Phase 4: Final Paper
Group No:15
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Topic: Establishing The Causal Relationship between Exports and Economic Growth in India

Abstract:
The purpose of this analysis is to study the causal relationship between Total Exports and Gross Domestic Product(GDP) of India using the Exports and GDP data of India from the year 1962 to 2021.Our motive is to find the direction of the causality, if existing using Granger Causality Test between the two variables.The linear Granger causality test infers no relationship between Total Exports and GDP whereas the nonlinear Granger Causality Test (Diks and Panchenko,2005) shows that there exists a unidirectional relationship from Total Exports to GDP but not vice versa.

Introduction and Motivation:
The Goods and Services provided to other countries make up the Total Exports of a country.
Exports create an influx of funds which makes a significant contribution to the economic standing of a country and thus increases the GDP value of a country. The major aim of this study lies in analyzing the fact that whether exports from a country should be improved to improve economic growth or the economic growth should be improved to carry out more exports.
In our study, we use Granger tests to run an econometric statistical analysis using the collected data to study the direction of the relationship between exports and GDP values of India which is a rapidly developing economy so that significant policies can be developed regarding exports to improve the growth rate of India.
The data used in this report is the Time Series data of export and Real GDP from 1962-2021 and it is extracted from the CMIE database. This study has already been done for countries that are major exporters of oil across the world so we are motivated to run the same analysis for India to check if the relation is unidirectional or bidirectional.
The motivation of this study is to reflect the significance of Exports in the GDP of a country.
Identifying the direction between exports and GDP is also a major motivation for our study.
Proper planning to improve Export services and goods are necessary for a country's economic development.

Literature Review:

Amiri and Gerdtham (2012) examines the directional relationship between three variables i.e. exports, imports, and GDP in France. They used two different approaches to test the Granger causality between the variables in this study(using geostatistical methods): 1)VAR and 2)Improved-VAR.
The results of linear and nonlinear Granger causality analyses lead us to conclude that there was a unidirectional relationship between GDP and commerce in France, regardless of the sample used. Both methodologies yielded similar results, indicating the existence of short-run unidirectional causality from GDP to exports and imports. Improved-VAR, on the other hand, provided considerable support for the existence of a unidirectional link from exports to imports.

Mehrara and Firouzjaee (2011) examines the test for panel Granger causality between export and GDP growth for 73 developing countries during the period 1970-2007. The cointegration and Granger's causality tests are applied to investigate the relationship between export, GDP, and openness. The granger causalities are tested in 1) the bi-variate model (including export and GDP) and 2) the tri-variate model(including export, GDP, and openness).
In bi- and tri-variate models, the results show that there are long-run equilibrium linkages between export and GDP in both groups of oil and non-oil emerging countries. In both categories of nations and models, we found substantial evidence of bidirectional long-run causality between export and GDP growth. In either bivariate or trivariate models, it is proven that there is no short-run causation relationship between export growth and economic growth in oil-rich countries. However, in a bi-variate model, the results demonstrate a bidirectional short-run causality between export and GDP growth for non-oil developing nations. Overall, the combined F-statistics for the short- and long-term solar causalities indicate bidirectional causation between export and GDP in the sample developing countries. In conclusion, the export-based growth theory, according to which export growth is one of the primary drivers of economic growth in developing nations, is widely recognized, at least in the long run. Furthermore, increasing GDP through the development of human capital, labor force skills, and technology prepares the essential institutional backdrops for increased export.

Ajmi, Aye, Balcilar, and Gupta (2013) examines the dynamic causal relationship between exports and economic growth is investigated in this research. From 1911 through 2011, this study used annual South African statistics on real exports and real GDP: 1) Linear Granger causality test and 2) Nonlinear Granger causality test.
The linear Granger causality result shows no evidence of significant causality between exports and GDP. The relevant VAR is unstable, undermining our confidence in the causality result identified by the linear Granger causality test. Accordingly, we turn to the nonlinear methods to evaluate the Granger causality between exports and GDP. First, the study uses Hiemstra and Jones (1994) nonlinear Granger causality test and finds a unidirectional causality from GDP to exports. However, using a more powerful and less biased nonlinear test, the Diks and Panchenko (2006) test, it finds evidence of significant bi-directional causality. These results highlight the

risk of misleading conclusions based on the standard linear Granger causality tests which neither account for structural breaks nor uncover nonlinearities in the dynamic relationship between exports and GDP.

