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RELATIONSHIP BETWEEN LEADING HEALTH INDICATORS AND ECONOMIC GROWTH OF INDIA

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Abstract

Health is an important determinant of economic development; a healthy population indicates higher productivity, thus higher income per head. Being the second largest populated country in the world, India should recognize the need for higher investment in health expenditures to achieve the desired economic growth. [1]As per National Health Profile 2018, India spends annually on public health per capita approximates to Rs.1112, i.e.Rs.93 per month and Rs.3 per day, which is lower than most of the low-income countries. The study initiates to understand the relation among GDP and leading macro health indicators that reflects the overall health of the economy in terms of quality and assurance. The major objective is to identify the cause and effect relationship and long run equilibrium stability between the selected indicators under study. Time series data for the period 1990 to 2019 is used to conduct the empirical analysis. Time series econometric tools like trend analysis, unit root test, Cointegration test, Vector Error Correction Model and Lagrangian Multiplier (LM) are employed to identify the level of stationarity in the TS, followed by dimensions of causality. The outcome of the study reveals the presence of long run relationship and existence of feedback causality between GDP and the health indicators. The study concludes by recommending the enhancement of health investments pertaining to infrastructure and facilitate effective policy decisions to promote healthcare and eventually economic growth.

Keywords: Health, Economic growth, Life Expectancy, Fertility Rate, Under Five Mortality Rate, Gross Domestic Product, Cointegration, VECM, Granger Causality

Introduction

Health being one of the vital indicators of the quality of life, has been rightly said that, 'Health is wealth'. According to World Health Organisation (WHO): "The linkages of health to poverty reduction and to long-term economic growth are powerful, much stronger than is generally understood". Health is a crucial determinant of growth. Hence it is related to economics and sound social development[2]. There exists a two-way relationship between health and economic growth.[3] It

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[1] According to the National Health Profile, 2018, released by union minister for health and family welfare, J P Nadda, on June 19, 2018.

[2] The Economics of Social Determinants of Health and Health Inequalities: a resource book, WHO, 2013

[3] Barro (2013), Health and Economic Growth, Annals of Economics and Finance 14-2, 329-366

has been observed that better health enhances growth by improving productivity[4]. Higher the growth, better the capital formation through increased income resulting in the enhancement of the health status of citizens of a country. Thus, it is believed that health and economic growth are inter-related and that the relationship between the two does exist.

The objectives of this research is to identify the relationship between health and economic growth of the Indian economy. A thirty years' time series data (1990-2019) is used to examine the causal relationship (if any) exist between the selected variables. The expected outcomes of the empirical study would be helpful in determining the possible effects of overall health and the subsequent policy revisions for the betterment of the macro indicators.

Certain noted studies [Weil (2007), Chen(2007), Granados (2008), Akram(2008)] were initiated to identify the association between economic growth and health progress in the various parts of the world. Akram et al (2008) investigate the impacts of different health indicators on economic growth in Pakistan for the time period 1972-2006. For this purpose, Cointegration and Error Correction techniques have been applied on the time series data of Pakistan. Siaosi (2014) empirically verifies the impact of health on economic performance of the island kingdom of Tonga which is located in the midst of the central south pacific. Review of related studies reveals that good health may bring positive growth for the entire economy. The empirical results of these studies summarises that ………..(inference to be added)

After an extensive review of similar studies, the following gap has been identified as given below:

- The existing studies showcased that the improvement in health indicators bring economic growth in countries like Nigeria, Pakistan, Sweden, China etc.
- Similar studies on Indian perspective[5] analyses the relationship based on single health indicator like IMR.
- Seldom macro studies are conducted to analyze the long run relationship considering the leading health indicators and economic growth of India.

Being the second largest populated country in the world, India should recognise the need for higher investment in health expenditure to achieve the desired economic growth. As of now, the amount Government of India spends on public health per-capita every year is Rs.1112, i.e.Rs.93 per month and Rs.3 per day which is lower than most of the low-income countries. This shows that the proportion of health expenditure to GDP is less than …. In India.This study analyses various health indicators and their impact on economic indicators such as per capita GDP. It studies the long run relationship between health variables and economic growth in India from 1990 to 2019.

The study is significant in two main ways. First, it reveals the causal relationship between health and economic growth in Indian economy. Second, it helps policy makers understand and undertake various policy exercises and it also contributes to further studies related to this area of research focusin India.

