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**Original Research Article**

# Econometric Analysis on Unemployment, Inequality and Economic Growth in India

Dr. Debesh Bhowmik[1*]

[1]Department of Business and Accountancy, Prof. Lincoln University College, Malaysia

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***Corresponding author:** Dr. Debesh Bhowmik
Department of Business and Accountancy, Prof. Lincoln University College, Malaysia

## Abstract

In this paper the author tried to find out the long run association between unemployment rate, GDP growth rate and income inequality in the post independent period in India from 1951 to 2023 by applying cointegration and vector error correction model. The paper found out that there is one cointegrating equation among the three variables where VECM implies that the change of unemployment rate and GDP growth rate is inversely related while the change of unemployment and the change of income inequality is positively related in the long run. The former is significant and the latter is insignificant in case of cointegrating equation which is convergent towards equilibrium with a speed of adjustment of 2.4% per year. There is short run causality between unemployment rate, GDP growth rate and income inequality. The VECM is stable and non-stationary having autocorrelation and multivariate normality problems.

**Keywords:** Unemployment Rate, Growth Rate, Income Inequality, Cointegration, VECM, Short Run Causality,
**JEL Classification Codes:** C22, E24, E32, J64.



## INTRODUCTION

The general relationship between income inequality and unemployment is positive when the growth rates of GDP is either downswing or is under recession the unemployment rate will rise as well as income inequality will enhance however small. This phenomenon is not always true in India and other developing countries while these relationships are necessarily valid in USA, UK and other developed countries although exceptions were happened.

In India, increase in income inequality is significantly associated with rising unemployment during 1965-70,1990s, and the opposite is true during 1956-69, 1971-76,1985-90 where in both cases, GDP growth rates were volatile. Unemployment rate is marginally falling with increasing income inequality during 2006-2016 along with cycles of growth rate (Figure 1). The general relationships are not satisfied in all the years from 1951 to 2023.

From the cyclical trends of GDP growth rate, unemployment rate and income inequality during 1951-2023 in India which were prepared from Hamilton (2018) decomposition model, it is found that unemployment and growth cycles are upswing but income inequality declined during 1960-65 followed in 1965-70, growth and unemployment are downswing while income inequality was upswing. During 1975-80, growth and income inequality are downswing and unemployment is upswing followed by growth and unemployment are downswing with increasing and decreasing income inequality in 1986-90. The growth rate, unemployment and income inequality all are upswing during 1993-97 followed by upswing of unemployment and income inequality and downswing of growth rate and finally during 2004-10, income inequality marginally increasing with downswing unemployment and growth but during 2010- 23, unemployment and income inequality are downswing along with both decreasing and increasing of growth rate. Therefore, long run association among the three variables are complex and insignificant in India. These trends have been plotted in Figure 2.

