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The Causal Relationship between Public Expenditure and Economic Growth in India: VECM Estimation

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Abstract: *The relationship between public expenditure and economic growth is obvious, but the direction of the causality is not clear. This paper analyses the relative impact of the different components of public expenditure on economic growth. Specifically, this paper examines whether the level of government expenditure is managed to accelerate economic growth or whether the government expenditure is used excessively which may hurt the domestic economy because of increased taxes and/or high government borrowing. The vector error correction method is applied to the annual time series data for India from 1983 to 2020 for testing the long and short-run causality. The pair-wise Granger causality test indicates one-way causality moving from gross domestic product to total government expenditure and from gross domestic product to government revenue showing that the growth of the economy leads to an increase in both government revenue and expenditure. The estimated error correction coefficient is significantly negative indicating that the speed of adjustment between the short-run dynamics and the long-run equilibrium is about 0.03%. The results show a stable long-run relationship between public expenditure and economic growth.*

Introduction

Public expenditure plays a significant role in the functioning of an economy. The relationship between public expenditure and economic growth is obvious and has been extensively studied both theoretically and empirically. The theoretical foundation of this relationship can be traced as far back as Wagner (1883) in his famous Wagner's Law. Wagner advanced his 'law of rising public expenditures' by analysing trends in the growth of public expenditure and in the size of the public sector. Wagner's law postulates that: (i) the extension of the functions of the states leads to an increase in public expenditure on administration and regulation of the economy; (ii) the development of modern industrial society would give rise to increasing political pressure for social progress and call for increased allowance for social consideration in the conduct of industry; and (iii) the rise in public expenditure will be more than proportional increase in the national income and thus result in a relative expansion of the public sector. Musgrave and

Musgrave (1973), in support of Wagner's law, argue that as progressive nations industrialise, the share of the public sector continues to grow in the national economy.

The role of public expenditure in the economy is now well-grounded in the macroeconomic theory after the Keynesian revolution. The macroeconomic theory establishes credit for public expen-diture not only in the determination of the level of income but also in its distribution. Keynesian macroeconomics provides a theoretical basis for the developments in public expenditure programmes in developed economies. However, empirical studies on the relationship between government expenditure and economic growth arrive at different and even conflicting results. The direction of causality between public expenditure and economic growth is not always clearly established. Whether public expenditure causes economic growth or whether economic growth necessitates more government expenditure is the moot question. Some studies suggest that an increase in government expenditure on socio-economic and physical infrastructure impacts the long-run growth rate of the economy. For instance, government expenditure on health and education raises the productivity of labour and increases the growth of national output. Similarly, public expenditure on infrastructure such as roads, power etc. reduces production costs and increases private sector investment and profitability of firms, thus ensuring economic growth (Barro, 1990; Barro and Salai-i-Martin, 1992). There is also overwhelming evidence that fast-growing economies have heavily expanded their public investments. Even some studies suggest bi-directional causality between government expenditure and economic growth.

The main objective of this paper is to establish the direction of the causal relationship between public expenditure and economic growth. Specifically, this paper aims to analyse whether the level of government expenditure has been properly managed to accelerate economic growth or whether the government expenditure has been used excessively which may hurt the domestic economy because of increased taxes and/or high government borrowing. This paper assesses the relative impacts of different components of public expenditure on economic growth. Empirically, this paper examines the relationship and the direction of causality among GDP, total government expenditure, inflation and total revenue as a percentage of GDP in India. The annual time series data between 1983 and 2020 for India from the World Bank Indicators is used in the empirical analysis. Econometrically, the Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests for unit root, Granger causality test for the direction of causality, Johansen's cointegration test for

cointegration, and Vector Error Correction Model (VECM) for testing the long and short-run relationship between the variables are employed.

Review of Literature

Bagdigen and Cetintas (2004) examine Wagner's Law of the long-run relationship between public expenditure and GDP for Turkey over the period 1965-2000. The hypothesised relationship is that public expenditure is the outcome, not the cause, of growth in GDP. Therefore, the causality is from GDP to public expenditure. Using cointegration and Granger causality tests, they empirically find no causality in both directions. Thus, neither Wagner's Law nor Keynes's hypothesis is valid for Turkey.

