Wagner's Law: An Empirical Analysis with Reference to India

Vishavdeep Sharma[1], Deepali[2*], and Ravi Sundaram[3*]

[1] Centre for Economic Studies and Planning, JNU, Delhi, India

[2] Ambedkar University, Delhi, India

[3] Economics and Planning Unit, ISI-Delhi, India

Abstract

The objective of this paper is to examine Wagner's law validity concerning India for the period 1980−2020. According to Wagner's Law, as income growth expands, then the public expenditure rises constantly. We test this hypothesis for India. Furthermore, the reliability and validity of our results in terms of statistical and economic conclusions are supported by the extended data set and all the possible diagnostic tests. Our paper applied time-series regression analysis, unit root tests, cointegration techniques, and vector error correction mechanisms. Our results indicate a positive elasticity of growth rate in expenditure with respect to the first difference of per−capita GDP; thus, we found support for Wagner's hypothesis and contributed to the existing literature with some new modifications in the theoretical model proposed by researchers.

Keywords: Wagner's law, Time series, Public finance, Applied econometrics, Economic development

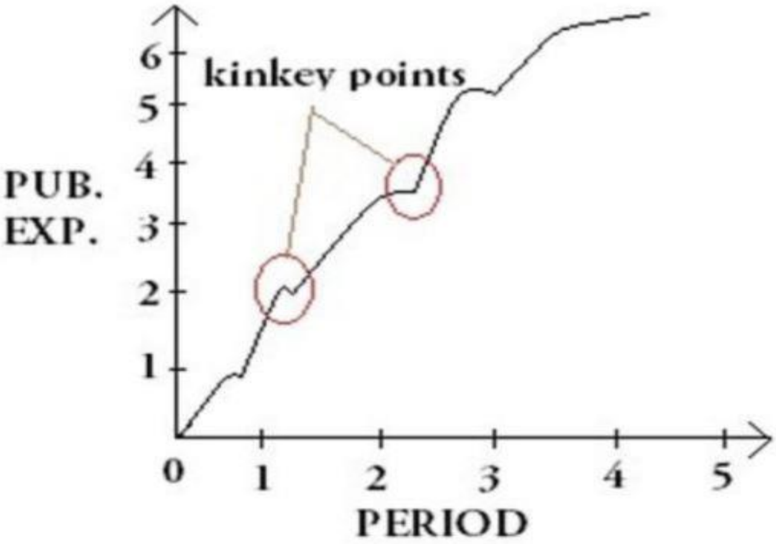
1 Introduction

During the post-independence period, India saw considerable expansion in public expenditure in the spirit of the welfare state, as postulated by Keynes. The reasons behind the increase have been the motivation to work in this area for researchers around the world. Their resulting explanations are diverse, but one of those most referred to researchers is Wagner's Law, which proposes a causality relationship between public spending and national income. The relation between public expenditure and income is intricate. Wagner's law points out that public expenditure is an endogenous factor driven by the growth of the national income of a country. It is essential to mention the name of a distinguished German economist Adolf Wagner who first developed and analyzed the relationship between public expenditure and gross domestic product. According to him, the change in public expenditure is identified with the difference in the economic organization and economic development, e.g., change in population, technological improvement, increased benefits from economic activities, increase in productivity, and tax and non-tax revenue resources, etc. Moreover, other objectives, including output, employment, and redistribution, which can contribute to economic welfare, are public expenditure's main interest. On the other hand, a tax policy can also be used to redistribute income and wealth, efficient resource allocation, and economic stabilization. According to (Musgrave, 1989), Wagner recognized three main reasons why public expenditure should increase: first, there is a socio-political reason because of an increase in state functions over time, for example for retirement, insurance, and natural disaster aid. The second reason is economic, for example, an increase of state assignments into science and technology, and thirdly, historical, for instance, serving previously accumulated debt. For all these reasons (Magazzino, 2012) predicted that economic growth would be accompanied by a relatively significant increase in public spending. A modern formulation of Wagner's law mentioned by (Bird et al., 1971) might run as follows: as per capita income increases in industrializing nations; their public sectors will grow in relative importance. Thus, the causality, according to Wagner's law, is running from economic growth to public spending.

