

Trends in CPI and GDP of India

Riya Chaudhary¹, Dr. Bharti Kapur²

¹Student, University School of Business, Chandigarh University, Punjab, India

²Assitant Professor, University School of Business, Chandigarh University, Punjab, India

Abstract: *The present study attempts to examine the trends of Consumer Price Index and Gross Domestic Product of India over the years, with special emphasis on the impact on each other. This study uses regression model to estimate the trend of CPI over the years and GDP over the years with observations from 1980-2021. Data of determinants and other related information has been collected from a variety of secondary sources like World Bank and IMF. Paired t test and granger causality test has been developed to estimate the results. Before reporting the results obtained by paired t test and granger causality test, this study presents various hypothesis testing results to know the significance of unobservable significance in data set. Paired t test is carried out to compare the means of two related or dependent groups. It is specifically designed to analyze the differences between paired observations. Granger causality test is carried out to check if the variable CPI is having any cause on variable GDP. Final results have been drawn from both tests. Overall trends of CPI and GDP show that the CPI and GDP of India have increased over the years. The econometric tool used is paired t test, which shows that the mean difference between two variables which is relatively higher from each other, stating the increment in the level of CPI. Fluctuations in the level of GDP were observed during 2020 due to corona virus situation. Granger causality test was performed to observe the impact of CPI on GDP which was clarified after the test by stating the result that GDP does not cause impact on GDP and GDP does not granger cause on CPI. There have been many policy suggestions provided for the government to review the ideas for the better growth of the economy.*

Keywords: CPI, GDP, Fluctuations, Corona virus, Taxation, Fiscal policy

JEL: H2, H3, H6, E3

1. Introduction

The Consumer Price Index (CPI) is a measure of the average change in household prices for goods and services over time. It is often used as an inflation measure since it measures changes in the cost of a "basket" of goods and services typical of what an ordinary family may consume. Studies have been conducted on the view of CPI and the study by Bruce W. Hamilton (2001) estimated cross-section food Engel curves for white families in the PSID from 1974 to 1991. However, the Engel curves consistently drift to the left from year to year. He was able to reconcile the cross section income coefficient with time-series movement in food's budget share by introducing annual CPI bias of around 3% per year from 1974 to 1981, and of approximately 2% from 1982 to 1994. The indirect technique presented in this research for assessing CPI bias is both strength and a weakness. The flaw is that CPI bias is blamed for the entire unexplained movement of the Engel curve. The Engel curve is a measure of the total value of all products and services produced inside a country's boundaries over a specified time period, often a year or a quarter.

The Gross Domestic Product (GDP) is a measure of the total value of all products and services produced inside a country's boundaries over a specified time period, often a year or a quarter. Sajal Ghosh (2009) demonstrates a long-run equilibrium link between employment, electricity supply, and real GDP in a multivariate framework utilising the limits test technique for cointegration for data spanning 1970-71 to 2005-06. The analysis also proves long- and short-run Granger causation from real GDP and electricity supply to employment without any feedback effect, showing that real GDP and electricity supply growth are responsible for India's high level of employment. The analysis reveals unidirectional short-run causation between economic

development and power supply. Higher income drives higher electricity demand in end-use sectors, necessitating supply augmentation. According to McNeil et al. (2008), energy efficiency improvement possibilities for domestic refrigerators, room air conditioners, industrial and agricultural motors, and distribution transformers in India could range from 12% to 60%. To supplement supplies, India could explore renovating and modernising existing power facilities, using imported coal for coastal power plants and washed local coal, as well as supercritical and combined cycle gas turbines. Narayan and Prasad (2008) recently used a novel modelling technique termed the bootstrap approach to identify causation between energy consumption and GDP for 30 OECD nations. This approach could be used to investigate the relationship between power and GDP in India.

The Consumer Price Index (CPI) and Gross Domestic Product (GDP) are two important economic indicators that measure different aspects of the economy. The CPI measures the average change in prices of a basket of goods and services purchased by households over time, while the GDP measures the total value of all goods and services produced within a country's borders during a specific period. While there is no direct relationship between the CPI and GDP, there are some ways in which they can be indirectly related. For example, inflation can lead to a decrease in consumer spending, while GDP growth can lead to an increase in demand for goods and services.

This paper is divided into following sections: section 1 briefly describes the data used to analyze diversification impact on yield. Section 2 discusses the results regards with the tables. Section 3 explains the findings. Section 4 conclusion and implications.

