≤k Vs H_1:CI rank>k. If the LR is greater than the critical value for a certain rank, then H_0 is rejected.

The Trace Test: $LR_{trace}(k)=-2\ln\Lambda=-T\sum_{i=k+1}^{m} \ln(1-\lambda i)$ where λ_i denotes the descending ordered Eigen values $\lambda_1>\lambda_2>\ \ldots\ldots>\lambda_m>0$ of the determinant $(\lambda S_{11}-S_{10}S00^{-1}S_{01})=0$

If $LR_{trace}(k)$>CV (for rank k), then H_0(CI rank k) is rejected.

Alternatively,

$LR_{max}(k)=-2\ln\Lambda=-T\ln(1-\lambda_{k+1})$ is called the maximal Eigen value statistic. Test H_0:CI rank =k Vs H_1:CI rank=k+1.

The impulse response function can be expressed as MA (Moving Average) process which is derived from VAR(p) model as,

$Y_t=c+\varepsilon_t+\psi_1\varepsilon_{t-1}+\psi_2\varepsilon_{t-2}+\ldots\ldots\psi(B)\varepsilon_t$

$\Delta y_{t+1}/\delta\varepsilon_t=\psi_1$

The row i, column j element of ψ_1 identifies the consequences of one unit increase in the jth variable's innovation at date t(ε_{tj}) for the value of the ith variable at time t+1, holding all other innovations at all dates constant. A plot of the row i, column j element of as a function of lag l is called the non-orthogonalized impulse response function.

The Wald test (1943) has been explained in brief which is relevant in this analysis.

Y_t in a VAR(p) process is divided into sub-processes z_t and x_t i.e.,$\ddot{Y}_t=(\dot{x}_t, \dot{z}_t)$.Causality is defined by zero constraints on VAR coefficients and when in VAR(p) system, it is tested zero constraints for the coefficients to derive asymptotic test considering ca=c < = >A_{jki} =0 in a manner of :

H_0:ca=c against H_1:ca≠c where c is an (Nx(k^2p+k) matrix of rank N and c is an (Nx1) vector. Assuming that $\sqrt{T}$(cä -a)∩N[(0, $\Gamma^{-1}\Sigma_u)'$] is an least square/maximum likelihood estimation and then we get $\sqrt{T}$(cä -ca) ∩N[0, c($\Gamma^{-1}\Sigma_u$)c′] . Hence the Wald statistic is given by

$T(cä-c)'[c(\Gamma^{-1}\Sigma_u)c']^{-1}(cä-c) \cap \chi2(N)$.

Then we replace Γ and I_u by their unusual estimator

$\Gamma'=zz'/T$ and $\Sigma'_u=T/(T-k_p-1)x\Sigma'_u$, then the resulting statistic becomes

$\lambda_w=(\ c\ddot{a}\ -a)'[c((zz')^{-1}\ \Sigma'_u)c']^{-1}(\ c\ddot{a}\ -c)$

It is still asymptotic $\chi 2$ distribution with N degree of freedom and it has the condition of

$[c((zz')^{-1}\ \Sigma'_u)c']^{-1}/T$ which is a consistent estimator of $[c(\Gamma^{-1}\Sigma_u)c']^{-1}$

Hence, we have the following result: The asymptotic distribution of the Wald statistic supposed:

$\sqrt{T}\ (c\ddot{a}\ -a)\cap N[(0,\ \Gamma^{-1}\Sigma_u)]$ holds and in practice, $NF(N,T)\ \cap\ \chi 2(N)$ as t tends to infinity where F(N,T) indicates as F random variable with N and T degrees of freedom because F(N,T) distribution has flatter tail than the $\chi 2(N)/N$ distribution and it is reasonable to consider the test statistic $\lambda_F=\lambda_w/N$ in conjunction with critical values from the F -distribution.

Observations and Results

Based on the semi-log linear trend model, the rate of increase of CPI is higher than the rate of increase of WPI during 1980-2022(7.18%>5.84%) and the rate of increase of gold price is higher than the rate of increase of silver price (8.27%>7.63%) and the rate of BSE market capitalization is greater than rate of increase money supply followed by BSE index (15.73% >14.88%>13.58%) and the rupee dollar exchange rate has been depreciating at the rate of 5.12% per year. These findings are vividly shown in the Table 1.

Table 1. Growth rates

	Growth rate % per year(1980-2022)	R^2	Significant/ insignificant at 5%
CPI	7.18%	0.99	significant
WPI	5.84%	0.97	significant
Gold Price	8.27%	0.94	significant
Silver Price	7.63%	0.91	significant
BSE Index	13.58%	0.95	significant
BSE Market Capitalization	15.73%	0.95	significant
Money Supply	14.88%	0.99	significant
Exchange Rate	5.12%	0.89	significant

Source: calculated by author.

All the dependent and independent variables showed unit roots in the level series which were found by applying ADF test but their first difference series had no unit roots. Moreover, all the series consist of break unit roots in a single year, all of which are tabulated below in Table 2.

Table 2. Unit root test

	ADF	Probability	Trend+intercept (1980-2022)	Break unit root at
CPI	2.22	1.0	Has unit root	2019
WPI	-1.599	0.779	Has unit root	2009
Gold Price	0.720	0.99	Has unit root	2017
Silver Price	-1.71	0.72	Has unit root	2010
BSE Index	2.87	1.0	Has unit root	1990
BSE Market Capitalization	0.812	0.99	Has unit root	1999
Money Supply	5.16	1.0	Has unit root	2018
Exchange Rate	-1.55	0.79	Has unit root	2002

Source: calculated by author.

Johansen cointegration rank test of the first difference series of CPI, gold price, silver price, BSE index, BSE market capitalisation, money supply and exchange rate of rupee against US$ from 1980 to 2022 revealed that there are at least 3 cointegrating equations in Trace and Max Eigen statistics in each of the categories of tests which are significant at 5% level and is tabulated below in Table 3.

Table 3. Cointegration test of CPI

Data trend	None	None	Linear	Linear	Quadratic
Test type	No intercept, no trend	Intercept, no trend	Intercept, no trend	Intercept, trend	Intercept,trend
Trace statistic	4	3	4	3	4
Max Eigen statistics	3	3	3	3	3

Critical values based on Mackinnon-Hang-Michellis (1999).

Source: calculated by author.