Chude and Chude (2013) investigate the long and short-run effects of public expenditure in education on economic growth in Nigeria over a period from 1977 to 2012 using the error correction model. The results of the study indicate that total expenditure on education is statistically highly significant and has a positive effect on economic growth in Nigeria in the long run. Thus, it is concluded that economic growth is clearly impacted by factors both exogenous and endogenous to the public expenditure in Nigeria.

Odo *et al.* (2016) study the long-run causal relationship between public expenditure and economic growth in South Africa from 1980 to 2014 employing a cointegration test, vector error correction mechanism and Granger causality test. The estimated results show an insignificant negative relationship between total government expenditure and economic growth, a significant positive relationship between economic growth and total revenue, and a significant positive relationship between inflation and economic growth. The pair-wise Granger causality shows a one-way causality running from national income to total government expenditure that seems to support Wagner's theory. Thus, the study concludes that a stable long-run relationship exists between public expenditure and economic growth in South Africa and that the growth in national income leads to an increase in government expenditure as implied by Wagner's hypothesis in South Africa.

In the Indian context, Gangal and Gupta (2013) analyse the impact of public expenditure on economic growth between 1998 and 2012 using the annual data of total public expenditure and GDP per capita from the World Economic Outlook and IMF. The study employs the ADF unit root, cointegration, and Granger causality tests. The econometric results reveal that there is a positive impact of total public expenditure on economic growth and there is a unidirectional relationship, between total public expenditure to GDP in India.

Lhoungu *et al.* (2016) study the causal relationship between public expenditure and economic growth in India for 30 years from 1980-81 to 2009-10 employing the Granger causality, ADF and cointegration tests as well as the ECM model. Empirically, the causality from GSDP to public expenditure is shown to be weak while the causality from public expenditure to GSDP is strong. The ECM also reveals that there is strong bi-directional causality only between growth (GSDP) and public expenditure on social services in the long run.

Data and Methodology

In the empirical analysis, this paper uses annual time series data from 1983 to 2020 from World Bank Indicators (WDI) for India. The variables are GDP, total government expenditure, inflation and total revenue as a percentage of GDP expressed in 2010 US$. The GDP is measured in constant price, general government final consumption expenditure includes all government current expenditures for purchases of goods and services including national defence and security, inflation is measured by the consumer price index that reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services, and the revenue is measured by the cash receipts from taxes, social contributions, and other revenues such as fines, fees, rent, and income from property or sales. The econometric tests and models used in the analysis include the unit root test, Johansen cointegration test, Granger causality test and VEC model. Johansen's (1988) cointegration approach and VECM have been employed in this paper to investigate the causal relationship between public expenditure and economic growth in India. Before this, the stationarity of the time series and the co-relationship between the two series need to be checked.

Unit Root Test: The unit root test is to test the stationarity of the time series. There are two ways to test for stationarity using the unit root test in the time series: the ADF and PP unit root tests.

Augmented Dickey-Fuller Test: A variable is said to be stationary if it has a time-invariant mean, time-invariant variance and the value of the covariance between the two time periods depends only on the distance or gap or lag between the two time periods and not the actual time at which the covariance is computed. The regression to be estimated for the application of the ADF test is:

$$\Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \Sigma_{i=1}^{n} \alpha_i \Delta y_{t-i} + u_t \quad (1)$$

where y_t is the stationary series, Δy indicates the first difference of y_t, $\beta_2 t$ is the trend of time and u_t is the error term. The null hypothesis is that the

series has a unit root ($\delta = 0$) meaning that the series is non-stationary against the alternative hypothesis of the series being stationary. If a unit root (non-stationarity) exists, then δ would not be statistically different from zero. If the p-value of the coefficient of y_{t-1} is less than 0.05 at 5% level of significance, the null hypothesis is rejected indicating that the series is stationary.

Phillips-Perron Test: The Phillips-Perron (PP) unit root tests differ from the ADF tests mainly in how they deal with serial correlation and heteroskedasticity in the errors.