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2. Review of Literature

Studies have been conducted on the topic of CPI and GDP, such as Libena CERNOHORSKA (2018), Shazad Hussain (2011), George Marbuah (2011), Aminu Umaru and Anono Abdulrahman Zubairu (2012), and Aminu Umaru and Anono Abdulrahman Zubairu (2013). The study by Libena CERNOHORSKA (2018) used the Engle-Granger co integration test to examine the efficacy of monetary policy executed in the Czech Republic and Switzerland during periods of low interest rates and foreign currency interventions. Shazad Hussain (2011) found that inflation in Pakistan is positively associated to economic growth and vice versa. George Marbuah (2011) found that the lowest and highest inflation threshold values are 6% and 10%, respectively. Aminu Umaru and Anono Abdulrahman Zubairu (2013) found that inflation had a favourable influence on economic growth through increasing productivity and output levels, as well as the evolution of total factor productivity. Adegbite Tajudeen Adejare (2018) studied the influence of real income, inflation, and industrial productivity in Nigeria. Tariq Ahmad (2022) re-examined the link between inflation and economic development in Pakistan from 1985 to 2019. Steven Cook (2004) investigated the features of the GLS-based Dickey-Fuller test in the presence of breakdowns in innovation variance. The DFGLS test has reduced power only when extremely big breakdowns in variance occur early in the sample period.

3. Data and Methodology

The study is based on secondary data sources from the IMF and World Bank, which provides the GDP and CPI of India from 1980-2021. The Stastical method of regression model paired T-Test is used to evaluate the trend of CPI over the years. Granger causality is used to measure the relationship between GDP and CPI.

$$d = x_1 - x_2$$

Where d= difference

x_1 = variable 3(year 1980-2000)

x_2 = variable 4(year 2001-2021)

After knowing the mean, the test required the values of average mean as well which can be divided as

$$\bar{d} = d_1 + d_2 + \dots + d_{nn} \text{ mean difference}$$

Where, d_1 is the difference in 1st variables and d_2 is the difference in 2nd variable.

SD = sqrt $[n (\sum (d_i - \bar{d})^2 / (n - 1))]$ Sample standard deviation

$$t = \frac{\bar{d}}{s} \cdot \sqrt{n} \text{ t test statistic}$$

For Granger causality the data of GDP and CPI was converted into log because the value of GDP were too lengthy and it becomes difficult to analyze that.

Equation for log of CPI: $\log_{cpi} = \log(\text{CPI})$

Equation for log of GDP: $\log_{gdp} = \log(\text{GDP})$

Trend signifies a direction in which something is changing or developing over time. The increase or decrease in the level of CPI of India is observed in this study. This chapter will examine the trends of CPI of India over the years. CPI of India has been divided into two decades.

Table 1: Total CPI of India over the years (1980-2021)

Year	CPI	Year	CPI
1980	97.99	2001	567.57
1981	110.87	2002	591.95
1982	119.57	2003	614.47
1983	133.81	2004	637.6
1984	144.91	2005	664.69
1985	152.98	2006	703.21
1986	166.33	2007	748.01
1987	180.95	2008	810.45
1988	197.94	2009	898.66
1989	211.94	2010	1004.51
1990	230.95	2011	1096.09
1991	262.97	2012	1199.99
1992	293.98	2013	1320.2
1993	312.56	2014	1408.2
1994	344.62	2015	1477.3
1995	379.85	2016	1550.4
1996	413.94	2017	1602
1997	443.61	2018	1665.1
1998	502.32	2019	1729.8
1999	525.77	2020	1841.6
2000	546.88	2021	1936.1

Source: IMF, 2022

The table signifies the increase in the level of CPI in India. CPI is increasing at an increasing rate, without fluctuations. The change in government has not impacted the growth of CPI in India. From year 1980-1984, 1984-1989, 1989-1990, 1991-1996, 1996-1997, 1997-1998, 1998-2004, 2004-2014, 2014 to present there have been change of Government in all these years. The level of CPI is increasing at a constant rate shows stable inflation and can provide a signal of a healthy and stable economy with consistent economic growth.