While several studies have concluded the relationship between public expenditures and economic growth. However, there is ambiguity on the exact relationship between public spending and economic development. Hence, we are trying to contribute to the existing literature by studying the association between the development of total expenditures and the difference in gross domestic product for India within this context using time series econometric techniques from 1980 to 2020.

In the Figure 1 represents Wagner's how public expenditure rises over the time-period. There are two structural breaks which are represented by the two kinky points explained in (Singh, 2008). In our study, we hypothesized two things; the first thing is to know the causal relationship between the growth rate of total expenditure and the first difference of gross domestic product, and the second one is to know the long-run relationship between these two variables by VECM. The paper is structured as follows. Section 2 briefly reviews the theoretical explanations and empirical literature on Wagner's law. Section 3 explains the data sources and methodological framework adopted in the study to test Wagner's hypothesis in more detail. Section 4 presents the empirical pieces of evidence from time series perspectives. This will give a more quantitative insight, and the last, Section 5 recapitulates the significant findings of the study and suggests possibilities for future research.

Figure 1: Graph showing kink in increasing public expenditure in the 'Peacock-Wiseman hypothesis'



Source: (Singh, 2008)

2 Literature review

This paper explores possible linkages between the growth rate in expenditure and the first difference of per-capita GDP.

Wagner suggested that the development of government spending will take place because of industrialization, social process, and increasing incomes. Many authors widely examine the relationship between public expenditure and a country's income by using a different theoretical model. In 1961, Peacock-Wiseman claimed, Wagner's Law is simply a collar of an old-fashioned and repugnant political philosophy and rests on Wagner's extraordinary view of the nature of the state as a political entity.

In the Peacock-Wiseman version, the relationship between the log of real government expenditures and the log of real GDP is examined. The theoretical model proposed by him is the following one:

$$log(G_t) = \beta_0 + \beta_1 log(Y_t) + u_t \qquad \text{Eq. 1}$$

Here, G_t is the real government expenditures, and Y_t is the log of real GDP and $\beta_1 > 1$.

They have reported that Wagner had not examined the wars, which resulted in a massive increase in government spending, the so-called 'Displacement Hypothesis.' They also used the concept of the 'tolerable burden of taxation to explain the displacement hypothesis. (Bird et al., 1971) also tested Wagner's Law using the above equation for the period 1933 to 1965 in Canada and found strong supporting evidence for the Law. He used cross-section data in his analysis and measured the size of government by government expenditure plus transfers at current prices. In his paper, the dependent variable is the total expenditure of central and local governments. The explanatory variables will be administration, debt, defence, goods services, environmental service, and transfers.

(Thornton, 1999) used data from 1850 to 1913 and found supporting evidence for the Wagner's law by using the Peacock-Wiseman version for six European countries (United Kingdom, Denmark, Italy, Germany, Sweden, Norway).

On the other hand, some authors haven't supported Wagner's Law. (Thorn, 1967) did not find evidence against Wagner's law. In his study, he examined the Law for 52 countries. Moreover, (Courakis et al., 1993) also argued that the Law does not hold, tested for Greece and Portugal. However, (Kolluri et al., 2000) found evidence for G7 countries and (Oxley et al., 1994) found evidence for the U.K.

Mann interpreted the law in relative sense. He used the real GDP instead of real GDP per capita as an independent variable. According to him, the ratio of nominal government expenditures and nominal GDP $\frac{NG_t}{NY_t}$ depend real GDP (Y_t) as follows:

$$log\left(\frac{NG_t}{NY_t}\right) = \psi_0 + \psi_1 log(Y_t) + u_t \qquad \text{Eq. 2}$$

Here, $\psi_1 > 1$

This study attempts to test the validity of all six versions of Wagner's Law in the case of Sri Lanka for the period from 1960 to 2010.