Johansen unrestricted cointegration rank test among first difference series of y_1, x_1, x_2, x_3, x_4, x_5 and x_6 of India during 1980-2022 (adjusted 1995-2022) has been conducted with assumption of linear intercept and trend where Trace and Max-Eigen statistics are significant at 5% level for three cointegrating equations which are given below in Table 4.

Table 4. Cointegrating equations

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.979571	291.0670	150.5585	0.0000
At most 1 *	0.929722	182.1245	117.7082	0.0000
At most 2 *	0.831647	107.7761	88.80380	0.0011
At most 3	0.609630	57.88866	63.87610	0.1439
At most 4	0.480542	31.55015	42.91525	0.4130
At most 5	0.256564	13.21103	25.87211	0.7216
At most 6	0.160836	4.909789	12.51798	0.6094
		Max-Eigen statistic		
None *	0.979571	108.9425	50.59985	0.0000
At most 1 *	0.929722	74.34840	44.49720	0.0000
At most 2 *	0.831647	49.88745	38.33101	0.0016
At most 3	0.609630	26.33851	32.11832	0.2154
At most 4	0.480542	18.33912	25.82321	0.3518
At most 5	0.256564	8.301241	19.38704	0.7937
At most 6	0.160836	4.909789	12.51798	0.6094

* denotes rejection of the hypothesis at the 0.05 level,n=28,

**MacKinnon-Haug-Michelis (1999) p-values

Source: calculated by author.

Since Johansen model found out cointegration among the said variables then the VEC is necessary to explain its impact of variations, so that the estimated VEC model of CPI is given below in Table 5 for further analysis.

Table 5. VEC model of CPI

Error Correction:	$d(y_{1t})$	$d(x_{1t})$	$d(x_{2t})$	$d(x_{3t})$	$d(x_{4t})$	$d(x_{5t})$	$d(x_{6t})$
CE1	-0.223035	262.4355	1504.040	-95.74086	395143.5	25156.95	-0.099208
t value	[-1.54240]	[1.77667]	[2.33577]*	[-0.33193]	[2.45976]*	[2.71744]*	[-0.43056]
CE2	0.000139	0.029441	4.937800	2.014601	943.0196	-86.25751	-0.001639
t value	[0.34506]	[0.07151]	[2.75112]	[2.50582]	[2.10603]	[-3.34276]	[-2.55223]
CE3	-1.69E-05	-0.175976	-2.189884	-0.747159	-546.8186	5.046717	0.000660
t value	[-0.10847]	[-1.10703]	[-3.16018]*	[-2.40707]*	[-3.16302]*	[0.50656]	[2.66018]*
$d(y_{1t-1})$	0.571562	-219.5442	-316.8573	-1269.779	-378311.7	-11988.31	0.631066
t value	[3.55758]*	[-1.33774]	[-0.44290]	[-3.96233]*	[-2.11960]*	[-1.16554]	[2.46505]*
$d(x_{1t-1})$	3.19E-06	0.250335	0.850969	-0.691166	-23.47942	27.60063	0.000559
t value	[0.01496]	[1.14844]	[0.89555]	[-1.62383]	[-0.09904]	[2.02034]*	[1.64254]
$d(x_{2t-1})$	5.57E-05	0.267658	1.143163	0.562477	318.1909	-4.283637	-0.000362
t value	[0.54398]	[2.56057]*	[2.50872]*	[2.75571]*	[2.79898]*	[-0.65387]	[-2.21983]*
$d(x_{3t-1})$	0.000305	0.203388	0.784959	0.247198	297.0248	4.178483	-0.000542

Table 5 (cont). VEC model of CPI

t value	[2.70681]*	[1.76419]	[1.56191]	[1.09809]	[2.36902]*	[0.57831]	[-3.01289]*
$d(x_{4t-1})$	-5.12E-07	-0.000433	-0.002874	-0.000539	-0.725785	0.116753	1.54E-07
t value	[-1.17436]	[-0.97181]	[-1.48118]	[-0.62056]	[-1.49938]	[4.18538]*	[0.22172]
$d(x_{5t-1})$	9.41E-07	0.000976	0.017235	0.012130	2.890487	0.225489	-3.84E-06
t value	[0.45922]	[0.46632]	[1.88873]	[2.96750]*	[1.26967]	[1.71874]	[-1.17699]
$d(x_{6t-1})$	0.091101	84.82940	-831.5242	1360.559	504878.4	23719.12	-0.453007
t value	[0.55767]	[0.50835]	[-1.14308]	[4.17544]*	[2.78198]*	[2.26794]*	[-1.74028]
C	1.649940	1114.067	-9502.097	-1758.798	-639840.1	478140.9	2.377722
t value	[1.61574]	[1.06801]	[-2.08963]*	[-0.86348]	[-0.56401]	[7.31371]*	[1.46125]
R-squared	0.908504	0.862218	0.640490	0.756497	0.703869	0.985042	0.589008
F-statistic	17.87291	11.26414	3.206818	5.592096	4.278401	118.5405	2.579649
Akaike AIC	3.618946	17.47701	20.42162	18.81540	31.46036	25.75287	4.550758
Schwarz SC	4.137575	17.99564	20.94025	19.33403	31.97899	26.27150	5.069388

*=significant at 5% level, [(1994-2022), n=29]

Source: calculated by author.

The estimated VEC equations can be stated as follows. The increment of CPI is positively related to all incremental variables except BSE market capitalisation where relation between CPI and BSE index is significant at 5% level. The increment of gold price is negatively related with incremental CPI and BSE market capitalisation and the rest are positively related but all are insignificant. The increment silver price is negatively related with CPI, BSE market capitalisation and rupee dollar exchange rate insignificantly but others are positively related insignificantly. The increment BSE index is negatively related with CPI, BSE market capitalisation and gold price where first relation is significant but it is positively related with rest of the variables where silver price, money supply and exchange rate are significant at 5% level. The increment BSE market capitalisation is positively related with incremental silver price, BSE index, money supply and exchange rate where BSE index and exchange rate are significant but it is negatively related with incremental CPI and gold price where former is significant. The increment money supply is positively related with incremental gold price, BSE index, BSE market capitalisation, money supply and exchange rate where BSE index and money supply are insignificant and it is negatively related with incremental CPI and silver price where both are insignificant. The increment rupee dollar exchange rate is positively related with incremental CPI, gold price and BSE market capitalisation where the first one is significant but it is negatively related with incremental silver price, BSE index, money supply and exchange rate respectively where former two are significant.