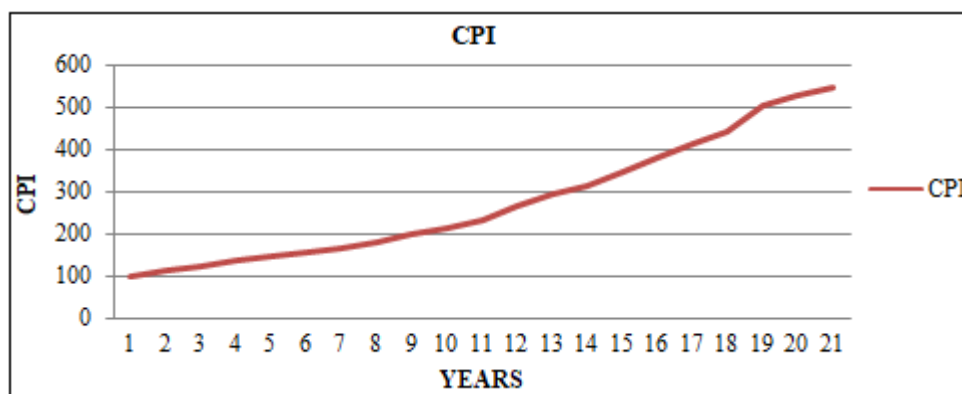


Figure 4.1: Trends of CPI over the years

The figure depicts the increase in the level of CPI over the years; the constant increase may result in GDP growth as well. The CPI of Indian economy is almost constant throughout the reference period. Trend is noticed in this case, as this trend has noticed increasing trend over the years.

4. Results and Discussions

The econometric tool to find the changes in CPI over the year from 1980-2000 and from 2000-2021, Paired t test is applied here, which will help to find how significant changes are there in the CPI with the interval of 21 years. The test was conducted at 5% level of significance or 95% confidence interval. In order to solve the test two hypotheses are being considered.

H₀: Null Hypotheses – where it states that there is no change in CPI over the time period of 21 year

Null hypotheses= H₀: μ₁ = μ₂

H₁: Alternative Hypotheses – Where it states that there is a change in CPI over the time period of 21 years

Alternative hypotheses= H₁: μ₁ ≠ μ₂

$$t = \frac{d}{s} \cdot \sqrt{n_t} \text{ test statics}$$

T test of cpi from year 1980-2000 and 2001-2021
T-TEST PAIRS=VAR00003 WITH VAR00004 (PAIRED)
/CRITERIA=CI(.9500)
/MISSING=ANALYSIS.

Table 2: Paired Samples Statistics CPI

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	VAR00001	274.9876	21	145.02671	31.64742
	VAR00002	1146.0905	21	461.87639	100.78969

Variable 1 is CPI from year 1980-2000

Variable 2 is CPI from year 2000-2021

The mean for year 1980-2000 is 274.9876 which is less than the mean of CPI from year 2001-2021 which is 1146.0905 and same goes with the standard deviation for both of the period, if we comply we can observe that there is a high difference in the CPI

$$\text{Mean difference} = \bar{d} = d_1 + d_2 + \dots + d_n$$

$$sd = \sqrt{\frac{\sum (d_i - \bar{d})^2}{(n - 1)}} \text{ Sample standard deviation}$$

Table 3: Paired Samples Test CPI

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	VAR00001 - VAR00002	-871.10286	319.91589	69.81137	-1016.72682	-725.47889	-12.478	20	.000

In table 3 we can depict the results of paired T test on CPI, under mean the value is 871.10286 which is the mean difference between two variable which can be calculated by subtracting the variable 2nd mean value with variable 1st mean value. The t static is -12.478 which a small number is and correlated to a very small significant value which is .000, the significance value or p value is less than .005 which is less.

A trend denotes the direction in which something changes or develops over time. This study looks at whether India's GDP is increasing or decreasing. This chapter will look at India's GDP developments over time. India's GDP has been separated into two decades.

Table 4: Total GDP of India over the years (1980-2021)

Year	GDP	Year	GDP
1980	2,70,94,26,78,836.50	2001	8,39,15,17,74,957.40
1981	2,87,21,60,47,837.20	2002	8,71,07,29,01,385.70
1982	2,97,19,89,11,481.60	2003	9,39,54,25,54,364.60
1983	3,18,86,14,21,848.60	2004	10,13,98,19,15,397.80
1984	3,31,04,42,80,901.70	2005	10,94,32,40,68,978.90