Cointegration Test: If two-time series data are non-stationary, there is a possibility that there exists a linear combination of the two variables, such that the error term is stationary. The two variables are said to be cointegrated if they have a long term or equilibrium relationship between them. Therefore, the cointegration between the variables is to be tested using the eigen value and trace statistic:

Trace statistic: $$Trace = -T \Sigma_{t=t+1,....\lambda_p^1} \Sigma Log(1-\lambda_t^1) \quad (2)$$

where $\lambda_{r+1}^1, \ldots \ldots, \lambda_p^1$ are (p-r) number of estimated eigen values.

Maximum eigen value statistic: $$\lambda_{\max}(r, r+1) = -TLog(1-\lambda_{r+1}^1) \quad (3)$$

H_0: No cointegration ($r = 0$) and H_1: presence of cointegration ($r > 0$)

where 'r' implies cointegrating relation. If the absolute value of the computed trace and computed eigen value statistics are greater than their respective critical values, then the null hypothesis is rejected at 5% level of significance concluding that there exists at least one cointegrating relation between the variables. Then, the test for cointegration is:

H_0: presence of one cointegrating relation (r=1)

H_1: presence of more than one cointegrating relation among the variables (r>1).

Based on the value of the computed trace statistic and the eigen value, the null hypothesis is either accepted or rejected.

If the two-time series are cointegrated, then the direction of causality between them needs to be tested. The existence of a relationship between the variables does not show the direction of influence. The causal relationship between them may be short-run or long-run. The short-run causality is established by the analysis of the joint significance of the lagged explanatory variable and movements of the deviations from the long-run path are explained by long-run causality.

Granger Causality Test: The Granger causality approach allows determining the direction of the short-run relations between the variables. This model is expressed in two equations:

$$y_t = \alpha_0 + \Sigma_{i=1}^{n} \alpha_i y_{t-1} + \Sigma_{j=1}^{n} \beta_j x_{t-1} + u_{1t} \tag{4}$$

$$x_t = \mu_o + \Sigma_{i=1}^{n} \alpha_i y_{t-1} + \Sigma_{j=1}^{n} \delta_j x_{t-1} + u_{2t} \tag{5}$$

The null hypothesis is that one variable does not Granger cause the other against the alternative hypothesis which states that the variable Granger causes the other. The coefficients are jointly tested for their significance. If their p-value exceeds 0.05 at 5% level of significance, the null hypothesis is rejected indicating causality between the two variables and no causality otherwise.

Vector Error Correction Model: Causality exists in at least one direction if the variables contain a cointegrating vector and the direction of a casual relationship is detected through the vector error correction model (VECM). Engel and Granger (1987) show that in the presence of cointegration, there always exists a subsequent error correction representation, captured by the error-correction term which captures the long-run adjustment of cointegration variables. The VEC has cointegration relations built into specification so that it restricts the long-run behaviour of the endogenous variables to converge to their cointegrating relationships while allowing for short-run adjustment dynamics. The cointegrating term is the Error Correction Mechanism (ECM) since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments. The error correction term needs to be significant at a 0.05 level for long-run causality, otherwise, there is no long-run causality from the independent variable(s) to the dependent variable. Apart from identifying the direction of causality, the incorporation of the error correction term in the VECM model helps to analyse the long-term relationship between the variables. The error correction model is specified as:

$$\begin{aligned} \Delta LnRGDP_t = &\sum_{j=1}^{p-1} \beta_1 \Delta LnRGDP_{t-j} + \sum_{j=1}^{p-1} \beta_2 \Delta LnGEXP_{t-1} \\ &+ \sum_{j=1}^{p-1} \beta_3 \Delta LnREV_{t-1} + \sum_{j=1}^{p-1} \beta_4 \Delta LnINF_{t-1} + \alpha_1 ECT_{t-1} + u_t \end{aligned} \tag{6}$$

where the first difference operator is represented as Δ and u_t is the white noise error term and j is the lag length. The error correction term is denoted by ECT and the order of the VECM model is presented by p which is

translated to *p*-1 in the ECM. The term α_1 represents the pace of adjustment after the LnRGDP, LnGEXP, LnREV and LnINF deviate from the long-run equilibrium in period *t*-1.