The VEC model has 4 unit-roots and other roots are less than one which implies that the model is stable but nonstationary. The values of roots have been arranged below in Table 6.

Table 6. Roots of VEC model of CPI

Root	Modulus
1.000000	1.000000
1.000000	1.000000
1.000000	1.000000
1.000000	1.000000
0.907109	0.907109
-0.675413 - 0.479790i	0.828481
-0.675413 + 0.479790i	0.828481
-0.047171 - 0.768042i	0.769489
-0.047171 + 0.768042i	0.769489
0.271328 - 0.643970i	0.698796
0.271328 + 0.643970i	0.698796
0.657474 - 0.213842i	0.691376
0.657474 + 0.213842i	0.691376
-0.571969	0.571969

Source: calculated by author.

Therefore, the roots lie on or inside the unit circle which proves stability of the model which is shown below in Figure 1.

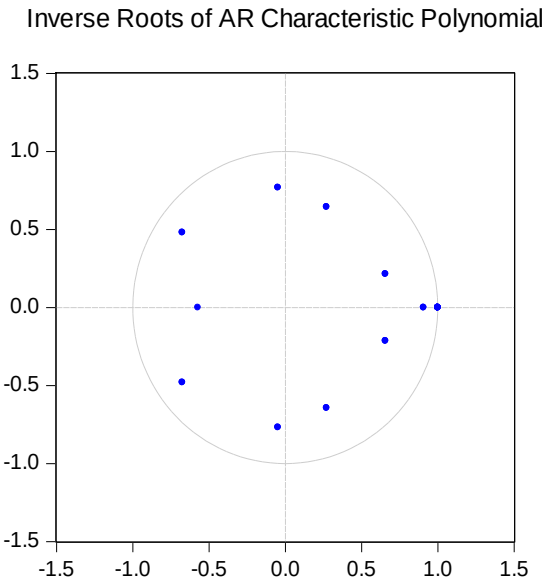

Figure 1. Unit circle

Source: plotted by author.

The VEC model contains autocorrelation problems which is seen in the Figure 2 below where values of autocorrelation randomly varied from positive to negative.

Figure 2. Autocorrelation

Source: plotted by author.

The impulse response functions are given below in Figure 3.

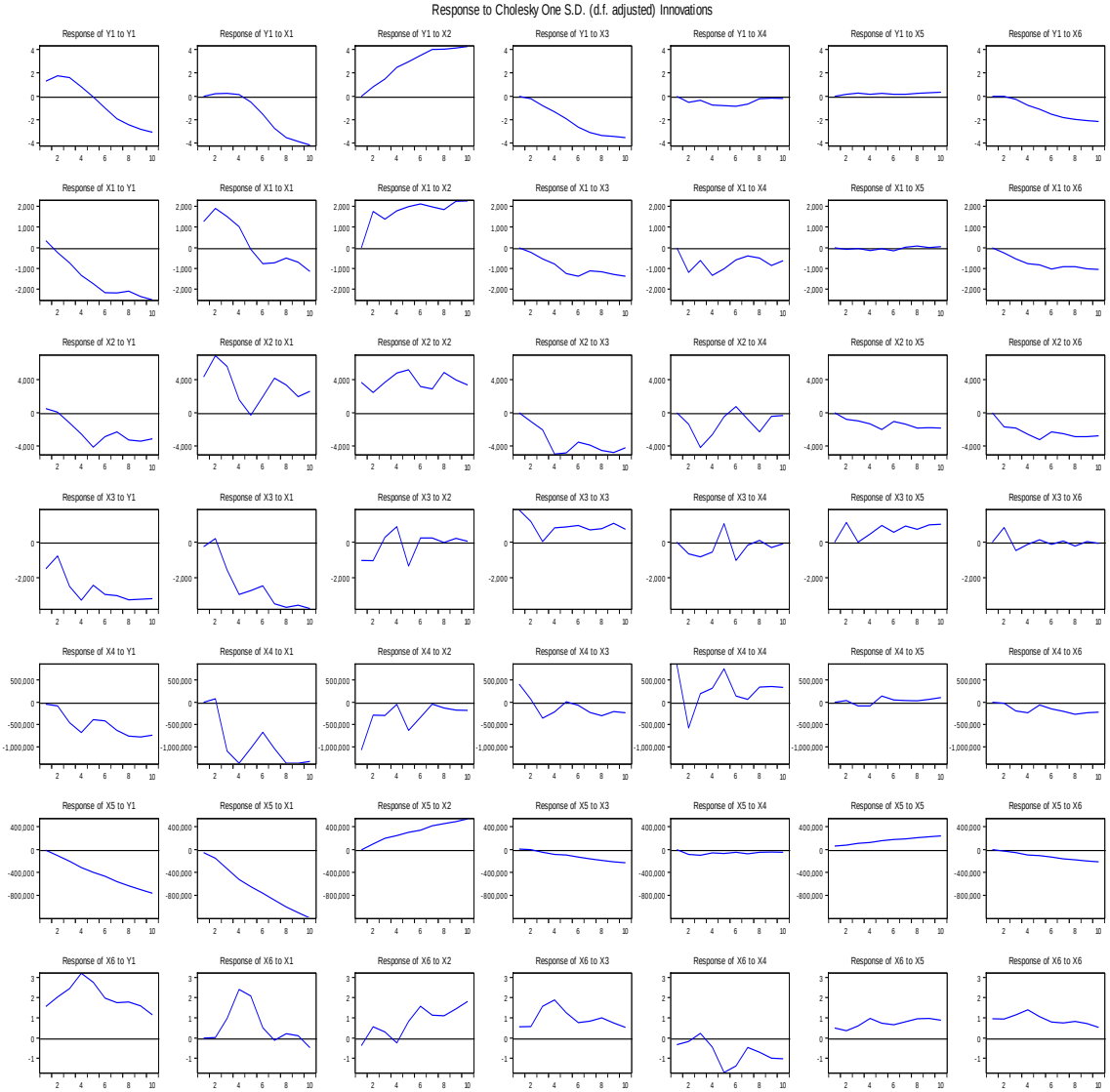

Figure 3. Impulse response functions

Source: plotted by author.