1985	3,48,43,83,37,981.20	2006	11,82,53,46,05,661.60
1986	3,65,08,17,18,782.50	2007	12,73,12,63,94,881.60
1987	3,79,55,85,07,289.90	2008	13,12,42,39,62,607.80
1988	4,16,10,15,76,411.30	2009	14,15,60,52,75,566.10
1989	4,40,84,85,65,769.60	2010	15,35,89,75,32,897.40
1990	4,65,24,27,20,840.40	2011	16,16,39,87,60,695.40
1991	4,70,15,95,52,155.70	2012	17,04,59,57,60,877.20
1992	4,95,93,55,60,738.60	2013	18,13,45,30,59,872.80
1993	5,19,49,63,49,422.90	2014	19,47,83,40,59,120.90
1994	5,54,08,92,16,863.60	2015	21,03,68,78,13,812.80
1995	5,96,05,86,59,383.00	2016	22,77,26,64,50,219.60
1996	6,41,05,82,40,489.20	2017	24,32,01,54,36,983.80
1997	6,67,01,99,50,767.30	2018	25,88,97,40,97,973.60
1998	7,08,27,12,38,131.20	2019	26,85,74,78,40,248.30
1999	7,70,92,31,80,565.50	2020	25,08,59,37,50,079.00
2000	8,00,53,42,71,756.90	2021	27,26,37,05,11,450.70

Source: World Bank

The table shows that the GDP of India has increased significantly since 1980, from 2.7 trillion INR in 1980 to 27.3 trillion INR in 2021, but there have been periods of slower development or even loss.

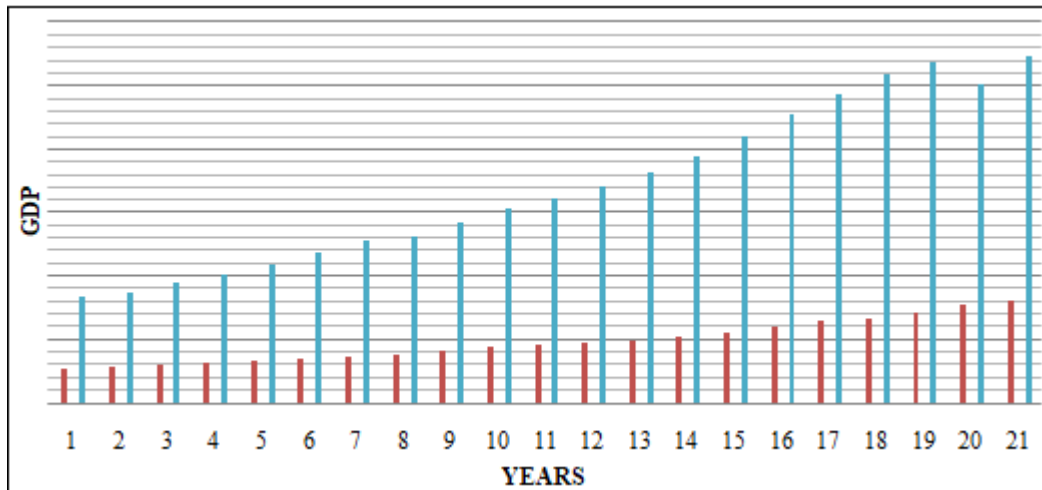


Figure 2: Trend of GDP over the years

The figure depicts the increase in the level of GDP over the years. The GDP of Indian economy is almost constant throughout the reference period. Trend is noticed in this case, as this trend has noticed increasing trend over the years but there have been a slower trend of GDP which is observed that is caused due to COVID 19.

Results and Discussions

The econometric tool to find the changes in GDP over the year from 1980-2000 and from 2000-2021, Paired t test is applied here, which will help to find how significant changes are there in the GDP with the interval of 21 years. The test was conducted at 5% level of significance or 95% confidence interval. In order to solve the test two hypotheses are being considered.

H₀: Null Hypotheses – where it states that there is no change in GDP over the time period of 21 year

Null hypotheses= H₀: μ₁ – μ₂

H₁: Alternative Hypotheses – Where it states that there is a change in GDP over the time period of 21 years

Alternative hypotheses= H₁: μ₁ ≠ μ₂

$$t = \frac{\bar{d}}{s} \cdot \sqrt{n}$$

T-Test

T test of GDP from year 1980-2000 and 2001-2021

T-TEST PAIRS=VAR00003 WITH VAR00004 (PAIRED)/CRITERIA=CI(.9500)/MISSING=ANALYSIS.