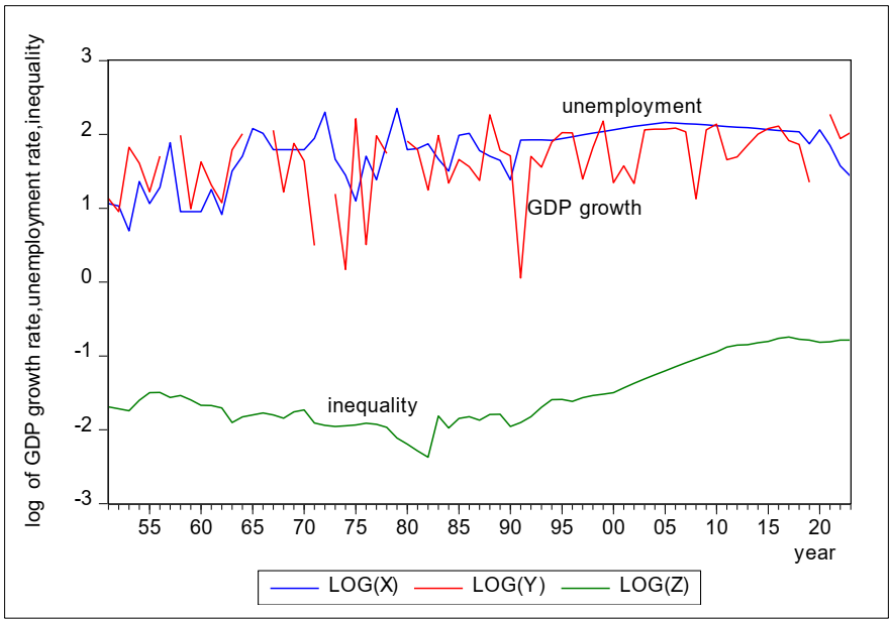


**Figure 1: Unemployment, inequality and GDP growth in India**
**Source**: Plotted by author

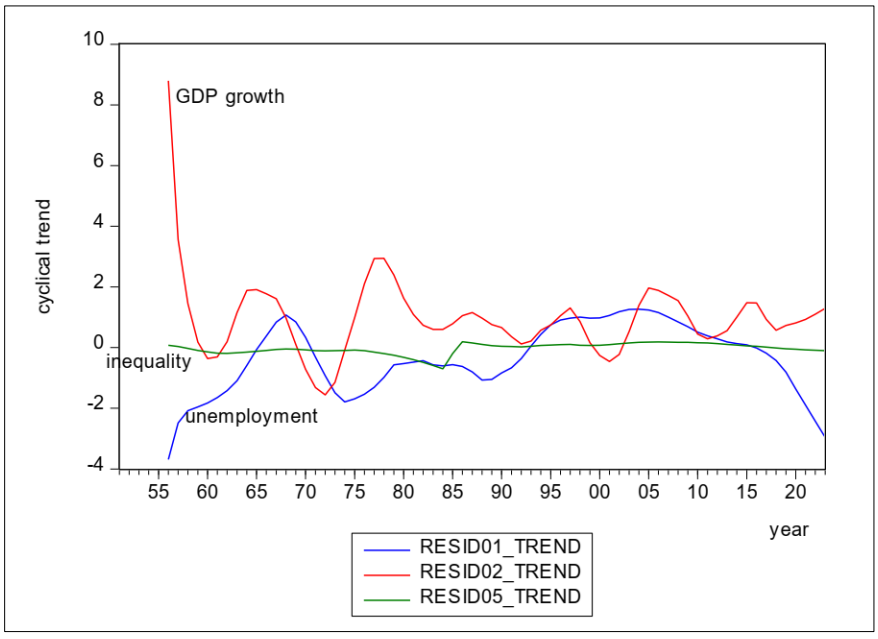


**Figure 2: cyclical trends of unemployment, growth and inequality**
**Source**: Plotted by author

One important character among these three macro variables of India during the post independent period is that both unemployment rate and income inequality had two structural upward breaks. Unemployment had breaks in 1964 and 1995 and income inequality had two upward structural breaks in 1994 and 2008 but it had downward break also in 1963.On the other hand, growth rate of GDP had one upward structural break in 1980.Therefore, after 1994, unemployment and income inequality nexus were mostly relevant but not with GDP growth rate. Before 1980s and after 1965, growth-income inequality nexus was relevant but in 1980s all three declined is irrelevant. Before 1963, all the three relationships are not justified.

Thus, the author is interested to re-examine the long run and the short run association among the three macro variables in India from 1951 to 2023 through econometric analysis.

**Literature Review**

It was evident that there is a positive relationship between unemployment and income inequality as explained by da Silva *et al*., (2022) and Mocan (1999) and depicted the unemployment-

inequality curve which was empirically verified by Hoover, Giedeman and Dibooglu (2009) using countercyclical Gini coefficient. In this regards, Rolim (2024) explained that the bottom level workers' bargaining power decreases having falling wage rate when unemployment rate increases and inequality in wage increases and the gap of wage between low and high wage earners rises. The author also redefined the Inequality-Augmented Phillips Curve.

Schettkat (2012) using OECD data tried to show that inequality in USA has been steadily upward rising from 1970 to 2010 while its unemployment trend is cyclically upswing and downswing. On the other hand, the cycles of unemployment rate and income inequality in Germany during the same period moved in the same directions but not always after 1995 and 2000s where income inequality cycle of Germany is less volatile than the unemployment rate (Figure 3).

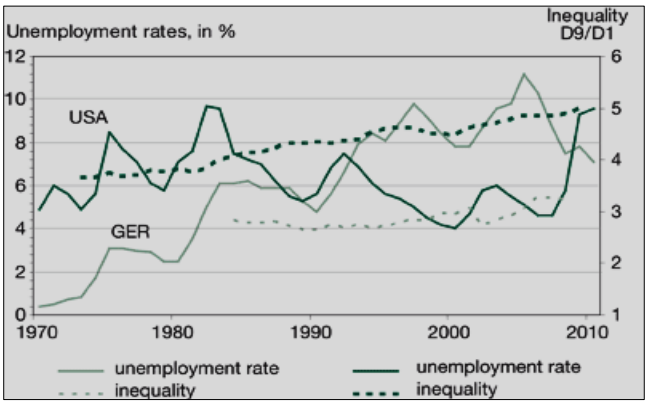


**Figure 3: Inequality and unemployment**
**Source**: Schettkat (2012)

Ali and Asfaw (2023) examined in the long run and the short run association between inflation, income inequality and real GDP using cointegration and VECM in Ethiopia from 1980 to 2022 and found that both inflation and income inequality have negative effects on real GDP while income inequality has a positive and statistically significant relationship with real GDP and inflation in the long run.