The impulse response functions imply that responses of CPI to gold price, BSE market capitalization and money supply converged towards equilibrium for some periods but the rest of the variables have opposite directions. On the other hand, responses of all other variables to CPI move away from equilibrium. In analysing the short run associations, the short run causality among CPI, gold price, silver price, BSE index, BSE market capitalisation, money supply and rupee dollar rate during 1980-2022 have been presented in the Table 7 where it was found that there are short run causalities to BSE index from CPI, money supply and rupee dollar rate. BSE market capitalisation has short run causalities from CPI, silver price, BSE index and rupee dollar exchange rate respectively. Money supply has short run causal relationships from BSE market capitalisation and rupee dollar exchange rate which has also short run causal relationships with CPI, silver price, and BSE index respectively. CPI and BSE index has bidirectional short run causality. There is short run causality to gold price from silver price. Their Chi-square and F values with probabilities showed significant and have been included in the Table 7 for verification.

Table 7. Short run causality from x_1,x_2,x_3,x_4,x_5,x_6 to y_1

Causality from …..to …..	Chi-square(1)(prob)	F(1,18)(prob)	Sig/insig
From BSE index to CPI	7.32(0.0068)	7.32(0.0144)	significant

Table 7 (cont). Short run causality from x_1,x_2,x_3,x_4,x_5,x_6 to y_1

From silver price to gold price	6.55(0.0155)	6.55(0.0197)	Significant
From CPI to BSE index	15.70(0.0001)	15.70(0.0009)	significant
From money supply to BSE index	8.806(0.0030)	8.806(0.0082)	significant
From exchange rate to BSE index	17.43(0.0000)	17.43(0.0006)	significant
From CPI to BSE market capitalisation	4.49(0.0340)	4.49(0.0482)	Significant
From silver price to BSE market capitalisation	7.83(0.0051)	7.83(0.0119)	significant
From BSE index to BSE market capitalisation	5.61(0.0178)	5.61(0.029)	significant
From exchange rate to BSE market capitalisation	7.73(0.0054)	7.73(0.0123)	significant
From BSE market capitalisation to money supply	7.51(0.000)	7.51(0.0006)	Significant
From exchange rate to money supply	5.14(0.023)	5.14(0.035)	significant
From CPI to exchange rate	6.076(0.0137)	6.076(0.024)	significant
From silver price to exchange rate	4.92(0.026)	4.92(0.039)	Significant
From BSE index to exchange rate	9.077(0.0026)	9.077(0.0075)	significant

Source: calculated by author.

The VECM revealed three cointegrating equations which imply that the variables are cointegrated in the long run. The three cointegrating equations are stated below where equation (1) implies that CPI has long run causal relationships with BSE index, BSE market capitalisation, money supply and rupee dollar exchange rate respectively which are significant at 5% level where first two are positively related, money supply impacted inversely but exchange rate impacted directly but its trend is negative. The first cointegrating equation has been approaching towards equilibrium insignificantly at the speed of adjustment of 22.3% per year because the t value of the coefficient of y_{1t-1} is insignificant but its coefficient is negative satisfying equilibrium condition.

Likewise, cointegrating equation (2) implies that gold price has long run causal relationships with BSE index, BSE market capitalisation, money supply and rupee dollar exchange rate respectively which are significant at 5% level except BSE index. It is divergent because the coefficient of x_{1t-1} is positive and its t value is insignificant. It is diverging at the speed of adjustment 2.9% per year. Moreover, the cointegrating equation (3) expressed that silver price has long run causal relationships with BSE index, BSE market capitalisation, money supply and rupee dollar exchange rate respectively which are significant at 5% level where all are positively related except money supply and the trend is negative. The third cointegrating equation has been approaching towards equilibrium significantly at the speed of adjustment 218% per year because the t value of coefficient of x_{2t-1} is significant and its coefficient is negative satisfying equilibrium condition.

$$Z_{1t-1}=-0.223y_{1t-1}+0.00131x_{3t-1}+2.28e^{-06}x_{4t-1}-1.09e^{-06}x_{5t-1}+0.874x_{6t-1}-3.709t+0.359 \quad (1)$$

(-1.54) (3.21)* (3.51)* (-16.24)* (6.62)* (-12.92)*

$$Z_{2t-1}=0.0294x_{1t-1}+0.192x_{3t-1}+0.0039x_{4t-1}-0.00702x_{5t-1}+1079.63x_{6t-1}-1693.34t+3975.39 \quad (2)$$

(0.071) (1.35) (10.84)* (-18.53)* (14.52)* (-10.48)*

$$Z_{3t-1}=-2.189x_{2t-1}+1.46x_{3t-1}+0.0102x_{4t-1}-0.0162x_{5t-1}+3462.74x_{6t-1}-6173.24t-6105.87 \quad (3)$$

(-3.16)* (3.65)* (9.92)* (-15.14)* (16.48)* (-13.52)*

In the Figure 4, the three cointegrating equations have been depicted where their approaching equilibrium conditions are visible clearly in the diagrams.

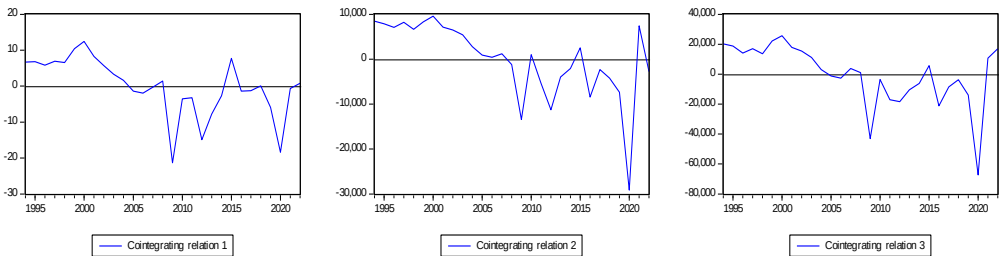

Figure 4. Cointegrating equations

Source: plotted by author.

Johansen unrestricted cointegration rank test of the first difference series of WPI, gold price, silver price, BSE index, BSE market capitalisation, money supply and exchange rate of rupee against US$ from 1980 to 2022 revealed that there are at least 4 cointegrating equations in Trace and Max Eigen statistics in each of the categories of tests which are significant at 5% level and is tabulated below.