Table 5: Paired Samples Statistics GDP

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	VAR00001	483051475631.1619	21	162781081831.49490	35521744247.60125
	VAR00002	1708695168001.5718	21	637689307738.63090	139155215360.77454

Variable 1 is GDP from year 1980-2000

Variable 2 is GDP from year 2000-2021

The mean for year 1980-2000 is 483051475631.1619 which is less than the mean of GDP from year 2001-2021 which is 1708695168001.5718 and same goes with the standard deviation for both of the period, if we comply we can observe that there is a high difference in the GDP

$$\text{Mean difference} = \bar{d} = d_1 + d_2 + \dots + d_n$$

$$sd = \sqrt{\frac{\sum (d_i - \bar{d})^2}{(n - 1)}}$$

Table 6: Paired Samples Test GDP

		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	VAR00001 - VAR00002	-1225643692370.41000	478405421608.57940	104396621780.88464	-1443411229423.36570	-1007876155317.45410	-11.740	20	.000

In 6th table we can depict the results of paired T test on GDP, under mean the value is 1225643692370.41000 which is the mean difference between two variable which can be calculated by subtracting the variable 2nd mean value with variable 1st mean value. The t static is -11.740 which a small number is and correlated to a very small significant

value which is .000, the significance value or p value is less than .005 which is less.

Evaluating the t test we will reject the null hypotheses which say that there is no significant difference between the GDP of two periods. And we will accept the alternative

hypothesis which states that there is a significant difference between the GDP of two periods. The differences are on a high comparison rates.

There is the significant difference in the GDP growth from 1980-2000 and 2001-2021. It is evident that GDP significantly rose after 2001-2021 by approximately four times. In order to check the relationship of the GDP and CPI and if the dependent variable GDP and CPI the independent variable are granger causing each other or not, we conduct another test by using regression model and in that the granger causality test is applied.

The value of GDP was too vast due to which the results were not accurate and due to this log is applied on both the variables so that current and accurate results can be extracted and the analysis and interpretation can be easily done. Granger causality test was run which shows that both CPI and GDP do not cause any granger cause to each other.

Table 7: Total GDP and CPI of India (1980-2021)

YEAR	GDP	CPI
1980	2,70,94,26,78,836.50	97.99
1981	2,87,21,60,47,837.20	110.87
1982	2,97,19,89,11,481.60	119.57
1983	3,18,86,14,21,848.60	133.81
1984	3,31,04,42,80,901.70	144.91
1985	3,48,43,83,37,981.20	152.98
1986	3,65,08,17,18,782.50	166.33
1987	3,79,55,85,07,289.90	180.95
1988	4,16,10,15,76,411.30	197.94
1989	4,40,84,85,65,769.60	211.94
1990	4,65,24,27,20,840.40	230.95
1991	4,70,15,95,52,155.70	262.97
1992	4,95,93,55,60,738.60	293.98
1993	5,19,49,63,49,422.90	312.56
1994	5,54,08,92,16,863.60	344.62
1995	5,96,05,86,59,383.00	379.85
1996	6,41,05,82,40,489.20	413.94
1997	6,67,01,99,50,767.30	443.61
1998	7,08,27,12,38,131.20	502.32
1999	7,70,92,31,80,565.50	525.77
2000	8,00,53,42,71,756.90	546.88
2001	8,39,15,17,74,957.40	567.57
2002	8,71,07,29,01,385.70	591.95
2003	9,39,54,25,54,364.60	614.47
2004	10,13,98,19,15,397.80	637.6
2005	10,94,32,40,68,978.90	664.69
2006	11,82,53,46,05,661.60	703.21
2007	12,73,12,63,94,881.60	748.01
2008	13,12,42,39,62,607.80	810.45
2009	14,15,60,52,75,566.10	898.66
2010	15,35,89,75,32,897.40	1004.51
2011	16,16,39,87,60,695.40	1096.09
2012	17,04,59,57,60,877.20	1199.99
2013	18,13,45,30,59,872.80	1320.2
2014	19,47,83,40,59,120.90	1408.2
2015	21,03,68,78,13,812.80	1477.3
2016	22,77,26,64,50,219.60	1550.4
2017	24,32,01,54,36,983.80	1602
2018	25,88,97,40,97,973.60	1665.1
2019	26,85,74,78,40,248.30	1729.8
2020	25,08,59,37,50,079.00	1841.6
2021	27,26,37,05,11,450.70	1936.1

Due to wide GDP value, log values are used to observe the impact of CPI on GDP.

