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Openness-Growth Nexus in India during 1948-2021

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Abstract

In this paper, the author examined the econometric relation between economic growth and trade openness in India in the post-independence period from 1948 to 2021. The author used semi-log linear and non-linear trend models, Bai-Perron structural breaks model (2003), Hamilton (2018) regression filter decomposition model, Johansen (1988) cointegration model and Wald test (1943) model respectively. The paper found that the openness has significant nonlinear trend in which decomposition has revealed that it contains cycles, cyclical trend and seasonal fluctuations during the period. There is one significant cointegrating equation between the openness and growth nexus where both short run and long run causalities exist but its cointegrating equation has been converging towards equilibrium significantly in a nonstationary process since its VECM is nonstationary.

Keywords: openness, linear trend, nonlinear trend, cyclical trend, openness-growth nexus, cointegration, vector error correction, short run causality, long run causality

JEL Classification Codes: C32, F14, F43, O40, O50

Introduction

The growth-openness nexus has many contexts of economic implications, such as trade policy, trade-growth relation, globalisation-growth relation and raises many issues on the dimension of growth measurement whether it will be indicated by GDP, GDP per capita or human development index and so on. Besides, there are many indicators of openness, each of which revealed separate results and implications. It is evident that no independent measure of so-called 'openness' is free of methodological problems. The endogenous growth model generates economic growth but trade openness may hamper economic growth, where technological innovations or learning by doing are primarily exhausted, or where selective protection may foster faster technological advances (Lucas, 1988). Grossman and Helpman (1991) showed that trade openness improves transfers of new technologies, facilitating technological progress and productivity, and these benefits depend upon the degree of trade openness which reduces the misallocation of resources in the short-run. The empirical evidence of trade openness impact on economic growth is still inconclusive and mixed. Some economists verified the relation as positive and others showed it negative. Trade openness boosts economic growth by not only raising output levels of capital and labour but also by redistributing resources from less productive companies to higher productive ones. On the other hand, standard measures of trade policy are basically uncorrelated with growth (Wacziarg & Welch, 2003). Even, the theory and practice of capital flows have controversial implications of growth-openness relationship too. On the recent development of growth-openness model, Balke and Fomby (1997) proposed a threshold cointegration analysis that assumes the adjustment towards the long-run equilibrium holds when the deviation from the equilibrium exceeds some threshold level. The threshold cointegration corrects the autocorrelation and endogeneity in the models.

This paper seeks to verify the openness growth relationship in India during the period of 1948-2021, i.e., in the post-independence of India taking trade openness as indicator and GDP at current prices and GDP per capita at current prices as the indicators of growth.

Literature Review

Many researches have been conducted to relate growth and openness for a long time in which the author has mentioned a few researches which are closely related in this nexus. Harrison (1996) empirically verified in various countries in different time periods that openness can boost growth in several measures of openness and there is bidirectional causality between openness and growth.

Edwards (1998) examined empirically the robustness of the openness-growth relationship to the use of nine existing indicators including the Sachs-Warner indicator and other trade policy indicators and found that six of the measures are statistically significant in the expected direction.

Nourzad and Powell (2003) tested empirically using a panel of forty-seven developing countries and five-year averages for period, 1965-1990 and showed that openness has a positive influence on both economic growth and human development.

Yanikkaya (2003) applied a cross-country regression to a panel data of more than 100 developed and developing nations for the 1970-1997 period and found that trade openness contributes significantly to economic growth.

Baldwin (2004) concluded from this survey of empirical studies and from the individual country and cross country about the relationships between openness and growth that on balance, general economic openness is much more favourable to growth than a general inward-looking economic approach.

Rodríguez (2006) used six measures of openness and related with growth during 1990-2003 in cross section regression which attempted to account for growth in per capita GDP as a function of the alternative openness indicators and a set of common controls like trade shares, changes in trade shares, Sachs-Warner dummy etc. and found that the Trade/GDP ratio has a positive albeit far from significant effect on growth, which actually becomes negative (always insignificant) as more controls are added to the regression but when the import-weighted tariffs or unweighted tariffs are used, the coefficient of openness on growth is actually negative and insignificant. The author commented that a positive (or negative) relationship between trade and growth could well exist but failed to be picked up because the information contained in the data is not sufficiently strong.

Madsen (2009) relied on a long data set for 16 industrialized countries to examine the correlation between openness and economic growth. The author found that trade openness did not considerably affect growth.

Bhowmik (2009) verified in India in the pre reform and post reform periods during 1970-71 to 1990-91 and 1991-92-2005-06 on the relation between degree of openness and GDP growth rate and found significant positive relation.

Birinci (2013) verified the relationship between trade openness and economic growth in the OECD countries and found bidirectional causality between trade openness and economic growth.

In the context of the Algerian economy, Hamdi and Sbia (2013) examined through econometric models and found unidirectional causality from trade openness to economic growth in the short-and long-run.

Hye and Lau (2014) applied ARDL approach and examined the nexus between trade openness and economic growth in India over the period 1971–2009 and found that trade openness has a positive impact on economic growth in the short-run and detrimental in the long run. Besides, the Granger causality test shows the unidirectional causality runs from trade openness to economic growth in the short-run as well as in the long-run.

Huchet, Mouël, and Vijil (2018) took a panel of 169 countries between 1988 and 2014 and used a Generalized Method of Moments estimator and found a non-linear pattern between the export ratio and the quality of the export basket, suggesting that openness to trade may

impact growth negatively for countries which are specialized in low quality products and also found a non-linear relationship between exports variety, the export ratio and growth. The authors also observed that the cross effect of the export ratio and the export variety index clearly relates to changes at the intensive and extensive margins so as to investigate further at the macroeconomic level are required to clarify the role of trade dependency and each trade margin as regards the relationship between trade and growth.

Sheng, Fatima, Irshad, and Ramzan (2019) examined in 19 developing countries for the periods of 1980-2013 and found that economic growth and openness relation is negative but it may tend to positive when fixed capital formation is taken as a mediating variable and show a threshold.

Mallick and Behera (2020) examined the long-run equilibrium relationship between economic growth and trade openness in India during the period 1960–2018 using the asymmetric error-correction model with threshold cointegration in pre reform period from 1960 to 1990 and post reform period from 1991 to 2018 and found asymmetric cointegration between economic growth and trade openness and showed a unidirectional causal relationship between them. During the pre-trade reforms period, trade openness response to positive and negative deviations are fully removed within approximately one month and less than a month, respectively and disturbances in trade openness fully digest positive and negative economic growth shocks within a month and less than a month respectively. The study suggests that policymakers can give priority to import substitution, export promotion, and trade liberalization policies, such that the degree of trade openness can substantially raise the economic growth in India.