Table 8. Cointegration test of WPI

Data trend	None	None	Linear	Linear	Quadratic
Test type	No intercept, no trend	Intercept ,no trend	Intercept, no trend	Intercept, trend	Intercept,trend
Trace statistic	4	4	4	4	4
Max Eigen statistics	4	4	4	4	4

Critical values based on Mackinnon-Hang-Michellis (1999). Source-Calculated by author.

Johansen unrestricted cointegration rank test among first difference series of y_2, x_1, x_2, x_3, x_4, x_5 and x_6 of India during 1980-2022 (adjusted 1995-2022) has been conducted with assumption of linear intercept and trend where Trace and Max-Eigen statistics are significant at 5% level for four cointegrating equations which are given below in Table 9.

Table 9. Cointegration test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.962679	293.8458	150.5585	0.0000
At most 1 *	0.927126	201.7760	117.7082	0.0000
At most 2 *	0.880814	128.4432	88.80380	0.0000
At most 3 *	0.772709	68.88525	63.87610	0.0178
At most 4	0.392667	27.40253	42.91525	0.6576
At most 5	0.261486	13.43954	25.87211	0.7034
At most 6	0.162110	4.952317	12.51798	0.6033
		Max-Eigen statistic		
None *	0.962679	92.06985	50.59985	0.0000
At most 1 *	0.927126	73.33281	44.49720	0.0000
At most 2 *	0.880814	59.55793	38.33101	0.0001
At most 3 *	0.772709	41.48272	32.11832	0.0027
At most 4	0.392667	13.96299	25.82321	0.7256
At most 5	0.261486	8.487224	19.38704	0.7759
At most 6	0.162110	4.952317	12.51798	0.6033

* denotes rejection of the hypothesis at the 0.05 level,n=28

**MacKinnon-Haug-Michelis (1999) p-values;

Source: calculated by author.

The estimated VEC model of WPI can be expressed as follows. The incremental WPI is negatively related with incremental gold price, BSE market capitalisation, and rupee dollar exchange rate insignificantly and is positively related with incremental silver price, BSE index, and money supply where second is significant at 5% level. The incremental gold price is positively related with incremental silver price, BSE index, BSE market capitalisation, and exchange rate in which silver price is significant and it is negatively related with WPI and money supply insignificantly. The incremental silver price is positively related with incremental gold price, BSE index, and money supply insignificantly and is negatively related with WPI, BSE market capitalisation and exchange rate insignificantly. The incremental BSE index is positively related with incremental WPI, gold price, silver price, BSE index, BSE market capitalisation, money supply and exchange rate respectively where silver price and exchange rate are significant. The incremental BSE market capitalisation is positively related with incremental WPI, silver price and exchange rate insignificantly and others are related negatively which are insignificant. The incremental money supply is positively related with incremental gold price, BSE index, BSE market capitalisation, money supply and exchange rate where gold price, BSE market capitalisation are significant. Other negative relations are insignificant. The incremental rupee dollar exchange rate is positively related with incremental WPI, gold price, BSE market capitalisation insignificantly and is negatively related with increment silver price, BSE index, money supply

and exchange rate where BSE index is significant. The coefficients and their t values with probabilities of all variables of the VEC model have been incorporated in Table-10.

Table 10. VEC model of WPI

Error correction	$d(y_{2t})$	$d(x_{1t})$	$d(x_{2t})$	$d(x_{3t})$	$d(x_{4t})$	$d(x_{5t})$	$d(x_{6t})$
CE1	-1.097505	111.0028	1437.900	-243.9797	-397212.3	24069.34	-0.155959
t value	[-3.42364]*	[0.45336]	[1.13728]	[-0.39850]	[-1.80951]	[1.19102]	[-0.36587]
CE2	0.001307	-0.210044	2.207616	0.960336	578.7838	-140.4054	-0.000603
t value	[3.19904]*	[-0.67314]	[1.37009]	[1.23080]	[2.06891]*	[-5.45159]*	[-1.11018]
CE3	0.000130	-0.116729	-1.826017	-0.500115	-71.94475	19.93731	0.000460
t value	[0.79270]	[-0.92849]	[-2.81279]*	[-1.59090]	[-0.63831]	[1.92138]	[2.10184]*
CE4	-0.000763	0.035458	-1.393770	-0.881724	209.1152	16.71293	0.000723
t value	[0.79270]	[-0.92849]	[-2.81279]*	[-1.59090]	[-0.63831]	[1.92138]	[2.10184]
$d(y_{2t-1})$	0.191039	-47.61597	-291.0764	252.0760	32133.56	-16937.51	0.121020
t value	[1.09778]	[-0.35824]	[-0.42409]	[0.75844]	[0.26966]	[-1.54389]	[0.52298]
$d(x_{1t-1})$	-0.000370	0.143275	1.511283	-0.790275	-491.8352	53.89741	0.000170
t value	[-0.95831]	[0.48585]	[0.99245]	[-1.07172]	[-1.86030]	[2.21434]*	[0.33018]
$d(x_{2t-1})$	0.000133	0.247126	0.930682	0.414335	73.17281	-12.88436	-0.000257
t value	[1.27877]	[3.11324]*	[2.27052]*	[2.08745]*	[1.02819]	[-1.96653]	[-1.85628]
$d(x_{3t-1})$	0.000563	0.168849	1.095185	0.277885	-89.79825	3.020493	-0.000664
t value	[3.24964]*	[1.27615]	[1.60296]	[0.83992]	[-0.75701]	[0.27658]	[-2.88429]*
$d(x_{4t-1})$	-6.50E-07	3.40E-06	-0.003091	0.000222	0.793865	0.098338	5.97E-07
t value	[-0.86722]	[0.00594]	[-1.04608]	[0.15548]	[1.54733]	[2.08195]*	[0.59945]
$d(x_{5t-1})$	1.42E-05	-0.001133	0.020711	0.013494	-3.519402	0.188854	-7.94E-06
t value	[3.45151]*	[-0.36058]	[1.27591]	[1.71670]	[-1.24876]	[0.72787]	[-1.45053]
$d(x_{6t-1})$	-0.344845	17.21016	-969.7056	975.4029	213536.8	7948.995	-0.137095
t value	[-1.89668]	[0.12393]	[-1.35229]	[2.80900]*	[1.71515]	[0.69351]	[-0.56706]
C	-6.210617	1590.279	-13258.67	-10389.81	2817379.	524836.4	8.025387
t value	[-2.32564]*	[0.77967]	[-1.25883]	[-2.03710]*	[1.54067]	[3.11748]*	[2.26000]*
R-squared	0.888024	0.894070	0.612163	0.693002	0.845276	0.980055	0.606411
F-statistic	12.25622	13.04400	2.439349	3.488630	8.443022	75.94013	2.381111
Akaike AIC	4.006505	17.28308	20.56643	19.11608	30.88017	26.10960	4.576459
Schwarz SC	4.572282	17.84886	21.13220	19.68186	31.44595	26.67538	5.142236

*=significant at 5% level; (1994-2022),n=29;

Source-Calculated by author.