Using Burdett and Mortensen (1998) job-search model, Cysne and Turchick (2012) has examined that relation between unemployment and income inequality is positive provided that the unemployment rate is not larger than 15% through the relationship.

Deyshappriya (2017) studied 33 Asian countries during 1990-2013 and found u shaped relationship between gross domestic product (GDP) and income inequality while inflation rate, unemployment rate, terms of trade and political risk have increased.

Martin (2023) tested the relation between GDP growth, income inequality (measured by Gini index), unemployment and interest rate in two developed countries, USA and Italy, and in three developing countries, Peru, Belarus and Indonesia taking data from 1991 to 2019 for USA, from 1998 to 2018 for Italy, from 1998 to 2020 for Peru, from 1997 to 2020 for Belarus and from 1998 to 2021 for Indonesia respectively. The author found that there is significant positive relation between Gini index and GDP growth in all developing countries and insignificant in developed countries. Even there is significant positive relation between unemployment rate and Gini index for all countries. The relationship between income inequality and economic growth for developed and the developing countries remains unclear.

Taresh, Sari and Purwono (2021) applied the structural vector autoregression model and cointegration test in the panel data of 33 provinces in Indonesia during 2005-2018 and observed that income inequality has positive relation with population growth, unemployment, and poor health while it has negative relation with education, human development and urbanisation growth respectively.

Stiglitz (2015) interpreted in a paper that GDP was not a good measure to reduce income inequality which was rising in USA during 1980-2014.

Tregenna (2009) studied South African unemployment-income inequality nexus from 2001 February to 2007 September using 14 data sets of the Labour Force Survey and commented that there is trade -off between unemployment and inequality and even there may a trade off between reducing unemployment and reducing inequality. Moreover, in UK, wage inequality widened in course of high unemployment while in Germany had low wage inequality with low unemployment.

Ekpeyong (2023) studied the poverty reduction against inflation, unemployment, population growth and GDP growth in Nigeria from 1980 to 2021 and found that in the short run, there is insignificant positive and negative shock of inflation, unemployment and

population on poverty reduction and in the long run there is significant negative shock of unemployment, inflation and population growth on the poverty reduction while GDP growth had positive impact on poverty reduction.

Forbes (2000) used panel estimation (Houseman test was applicable) of 45 countries with 180 observations during 1966-1995 on economic growth showing determinants of inequality, income, male education, female education, purchasing power parity of investment and found that in the short and medium term, an increase in a country's level of income inequality has a significant positive relationship with subsequent economic growth. This relationship is highly robust across samples.

Bhowmik (2012) tested double log regression model between unemployment rate and GDP growth rate in India from 1994 to 2010 taking World Economic Outlook data -2011 and found that 1% increase in GDP growth rate per year stipulated unemployment rate by 0.286% per year insignificantly in which there is autocorrelation and ARCH errors and even, there is no cointegration between the two in the order of (1,1).Moreover, Bhowmik (2016)examined unemployment rate and GDP growth in India from 1991 to 2014 and found that their cointegration is insignificant and Okun's law is also insignificant and their negative relation is insignificant. Further, Bhowmik (2018) tested cointegration and VECM between unemployment rate and GDP growth rate in India during 1991-2014 using World Bank data and found that the variables are negatively related significantly where Okun's law is insignificant since 1% fall in the change of unemployment rate, GDP growth rate led to 1.39% increase per year while both the variables have bi-directional causality but there is no cointegrating equations at all.

**Objective of the Paper**

The paper attempts to examine the short run and the long run relationships among the unemployment rate, GDP growth rate and income inequality in India from 1951 to 2023 expecting that unemployment rate might be increased by rising income inequality in which it has bi-directional causality and unemployment rate should be related with GDP growth rate inversely. The case study may influence policy suggestions.

**Methodology and the Sources of Data**

For long run association among the unemployment rate (x), GDP growth rate(y) and income inequality (z) of India from 1951 to 2023, cointegration and vector error correction techniques were done by using Johansen (1988) model. The short run causality relation was found out by applying the Wald test (1943). The long run causality was shown by the cointegrating equation. Doornik-Hansen (1994) normality test was done in the residuals of VECM. Hamilton (2018) regression filter model was used for decomposition into cycles, cyclical trends and seasonal variations.