Methods

Secondary data is used for conducting the empirical study. Time Series data pertaining to the

[4] Saha S (2013), Impact of Health on Productivity Growth in India, International Journal of Economics, Finance and Management, VOL. 2, NO. 4, Jun-July 2013, ISSN 2307-2466

[5] Verma, Cs & Usmani, Gulnawaz. (2019). Relationship Between Health and Economic Growth in India. Indian Journal of Human Development. 13. 10.1177/0973703019887601.

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selected variables for a period of thirty years (1990-2019) is extracted from the World Bank Database.

The conceptual framework of the model is:

$lnYt = \beta0 + \beta1lnX1t + \beta2lnX2t + \beta3lnX3t + \in t$

Where,

Y1 = Gross Domestic Product per capita from 1990-2019

X1t = Life expectancy of India for the same period

X2t = Fertility rate of India for the same period

X3t = Under Five Mortality Rate of India for the period

Dependent variable: Gross Domestic Product (GDP) per capita of India.

Independent variables: Life Expectancy (LE), Fertility Rate (FR) and Under Five Mortality Rate (UFMR).

Hypothesis framed:

Ho: Health indicators does not influence on economic growth in the long run

H1: Health has an impact on economic growth in the long run

Tools employed:

Augmented Dickey-Fuller (ADF) Unit Root Test is used for testing the stationarity of the variable. Existence of long run relationship between the variables is tested using Johansen Cointegration Test. Granger causality test is used to analyse the existence of causal relationship between the selected health indicators and GDP per capita. The EViews version 9 and SPSS 13 are the softwares used for conducting the analysis.

Empirical results:

GDP per capita is taken as the dependent variable and the independent variables are life expectancy, fertility rate and Under Five Mortality Rate in India. It is observed that GDP per capita and life expectancy rate (figure 1) has shown an increasing trend whereas GDP per capita and fertility rate (figure 2) shows a decreasing trend.

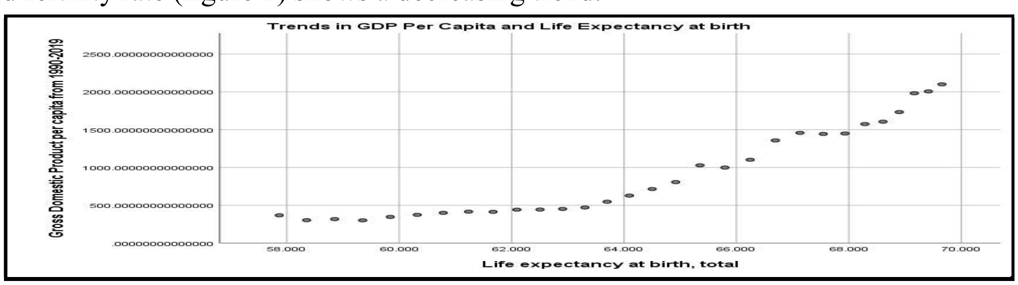

Figure 1: Trends in Gross Domestic Product Per Capita and Life Expectancy in India

Source: Self-analysis

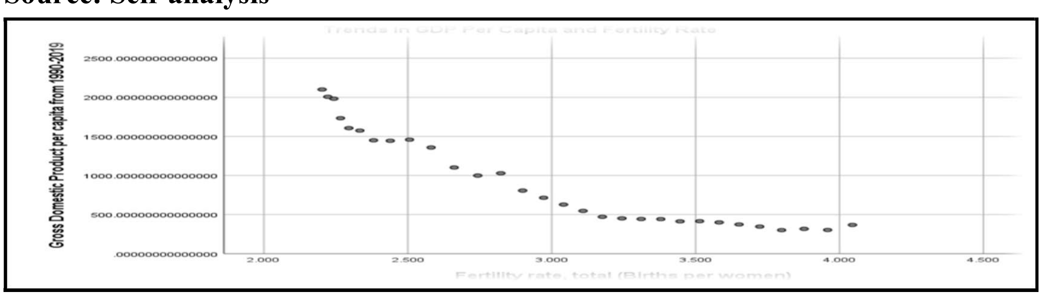

Figure 2: Trends in Gross Domestic Product Per Capita and Fertility Rate in India