In the Peacock-Wiseman share version (Mann version) study, they used the log of the share of government spending in the total output and as an explanatory variable log of real GDP as follows:

$$log\left(\frac{G_t}{Y_t}\right) = \theta_0 + \theta_1 log(Y_t) + u_t \qquad \text{Eq. 3}$$

Here, $\theta_1 > 1$

This is quite a different interpretation of Wagner's Law as written above. This implies that the government expenditure needs to grow over-proportionally to GDP with an increase of GDP.

In the Musgrave Version of Wagner's law, per capita income $\frac{Y_t}{N_t}$ leads to the increase in the share of government spending in total output $\frac{G_t}{Y_t}$, which can be written in mathematical form as follows:

$$log\left(\frac{G_t}{Y_t}\right) = \gamma_0 + \gamma_1 log\left(\frac{Y_t}{N_t}\right) + u_t \qquad \text{Eq. 4}$$

Here, $\gamma_1 > 1$

Wagner's Law seems to be counter-intuitive in this case. It explains that as the welfare of the people in the economy increased, they demanded higher government spending. But Wagner noticed in 1848 that an increase in wealth was not shared across the population, and therefore the government should intervene with increased government expenditure.

(Islam, 2001) adopted the Musgrave formulation and tested the validity of Wagner's Law for the USA and used annual time series data for the period 1929-1996 and supported the strong evidence of a long-run equilibrium relationship between per capita real income and the size of the government expenditure. On the other hand, (Payne, 1997) tested the sustainability of the G7 countries (France, Germany, Canada, UK, Italy, and the USA) during the period 1949-1994. They examined that fiscal policy is sustainable only for Germany by employing cointegration tests between government revenues and Government spending. However, there are some authors who found mixed results. (Abizadeh & Gray, 1985) who got mixed results for 53 countries, (Bohl et al., 1996) who got mixed results for G7 countries. Moreover, (Lin et al., 1995) and (Murthy et al., 1993) who found the support in the validity of Wagnerˆas law in Mexico. There are other researchers who used this formulation: (Lall, 1969), (Halicioglu, 2003) and (Ahsan et al., 1996).

In the Gupta Version of Wagner's law (Gupta, 1967), he used per capita income $\frac{Y_t}{N_t}$ leads to the increase in the per capita government spending $\frac{G_t}{N_t}$ which can be written in mathematical form as follows:

$$log\left(\frac{G_t}{N_t}\right) = \delta_0 + \delta_1 log\left(\frac{Y_t}{N_t}\right) + u_t \qquad \text{Eq. 5}$$

Here, $\delta_1 > 1$

However, as the average income is calculated using equal weight, the right-hand side has some bias in the result as it doesn't account for the inequality. As a result, if the average income rises due to the higher incomes of the high-income earners, then this leads to an increase in demand for government expenditure.

(Henrekson, 1993) used Gupta version and tested the Law for Sweden from 1861 to 1990 and concluded that "in a test of Swedish data we cannot find any long-run positive relationship between the two variables and we judge it to be probable that this finding carries over to other countries as well" (Henrekson, 1993). He argued that studies such as (Wagner & Weber, 1977),(Ganti & Kolluri, 1979), (Mann, 1980), (Abizadeh & Gray, 1985), and (Ram, 1987) which got the strong empirical support to Wagner's law, suffer from various methodological limitations so that their results might be questionable.

(Al-Faris, 2002) used a dynamic model to test Wagner's Law for the Gulf Cooperation Council (GCC) countries (Saudi Arabia, (UAE), Bahrain, Kuwait, Oman, and Qatar) by using annual time series data from 1970-1997. He used the Unit root tests test, Johansen procedure, and Granger causality test. His results are not supporting the evidence of Wagner's Law.