The data on GDP growth rates in % (y) from 1961 to 2023 and unemployment rate in %(x) from 1991 to 2023 for India were collected from the World Bank. The data on the GDP growth rate from 1951 to 1960 were collected from EPW research foundation. The data on the unemployment rates of 1st,2nd,3rd, and annual plans were taken from Dutta and Sundaram (1998). Data on unemployment rates from 1970 to 1990 were collected from the sources of Raj Krishna (1984), West Cott and Bednarrik (1981), NSSO, Mospi.gov.in (chapter-11), and Papola (2012) respectively. The data on income inequality(z) which is represented by the difference between the income share of top 10% and the income share of bottom 50% of India from 1951 to 2023 were collected from the World Inequality Data Base.

**Cointegration and ECM**

Unit root test for the series of unemployment rate (%), GDP growth rate (%), the income inequality of India from 1951 to 2023 revealed that in both the level series and first difference series, unemployment rate(x) and GDP growth rate(y) have no unit root but the level series of income inequality (z) has unit root while first difference series has no unit root. Level series of x and y are stationary but z is nonstationary. All first difference series of x, y, and z are stationary as recorded in ADF test given in Table1.

**Table 1: Unit root test**

| series | ADF value observed | ADF 5% (Tabulated) | Probability |
|---|---|---|---|
| Unemployment rate, X | -4.194448 | -3.473447 | 0.0074 |
| Change of unemployment rate, d(x) | -6.915078 | -3.473447 | 0.0000 |
| GDP growth rate, Y | -9.397875 | -3.473447 | 0.0000 |
| Change of GDP growth rate, d(y) | -7.042040 | -3.473447 | 0.000 |
| Income inequality, Z | -1.101383 | -3.473447 | 0.921 |
| Change of income inequality, d(z) | -8.080920 | -3.473447 | 0.000 |

**Source**: Author's own

Indian unemployment rate, GDP growth rate and income inequality from 1951 to 2023 in one period lag has long run association as indicated by Johansen cointegration unrestricted rank test in the following five categories in which Trace statistic and Max Eigen

statistic have one significant cointegration equation each which is given below in Table 2.

**Table 2: Cointegration test summery**

| 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 | 1 | 1 | 1 | 1 | 1 |
| Max-Eigen statistic | 1 | 1 | 1 | 1 | 1 |

**Source**: Calculated by author, n=71, significant level 5%

Now, let us consider the linear case with trend and intercept, the one lag series of unemployment rate ,GDP growth rate and income inequality of India during 1951-2023 whose observations of unrestricted rank test of cointegration are given below where the Eigen value, trace statistic, critical value at 5% level and the probabilities including Max Eigen statistic have been tested and found that there is one cointegrating equation in each test statistic which are significant at 5% level(Table 3).

**Table 3: Cointegration test**

| **Hypothesized No. of CE(s)** | **Eigenvalue** | **Trace Statistic** | **0.05 Critical Value** | **Prob.**** |
|---|---|---|---|---|
| None * | 0.468856 | 62.22444 | 42.91525 | 0.0002 |
| At most 1 | 0.166463 | 17.30120 | 25.87211 | 0.3928 |
| At most 2 | 0.059742 | 4.373698 | 12.51798 | 0.6876 |
| | | Max-Eigen Statistic | | |
| None * | 0.468856 | 44.92323 | 25.82321 | 0.0001 |
| At most 1 | 0.166463 | 12.92751 | 19.38704 | 0.3339 |
| At most 2 | 0.059742 | 4.373698 | 12.51798 | 0.6876 |

**Source**: Calculated by author; * denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Since there is cointegration among unemployment rate, GDP growth rate and income inequality in India, then the vector error correction model is to be tested. The estimates of the model during 1954-2023 (after adjusted samples) is given below (Table 4).

**Table 4: Estimation of VECM**

| **Error Correction** | **$dx_t$** | **$dy_t$** | **$dz_t$** |
|---|---|---|---|
| CointEq1 | -0.042077 | 0.137042 | -6.69E-05 |
| t values | [-4.27487]* | [ 5.96807]* | [-0.54273] |
| $dx_{t-1}$ | -0.173395 | -0.012945 | 0.001655 |
| | [-1.31850] | [-0.04219] | [ 1.00435] |
| $dx_{t-2}$ | -0.221729 | -0.408447 | -0.000399 |
| | [-1.70253]* | [-1.34434] | [-0.24453] |
| $dy_{t-1}$ | -0.217737 | 0.307416 | -0.000248 |
| | [-2.39738]* | [ 1.45088] | [-0.21811] |
| $dy_{t-2}$ | -0.143618 | 0.007027 | -0.000474 |
| | [-2.39738]* | [ 1.45088] | [-0.21811] |
| $dz_{t-1}$ | -28.24816 | 30.99681 | 0.054147 |
| | [-2.67522]* | [ 1.25831] | [ 0.40919] |
| $dz_{t-2}$ | 9.070158 | 55.26737 | 0.125750 |
| | [ 0.83189] | [ 2.17280]* | [ 0.92031] |
| C | 0.152014 | -0.307825 | 0.003367 |
| | [ 0.92936] | [-0.80669] | [ 1.64254]* |
| R-squared | 0.385985 | 0.610469 | 0.046122 |
| F-statistic | 5.567824 | 13.88081 | 0.428257 |
| Akaike AIC | 3.420489 | 5.114725 | -5.338435 |
| Schwarz SC | 3.677460 | 5.371696 | -5.081464 |