Ozturk and Radouai (2020) used econometric model of ARDL and Granger causality during 1960-2018 to relate openness and growth in Morocco and found that trade openness has a statistically significant yet negligibly small impact on economic growth both in the short-run and in the long run and there was unidirectional causality running from trade openness to economic growth.

Fatima, Chen, Ramzan and Abbas (2020) verified through econometric model of system generalized method of moments (GMM) estimator during 34-year period from 1980 to 2014 of 80 developing countries on relationship between trade openness and GDP growth and observed that the trade openness and GDP growth is non-linear when HCA is taken into account but trade may have a negative impact on GDP growth when countries exhibit a low level of HCA although trade clearly contributes to enhanced economic growth once a country exhibits a minimum HCA threshold. Therefore, the higher the level of HCA, the greater the impact of trade openness on GDP growth.

Bhowmik (2020) examined in econometric model of Sino-US trade and found that increment in Chinese openness was positively related with the increment of Chinese GDP and there was significant short run causality from openness to Chinese GDP during 1990-2019.

Moreover, Bhowmik (2021) verified empirically that the change of openness is negatively related with the change of GDP in the VECM analysis of ASEAN's trade during 1990-2016 which is significant.

Objectives of the Paper

The author tried to examine the relationship between trade openness and GDP at current prices and GDP per capita at current prices of India during 1948-2021 by applying the econometric models. Moreover, the author also analyses the linear and nonlinear trends of openness in which cyclical trend, cycle and seasonality of openness of India in more details.

Methodology and Source of Data

The semi-log linear was estimated to get the trend line through the model of $\log(y)=a+bt+u_i$ where y is the variable, t is the time, u_i is the random error.

The non-linear trend was fitted by the semi-log regression model.

The estimated equation can be written as: $\log(x_i)=a+bt+ct^2+dt^3+et^4+ft^5+u_i$ where x_i=variable to be estimated, a, b, c, d, e and f are constants, t=time(year), u_i=random error, for all values of i=1,2,3,……n.

To show structural breaks, the Bai-Perron model (2003) was applied.

Decomposition into cycles, trends and seasonality were done through the Hamilton regression filter model (2018) which is stated below.

$y_{t+8}=\alpha_0+\alpha_1 y_t+\alpha_2 y_{t-1}+\alpha_3 y_{t-2}+\alpha_4 y_{t-3}+v_{t+8}$ where y=variable to be regressed.

Or, $v_{t+8}=y_{t+8}-(\acute{\alpha}_0+\acute{\alpha}_1 y_t+\acute{\alpha}_2 y_{t-1}+\acute{\alpha}_3 y_{t-2}+\acute{\alpha}_4 y_{t-3})$

So, $y_t=\alpha_0+\alpha_1 y_{t-8}+\alpha_2 y_{t-9}+\alpha_3 y_{t-10}+\alpha_4 y_{t-11}+v_t$

Therefore, $v_t=y_t-(\acute{\alpha}_0+\acute{\alpha}_1 y_{t-8}+\acute{\alpha}_2 y_{t-9}+\acute{\alpha}_3 y_{t-10}+\acute{\alpha}_4 y_{t-11})$ where $\acute{\alpha}_i$ are estimated.

$v_{t+h}=y_{t+h}-y_t$ is the difference i.e., how the series changes over h periods. For h=8, the filter $1-L^h$ wipes out any cycle with frequencies exactly one year and thus taking out both long run trend as well as any strictly seasonal components.

It also applies random walk: $y_t=y_{t-1}-\varepsilon_t$ where d=1 and $\omega_t^h=\varepsilon_{t+h}+\varepsilon_{t+h-1}+\ldots\ldots\ldots\ldots+\varepsilon_{t+1}$

Regression filter reduces to a difference filter when applied to a random walk. Hamilton suggested h=8 for business cycles and h=20 for studies in financial cycles. Regression v_t converges in large samples to $\alpha_1=1$ and all other $\alpha_i=0$. Thus, the forecast error is $v_{t+h}=y_{t+h}-y_t$.

The residual equation v_t can be decomposed into trend, cycle and seasonally adjusted through SEATS/TRAMO or STL or census X-13 packages. The STL method is developed by Cleveland, Cleveland, McRae and Terpenning (1990).

The Hamilton regression filter residual is passed through ARIMA (p, d, q) model for forecasting at date using Box and Jenkins (1976) model.

Box and Jenkins (1976) methodology of ARIMA (p, d, q) can be estimated as below:

$$x_t= a+ b_i x_{t-i}+ \varepsilon_t+ b_{oi}\varepsilon_{t-i}+ \grave{e}_t$$

where x_t is the variable, a is constant, b_i are the coefficients of AR process and b_{oi} are the co-efficients of MA process and $\grave{e}_t$ is residual and i=1,2,…….n, and t= time. If b_i and b_{oi} are less than zero and significant at 5% level then the model is convergent and significant. If the roots of AR and MA are less than one then the model is stable and stationary.

The Johansen models (1988) is briefly noted here:

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

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

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

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

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

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

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

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

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

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

ε_t are Nm(0,Σ) errors.

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

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

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

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

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

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

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

Alternatively,

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

The central part of the methodology of Wald test (1943) is explained in brief.

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

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

T(cä-c)′[c($\Gamma^{-1}\Sigma_u$)c′]$^{-1}$(cä -c) ∩ χ2(N).

Then we replace Γ and I_u by their unusual estimator

Γ′=zz′/T and Σ'_u=T/(T-k_p-1)xΣ'_u, then the resulting statistic becomes

λ_w=(cä -a)′[c((zz′)$^{-1}$ Σ'_u)c′]$^{-1}$(cä -c)

It is still asymptotic χ2 distribution with N degree of freedom and it has the condition of [c((zz′)$^{-1}$ Σ'_u)c′]$^{-1}$/T which is a consistent estimator of [c($\Gamma^{-1}\Sigma_u$)c′]$^{-1}$

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

$\sqrt{T}$ (cä -a)∩N[(0, $\Gamma^{-1}\Sigma_u$)] holds and in practice, NF(N,T) ∩ χ2(N) as t tends to infinity where F(N,T) indicates as F random variable with N and T degrees of freedom because F(N,T) distribution has flatter tail than the χ2(N)/N distribution and it is reasonable to consider the test statistic $\lambda_F=\lambda_w/N$ in conjunction with critical values from the F-distribution.