The VEC model of WPI consists of 14 roots in which two roots are greater than one, three roots are equal to one and other 9 roots are less than one, so that the model is unstable and nonstationary. The values of roots are shown in Table 11, below.

Table 11. Roots of VECM of WPI

Root	Modulus
0.892957 - 0.538736i	1.042884
0.892957 + 0.538736i	1.042884
1.000000	1.000000
1.000000	1.000000
1.000000	1.000000
-0.339490 - 0.929649i	0.989698
-0.339490 + 0.929649i	0.989698
0.833084	0.833084
-0.742122 - 0.309522i	0.804083
-0.742122 + 0.309522i	0.804083
0.195167 - 0.629220i	0.658793
0.195167 + 0.629220i	0.658793
-0.320612 - 0.502025i	0.595669
-0.320612 + 0.502025i	0.595669

Source: calculated by author.

Its two roots are greater than one which lie outside unit circle, other roots lie on or inside the unit circle which are depicted in Figure 5 below. It implies that the model is unstable.

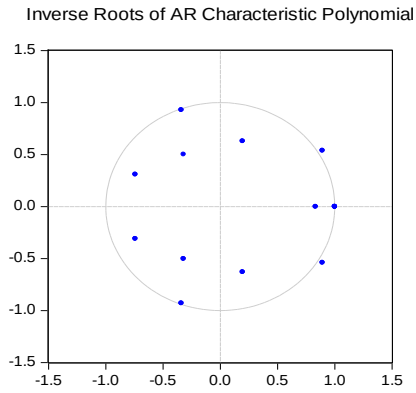

Figure 5. Unit circle of VEC of WPI

Source: plotted by author.

The VEC model indicated autocorrelation problem because the values of autocorrelations randomly varied from positive to negative which are shown in the correlogram below.

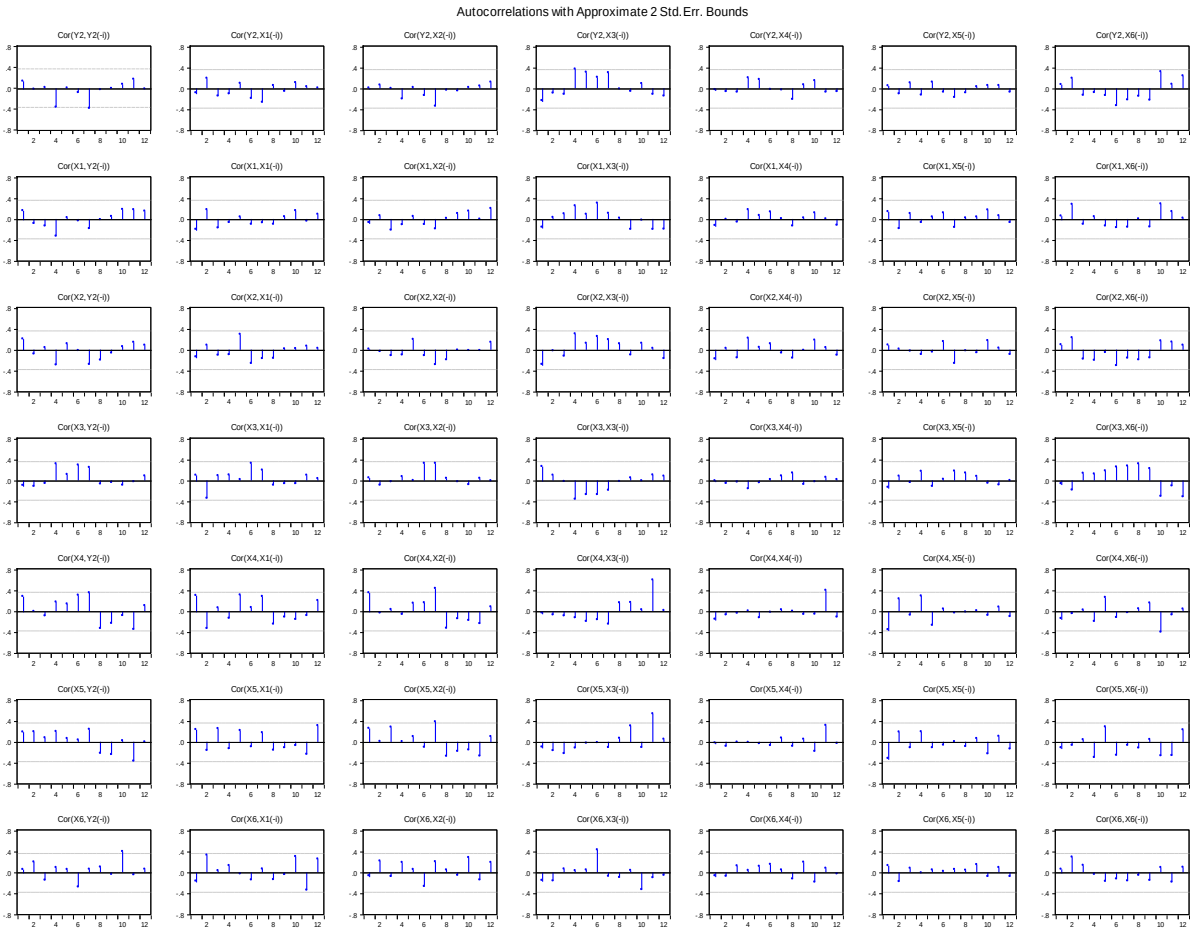

Figure 6. Autocorrelation

Source: plotted by author.

The impulse response functions of the VEC model showed that responses of WPI to gold price, silver price, BSE index, BSE market capitalisation and exchange rate of rupee in terms of US Dollar have been approaching towards equilibrium many times but response of WPI to money supply moves away from equilibrium. In Figure 7, it is diagrammed below.