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Source: Self-analysis

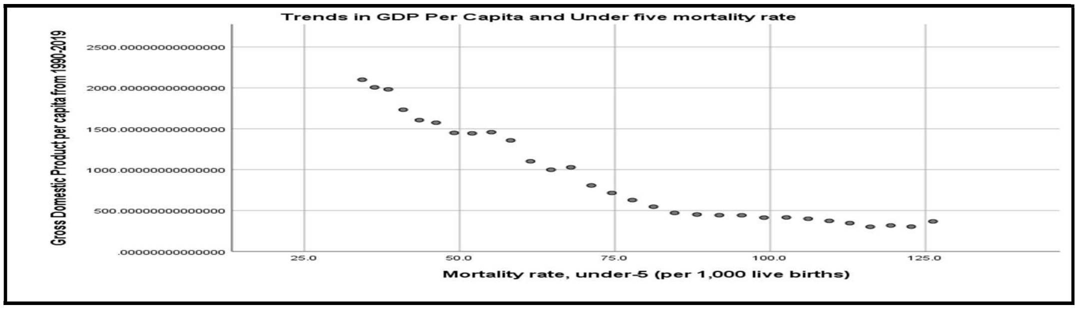

Figure 3: Trends in Gross Domestic Product Per Capita and Under Five Mortality Rate in India

Source: Self-analysis

Unit Root Test Results

To avoid the problems of seasonality in the data the Unit root test is used to check whether the data is stationary or not. The ADF unit root test results under the null hypothesis showing the presence of unit root reveals that, LNGDP and LNFR becomes stationary at its first difference and variable LNLE and LNUFMR are stationary by nature.

After treating the data for stationarity, the fitted model representing the relationship between health factors and GDP is used for better prediction among variables.

The finding that many macro time series may contain a unit root has spurred the development of the theory of non-stationary time series analysis. Engle and Granger (1987) pointed out that a linear combination of two or more non-stationary series may be stationary. If such a stationary linear combination exists, the non-stationary time series are said to be cointegrated. The stationary linear combination is called the cointegrating equation and may be interpreted as showing the presence of long-run equilibrium relationship among the variables.

Cointegration Test Analysis

With the aim of determining the long run relationship between the variables, Cointegration technique is used. Johansen Cointegration procedure is employed to check the number of cointegrating vectors among the variables in the model. The results are as follows:

Ho: There is no Cointegration among the variables.

The long run elasticity of all variables is estimated using Johansen Cointegration test and the results implies that the trace statistics being greater than the critical value, statistically significant at 5 percent level. This implies that null hypothesis is rejected and hence no Cointegration exists between the variables. The trace statistics indicate that is three cointegrating equations at the 5percent level of significance i.e., a unique relationship exists.

Since the cointegration test reveals that there exist long run relationship between variables therefore we proceed with VECM model.

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Vector Error Correction model results

Cointegration analysis demonstrates that log of GDP per capita, log of crude death rate, log of fertility rate and log of life expectancy do have long run equilibrium relationship but in short term,these four are in disequilibrium. The short-term imbalance and dynamic structure can be expressed as VECM.

Vector Error Correction Estimates
Date: 07/12/21 Time: 11:22
Sample (adjusted): 5 30
Included observations: 26 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	CointEq2	CointEq3
LNGDP(-1)	1.000000	0.000000	0.000000
LNFR(-1)	0.000000	1.000000	0.000000
LNLE(-1)	0.000000	0.000000	1.000000
LNUFMR(-1)	2.491308	-0.443622	0.104282
	(0.48581)	(0.02809)	(0.01174)
	[5.12810]	[-15.7912]	[8.88049]
C	-17.24045	0.821081	-4.611349