The openness was calculated by using the formula of Σ(x+m)/2/GDPx100 taking data of India's export, import and GDP at current prices from UNCTAD during 1948-2021. Besides, the data on GDP per capita at current prices during 1948-2021 were collected from the World Bank and EPW.

Results and Findings

Linear and Non-Linear Trends, Structural Breaks, Cycles and ARIMA

India's openness (per cent) has been increasing at the rate of 1.86% per year significantly during 1948-2021 in linear trend line which is estimated below.

$$\text{Log}(y)=1.3329+0.01864t+u_i$$
$$(17.30)^* \quad (10.44)^*$$

R^2=0.602, F=109.05*, DW=0.184, *=significant at 5% level, y=India's openness index in per cent, t=year and n=74

In Figure 1, the linear trend has been depicted which is upward sloping from left to right.

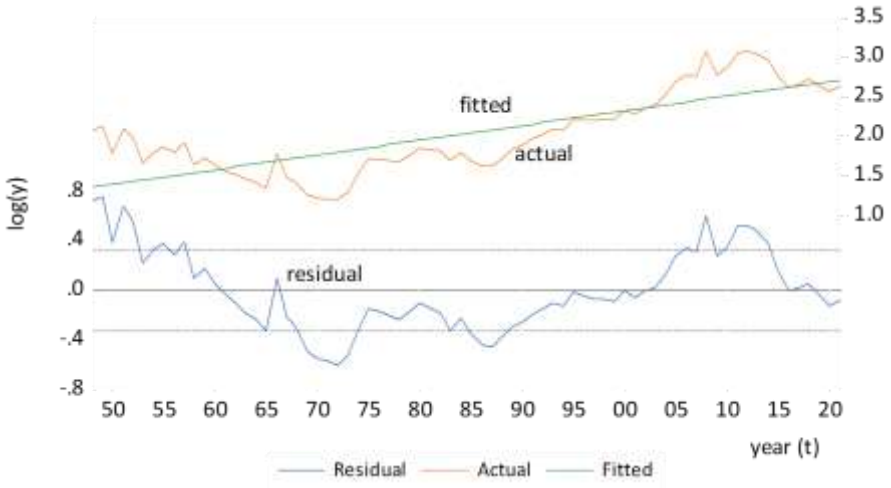

Figure 1: Linear trend of openness
Source: Plotted by author

This estimated linear trend line is proved to be an unstable one since its CUSUM of square line passes away from the ±5% significant area which is shown below in Figure 2.

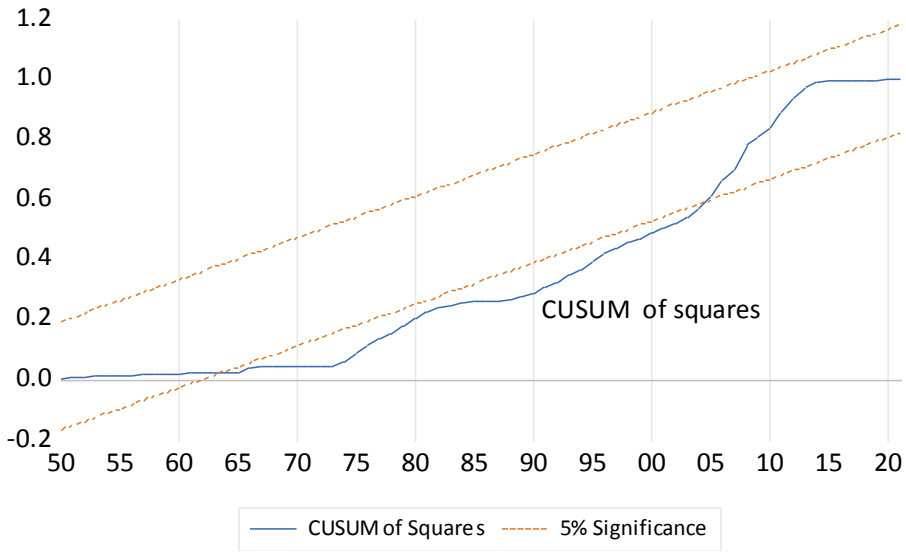

Figure 2: Stability of linear trend line
Source: Plotted by author

Therefore, the non-linear trend line of openness has been estimated below, in which it is downswing in the first phase, upswing in the second phase and then it is upswing at significant level.

$$Log(y)=2.336-0.0969t+0.0030t^2-2.18e^{-05}t^3+u_i$$
$$(28.69)^* \ (-10.38)^* \ (10.43)^* \ (-8.64)^*$$

$R^2=0.90$, $F=211.52^*$, $DW=0.701$, $n=74$

In Figure 3, the flat s shape nonlinear trend line of India's openness during 1948-2021 has been found.

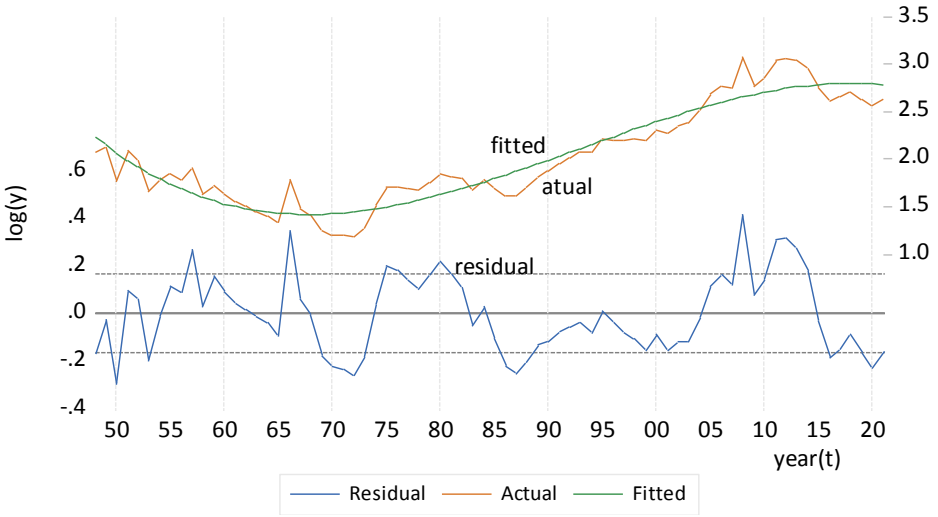

Figure 3: Nonlinear trend line
Source: Plotted by author

This nonlinear trendline of openness is shown as a stable model because its CUSUM line passes through the ± significant area which is visible in Figure 4.