The studies mentioned above attempted to prove that export and GDP have a causal and directional relationship. A variety of methodologies, including linear and nonlinear granger approaches, were used to determine the link between the variables. Cointegration analysis was also performed on a number of countries. In the second research paper, it is demonstrated that there is no short-run causation relationship between export growth and economic growth in oil-rich countries using either bivariate or trivariate models. However, the results show a bidirectional short-run causality between export and GDP growth for non-oil developing countries in a bivariate model. The first paper established unidirectional causality between GDP and exports. When a more powerful and less biased nonlinear test, the Diks and Panchenko (2006) test, finds evidence of significant bi-directional causality between GDP and Exports. A rigorous analysis of India using both linear and nonlinear tests should be used so as to establish the causality direction.

Research Question:

What is the Causal Relationship between Exports and Economic Growth in India and whether there exists a bi-directional causality relation between them?

Methodology:

The methodology we intend to use to establish the causal relationship between export and the GDP of India is using the modern linear and nonlinear Granger causality tests model. We are using nonlinear tests so as there is a risk of misleading conclusions based on the standard linear Granger causality tests which neither account for structural breaks nor uncover nonlinearities in the dynamic relationship between exports and GDP.

The Linear Granger causality test is a regression model which is a statistical technique that is one of the most important techniques to determine causality between two variables and helps us to determine whether one time series helps us to predict vital information about another time series.

Both variables are taken to be independent of each other. The difference between linear and non-linear causality tests is that in a nonlinear Granger causality test is that in a linear test an effect moves in one direction whereas in a non-linear the effect can be bi-directional. We also have to confirm that our given data is stationary. To check whether the given data is stationary or not we use Augmented Dicky Fuller's Test and check for the p-value obtained as its result. If the obtained p-value is less than 0.05 we can reject the null hypothesis and the given data is stationary. If the initial data is not stationary we can convert it to stationary by using the differencing technique.

The equation for the Granger causality test involving two independent variables is-

$$Y_t = \sum_{i=1}^{n} \alpha_i Y_{t-i} + \sum_{j=1}^{n} \beta_j X_{t-j} + u_{1t}$$

$$X_t = \sum_{i=1}^{n} \lambda_i Y_{t-i} + \sum_{j=1}^{n} \sigma_j X_{t-j} + u_{2t}$$

Here Y_t denotes the GDP values in million rupees, X_t denotes the Export values in million rupees and u_{1t} and u_{2t} denote the residual error terms and n is the number of lag observations.
We expect a bidirectional relationship between the variables majorly with chances of a unidirectional relationship from exports to GDP. We expect slim chances of unidirectional causality from GDP to Exports.

A Non-Linear Granger causality test was implemented by Diks and Panchenko (2006).
Let's say we want to infer causality between two variables X and Y using the q and p lags of those variables. Consider the vectors Xqt=(Xt-q+1,...,Xt) and Ypt=(Yt-p+1,..,Yt), where q,p are positive integers. The null hypothesis that Xqt doesn't contain any additional information about Yt+1 is

H0=Yt+1|(Xqt; Ypt)~Yt+1|Ypt

This null hypothesis states that the vector of random variables Wt=(Xqt, Ypt, Zt), where Zt=Yt+1, has an invariant distribution. The joint probability density function fX, Y, Z(x,y,z) and its marginals must satisfy the following relationship if the time indexes are removed:

$$\frac{f_{X,Y,Z}(x,y,z)}{f_Y(y)} = \frac{f_{X,Y}(x,y)}{f_Y(y)} \cdot \frac{f_{Y,Z}(y,z)}{f_Y(y)}$$

for each vector (x,y,z) in the support of (X, Y, Z). Diks and Panchenko (2006) show that, for a proper choice of weight function, g(x,y,z)=f2Y(y), this is equivalent to

$$q = E[f_{X,Y,Z}(X,Y,Z) f_Y(Y) - f_{X,Y}(X,Y) f_{Y,Z}(Y,Z)]$$

They proposed the following estimator for q:

$$T_n(\varepsilon) = \frac{(n-1)}{n(n-2)} \sum_i (\hat{f}_{X,Y,Z}(X_i,Y_i,Z_i)\hat{f}_Y(Y_i) - \hat{f}_{X,Y}(X_i,Y_i)\hat{f}_{Y,Z}(Y_i,Z_i))$$