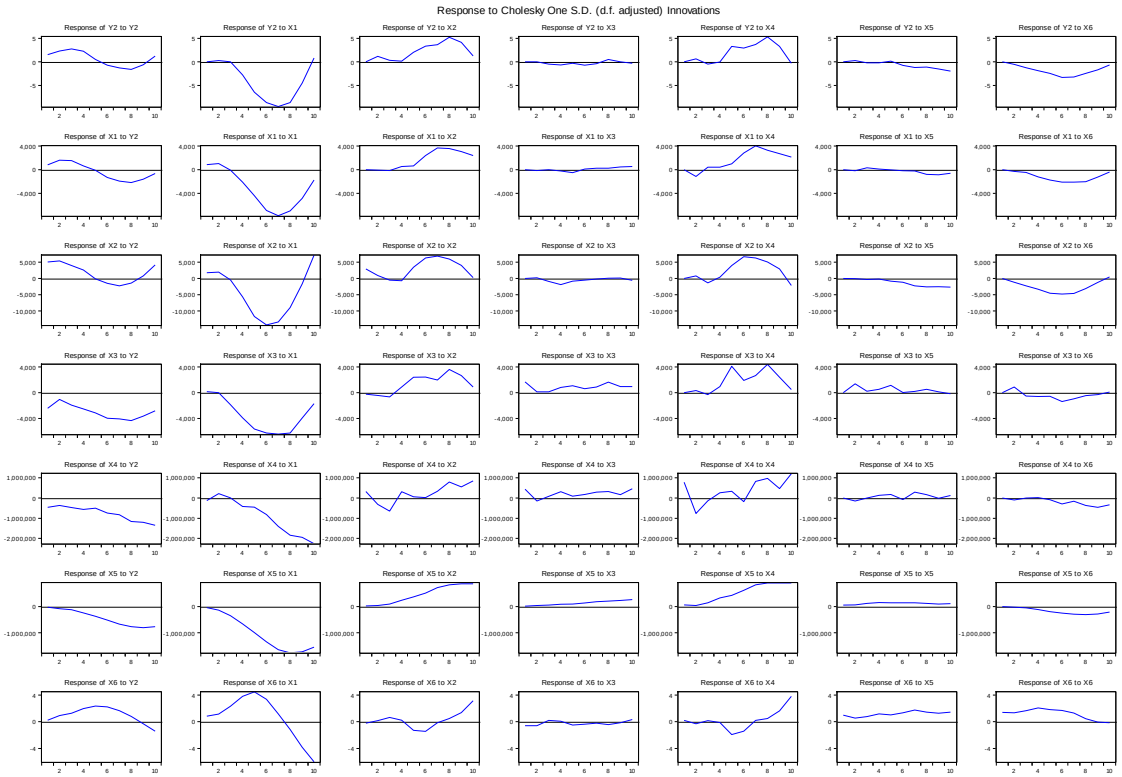

Figure 7. Impulse Response Functions

Source: plotted by author.

The VECM showed that there are long run cointegrating relationships among WPI, gold price, silver price, BSE index, BSE market capitalisation, money supply and rupee dollar exchange rate respectively which have revealed four cointegrating equations significantly except equation two. The first equation implies that WPI has long run cointegrating relationships with BSE market capitalisation, money supply and rupee dollar exchange rate which are significant at 5% level where money supply is negatively related and others are positively related with WPI in the long run and their trend line is negative. This equation has been converging towards equilibrium significantly at the speed of adjustment of 109% per year. It is significant because the t value of coefficient of y_{2t-1} is significant and negative. The equation two has long run cointegrating relationships with BSE market capitalisation, money supply and rupee dollar exchange rate which are significant at 5% level where money supply is negatively related and others are positively related with gold price in the long run and their trend line is negative. This equation has been converging towards equilibrium insignificantly at the speed of adjustment 21% per year. It is insignificant because the t value of coefficient of x_{1t-1} is insignificant and negative. The equation three has long run cointegrating relationships with BSE market capitalisation, money supply and rupee dollar exchange rate which are significant at 5% level where money supply is negatively related and others are positively related with silver price in the long run and their trend line is negative. This equation has been converging towards equilibrium significantly at the speed of adjustment 182% per year. It is significant because the t value of coefficient of x_{2t-1} is significant and negative. The equation four has long run cointegrating relationships with BSE market capitalisation, money supply and rupee dollar exchange rate which are significant at 5% level where money supply is positively related and others are negatively related with BSE index in the long run and their trend line is negative and significant. This equation has been converging towards equilibrium significantly at the speed of adjustment 88% per year. It is significant because the t value of coefficient of x_{3t-1} is significant and negative.

$$Z_{1t-1}=-1.097y_{2t-1}+8.1e^{-06}x_{4t-1}-1.03e^{-06}x_{5t-1}+1.172x_{6t-1}-4.44t-4.35 \quad (4)$$

(-3.43)* (9.94)* (-11.17)* (7.10)* (-13.90)*

$$Z_{2t-1}=-0.210x_{1t-1}+0.0038x_{4t-1}-0.0063x_{5t-1}+634.48x_{6t-1}-852.85t-5979.17 \quad (5)$$

(-0.673) (10.15)* (-14.63)* (8.208)* (-5.70)*

$$Z_{3t-1}=-1.826x_{2t-1}+0.0122x_{4t-1}-0.0146x_{5t-1}+1808.89x_{6t-1}-3203.42t-2642.58 \quad (6)$$

(-2.812)* (7.87)* (-8.39)* (5.77)* (-5.29)*

$$\text{(iv)}.Z_{4t-1}=-0.881x_{3t-1}-0.0037x_{4t-1}+0.00238x_{5t-1}-256.32x_{6t-1}+586.49t-14252.54 \quad (7)$$

(-2.021)* (10.12)* (5.78)* (-3.47)* (4.108)*

In the Figure 8, the four cointegrating equations have been depicted where the equilibrium conditions in context of convergence are visible clearly in the diagrams.