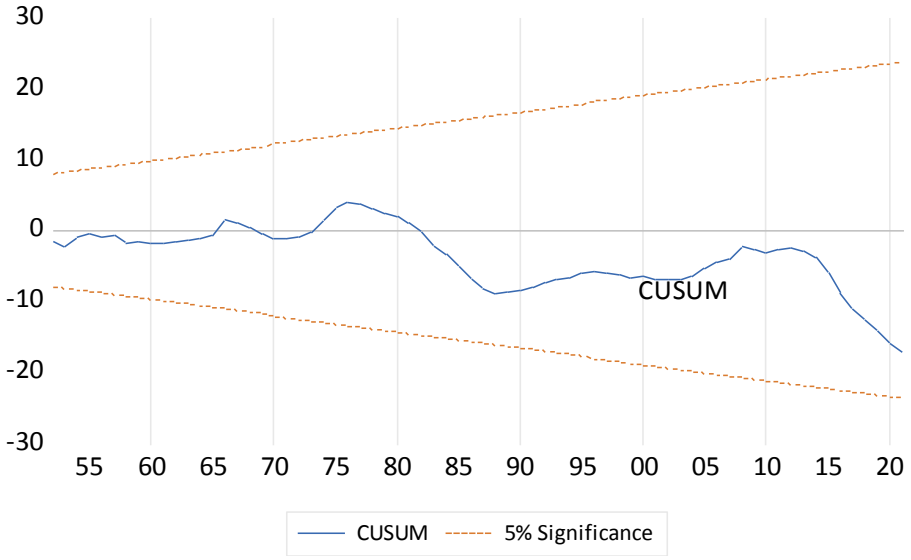

Figure 4: Stability of nonlinear trend
Source: Plotted by author

The openness of India from 1948 to 2021 consists of two upward structural breaks in 1992 and 2006 as measured by Bai Perron model (2003) using L+1vs L sequentially determined breaks selecting trimming 0.15 with maximum 5 breaks at 5% significant level assuming HAC standard errors and covariances (Bartlett kernel, Newey-West fixed bandwidth=4.00).

Table 1: Structural breaks

Variable	Coefficient	Standard error	t statistic	Probability
		1948-1991…44 observations		
C	1.672	0.0622	26.88	0.00
		1992-2005….14 observations		
C	2.2728	0.0729	31.149	0.00
		2006-2021….16 observations		
C	2.8097	0.0674	41.67	0.00

Note: R^2=0.83, F=173.53, DW=0.57, AIC=-0.1886, SC=-0.0952

In Figure 5, the structural breaks in 1992 and 2006 are markly visible in fitted line along with actual line of openness of India.

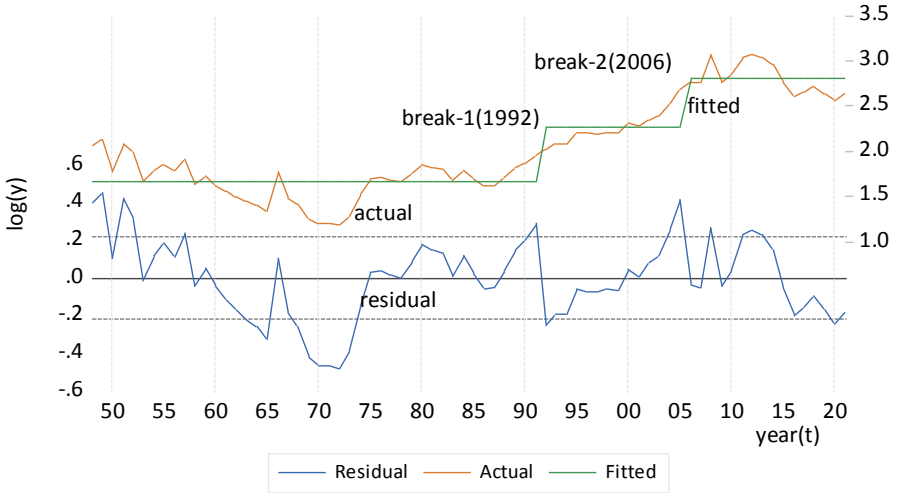

Figure 5: Structural breaks
Source: Plotted by author

For decomposition analysis, Hamilton (2018) regression filter residual has been given below.

$$V_t=\log(y)_t-[0.446+0.825\log(y)_{t-8}+0.348\log(y)_{t-9}-0.067\log(y)_{t-10}-0.284\log(y)_{t-11}]$$

where R^2=0.613, F=22.96*, n=63, DW=0.25

This v_t has been decomposed into cycles, trend and seasonal variation by applying STL method. In Figure 6, the cyclical pattern of openness is shown where the cycle consists of 13 peaks and 13 troughs respectively.

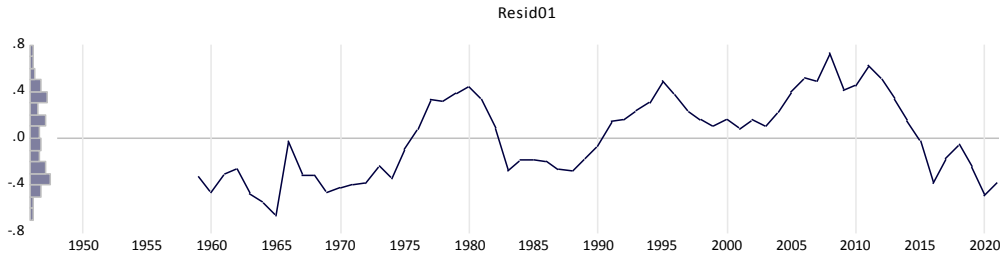

Figure 6: Cycle of openness under Hamilton model
Source: Plotted by author

The cyclical trend consists of 5 peaks and 4 troughs where 3 peaks and troughs are dominant and others are minors. In Figure 7, it is given below.

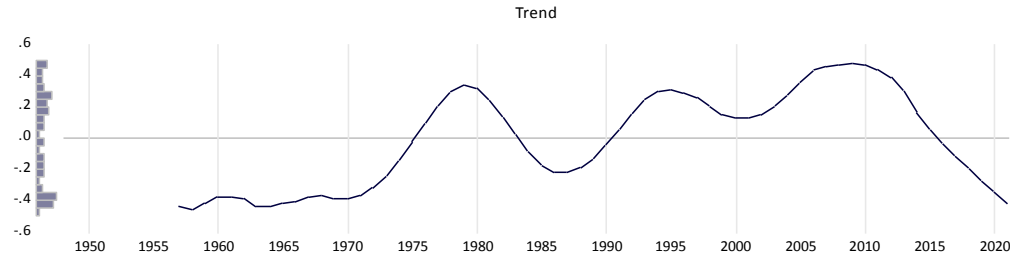

Figure 7: Cyclical trend
Source: Plotted by author

The seasonal variation is reflected with inverse v shaped whose fluctuations are shrinking followed by widening which is shown in Figure 8.