where n is the sample size, and f^W is a local density estimator of a dW-variate random vector W at Wi based on indicator functions Iij^W = I(// Wi−Wj // <ε), denoted by

$$\hat{f}_W(W_i) = \frac{(2\varepsilon)^{-d_W}}{n-1} \sum_{j,j\neq i} I_{ij}^W$$

In the case of bivariate causality, the test is consistent if the bandwidth ε is given by εn=Cn−β, for any positive constant C and β∈(1/4,1/3). The test statistic is asymptotically normally distributed in the absence of dependence between the vectors Wi. For the choice of the

bandwidth, Diks and Panchenko (2006) suggest εn=max(Cn^−2/7,1.5), where C can be calculated based on the ARCH coefficient of the series.

Data

Sl No	***Name***	***Description***	***Source***
1	GDP	First variable in million rupees (Yearly data)	Economics outlook, CMIE
2	Export	Second variable in million rupees (Yearly data)	Economics outlook, CMIE

Empirical Results:

Table 1: Initial details of our data.

Parameters	**Time**	**gdp_val**	**export**
count	60	6.00E+01	6.00E+01
mean	1991.5	4.47E+07	7.51E+06
std	17.464249	4.14E+07	9.76E+06
min	1962	7.87E+06	2.55E+05
25%	1976.75	1.35E+07	7.68E+05
50%	1991.5	2.61E+07	1.76E+06
75%	2006.25	6.51E+07	1.36E+07
max	2021	1.48E+08	3.09E+07

Figure 1: Graph between GDP of India versus Year.

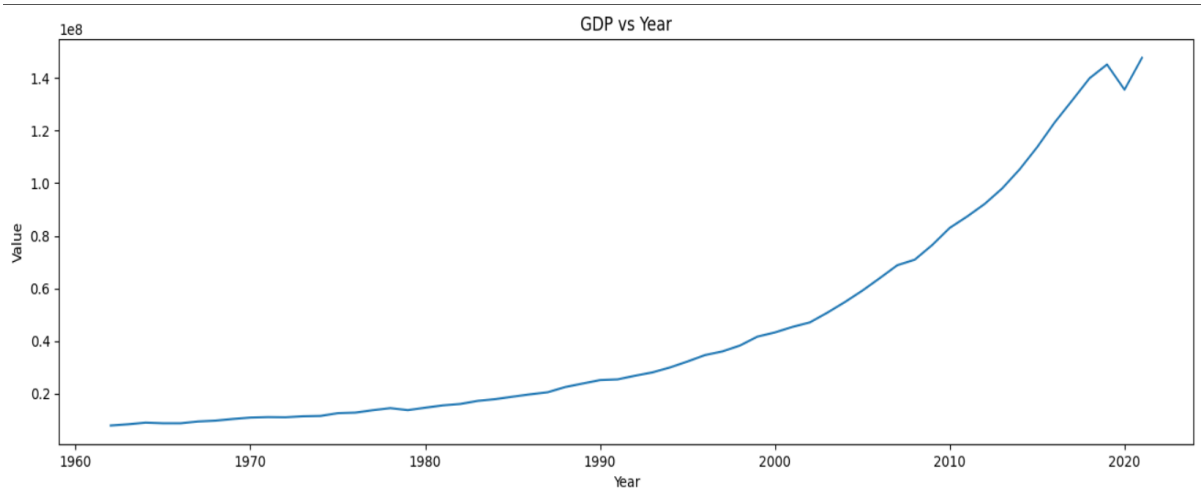
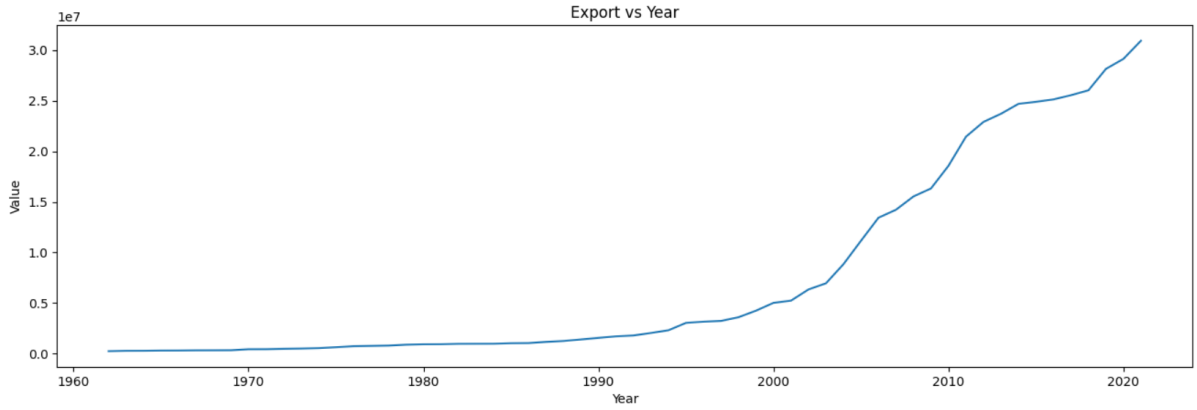


