Co-Integration And Causality Analysis: An Empirical Inquiry into the Validity of Wagner's And Keynesian Laws in India

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Co-Integration And Causality Analysis: An Empirical Inquiry into the Validity of Wagner's And Keynesian Laws in India

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Abstract: **The objective of this paper is to investigate the nature and direction of causal relationship between government expenditure and economic growth in India in contexts of and Wagner's and Keynesian laws. The time series data used in the present study covers the period from 1975-76 to 2014-15. It is found that there is no equilibrium long term relationship between economic growth and government expenditure. Uni-directional causality is observed from government expenditure to economic growth and no feed-back mechanism. It nullifies the applicability of Wagner's law in India and validates the Keynesian law. Thus, it is recommended to give insights into the trends of transformation process, association between the two. The policymakers are suggested to incur huge government expenditure to accelerate the growth of Indian economy and adopt active Keynesian policies.**

Keywords: **economic growth, government expenditure, causality, Keynesian law, Wagner's law, India.**

I. INTRODUCTION

The government expenditure always plays an important role in the growth of an economy. In the nineteenth century, government expenditure under the influence of the classicals, played a limited role in economic activity. However, in the latter part of the nineteenth century, Adolph Wagner (1835-1917), a German political economist put forward his law of increasing government expenditures in *Grundlegung der politischen okonomie* (1893). After the publication of English translations of Wagner's works in 1958, Wagner's Law has become very popular in academic circles and it has been analysed and tested by many researchers [1]. Today, the view that there is a long-run tendency for the public sector (or government activities) to grow relative to national income (or total economic activity) has become widely accepted as a stylized fact in public finance [2][3][4]. His hypothesis is a classical approach which views government expenditure as an endogenous factor to economic growth or national income. Adolph Wagner arguing that government expenditure must increase at an even faster rate than output [5]. On the other hand, Keynesian hypothesis stressed that government expenditure is seen as an exogenous factor that can be used as a policy variable, and which can impact upon growth and development in the short-run [6]. That is government expenditure is fundamental determinant of economic growth. Keynesian theory expressed that government expenditure as a fiscal policy instrument is useful for achieving short-run stability and higher long-run growth rate. Therefore his theory prescribes for government interventions in the economy through the fiscal policies [7]. Thus, these two approaches call for two opposite directions of causality: first (Keynesian law) running from government expenditure to economic growth and second (Wagner's law) running from economic growth to government expenditure.

II. OBJECTIVES AND HYPOTHESIS

The objective of this paper is to investigate the nature and direction of causal relationship between government expenditure and economic growth in India with reference to Wagner's and Keynesian laws. The first hypothesis of the study is to test that the government expenditure is endogenous, an outcome of economic growth. Second hypothesis is that government expenditure is an exogenous factor of economic growth.

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III. METHODOLOGY AND DATA SOURCES

Data used in the present study are collected from the *Handbook of Statistics on Indian Economy* by the Reserve Bank of India (RBI, 2015) [8]. All data are annual figures covering the 1975-76 to 2013-14 period and variables are measured (at constant price) with base year 2004-05 prices. The choice of the starting period was constrained by the availability of time series data on gross domestic product (GDP), government expenditure (GE) and capital formation. The study defines government expenditure (GE) as sum of government final *consumption* expenditure (CE) and government sector gross *capital formation* expenditure (I), that is GE = CE + I and economic growth as real gross domestic product at factor cost. Here, GDP means annual growth rate of gross domestic product (GDP) at factor cost (at constant price) base year: 2004-05 (per cent). GER is ratio of GE to GDP, i.e. share of govt. expenditure (on goods and services) in annual GDP. IR implies the ratio of investment to GDP i.e. the share of private investment in GDP.

The Stationary Test (Unit Root Test):

In the context of a time series, "stationary" refers to a condition wherein the series have constant mean and constant variance [9]. Stationarity tests are pre-tests to avoid the problem of spurious regression [10]. To determine the order of integration or to determine whether a series is stationary or non-stationary several unit root tests are available: the Dickey-Fuller (DF), the augmented Dickey-Fuller (ADF) [11] [12] and the Phillips-Perron (PP) [13].

Augmented Dickey–Fuller (ADF) test:

The extended Dickey–Fuller (DF) test for higher order equations is known as the ADF test. Given an observed time series $y_1, y_2, \ldots\ldots y_N$ Dickey and Fuller consider three differential-form autoregressive equations to detect the presence of a unit root.