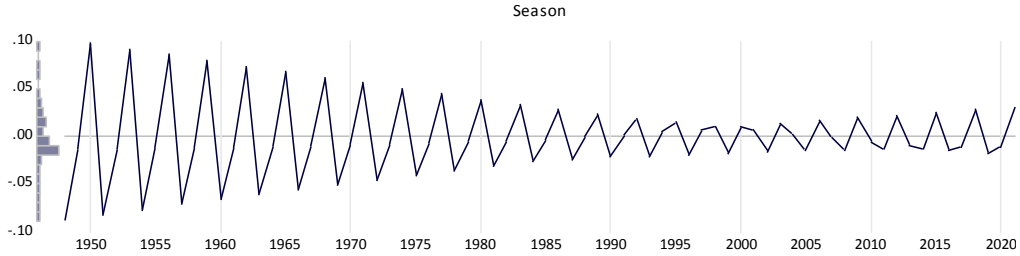

Figure 8: Seasonal variation
Source: Plotted by author

If the residuals of Hamilton filter model pass through the automatically best selected model of ARIMA(2,0,4) then the residual converges to equilibrium process where AIC is minimum. The estimated ARIMA(2,0,4) is given below.

$$V_t=-0.03625+0.6156v_{t-2}+\varepsilon_t+0.5532\varepsilon_{t-4}+0.0439\sigma^2_t$$
$$(-0.34) \quad (4.92)^* \quad (3.44)^* \quad (4.41)^*$$

R^2=0.62, F=32.27*, DW=0.81, AIC=-0.109, n=63, AR roots=±0.78, MA roots=0.61+0.61i,0.61+0.61i,-0.61-0.61i,-0.61-0.61i

Firstly, the model is stable because all roots of AR and MR are less than one. Secondly the model is stationary because the t values of coefficients of AR and MA are significant at 5% level where the coefficients are less than one that why the model is convergent.

If the model has been predicted for the future year of 2035, then the convergent process moves to the equilibrium significantly which is observed in the Figure 9 below. Conversely, the variability of India's openness approaches towards zero.

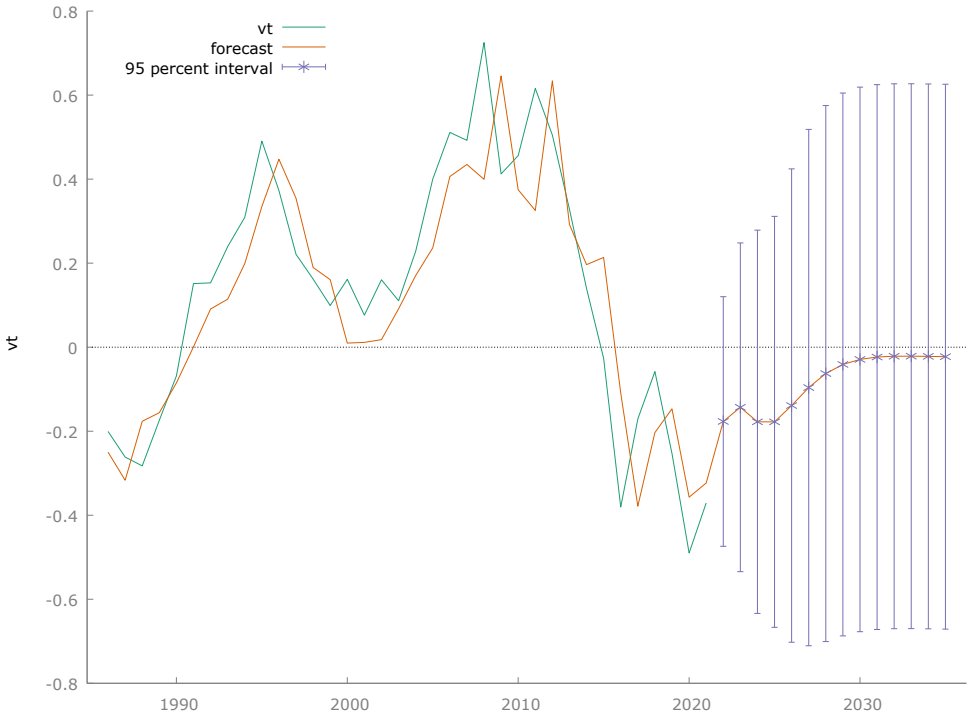

Figure 9: Forecast of ARIMA at 2035
Source: Plotted by author

Cointegration and VECM Analysis

Johansen (1988) cointegration between India's openness and GDP during 1948-2021 revealed that there is one significant cointegrating equation in both Trace statistic and Max - Eigen statistic under the assumption of linear deterministic trend in the lag interval 1 to 2 in the first differences of unrestricted cointegration rank test (Table 2).

Table 2: Cointegration test

Hypothesized no. of cointegrating equiations	Eigen value	Trace statistic	0.05 critical value	Probability**
None*	0.30954	28.9905	15.4947	0.0003
At most 1	0.037201	2.69165	3.841	0.1009
		Max-Eigen statistic		
None*	0.30954	28.9905	14.264	0.0004
At most 1	0.037201	2.69165	3.841	0.1009

Note: *Indicates rejection of hypothesis at 0.05 level,
** indicates MacKinnon-Haug-Michelis (1999) p-value, n=71
Source: Calculated by author

Since, the variables are cointegrated then vector error correction estimates are required to analyse the impact. The estimated VEC is given below.

dx_{1t}=0.0165CE+0.1253dx_{1t-1}-0.129dx_{1t-2}-12.067dy_{t-1}-3.187dy_{t-2}+43.171
(4.36)* (0.96) (-0.84) (-2.23)* (-0.63) (4.31)*
R^2=0.508, F=13.43, AIC=10.94, SC=11.13
dy_t=-0.000295CE+0.0183dx_{1t-1}-0.00338dx_{1t-2}+0.0279dy_{t-1}+0.2342dy_{t-2}-0.5401
(-3.90)* (7.12)* (-1.11) (0.26) (2.36)* (-2.71)*
R^2=0.466, F=11.34, AIC=3.105, SC=3.29

The estimated first equation of the VEC model states that change of openness at lag one has significant negative impact on the change of India's GDP during 1948-2021.On the other hand, the second estimated equation states that change of GDP at lag one has significant positive impact on the change of openness of India during 1948-2021.