Figure 2: Graph between Total Exports of India versus Year.



Plot for values in Rs.Million

Stationarity of data:- A stationary process has the property that the mean, variance and autocorrelation structure do not change over time.
Firstly we checked if our data is stationary using the ADF test (Augmented Dicky Fuller Test).
The Dicky fuller test also assumes the Null hypothesis that our data is non-stationary.

Table 2: p-value and conditions.

p-value	Null-Hypothesis	Data
<0.05	FALSE	Stationary
>0.05	TRUE	Non-Stationary
p-value		
0.9987987158		

The data has to be made stationary such that the mean and variance values do not vary with time. This we have done by converting the data to natural logarithm values and differencing technique. Logarithms and other transformations can aid in the stabilization of a time series variance. By removing changes in the level of a time series and thus eliminating (or reducing) trend and seasonality, differencing can help stabilize the mean of a time series, and then we again used the ADF test to confirm whether it is stationary.

Figure 3: Graph of first-order difference of ln(GDP of India) versus Year.

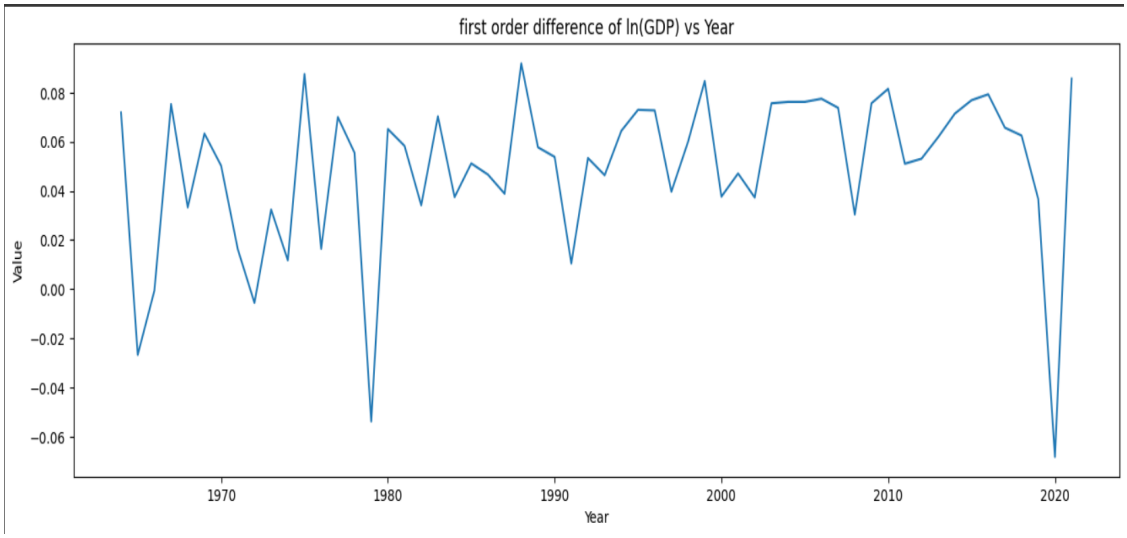
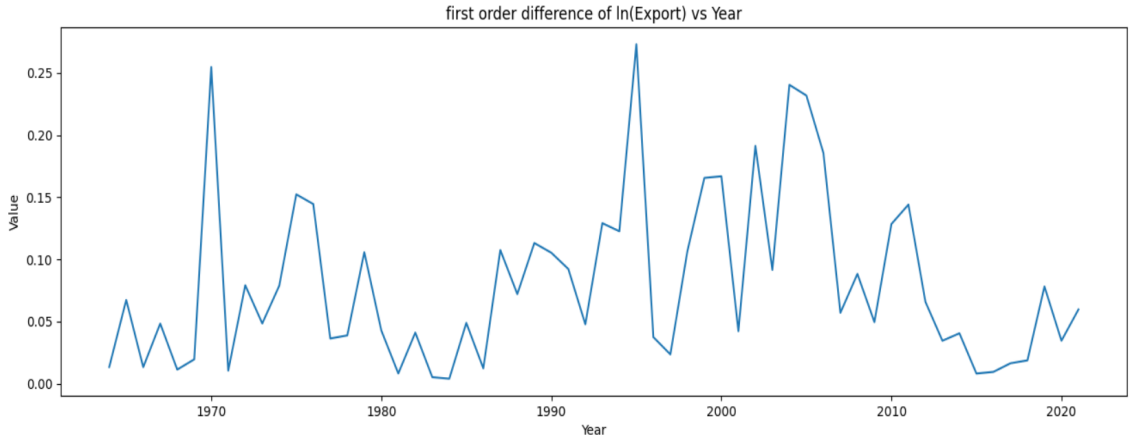