Model 1: $\Delta y_t = \delta\, y_{t-1} + \sum_{j=1}^{p} \Theta_j \Delta y_{t-j} + u_t$

Model 2: $\Delta y_t = \alpha + \delta\, y_{t-1} + \sum_{j=1}^{p} \Theta_j \Delta y_{t-j} + u_t$

Model 3: $\Delta y_t = \alpha + \beta\, t + \delta\, y_{t-1} + \sum_{j=1}^{p} \Theta_j \Delta y_{t-j}\, u_t$

Where,

α is a intercept constant called a drift,

β is the coefficient on a time trend

t is time trend or trend variable or time

δ is the coefficient presenting process root, i.e. the focus of testing,

p is the lag order of the autoregressive process or the lag length of the augmented terms for y_t

Δ is first difference operator, (i.e., $\Delta y_t = y_t - y_{t-1}$) or the first difference of y_t

u_t is disturbance term.

Phillips Peron (PP) Test:

A great advantage of Philips-Perron test, a unit root test, is that it is non-parametric, It rather takes the same estimation scheme as in DF test, but corrects the statistic to conduct for autocorrelations and heteroscedasticity (HAC type corrections).

The PP test entails the estimation of the following regression equation:

$X_t = \mu_t + b_1 t + p \sum_{i=1}^{n} X_{t-n} + u_t$

Y is the series under consideration, t is time, u_t is I(0) and may be heteroscedastic and n is number of the optimal Newey West bandwidth chosen by using the Bartlett Kernel criterion.

Testing for Co-integration Test (Johansen Approach):

There exist a number of co-integration tests. Johansen-Juelius approach is preferred to Engle-Granger method. If after Johansen cointegration test, the variables are not cointegrated, unrestricted VAR model is used. If after Johansen cointegration test, the variables are cointegrated, restricted VAR or Vector Error Correction Model (VECM) is used.

There are two likelihood ratio tests (proposed by the Johansen) namely, the trace statistic and the max-eigen statistic are employed to identify the co-integration between the two series.

Trace Test:

λ_{trace} (r, k) = - T $\sum_{j=r+1}^{k} ln(1-\hat{\lambda}_j)$

Maximum Eigen Value Test:

λ_{max} (r, r+1) = - T $ln(1-\hat{\lambda}_{r+1})$

Where,

r is the number of cointegrating relations and 0, 1, 2, 3….k-1

k is the number of endogenous I(1) variables.

T= Number of observations or sample size or the number of usable observations

$\hat{\lambda}_j$= the largest the eigen values of matrices or estimated values of characteristic roots ranked from largest to smallest or the eigen values of matrices. ($\hat{\lambda}_{r+1}$……. $\hat{\lambda}_k$)

The λ_{trace} test the H_0 that has at most h cointegrating vectors in the system. The λ_{max} test the H_0 that has r cointegrating vector(s) against the H_1 that has r+1 cointegrating vector(s) in the system [14]. Critical values for the λ_{trace} and λ_{max} statistics are provided by Osterwald-Lenum (1992)

The Granger Causality test:

If two or more series co-integrated then it implies that causality exists among the series but it does not indicate the direction of the causal relationship. Thus, the dynamic Granger causality based on Vector Error Correction Model (VECM) may be used to determine the causality direction between the variables [15][16].

The VECM captures both short-run dynamics and long-run equilibrium. In the ECT, the cointegrating vector represents the long-run equilibrium between variables. The coefficient of the ECT measures the speed of adjustment towards the long-run equilibrium, or the proportion of the long-term imbalance of the dependent variable that is corrected in each short-run period. Thus, the size and the statistical significance of this coefficient measure the extent to which each dependent variable has a tendency to return to its long-run equilibrium [17].

It can be written as follows:

ΔX_t= α + $\sum_{i=1}^{m} \alpha_i \Delta X_{t-i}$ + $\sum_{i=1}^{m} \beta_i \Delta Y_{t-i}$ + ε_t --- (1)

ΔY_t= α + $\sum_{i=1}^{m} \gamma_i \Delta X_{t-i}$ + $\sum_{i=1}^{m} \delta_i \Delta Y_{t-i}$ + u_t --- (2)

Where, $Y_t$and X_t are defined as Y and X observed over t time periods; Δ is the difference operator; k represents the number of lags; α, β, and γ are parameters to be estimated; and ε_t, u_t represents the serially uncorrelated error terms.

IV. EMPIRICAL ANALYSIS AND RESULTS

Unit Root Tests:

Before testing for cointegration, we tested for unit roots to find the stationarity properties of each series of the data. Augmented Dickey Fuller (ADF) and Phillips Perron (PP) were used on each of the three time series data. The lag length for ADF tests was selected to ensure that the residuals were white noise.