This VEC model contains one unit root and other roots are less than one so that all roots lie inside or on the unit circle, therefore, the model is stable one but it nonstationary.

Table 3: Values of roots

Roots	Modulus
1.00	1.00
0.993	0.993
0.0619-0.495i	0.499
0.0619+0.495i	0.499
-0.456	0.456
0.363	0.363

Source: Calculated by author

Its unit circle is shown below.

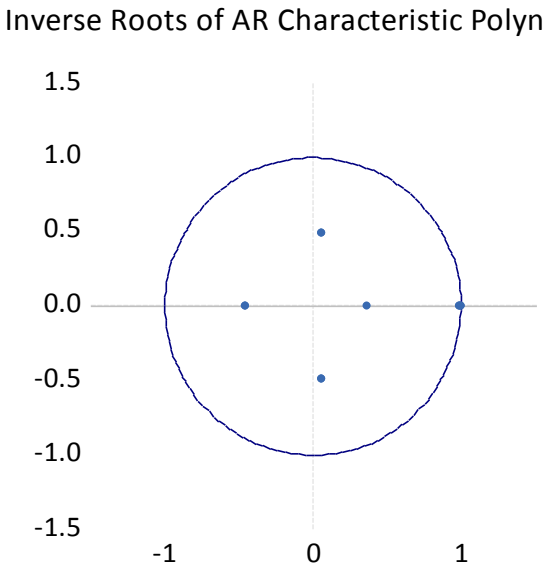

Figure 10: Unit circle
Source: Plotted by author

The VEC model contains autocorrelation problem that why DW values revealed very low and the model remains nonstationary. The correlogram is shown in Figure 11.

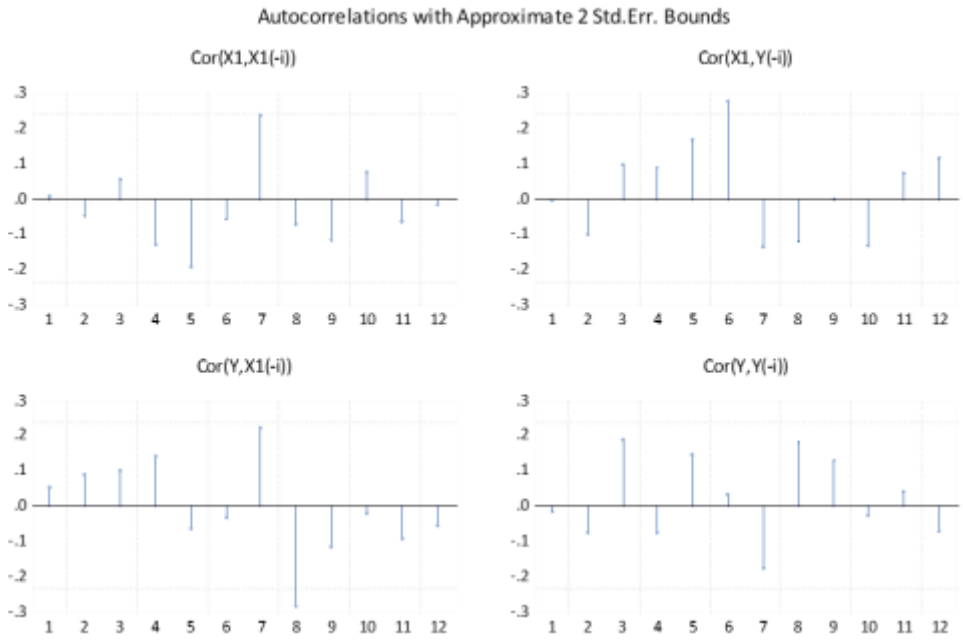

Figure 11: Autocorrelation of VEC

All the impulse response functions to Cholesky one standard deviation innovations are divergent away from equilibrium which revealed that openness has no impulse response to GDP during the specified period.

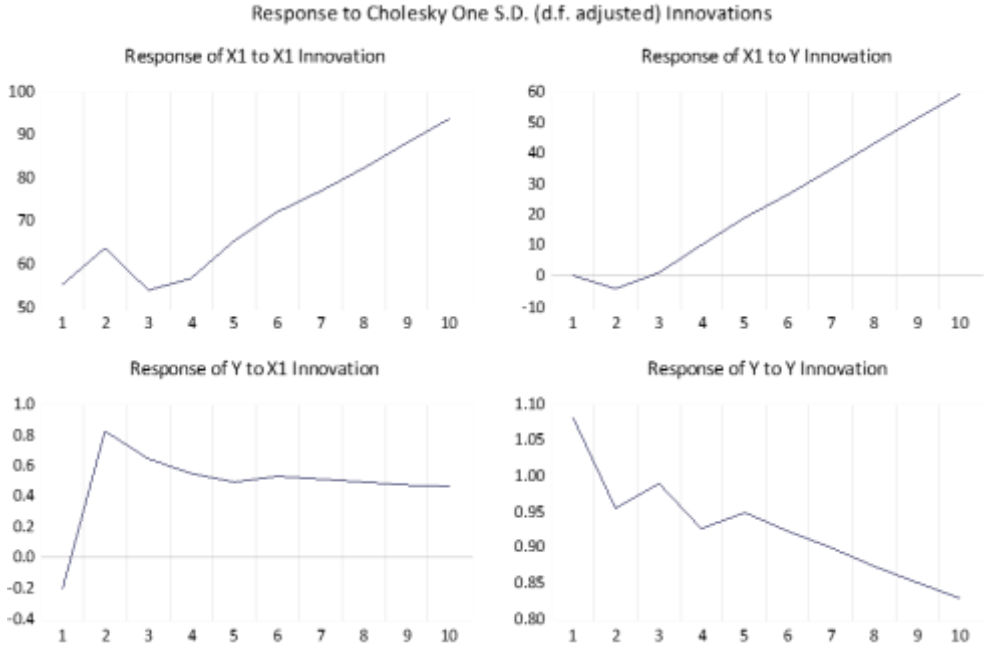

Figure 12: Impulse response functions

The cointegrating equation is estimated below.

$$X_{1t}=0.0165x_{1t-1}+489.94y_{t-1}-4836.089$$
$$(4.36)^* \qquad (4.59)^*$$

The cointegrating equation revealed that in the long run there remains a positive relation between openness and GDP, or, in other words, the long-run causality from openness to GDP of India during 1948-2021 showed positive which is significant at 5% level.