**Source**: Calculated by author, N=70(after adjustment, t value in third bracket, *=significant at 5% level.
x=unemployment rate, y=GDP growth rate, z=income inequality.

The above VECM estimates implied that the change in unemployment rate is inversely related with the change in GDP rate in (t-1) and (t-2) periods and the change in income inequality in the (t-1) period is significant at 5% level but income inequality is positively related with the change in unemployment rate in (t-2) period insignificantly at 5% level. Secondly, the change in the GDP growth rate is negatively related with the change in unemployment rate insignificantly and positively related with the change in income inequality where (t-1) period is insignificant while (t-2) period is significant. Thirdly, the change in income inequality is positively related with the change in unemployment rate in (t-1) period and negatively related in (t-2) period while the change in income inequality is negatively related with the change in GDP growth rate in both the periods insignificantly. The $R^2$ and F are insignificant in case of the change in income inequality equation while other two equations are satisfactory.

The impulse response functions as measured by the Cholesky one standard deviation innovations revealed that the response of GDP growth rate to the unemployment rate crossed the equilibrium many times till 8$^{th}$ period and then converged to equilibrium. The response of GDP growth rate is convergent and reached equilibrium after 7$^{th}$ period. The response of unemployment rate to GDP growth rate is divergent and the response of unemployment rate to the income inequality has been approaching towards equilibrium in a nonstationary manner (Figure 4).