To determine the stationarity property of the variable, the unit root test was used for their levels. The table I shows that the null hypothesis of a unit root cannot be rejected for the given variable accepts lnGDP. Thus we can conclude that the variables are not stationary at their levels. Then the unit test was applied to the first differences. However, the null hypothesis that the series have unit roots in first differences is rejected, meaning that the three series are stationary at their first differences , that is, they are integrated of the order one i.e I(1).

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TABLE I. UNIT ROOT TESTS

	Augmented Dickey Fuller (ADF)		**Phillips Perron (PP)**	
	Level			
Variable	Constant Without Trend	Constant With Trend	Constant Without Trend	Constant With Trend
lnGDP	-6.294*** (0)	-7.273*** (0)	-6.291*** [1]	-7.707*** [6]
lnGER	-2.524 (8)	-1.256 (0)	-1.361 [7]	-1.233 [4]
lnIR	-1.266 (0)	-1.972 (0)	-1.253 [3]	-1.922 [1]
	First Difference			
lnGDP	-4.638*** (3)	-3.505* (9)	-22.270*** [16]	-24.046*** [17]
lnGER	-5.571*** (0)	-2.681 (9)	-5.551*** [4]	-5.836*** [9]
lnIR	-5.356*** (1)	-5.688*** (1)	-6.812*** [0]	-7.106*** [3]

Notes: ***, ** and *denotes significant at 1%, 5% and 10% significance level, respectively. The figure in parenthesis (…) represents optimum lag length selected based on Akaike Information Criterion. The figure in bracket […] represents the Bandwidth used in the KPSS test selected based on Newey-West Bandwidth criterion.

Source: Estimated by the author on the basis of Secondary Data compiled from RBI

Selection of the Optimum Lag Length

The relevant order of lags used in the vector autoregression (VAR) model was determined using the Akaike information criterion (AIC), Schwarz information criterion (SC), Hannan-Quinn information criterion (HQ). Table II presents the lag specification results and the number of lags determined is one.

TABLE II. LAG SELECTION BASED ON VAR LAG LENGTH CRITERIA

Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	-43.483	NA	0.002	2.513	2.643	2.559
1	57.942	180.921*	1.68e-05*	-2.483*	-1.961*	-2.299*
2	60.487	4.126	2.41e-05	-2.134	-1.220	-1.812

Notes:
* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Source: Estimated by the author on the basis of Secondary Data compiled from RBI

Johansen-Juselius Co-integration Test:

Table III shows the results of Johansen-Juselius cointegration tests indicate that both Trace test and Max-Eigen test are statistically significant to reject the null hypothesis of the null hypothesis of the zero co-integrating vectors. This implies that the variables are co-integrated with at least one co-integrating vector. It indicates that there is one equilibrium long term relationships between GDP, GER and IR in India in the period of study and these variables move together in the long run.

TABLE III. JOHANSEN-JUSELIUS COINTEGRATION TESTS

Hypothesized	Trace	Max-Eigen	Critical Values (5%)	
No. of CE(s)	Statistic	Statistic	Trace	Max-Eigen
r = 0	32.977	21.193	29.797**	21.132**
r ≤ 1	11.785	8.862	15.495	14.265
r ≤ 2	2.923	2.923	3.841*	3.841*

Note: *** and * denotes significant at 5% and 10% significance levels.*

VECM Model Analysis:

Long run Equation:

The estimate of long-run equation along short-run dynamic ECM equation is presented below. In the long-run equation, the coefficient of GER is positive and statistically significant at 1 %. It indicates that a 1 % increase in GER increases GDP by 101 per cent. The estimated of coefficient of the error term indicates speed of adjustment of per capita GDP towards the equilibrium state. The state corrects approximately 89 per cent of their error during one year.

$\ln GDP_{t-1} = 0.631 + 1.010 \ln GER_{t-1} - 1.002 \ln IR_{t-1}$

SE (0.388) (0.422)

t-statistics [-2.605] [2.372] Significant at 5 % level. P-value.

ECM Equation:

$\Delta \ln GDP_t = - 0.891\, EC_{t-1} - 0.056\, \Delta \ln GDP_{t-1} + 0.482\, \Delta \ln GER_{t-1} + 0.683\, \Delta \ln IR_{t-1} - 0.032$

R-squared = 0.606; Adjusted R-squared = 0.556; Durbin-Watson statistic = 1.896

It is observed in table IV that the coefficient of the error correction term of the GDP variable is significant and negative. Its significance implies that any short run shock transmitted through the channel of GDP significantly affect the co-integrating relationship between GDP and GER. The negative sign of the ECT coefficient implies that the GDP series cannot drift far apart from the steady path and in the long run there is convergence towards the equilibrium path. The speed of adjustment of the error correction term is -0.891. Only 89.10 % of disequilibrium of GDP from the long run equilibrium is corrected within one year. The coefficient of short-run dynamic causal relationship between GDP and GER are statistically insignificant. That is, GER has a positive and statistically insignificant impact in the short-run on GDP.