Empirical Analysis

In the empirical analysis, the econometric model to be estimated is specified as:

$$Ln(RGDP)_t = \beta_0 + \beta_1 Ln(GEXP)_{t-1} + \beta_2 Ln(REV)_{t-1} + \beta_3 Ln(INF)_{t-1} + u_t \quad (7)$$

where RGDP represents the real gross domestic product, GEXP is the total government expenditure, REV refers to total revenue as a percentage of gross domestic product, INF refers to inflation, and u_t is the error term and $\alpha_0 \ldots \alpha_3$ are the parameters. Table 1 presents the descriptive statistics of variables to analyse the causal relationship between public expenditure and economic growth in India. All variables are expressed in US$ at current prices. The GDP averages US$ 27.333 and varies between 26.491 and US$ 28.315 with a standard deviation of 0.560. INF averages 1.996 and ranges from 1.182 to 2.630; GEXP averages US$ 25.191 and varies from 24.304 to 26.0186 USD. The mean of REV is USD 2.518 and its variation is from 2.410 to 2.683.

Table 1: Descriptive Statistics of Variables

	Ln(RGDP)	*Ln(INF)*	*Ln(GEXP)*	*Ln(REV)*
Mean	27.333	1.996	25.191	2.518
Median	27.289	2.167	25.229	2.518
Maximum	28.315	2.623	26.018	2.683
Minimum	26.491	1.183	24.304	2.411
Std. Dev.	0.560	0.432	0.5141	0.065

Table 2 reports the results of the Augmented Dickey-Fuller test (ADF) and Phillips-Perron (PP) unit root tests on the natural logarithms of the levels and first differenced forms of the variables. The guideline for testing the significance of the variable is that the t-statistics reported by the test should be less than the critical value at 5% and the corresponding probability (*p*) values should be greater than 0.05 (or 5%). If the p-value is less than 0.05 then the null hypothesis is rejected and the alternative hypothesis is accepted.

The Johansen cointegration test results are presented in Table 3. The trace and maximum Eigen statistics for the variables Ln(RGDP) Ln(REV), Ln(GEX) and Ln(INF) show that there are two statistically significant

Table 2: Augmented Dickey-Fuller and Phillips-Perron Unit Root Test

Variable	*ADF test*		*PP test*	
	At level	*At first difference*	*At level*	*At first difference*
Ln(RGDP)	2.149	-4.435*	4.204	-4.412*
Ln(INF)	-3.132*	-6.928*	-3.132*	-11.88*
Ln(GEXP)	0.726	4.511*	-0.674	-2.983*
Ln(REV)	-3.600*	-7.345*	-3.660*	-7.345*
Order of integration	I(1)	I(1)		

cointegrating vectors. In other words, the trace test indicates one cointegrating equation at the 0.05 level of significance and the max-Eigen value test also indicates one cointegrating equation.

Table 3: Johansen Cointegration Test Statistics

Hypothesised no. of CE(s)	*Trace test*			*Maximum eigen value*		
	Eigen value	*Trace statistic*	*Critical value*	*Eigen value*	*Max-Eigen statistic*	*Critical value*
None*	0.847	97.648	47.856	0.847	48.838	27.584
At most 1	0.464	31.811	29.797	0.464	17.672	16.132
At most 2	0.396	13.138	15.495	0.396	6.121	8.265
At most 3	0.0006	0.0170	3.841	0.0006	0.017	3.841

Trace test indicates 1 cointegrating eqn(s) at the 0.05 levelMax-eigen value test indicates 1 cointegrating eqn(s) at the 0.05 level

denotes rejection of the hypothesis at the 0.05 level denotes rejection of the hypothesis at the 0.05 level

The result of the error correction model from the normalised cointegration equation presented in Table 4 indicates a long-run significant positive relationship between total revenue as a percentage of GDP and economic growth showing as expected that an increase in government revenue leads to an increase in the growth of the economy.