Error Correction:	D(LNGDP)	D(LNFR)	D(LNLE)	D(LNUFMR)
CointEq1	-1.942540	-0.004972	-9.83E-05	-0.003760
	(0.54930)	(0.00258)	(0.00032)	(0.00625)
	[-3.53639]	[-1.92484]	[-0.30777]	[-0.60163]
CointEq2	32.86827	-0.248360	0.005531	0.624151
	(26.9334)	(0.12665)	(0.01565)	(0.30644)
	[1.22035]	[-1.96097]	[0.35335]	[2.03676]
CointEq3	117.7848	-0.690170	0.025727	0.708464
	(68.8951)	(0.32397)	(0.04004)	(0.78387)
	[1.70963]	[-2.13034]	[0.64252]	[0.90380]
D(LNGDP(-1))	0.496223	0.005415	7.73E-05	0.005649
	(0.32489)	(0.00153)	(0.00019)	(0.00370)
	[1.52737]	[3.54428]	[0.40918]	[1.52821]
D(LNGDP(-2))	-0.237602	0.004265	-0.000113	0.000604
	(0.37450)	(0.00176)	(0.00022)	(0.00426)
	[-0.63445]	[2.42198]	[-0.51837]	[0.14164]
D(LNGDP(-3))	-0.260995	0.000580	0.000117	-0.002003
	(0.26557)	(0.00125)	(0.00015)	(0.00302)
	[-0.98276]	[0.46460]	[0.75602]	[-0.66273]
D(LNFR(-1))	114.8111	0.042659	0.032057	0.449267
	(75.6937)	(0.35594)	(0.04399)	(0.86122)
	[1.51679]	[0.11985]	[0.72872]	[0.52166]
D(LNFR(-2))	50.31736	0.416211	0.030072	-0.541619
	(50.9812)	(0.23973)	(0.02963)	(0.58005)
	[0.98698]	[1.73614]	[1.01496]	[-0.93374]
D(LNFR(-3))	-109.3587	0.187531	-0.053857	-1.420687
	(72.7754)	(0.34222)	(0.04230)	(0.82802)
	[-1.50269]	[0.54798]	[-1.27336]	[-1.71576]
D(LNLE(-1))	843.9661	-9.191582	1.521673	-2.430669
	(485.735)	(2.28412)	(0.28230)	(5.52658)
	[1.73750]	[-4.02412]	[5.39034]	[-0.43981]
D(LNLE(-2))	938.9855	3.309177	0.130122	3.611777
	(847.211)	(3.98392)	(0.49238)	(9.63937)
	[1.10832]	[0.83063]	[0.26427]	[0.37469]
D(LNLE(-3))	-608.1571	1.841867	-0.707793	-1.539752
	(471.942)	(2.21926)	(0.27428)	(5.36964)
	[-1.28863]	[0.82995]	[-2.58055]	[-0.28675]
D(LNUFMR(-1))	1.863498	-0.010164	0.002041	-0.298637
	(18.4312)	(0.08667)	(0.01071)	(0.20971)
	[0.10111]	[-0.11727]	[0.19058]	[-1.42407]
D(LNUFMR(-2))	13.71295	0.078369	0.014186	0.666732
	(11.8220)	(0.05559)	(0.00687)	(0.13451)
	[1.15995]	[1.40972]	[2.06473]	[4.95681]
D(LNUFMR(-3))	-1.992093	0.028156	0.012123	0.577442
	(20.2143)	(0.09506)	(0.01175)	(0.22999)
	[-0.09855]	[0.29620]	[1.03194]	[2.51069]
C	-5.613842	0.021107	0.001786	-0.037874
	(3.53801)	(0.01664)	(0.00206)	(0.04025)
	[-1.58672]	[1.26866]	[0.86844]	[-0.94087]
R-squared	0.784139	0.999383	0.999790	0.998852
Adj. R-squared	0.460347	0.998457	0.999474	0.997129
Sum sq. resids	0.025300	5.59E-07	8.55E-09	3.28E-06
S.E. equation	0.050299	0.000237	2.92E-05	0.000572
F-statistic	2.421736	1079.635	3169.597	579.8688
Log likelihood	53.26315	192.6149	246.9752	169.6416
Akaike AIC	-2.866396	-13.58576	-17.76732	-11.81859
Schwarz SC	-2.092183	-12.81155	-16.99311	-11.04437
Mean dependent	0.074687	-0.020976	0.006159	-0.046896
S.D. dependent	0.068471	0.006022	0.001275	0.010681

Determinant resid covariance (dof adj.)	3.01E-27
Determinant resid covariance	6.58E-29
Log likelihood	696.0070
Akaike information criterion	-47.69284
Schwarz criterion	-44.01533
Number of coefficients	76

Source: Self Analysis

The overall fitness of the model is 78 percent. The P value suggests that rejection of null hypothesis at 10 percent level of significance.

It is observed that VECM reports causality from two dimensions: long run and short run Causality.

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(1) Long run causality

Long-run causality—investigated by verifying the coefficient of the error correction term (it should be between 0 and 1 with a negative sign), which implies convergence of the system back to the long-run equilibrium position.

Based on the interpretation of VECM model coefficient indicates the speed of adjustment of the variables towards long run equilibrium. The coefficient is negative at 5 percent level of significance. There exist long run causal relationship running from LNUFMR, LNFR, LNLE to LNGDP.