In Figure 13, the cointegrating equation is depicted in which it is observed that after 1995 it reached at equilibrium but since then it has departed and diverged away from equilibrium. The speed of adjustment is found as 1.65% per year.

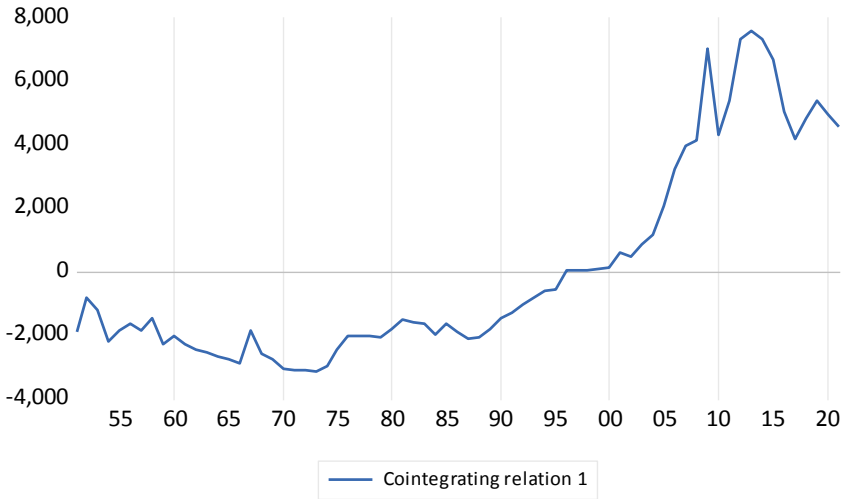

Figure 13: Cointegrating equation
Source: Plotted by author

From the Wald test (1943), it is observed that there is short run causality from openness to GDP which is significant at 8% level but the causality from GDP to openness is significant at 1% level.

Table 4: Short run causality

Short run causality	Chi-square values	Probability	Significant level
Causality from openness to GDP	$X^2(2)=5.0085$	0.0817	8% level
Causality from GDP to openness	$X^2(2)=50.844$	0.0000	1% level

Source: Calculated by author

Johansen unrestricted cointegration rank test under linear deterministic trend in lag interval of 1 to 2 in the first differences between openness and GDP per capita in current prices of India during 1948-2021 released one cointegrating equation between the two in Trace and Max-Eigen statistic which have been shown in Table 5.

Table 5: Cointegration test between GDP per capita and openness

Hypothesized no. of cointegrating equiations	Eigen value	Trace statistic	0.05 critical value	Probability**
None*	0.3154	26.927	15.4947	0.0006
At most 1	0.00024	0.0171	3.841	0.8958
		Max-Eigen statistic		
None*	0.3154	26.9099	14.2646	0.0003
At most 1	0.00024	0.0171	3.8414	0.8958

Note: *Indicates rejection of hypothesis at 0.05 level,
** indicates MacKinnon-Haug-Michelis (1999) p-value, n=71
Source: Calculated by author

Since, there is cointegration between openness and GDP per capita during 1948-2021, then it requires vector error correction model which is estimated below.

dx_{2t}=-0.0046CE-0.339dx_{2t-1}+0.1224dx_{2t-2}-18.1707dy_{t-1}-10.056dy_{t-2}+38.884

(-4.03)* (-2.43)* (0.64) (-3.15)* (-1.92)* (4.07)*

R^2=0.34, F=6.69, AIC=11.09, SC=11.28, *=significant at 5% level

dy_t=6.74e^{-05}CE+0.0148dx_{2t-1}+0.00105dx_{2t-2}-0.0903dy_{t-1}+0.1245dy_{t-2}-0.3152

(2.85)* (5.17)* (0.26) (-0.75) (1.15) (-1.59)*

R^2=0.327, F=6.33, AIC=3.33, SC=3.52, *=significant at 5% level

The estimated vector error correction implied that the change in openness in both periods have significant negative impact on the change of GDP per capita of India during 1948-2021 but the change in GDP per capita in lag one has only significant positive impact on the change of openness during the same period.

The model is nonstationary because it consists of one unit root along with other roots having less than one which are shown in Table 6.

Table 6: Values of roots

Roots	Modulus
1.00	1.00
0.9869	0.9869
-0.6147	0.6147
0.1457-0.4077i	0.4330
0.1457+0.4077i	0.4330
-0.2269	0.2269

Source: Calculated by author

This model is found stable because all roots lie on or inside the unit circle which is shown in Figure 14.

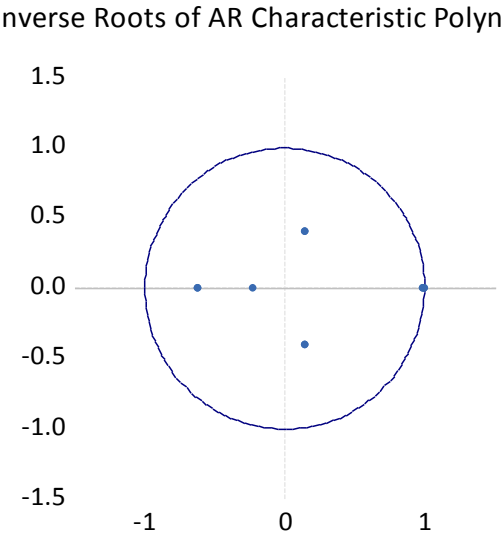

Figure 14: Unit circle

Source: Plotted by author

All the impulse response functions measured by Cholesky one standard deviation innovations are not converging to the equilibrium process which is shown in Figure 15.

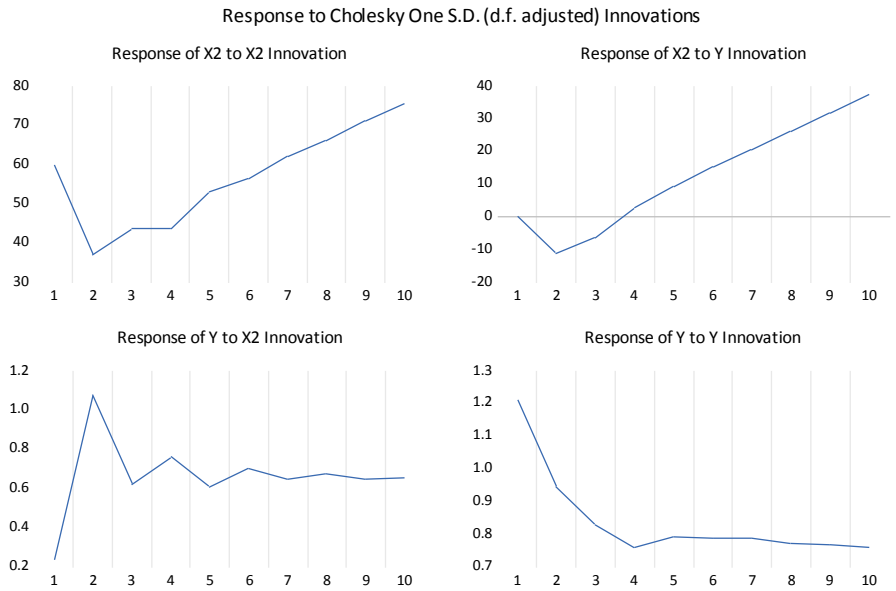

Figure 15: Impulse response functions
Source: Plotted by author

The estimated cointegrating equation is shown below.