Table 4: ECM from Normalised Cointegration Equation

RGDP	*GEXP*	*REV*	*INF*
1.000000	-0.841406	7.18E+09	2.85E+09

Table 5 presents VECM estimation for LnGDP=f (LnREV, LnGEXP, LnINF). The Johansen cointegration test reveals 2 cointegrating equations for LnGDP, LnREV, LnGEXP, LnINF, which have been specified while

estimating the vector error correction model. The coefficient of ECM(-1) is -0.0029 and its p-value of 0.030 is less than the 5% (0.05) level of significance. If there is a long-term relationship between two or more variables, the Granger causality test is applied to detect the direction of the causal relationship (unidirectional or bi-directional). The null hypothesis is $\hat{a}_i=0$, under the null hypothesis x does not Granger-cause y; if the null hypothesis is rejected, it can be said that x Granger cause y. Similarly, whether y Granger cause x can be tested. However, the Granger test is sensitive to the lag selection, and hence four lag lengths are selected considering the length of the time series.

Table 5: Vector Error Correction Model Estimates

Error Correction	*Coefficient*	*Std. error*	*t-statistics*	*p-value*
ECT(-1)	-0.002903	0.001251	-2.320264	0.0300
D(RGDP(-1)) = C(2)	0.093701	0.483703	0.193716	0.8482
D (GEXP (-1)) = C (4)	0.105203	0.285151	0.368936	0.7157
D (REV(-1)) = C(6)	4.97E+08	7.16E+09	0.069428	0.9453
D (INF (-1)) = C(8)	-6.85E=09	3.78E+09	-1.813052	0.0835
C = C (10)	4.62E+10	1.87E+10	2.475108	0.0215
Adj. R-square	0.618715	F-statistics		3.226

Table 6 presents the results of the pair-wise Granger causality tests. The p-values are greater than 0.05 and thus the null hypothesis that there is no causality between the variables for various lag lengths can not be rejected. The pair-wise Granger causality test of the variables indicates one-way

Table 6: Pair-wise Granger Causality

Null hypothesis	*F-statistic*	*Prob.*
GEXP does not Granger cause RGDP	2.98817	0.0666
RGDP does not Granger cause GEXP	5.45824	0.0100
REV does not Granger cause RGDP	0.22833	0.7973
RGDP does not Granger cause REV	5.67526	0.0085
INF does not Granger cause RGDP	10.0500	0.0005
RGDP does not Granger cause INF	2.53160	0.0976
REV does not Granger cause GEXP	0.01076	0.9893
GEXP does not Granger cause REV	5.91778	0.0072
INF does not Granger cause GEXP	5.40372	0.0104
GEXP does not Granger cause INF	1.17228	0.3244
INF does not Granger cause REV	6.28792	0.0056
REV does not Granger cause INF	4.00496	0.0295
No. of observations	30	

causality moving from gross domestic product to total government expenditure. The causality from gross domestic product to government revenue also exists showing that the growth of the economy leads to an increase in government revenue. Further, causality from inflation to gross domestic product is there showing that inflation can lead to the growth of the economy in both the long and short runs.

Conclusion

The main objectives of the paper are to examine the causal relationship between GDP, total government expenditure, inflation and total revenue as a percentage of GDP in India. The paper uses annual time series data from 1983 to 2020 collected from the World Bank and applies econometric methods of Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests for unit root, Granger causality test for the direction of causality, Johansen's cointegration test for cointegration, and Vector Error Correction Model (VECM) for testing the long and short-run relationship between the variables. The unit root tests show that the variables are stationary after the first difference and the Johansen cointegration test reveals one cointegrating vector suggesting that there exists a stable long-run equilibrium relationship between public expenditure and covariates. The direction of causality is detected using the Granger Causality test. The Vector Error Correction models are also used to analyze the long-run relationship in the economy. The error correction coefficient is negative and statistically significant indicating that the speed of adjustment between the short-run dynamics and the long-run equilibrium is about 0.03%. The pair-wise Granger causality test indicates one-way causality moving from gross domestic product to total government expenditure and from gross domestic product to government revenue showing that the growth of the economy leads to an increase in both government revenue and expenditure. Thus, the results of this paper show a stable long-run relationship between public expenditure and economic growth in India.

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