Figure 4: Graph of first-order difference of ln(Total Export of India) versus Year.



The two variables taken are A and B which are both time series where A is GDP value in million rupees and B is Exports value in million rupees.

If A Granger causes B then we can reject the null hypothesis.
We will perform this test for both the directions i.e from A to B and from B to A.

Linear Granger causality Test:
We will perform a Granger causality test till 4 lags.
(1) Do Exports of a country Granger cause the GDP of India?
Null Hypothesis: Exports do not have a Granger causality with the GDP of India.
Table 3: p-values for the above null hypothesis for all lag values.

number of lags (no zero) 1	
ssr based F test	F=2.7096 , **p=0.1056** , df_denom=54, df_num=1

ssr based chi2 test	chi2=2.8602 , **p=0.0908** , df=1
likelihood ratio test	chi2=2.7907 , **p=0.0948** , df=1
parameter F test	F=2.7096 , **p=0.1056** , df_denom=54, df_num=1
number of lags (no zero) 2	
ssr based F test	F=1.5147 , **p=0.2296** , df_denom=51, df_num=2
ssr based chi2 test	chi2=3.3263 , **p=0.1895** , df=2
likelihood ratio test	chi2=3.2313 , **p=0.1988** , df=2
parameter F test	F=1.5147 , **p=0.2296** , df_denom=51, df_num=2
number of lags (no zero) 3	
ssr based F test	F=0.7727 , **p=0.5150** , df_denom=48, df_num=3
ssr based chi2 test	chi2=2.6562 , **p=0.4477** , df=3
likelihood ratio test	chi2=2.5941 , **p=0.4585** , df=3
parameter F test	F=0.7727 , **p=0.5150** , df_denom=48, df_num=3
number of lags (no zero) 4	
ssr based F test	F=0.8569 , **p=0.4971** , df_denom=45, df_num=4
ssr based chi2 test	chi2=4.1130 , **p=0.3909** , df=4
likelihood ratio test	chi2=3.9639 , **p=0.4109** , df=4
parameter F test	F=0.8569 , **p=0.4971** , df_denom=45, df_num=4

As we analyze the data we can see that the **p values are >0.05** for all lag values, therefore, we can infer that the null hypothesis that we took for this analysis is right.
So, we can say that Exports do not have a Granger causality with the GDP values of India when inferred by the **linear** Granger causality test.

Now, we will reverse the direction of the above Granger causality.
(2) Does the GDP of a country's Granger cause the exports?
Null hypothesis: The GDP of a country does not have a Granger causality with Exports.
Table 4: p-values for the above null hypothesis for all lag values.