(2) Short Run Causality

Ho: Fertility Rate does not granger causes GDP per capita.

H1: Fertility Rate granger causes GDP per capita.

VECM Granger Causality Wald Test Result

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	1.970869	(3, 10)	0.1824
Chi-square	5.912607	3	0.1159

Source: Self-Analysis

The result shows that there exists no short run causality since the P value of Chi square statistics is greater than 5 percent level of significance. We accept the null hypothesis that there exists no short run causality from LNFR to LNGDP.

Ho: Life Expectancy does not granger causes GDP per capita

H1: Life Expectancy granger causes GDP per capita

VECM Granger Causality Wald Test Result

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	1.970869	(3, 10)	0.1824
Chi-square	5.912607	3	0.1159

Source: Self-Analysis

P value is greater than 5 percent level of significance therefore we accept the null hypothesis therefore there exist no short run causality from LNLE to LNGDP.

Ho: Under Five Mortality Rate does not granger causes GDP per capita

H1: Under Five Mortality Rate granger causes GDP per capita

VECM Granger Causality Wald Test Result

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	0.772017	(3, 10)	0.5356
Chi-square	2.316050	3	0.5095

Source: Self-Analysis

P value is greater than 5 percent level of significance therefore we accept null hypothesis therefore there exist no short run causality from LNUFMR to LNGDP.

In this way, the effect of health indicators LNLE LNFR and LNUFMR on GDP can be generalized as follows. The variables portray significant upward and downward trend and hence indicates there exist outliers in a long run that make it not stationary. The long run relationship between variables using Johansson Cointegration test implies that the given model can be corrected using the VECM model.

Adding on to the interpretation of the VECM model there exist statistically significant long run causality running from the independent variables to the LNGDP however there exist no statistically significant short run relationship between each of the independent variable to LNGDP. With R^2 statistics at 78 percent we see that out model is statistically significant. However, the Durbin Watson test statistics indicates the presence of autocorrelation in the model. To improve the fitting of the model it is necessary to check for the residual diagnostics to assess the significance of the variables and the residuals in the model.

First, we carry out the residual diagnostic testing of the time series for Heteroskedasticity, Autocorrelation and Normality test.

Heteroskedasticity Test.

To interpret the presence of heteroskedasticity in the time series data we use the Brush-Pagan-Godfrey Test (Appendix) . The null hypothesis of the test indicates that the residual statistics is free from the presence of heteroskedasticity. that is to say that the null hypothesis indicates that the series ais homoscedastic in nature. To check the statistical significance of the test the chi square statistics is taken into consideration. Since the chi square value is greater than 5 percent level of significance it indicates that we accept the null hypothesis. This indicates that the given time series data is homoscedastic

Normality Test

Ho: the residuals are not normally distributed

The normality test indicates that the errors are normally distributed. The null hypothesis here indicates that the series error terms are form a normal distribution which is desirable. Here to check the statistical significance of the test we use the Jarque Bera statistics to interpret the result on Normality if the P value is less than 5 percent level of significance, we can reject the null hypothesis. Based on the model fitted for the study the value of Jarque bera statistics, indicates value 0.52 with p value as 52 percent (Appendix) which indicates we cannot reject the null hypothesis meaning that residuals are normally distributed and that is desirable.

Serial Correlation – LM Test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 3 lags

F-statistic	5.076898	Prob. F(3,7)	0.0354
Obs*R-squared	17.81312	Prob. Chi-Square(3)	0.0005

The LM test indicates the presence of serial correlation with respect to the time series data set that we have taken. This is not desirable as it would make our model weak. So, one of the first steps is to remove the serial correlation from the data series. In order to do that we would include

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the first period lag of the dependent variable as the independent variable.

Breusch-Godfrey Serial Correlation LM Test: Null hypothesis: No serial correlation at up to 3 lags			
F-statistic	1.004600	Prob. F(3,21)	0.4103
Obs*R-squared	3.639582	Prob. Chi-Square(3)	0.3031

The Serial Correlation test results indicates that the chi square value is significant in greater than 5 percent level of significance, we accept the null hypothesis and therefore there exist no serial correlation within the data set. The Heteroskedasticity, Autocorrelation and Normality test results indicates that our model is perfect to explain the relationship between the given dependent and independent variables.[6]

Based on the statistical analysis of the variable LNLE LNFR AND LNUFMR on LNGDP it is seen that there exists a long run positive relationship running from the independent variables LNLE LNFR and LNUFMR to LNGDP. However, in short run there these variables do not impact on the GDP which indicates, how over a period of time developments on the health determinants will lead to a significant growth in GDP satisfying our hypothesis on the positive impact of health determinants on the growth variables.