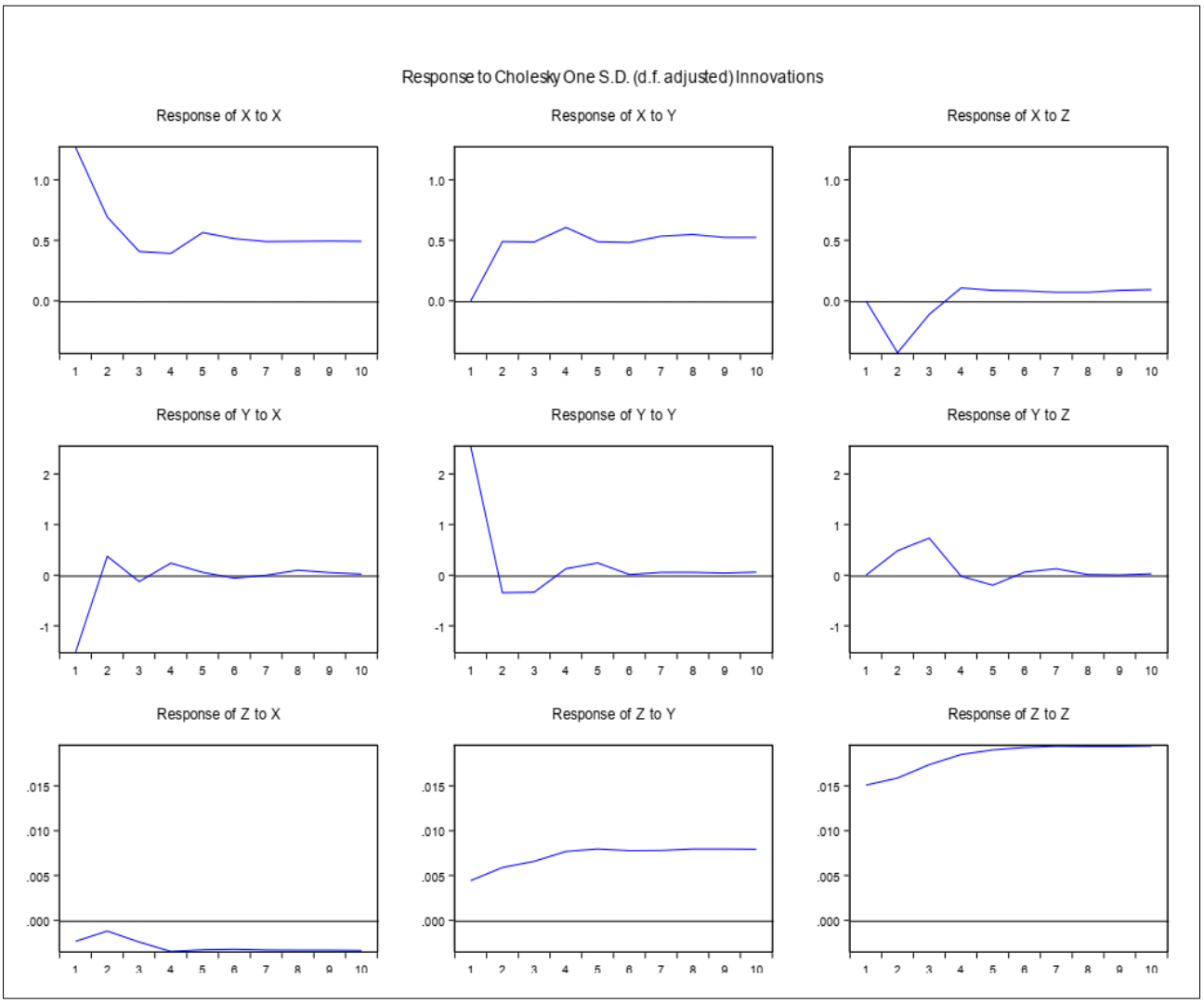


**Figure 4: Impulse Response Functions**
**Source**: Plotted by author

The VECM contains two roots whose value is unity. It also contains four imaginary roots and two negative roots and one less than one positive root in case of characteristic polynomial in lag two specification. So that the VECM is nonstationary (Table 5).

**Table 5: Values of roots**

| root | Modulus |
|---|---|
| 1.000000 | 1.000000 |
| 1.000000 | 1.000000 |
| -0.197724 - 0.613201i | 0.644290 |
| -0.197724 + 0.613201i | 0.644290 |
| 0.130851 - 0.578276i | 0.592895 |
| 0.130851 + 0.578276i | 0.592895 |
| 0.492879 | 0.492879 |
| -0.456219 | 0.456219 |
| -0.257037 | 0.257037 |

**Source**: Calculated by author

In the unit circle, all the roots have been depicted and it was found that all roots lie on the circle or inside the circle for which it can be inferred that the model is stable (Figure 5).

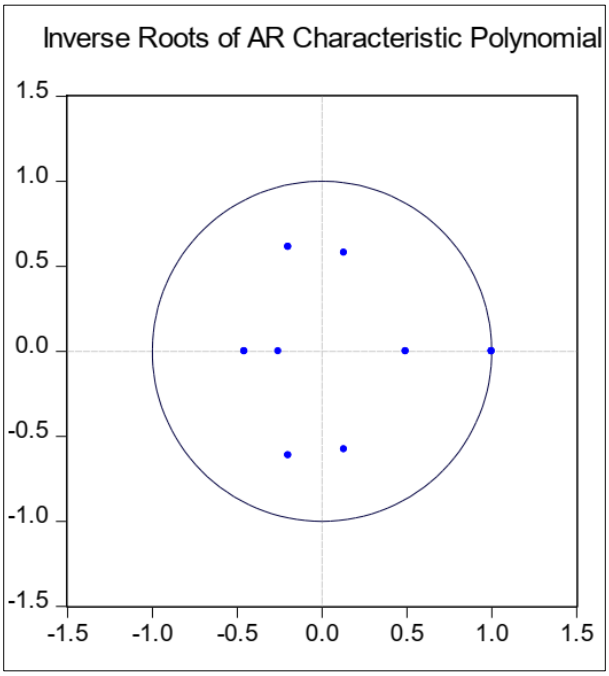


**Figure 5: Unit circle**
**Source**: Plotted by author.

The residual test of VECM for autocorrelation, it was found that the values of autocorrelations vary from positive to negative values randomly which imply that VECM suffers from autocorrelation problem that might be concluded that it is nonstationary (Figure 6).