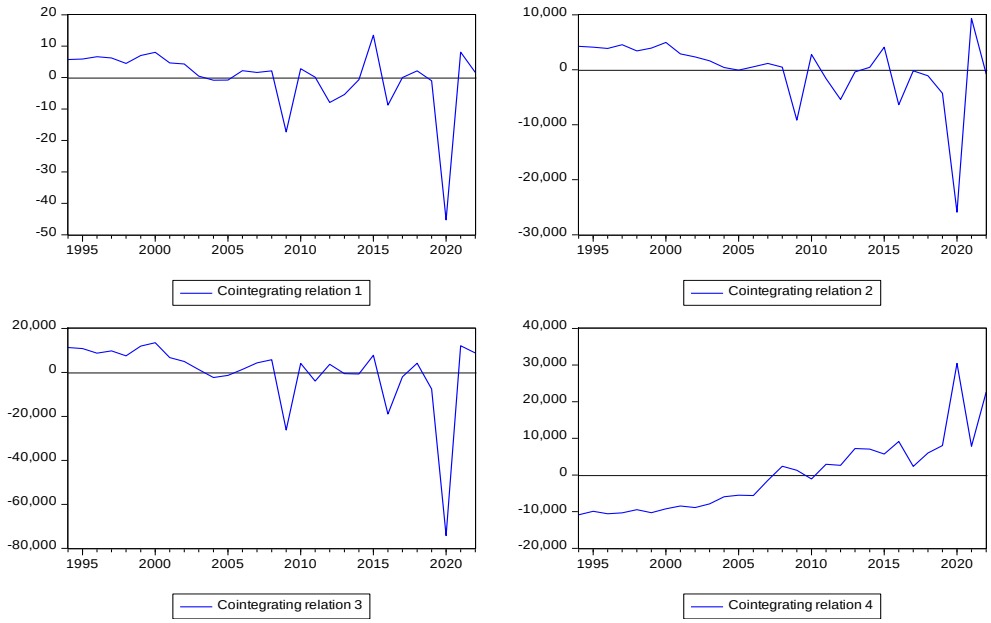

Figure 8.

Source: plotted by author.

Short run causalities among WPI, gold price, silver price, BSE index, BSE market capitalisation, money supply and rupee dollar rate during 1980-2022 have been presented in the Table 10 where it was found that there are significant short run causalities from BSE index and money supply to WPI. There is bi-directional short run causality between rupee dollar exchange rate and BSE index but gold price to money supply has unidirectional causality and from silver price to gold price causality is also unidirectional. Their Chi-square and F values with probabilities were obtained from the Wald test (1943) which are significant and have been given in the Table 12.

Table 12. Short run causality

Causality from …to…	Chi-square(1)(prob)	F(1,17)(prob)	Sig/insig
From BSE index to WPI	10.56(0.0012)	10.56(0.0047)	significant
From Money supply to WPI	11.91(0.0006)	11.91(0.003)	significant
From Silver price to gold price	9.69(0.0019)	9.69(0.0063)	significant
From Exchange rate to BSE index	7.89(0.0050)	7.89(0.0121)	significant
From Gold price to money supply	4.90(0.026)	4.90(0.0408)	significant
From BSE index to exchange rate	8.319(0.0039)	8.319(0.01303)	significant

Source: calculated by author.

Limitations

The paper consists of some limitations too. The monthly data might be helpful to find good results on the impact of Indian capital market on CPI and WPI. The determinants like interest rate, other shares, equity and bond prices and FDI inflows were not included in the model which might perhaps reveal good outcome.

Policy discussions

The long run causalities of CPI lead to increase in BSE index and market capitalisation, reduced money supply but depreciated exchange rate leads to strong capital market and international trade so that policies to boost share market, moderate supply of money and home investment will be beneficial to Indian economy in both short run and in the long run.

Long run cointegrating relation of WPI leads to strong capital market, depreciated rupee leads to increase in international trade, but reduction of money supply requires expansionary monetary policy. Even, in the short run, policies of off-shore and on-shore trading of shares revealed positive outcome in the capital market.

Normally, during high inflation, Central Bank should hike key fund rate, but it should try to reduce it. Even, the valuation of equity should be driven lower following higher risk-free rate in a discounted cash flow model to value stocks. This policy will rebalance between the observed stock prices and their intrinsic worth.

Stock market investors should follow an active portfolio management strategy to pick and choose the right companies and industries that can best weather the impact of inflation. Sometimes, high dividend payer companies may face high inflationary pressure to protect their investors irrespective of volatility in the stock market since high dividend may offset the impact of inflation (Cadre,2023).

Conclusion

The paper concludes that there are at least 3 cointegrating equations in Trace and Max Eigen statistics among CPI, gold price, silver price, BSE index, BSE market capitalisation, money supply and exchange rate in India during 1980-2022. CPI has long run causal relationships with BSE index, BSE market capitalisation, money supply and rupee dollar exchange rate respectively which are significant at 5% level where first two are positively related, money supply impacted inversely but exchange rate impacted directly but its trend is negative. The first cointegrating equation has been approaching towards equilibrium insignificantly at the speed of adjustment 22.3% per year. On the other hand, second cointegrating equation has been diverging away from equilibrium with the speed of adjustment 2.91% per year. The third cointegrating equation has been approaching equilibrium significantly with the speed adjustment 218% per year. Rupee dollar exchange rate has short run causal relationships with CPI, but CPI and BSE index showed bidirectional short run causality. The impulse response functions imply that responses of CPI to gold price, BSE market capitalization and money supply converged towards equilibrium for some periods but finally diverged away from equilibrium. Vector error correction model suffers from autocorrelation problem and non-stationarity although it is stable.

There are at least 4 cointegrating equations in Trace and Max Eigen statistics among WPI, gold price, silver price, BSE index, BSE market capitalisation, money supply and exchange rate in India during 1980-2022. Again, WPI has long run cointegrating relationships with BSE market capitalisation, money supply and rupee dollar exchange rate which are significant at 5% level where money supply is negatively related, and others are positively related with WPI in the long run and their trend line is negative. The first, third and fourth cointegrating equations have been significantly converging towards equilibrium with the speed of adjustments 109%,182% and 88.1% per year respectively while the second cointegrating equation has been approaching equilibrium insignificantly with the speed of adjustment 21% per year. There are significant short run causalities from BSE index and money supply to WPI. The exchange rate and BSE index has bidirectional short run causality. There is short run causality from silver price to gold price and from gold price to money supply. The impulse response of WPI to gold price, silver price, BSE index, BSE market capitalisation and exchange rate of rupee have been approaching towards equilibrium many times but finally moved away from equilibrium. Vector error correction model of WPI has been confronting with autocorrelation problem, non-stationarity, and instability.

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Conflict of interests

There is no conflict of interests in publishing this article in this journal.

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