The log equation for both variables were as follow

$$\text{Log GDP} = \text{loggdp} = \log(\text{GDP})$$

$$\text{Log CPI} = \text{logcpi} = \log(\text{CPI})$$

Table 8: Total values of log GDP and log CPI

Years	Log GDP	Log CPI
1980	26.32517	4.584865
1981	26.3835	4.708358
1982	26.41767	4.783902
1983	26.48802	4.896421
1984	26.52552	4.976113
1985	26.57673	5.030307
1986	26.62339	5.113974
1987	26.66227	5.198221
1988	26.7542	5.287964
1989	26.81197	5.356303
1990	26.86583	5.442201
1991	26.87634	5.57204
1992	26.92971	5.683512
1993	26.97613	5.744796
1994	27.04059	5.842442
1995	27.1136	5.939776
1996	27.18639	6.025721
1997	27.22609	6.094946
1998	27.28609	6.219237
1999	27.37085	6.264864
2000	27.40855	6.304229
2001	27.45566	6.341364
2002	27.49299	6.383422
2003	27.56866	6.42076
2004	27.64491	6.457711
2005	27.72116	6.499321
2006	27.79868	6.556656
2007	27.8725	6.617416
2008	27.9029	6.69759
2009	27.97858	6.800905
2010	28.06014	6.912255
2011	28.11122	6.999505
2012	28.16435	7.090069
2013	28.22625	7.185539
2014	28.29774	7.250068
2015	28.37471	7.297971
2016	28.454	7.346268
2017	28.51974	7.379008
2018	28.58228	7.41764
2019	28.61898	7.455761
2020	28.55074	7.51839
2021	28.63399	7.568431

The data table 8 displays the logarithms of the Gross Domestic Product (GDP) and the Consumer Price Index (CPI) from 1980 to 2021. The GDP measures a country's overall economic production, whereas the CPI measures the average price level of goods and services purchased by households. GDP and CPI are reported as logarithms because these quantities rise exponentially over time, and using the logarithm makes it simpler to see the percentage change over time. According to the data, both GDP and CPI tend to rise over time, with minor volatility and changes from year to year. GDP exhibits a generally consistent rise throughout time, but CPI has greater volatility and tends to reflect times of stagnation. It is crucial to note that this table does not display the real GDP or CPI figures, but rather their

logarithms, which implies that the actual values must be obtained by taking the exponential function of the data. Furthermore, these numbers are particular to the data's nation or location and may not apply to other countries or regions.

Granger causality test is performed on the log values of GDP and CPI

Table 9: Granger causality test

Pair wise Granger Causality Tests			
Date: 05/02/23 Time: 14:06			
Sample: 1980 2021			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
LOGGDP does not Granger Cause LOGCPI	40	0.79210	0.4608
LOGCPI does not Granger Cause LOGGDP		1.91808	0.1620

The null hypothesis is that LOGGDP does not Granger cause LOGCPI and that LOGCPI does not Granger cause LOGGDP based on the pair wise Granger causality tests. The F-statistic for the null hypothesis that LOGGDP does not cause LOGCPI is 0.79210 with a probability (p-value) of 0.4608, suggesting that there is insufficient evidence to reject the null hypothesis. Similarly, the F-statistic for the null hypothesis that LOGCPI does not Granger cause LOGGDP is 1.91808 with a probability (p-value) of 0.1620, indicating that there is insufficient evidence to reject the null hypothesis. As a result, there is no strong evidence in this data to imply that one variable Granger causes the other variable.

5. Conclusion

This study examines the historical trend of the Consumer Price Index (CPI) in India over the years 1980-2000 and 2000-2021. The mean difference between two variables is 871.10286, and the t static is -12.478. The Gross Domestic Product (GDP) has increased significantly, from 2.7 trillion INR in 1980 to 27.3 trillion INR in 2021. The mean difference between the two periods is 1225643692370.41000, and the t static is -11.740. The Consumer Price Index (CPI) and Gross Domestic Product (GDP) are important economic indicators that provide insight into the state of an economy. The Granger causality test is a statistical technique that determines if one time series may predict another. The data table 6.2 displays the logarithms of GDP and CPI from 1980 to 2021, and the results are presented in Table 6.3. The null hypothesis is that LOGGDP does not cause LOGCPI and LOGCPI does not Granger cause LOGGDP.

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