Conclusion

The study presents the relationship between leading health indicators and economic growth of India using annual time series data from the period 1990-2019. It investigates the impact of selected health indicators like Life expectancy, Under five mortality rate and fertility rate respectively on economic growth. The results are in tune with similar studies conducted in countries like Pakistan (Akram, 2008), USA(Costa, 2015), Island Kingdom of Tonga (Siaosi, 2014) that there exists a long run relationship between health indicators and economic growth. Causality between health indicators and economic growth also suggests that increased investment in health sector would bring higher economic growth to the country. This analysis is important from the perspective of framing policies and growth agenda for a country like ours. The major policy implication of the study is that if we desire high levels of per capita income, even when current stocks are at lower end, we can achieve it by increasing and improving stock of healthy human capital (Akram et al.2008). Today, India has been perceived as an emerging superpower and as an impressive global economic power. Accessible quality healthcare can be a vital competitive strength for any country and must be included as a way forward for any development policies framed by the country. It is thus essential to begin the development of our medical facilities, increase investments and services in the health sector, to make the country progressive and shape the economy into an advanced nation by achieving higher economic growth through better health

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Appendix:

Unit root test results:

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Null Hypothesis: D(LNGDP) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.819157	0.0000
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

*MacKinnon (1996) one-sided p-values.

Source: Self-analysis

Null Hypothesis: LNLE has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.547919	0.0001
Test critical values:	1% level	-3.699871	
	5% level	-2.976263	
	10% level	-2.627420	

*MacKinnon (1996) one-sided p-values.

Source: Self-analysis

Null Hypothesis: D(LNFR) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.135278	0.0003
Test critical values:	1% level	-3.699871	
	5% level	-2.976263	
	10% level	-2.627420	

*MacKinnon (1996) one-sided p-values.

Source: Self-analysis

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Null Hypothesis: LNUFMR has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.095976	0.0389
Test critical values:	1% level	-3.699871	
	5% level	-2.976263	
	10% level	-2.627420	

*MacKinnon (1996) one-sided p-values.

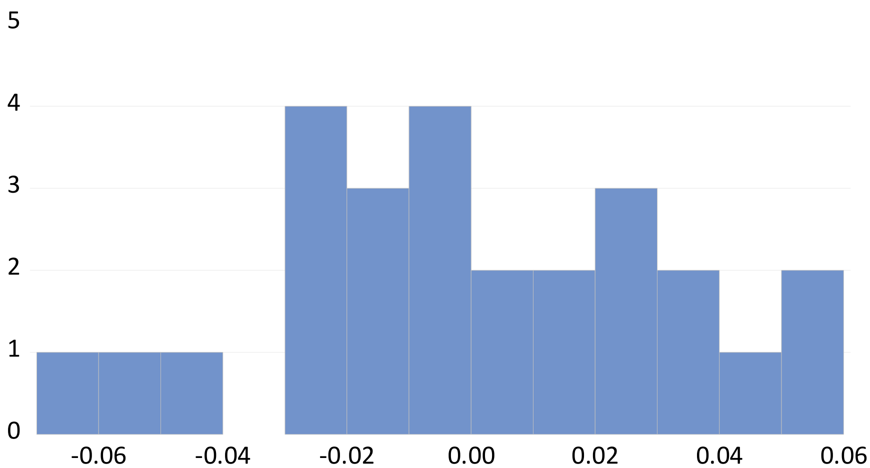
Source: Self-analysis

Heteroskasticity test results:

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	1.853692	Prob. F(14,11)	0.1543
Obs*R-squared	18.26017	Prob. Chi-Square(14)	0.1952
Scaled explained SS	1.821064	Prob. Chi-Square(14)	1.0000

Normality Test



Series: Residuals
Sample 5 30
Observations 26

Mean	2.36e-15
Median	-0.003208
Maximum	0.053409
Minimum	-0.064385
Std. Dev.	0.031812
Skewness	-0.119538
Kurtosis	2.348333
Jarque-Bera	0.521979
Probability	0.770289