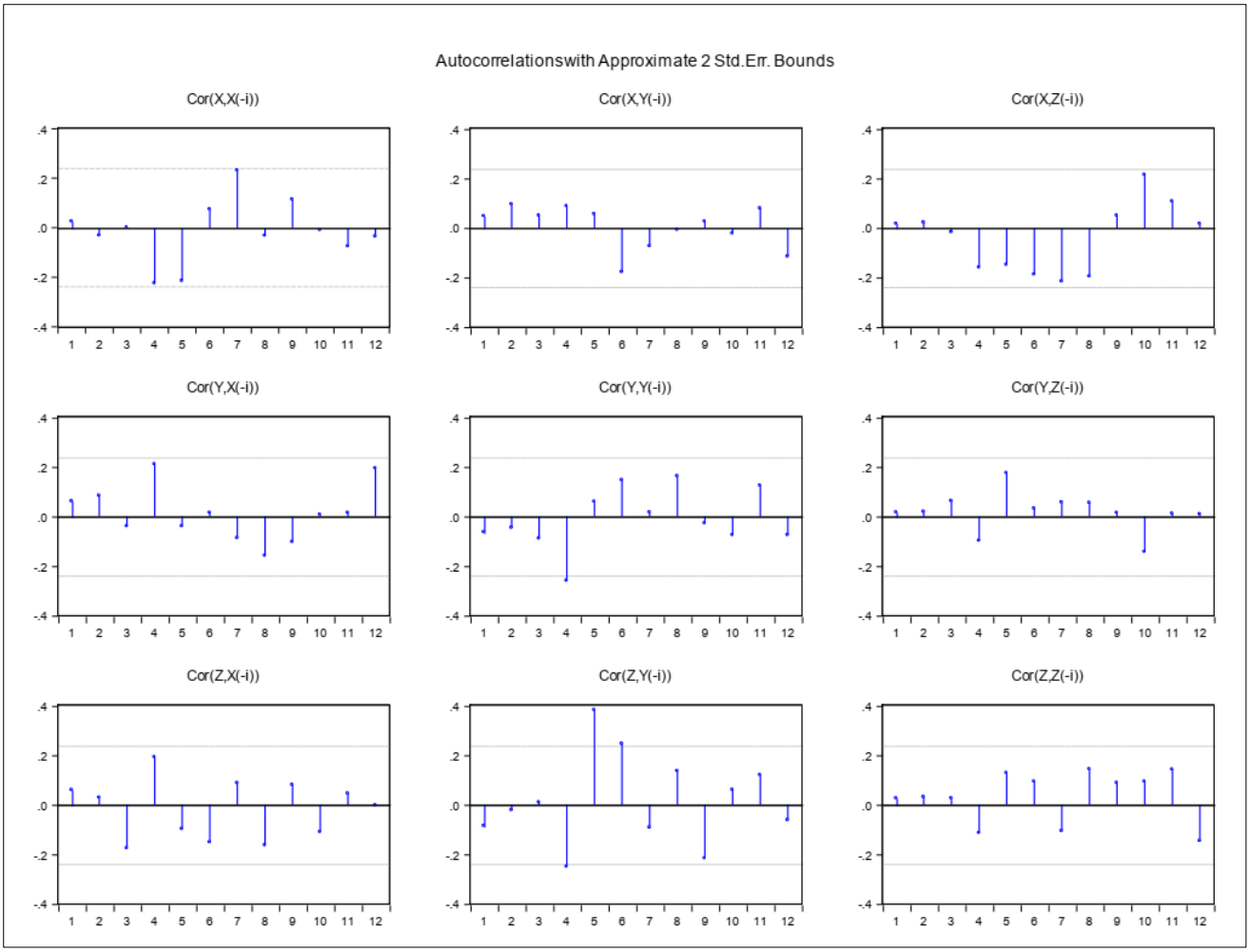


**Figure 6: Problem of autocorrelation**
**Source**: Plotted by author

The residual normality test of VECM through Doornik-Hansen (1994) residual correlation asserted that in case of skewness, kurtosis, the values of Chi-square test in all components are not significant at 5% level and all components of Jarque-Berra test are not significant so that the residuals are not multivariate normal in the samples during 1951-2023 in India (Table 6).

**Table 6: Normality test**

| Component | Skewness | Chi-square | Degree of freedom | Probability |
|---|---|---|---|---|
| 1 | 0.122058 | 0.204354 | 1 | 0.6512 |
| 2 | -1.114379 | 12.38212 | 1 | 0.0004 |
| 3 | 0.734475 | 6.293194 | 1 | 0.0121 |
| joint | | 18.879 | 2 | 0.0003 |
| | Kurtosis | Chi-square | Degree of freedom | |
| 1 | 3.429934 | 1.981547 | 1 | 0.1592 |
| 2 | 5.490052 | 0.004997 | 1 | 0.9436 |
| 3 | 7.512680 | 25.14516 | 1 | 0.0000 |
| joint | | 27.131 | 3 | 0.0000 |
| Component | Jarque-Bera | Degree of freedom | Probability | |
| 1 | 2.185901 | 2 | 0.3352 | |
| 2 | 12.38711 | 2 | 0.0020 | |
| 3 | 31.43835 | 2 | 0.0000 | |
| joint | 46.011 | 6 | 0.000 | |

**Source**: Calculated by author

The cointegrating equation has been estimated below.