TABLE IV. RESULT OF THE VECTOR ERROR CORRECTION MODEL

Dependent Variable	**Independent Variable**	**Coefficient**	**Std. Error**	**t-statistic**	**Prob.**
$\Delta \ln \boldsymbol{GDP_t}$	EC_{t-1}	-0.891	0.198	-4.511	0.000
	$\Delta \ln GDP_{t-1}$	-0.056	0.140	-0.399	0.693
	$\Delta \ln GER_{t-1}$	0.482	1.069	0.451	0.655
	$\Delta \ln IR_{t-1}$	0.683	0.455	1.501	0.143
	Constant	-0.032	0.090	-0.362	0.720
		R-squared	0.606	Akaike info criterion	1.120
		Adjusted R-squared	0.556	Schwarz criterion	1.338
		Log likelihood	-15.728	Hannan-Quinn criterion	1.197
		F-statistic (p-value)	12.290 (0.000)	Durbin-Watson statistic	1.896

Source: Estimated by the author on the basis of Secondary Data compiled from RBI

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Long run Equation:

From the estimate of long-run equation along short-run dynamic ECM equation, it is evident that in the long-run equation, the coefficient of GDP is positive and statistically significant at 1 %.

$\ln GER_{t-1} = -0.625 + 0.990 \ln GDP_{t-1} + 0.992 \ln IR_{t-1}$

SE (0.236) (0.120)

t-statistics [-4.194] [-8.282] Significant at 5 % level. P-value.

ECM Equation:

It is observed in table 5 that the coefficient of the error correction term of the GER variable is negative, but not significant. The coefficient of short-run dynamic causal relationship between GDP and GER are also statistically insignificant.

$\Delta \ln GER_t = -0.037\, EC_{t-1} + 0.101\, \Delta \ln GER_{t-1} + 0.000\, \Delta \ln GDP_{t-1} - 0.012\, \Delta \ln IR_{t-1} + 0.058$

R-squared = 0.069; Adjusted R-squared = -0.047; Durbin-Watson statistic = 1.959

Paire-wise Granger Causality

The results of pair wise Granger causality between economic growth (GDP) and expenditure of government (GER) are contained in Table VI. We accept the Ho and conclude that lnGDP does not Granger Cause lnGER and lnGER does not Granger Cause lnGDP. From the table it is evident that uni-directional causality exists from government expenditure (GER) to economic growth (GDP) and no feed-back mechanism.

TABLE VI. PAIRE-WISE GRANGER CAUSALITY BETWEEN GDP AND GER

Direction of Causality	Lags	Observations	F-Statistic	p-value	Decision	Outcome
GDP>GE	1	38	1.002	0.324	Accept Null	GDP does not Granger Cause GER
GE> GDP	1	38	6.033	0.019	Reject Null	GER Granger Cause GDP
GDP>GE	2	37	0.876	0.426	Accept Null	GDP does not Granger Cause GER
GE> GDP	2	37	0.839	0.441	Accept Null	GER does not Granger Cause GDP
GDP>GE	4	35	0.535	0.711	Accept Null	GDP does not Granger Cause GER
GE> GDP	4	35	1.856	0.148	Accept Null	GER does not Granger Cause GDP
GDP>GE	6	33	1.336	0.288	Accept Null	GDP does not Granger Cause GER
GE> GDP	6	33	2.184	0.088	Reject Null	GER Granger Cause GDP

Source: Estimated by the author on the basis of Secondary Data compiled from RBI

V. CONCLUSION AND RECOMMENDATION

Various studies across the world are trying to investigate the association between the government expenditure and economic growth and found mixed results. The objective of this paper is to investigate the nature and direction of causal relationship between government expenditure and economic growth in India in the contexts of Wagner's and Keynesian laws.

It is found that there is one equilibrium long term relationships between economic growth, government expenditure and investment in India in the period of study and these variables move together in the long run. Empirical evidences

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regarding the short-run dynamics refute the existence of any relationship between the economic growth and the government expenditure. The uni-directional causality is found from government expenditure to economic growth and no feed-back mechanism. Hence, it nullifies the applicability of Wagner's law in India and validates the Keynsian law. This becomes obvious from the results that active Keynesian policies may help in growth of India.

It is recommended to the government of India to give insights on the trends of transforming India, and association between government expenditure and economic growth. The policymakers and implementers are recommended to make huge government expenditure for accelerating the growth of Indian economy.

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