$$X_{2t}=-0.00460x_{2t-1}-1912.362y_{t-1}+16144.22$$
$$(-4.03)^* \qquad (-5.71)^*$$

The estimated cointegrating equation states that there is long run causality from openness to GDP per capita at current prices of India during 1948-2021 and the relation is negative. Since the coefficient of x_{2t-1} is negative and its t value is significant at 5% level, then it is convergent significantly. In Figure 16, it is observed that the cointegrating equation is converging toward equilibrium and touched equilibrium after 1995, then it had started diverging and finally moving towards equilibrium. The speed of adjustment is found as 0.46% per year which is significant.

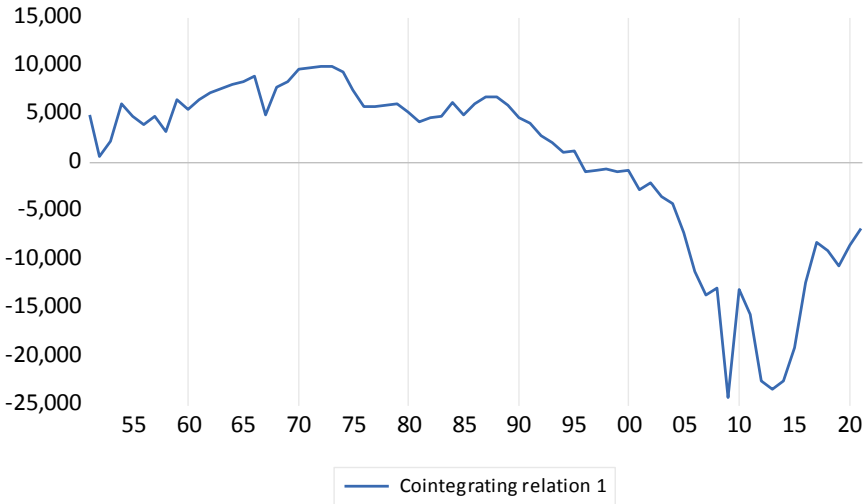

Figure 16: Cointegrating equation
Source: Plotted by author

The Wald test verified that there is bi-directional short run causality between openness and GDP per capita of India during the survey period of 1948-2021 where Chi-square values are significant at 1% level which are shown in Table 7 below.

Table 7: Short run causality

Short run causality	Chi-square values	Probability	Significant level
Causality from openness to GDP per capita	$X^2(2)=11.780$	0.0028	1% level
Causality from GDP per capita to openness	$X^2(2)=27.0088$	0.0000	1% level

Source: Calculated by author; where H0= no causality

Limitations and Scope of Future Research

The openness-growth nexus has a few limitations too. Firstly, the choice of indicator of openness by which trade policy and other economic policy depend upon. Even, the choice of data differs on the basis of openness indicator. Secondly, the GDP and GDP per capita are not only the indicators of growth itself but human development indicators and other variables related on social sector development should be considered as indicators of growth. The globalisation index is to be a part of openness indicator. A single country study may not be the final outcome of the nexus rather a panel cointegration among developing countries or blocs should be considered as the concrete result. Therefore, the paper has relevant scope of other areas of future research too.

Discussion

The opinion of Solow (1957) was that the technological change is exogenous which does not affect country's openness to world trade but new growth theory opposed it and sometimes it is very difficult to know how to measure correlation between trade policies and growth (Levine & Renelt, 1992). The authors suggested the linkages between trade and growth may occur through investment, instead of through improved resource allocation. It is also to be noted that the recent data again fails to display a no self-evident link between greater integration and economic growth.

On the issue of positive relation, Barro (1991) examined the impact of market distortions which is a measure of protectionary policies of a country where the more open an economy, the lower the level of market distortion and he observed that the growth of output per capita and the level of distortions are related negatively which is statistically significant. In addition to that Dollar (1992) constructed an index of openness based on purchasing power parity and relative prices and it is a weighted-average of the exchange rate distortions and variability indicating deviations from the optimal relative price level given the existence of non-tradable goods. Again, distortions are calculated as the difference between the actual price level of consumption goods and the predicted values from a regression model of the price level. The lower the distortion and the lower the variation, the lower the value of Dollar's openness index thus the more outward-oriented or open the economy. Dollar found a negative relationship between his index of openness and economic growth for a cross-section of 95 developing countries which implies that the more open an economy the more is the growth. It is likely that all measures of openness are jointly endogenous with economic growth, which may cause biases in estimation resulting from simultaneous or reverse causation. Various methods have been used to remedy this problem and there is still a debate among scientists about which method is the most appropriate. Greater importance can be given to the research of Fetahi-Vehabi, Sadiku and Petkovski (2015) which had implemented a system generalized methods of moments (GMM) and found that trade has a positive impact on the countries which have higher income per-capita, FDI and capital formation.

Conclusions

The paper found that the openness of India during 1948-2021 has the significant upward linear trend which is unstable but the nonlinear trend seems to be significant and stable. The cycle of openness consists of many peaks and troughs but the cyclical trend showed only three peaks and troughs and its seasonal variations are inverse v shaped according to Hamilton decomposition regression filter model. The openness has two upwards structural breaks in 1992 and 2006 respectively during 1948-2021. Its automatic ARIMA (2,0,4) model is convergent, stable and stationary where the forecast of ARIMA (2,0,4) model for 2035 is moving towards equilibrium process significantly. The openness and GDP at current prices and GDP per capita at current prices during 1948-2021 in India showed one significant cointegrating equation each in Trace and Max-Eigen statistic in which in the former case ,the short run causality is unidirectional and the long run causality between growth and openness is convergent and nonstationary showing positive relation but in the later case, the long run causality is negative, stationary and significant but the short run causality is bidirectional and significant.

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Conflict of Interests

There is no conflict of interest in publishing this article in the journal.

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