$Q_{t-1}$=-0.042077$x_{t-1}$-10.9428$y_{t-1}$+8.584$z_{t-1}$+0.237T+38.007

(-4.371)* (-6.51)* (0.260) (1.25)*

Where $Q_{t-1}$= normalised variable, *=significant at 5% level, T=trend, x=unemployment rate, y=GDP growth rate, z=income inequality.

The cointegration equation implies that the unemployment rate is inversely associated with GDP growth rate, directly associated with the income inequality where former is significant at 5% level and later is insignificant at 5% level. The nature of trend is increasing which is significant at 5% level.

Since the coefficient of $x_{t-1}$ is negative and significant at less than 5% level then the cointegrating equation is convergent towards equilibrium but for the other coefficients, t values are significant except for income inequality ($z_{t-1}$), therefore, the cointegrating equation did not reach to the equilibrium and finally it departed away from equilibrium. The speed of adjustment towards equilibrium is recorded as 4.20% per year. It is shown below where it crosses the equilibrium line several times which means cointegrating relationship is justified in the long run association between them (Figure 7).

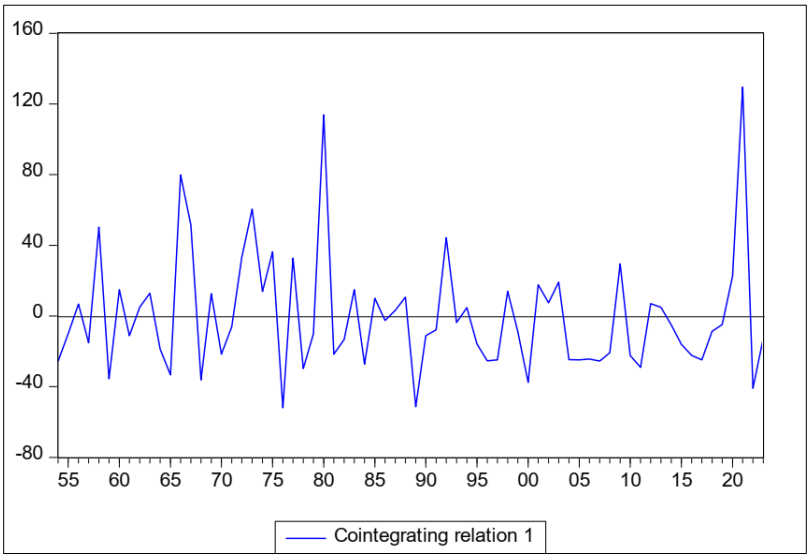


**Figure 7: Cointegration graph**

**Source:** Plotted by author

In the system equations after adjusted samples of 1951-2023, it was found from the Wald test (1943 ) that there is short run association from GDP growth rate to the unemployment rate during 1951 to 2023 because Chi-square at degree of freedom=2 is 6.809 whose probability is 0.0332 and its F statistic is 3.404 whose probability is 0.0395.Moreover,there is short run association from income equality to the unemployment rate because Chi-square at degree of freedom=2 is 7.689 whose probability is 0.0214 and its F statistic is 3.844 whose probability is 0.026.Again,there is short run causality from income inequality to GDP growth rate since Chi-square test value is 6.524 whose probability is 0.0383 and F value is 3.262 whose probability is 0.045 respectively(Table 7).

**Table 7: Short run causality**

| Causality from …..to.. … | Chi-square Test statistic (probability) | F statistic Value(probability) | Degree of freedom |
|---|---|---|---|
| Short run Causality From y to x | 6.809(0.0332) | 3.404(0.0395) | 2 |
| Short run Causality From z to x | 7.689(0.0214) | 3.844(0.026) | 2 |
| Short run Causality From z to y | 6.5243(0.0383) | 3.262(0.045) | 2 |

**Source**: Calculated by author

## CONCLUSION

The paper concludes that there is one cointegrating equation among the unemployment rate, GDP growth rate and income inequality in India during 1951-2023 according to Johansen cointegration test. The VECM revealed that the change in unemployment rate is negatively associated with the change in GDP growth rate and positively associated with the change in income inequality in the long run. The VECM contains, autocorrelation problems, and is not multivariate normal in the components of skewness, kurtosis and Jerque Berra statistic. The impulse response function of

unemployment rate to GDP growth rate is divergent and the response of unemployment rate to the income inequality has been approaching equilibrium in a nonstationary manner. The VECM is a stable model but non-stationary. There are short run causalities between unemployment and GDP growth and income inequality. According to Wald test these are significant at 5% level. The cointegrating equation has been approaching towards equilibrium significantly with the speed of adjustment of 2.4% per year showing significant negative association between unemployment and GDP growth rate and insignificant positive association between unemployment and income inequality in the long run.

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