number of lags (no zero) 1	
ssr based F test	F=1.6508 , **p=0.2043** , df_denom=54, df_num=1
ssr based chi2 test	chi2=1.7425 , **p=0.1868** , df=1
likelihood ratio test	chi2=1.7164 , **p=0.1902** , df=1
parameter F test	F=1.6508 , **p=0.2043** , df_denom=54, df_num=1

number of lags (no zero) 2	
ssr based F test	F=0.5366 , **p=0.5880** , df_denom=51, df_num=2
ssr based chi2 test	chi2=1.1784 , **p=0.5548** , df=2
likelihood ratio test	chi2=1.1662 , **p=0.5582** , df=2
parameter F test	F=0.5366 , **p=0.5880** , df_denom=51, df_num=2
number of lags (no zero) 3	
ssr based F test	F=0.4307 , **p=0.7319** , df_denom=48, df_num=3
ssr based chi2 test	chi2=1.4805 , **p=0.6868** , df=3
likelihood ratio test	chi2=1.4609 , **p=0.6913** , df=3
parameter F test	F=0.4307 , **p=0.7319** , df_denom=48, df_num=3
number of lags (no zero) 4	
ssr based F test	F=0.5713 , **p=0.6848** , df_denom=45, df_num=4
ssr based chi2 test	chi2=2.7423 , **p=0.6018** , df=4
likelihood ratio test	chi2=2.6750 , **p=0.6136** , df=4
parameter F test	F=0.5713 , **p=0.6848** , df_denom=45, df_num=4

From this data, we can also infer that **p value>0.05** for all lag values therefore GDP of a country does not have a causal relationship with Exports of India in particular when inferred through the linear Granger causality test.

We see that Linear Granger doesn't give us any relationship and we had to settle for the Null Hypothesis.
The nature of data we have used is time-series data for Exports of India and GDP of India.

As the linear test didn’t give us any relationship between GDP and Export, we tried a nonlinear granger test to test their causality. The test we used is Diks and Panchenko's (2005) test which is a nonparametric test to detect causality. Non-linear tests consider the feedback effect as well as other variables that might affect the causality hence obtaining relatively accurate results.

Nonlinear Granger Causality Test:
Here we used embedding dimension = max lag + 1 as 5 to have a constant max lag value. For the epsilon (bandwidth), we chose a value of more than 1.5.

Table 5: p-values for both null hypotheses.

Series length=60, Embedding dimension=5,

Bandwidth=1.660000	
Null hypothesis: Export does not cause GDP	
T statistics	**p-value**
2.227	**0.01296**
Null hypothesis: GDP does not cause Export	
T statistics	**p-value**
-0.836	**0.79843**

We can reject the null hypothesis for p-value < 0.05 **so we can infer a unidirectional causality from Export to GDP** using the nonlinear Granger causality test but not vice versa.Standard linear Granger causality tests neither account for structural breaks nor uncover nonlinearities in the dynamic relationship between exports and GDP. Thus, this nonlinear Test helps us establish causality.

Limitations due to our methodology:

1. The data has to be stationary. We can not perform the Granger causality test with non-stationary data.
2. The Granger causality test does not provide any significant relationship between the two chosen time series.
3. Limitation of Linear Test: Risk of misleading conclusions based on the standard linear Granger causality tests which neither account for structural breaks nor uncover nonlinearities in the dynamic relationship between exports and GDP.
4. Nonlinear Granger causality Limitation (Diks and Panchenko): Diks and Panchenko showed that in samples smaller than 500 observations their test may under-reject, it would be wise to make further investigations in case the test does not reject the null hypothesis. Our sample size is 60 so this limitation might give us wrong results.

Conclusion:

We applied a linear Granger causality test between the GDP of India and its Exports. For both the directions we found that there is no such causal relationship between these two when we perform the linear Granger causality test for 4 lags.

If a variable A and B have Granger causality then we can say that values of A can help us in predicting and forecasting the values of B where A and B are our two-time series. However, using a non-linear test implies a unidirectional causality from exports to GDP.

To summarize, causal research identifies the cause and effect relationship between variables and allows us to understand how current actions and behaviors will affect the future. This is

extremely useful in a variety of situations. This type of research can also be used to determine the causal relationship between various other bivariate or multivariate parameters.
We can infer that Total Exports are a granger cause to GDP but not Vice Versa. This implies that India being a non-oil GDP country needs to focus on its export capabilities which will directly affect its Economic Development.

Scope of Study:-

From the results obtained from the non-linear test we can say that there can be more variables that can be in the mix of export and GDP and can be used to establish Granger relationships(Multivariate).Few variables like unemployment index, and literacy rate can be used to conduct a multivariable regression analysis. There will be a feedback value between Export and GDP which is only accounted for by nonlinear tests.

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