(Al-Faris, 2002) tested Wagner's Law for three African countries (Ghana, Kenya, and South Africa) did not find any support for Wagner's Law.

However, (Nomura et al., 1995) examined the displacement hypothesis and the validity of Wagner's Law using annual time series data from 1960-1991, and the results he found supported Wagner's Law only for some periods.

In the Goffman Version of Wagner's law (Goffman, 1968), he used per capita income $\frac{Y_t}{N_t}$ leads to the increase in the total government spending G_t which can be written in mathematical form as follows:

$$log(G_t) = \lambda_0 + \lambda_1 log\left(\frac{Y_t}{N_t}\right) + u_t \qquad \text{Eq. 6}$$

Here, $\lambda_1 > 1$

It is somewhat like Peacock Wiseman Version and has a very slight difference in the explanatory model. Therefore, we can say that what has been told in the Peacock-Wiseman version is valid for the Goffman version.

(Dritsakis & Adamopoulos, 2004) used the Goffman version and examined the time series annual data from 1960-2001 for Greece and supported Wagner's Law.

(Biswal et al., 1999) attempted to test Wagner's and Keynesian hypothesis by using annual time series data from 1950-1995, and the results they found do not support the long-run relationship instead of the short-run relationship in Wagner's Law.

On the other hand, (Wagner & Weber, 1977) tested 34 countries by using this version and found no supporting evidence of the Law. However, (Nagarajan et al., 1990) examined the case of Mexico and found supporting evidence.

(Lin et al., 1995) also tested this case of Mexico and found supporting results for this version of Wagner's Law.

In the Pryor Version of Wagner's law (Thorson, 1969), he used real income (Y_t) leads to the increase in the government consumption expenditure (GC_t), which can be written in mathematical form as follows:

$$log(GC_t) = \varphi_0 + \varphi_1 log(Y_t) + u_t \qquad \text{Eq. 7}$$

Here, $\varphi_1 > 1$

One reason why Pryor may have chosen consumption expenditure may be due to the less availability of dataset. The Pryor hypothesis segregated between under-developed and developed regions doesn't support Wagner's Law. Several other researchers also used this formulation, such as (Abizadeh & Yousefi, 1988) tested the USA and found support.

(Hondroyiannis et al., 1995) also used this version to test the validity of Wagner's law. They used in their study the Maximum Likelihood Estimation in which they used real total government expenditure as a dependent variable. In contrast, the explanatory variables are real consumption expenditure real GDP, a ratio of real government expenditure to GDP, real GDP to population, and real government expenditure to population. They didn't find any support for Wagner's Law.

In the next section, we described the data and its variables. Also, explain the methodology, we performed.

3 Data, empirical model and methodology

3.1 Data

Time Series data is collected from EPWRF India Time Series, which is from 1980-2020, in which there are three variables: Total Expenditure, GDP at Constant Prices, and Total Population.

Theoretical model. The dependent variable is the natural logarithmic growth rate of expenditure at year t which we calculated in the following way:

$$ln\left(\frac{T.EXP_t - T.EXP_{t-1}}{T.EXP_{t-1}} \times 100\right) \quad \text{Eq. 8}$$

Here, $T.EXP_t$ refers to Total Expenditure at year t.

And, $T.EXP_{t-1}$ refers to Total Expenditure are year t − 1.

The explanatory variable is the natural logarithmic of the first difference of the per-capita GDP at constant prices at year t which we calculated in the following way:

$$log\left(\frac{\Delta GDP_t}{N_t}\right) \quad \text{Eq. 9}$$

Here, N_t is the Total Population at year t. And, $\left(\frac{GDP_t}{N_t}\right)$ is the per-capita GDP at constant prices at year t. And, $\Delta\left(\frac{GDP_t}{N_t}\right) = \frac{GDP_t}{N_t} - \frac{GDP_{t-1}}{N_{t-1}}$ is the first difference of Per-Capita GDP using lag one.

Consider, the variables in the form of X & Y which is written as follows:

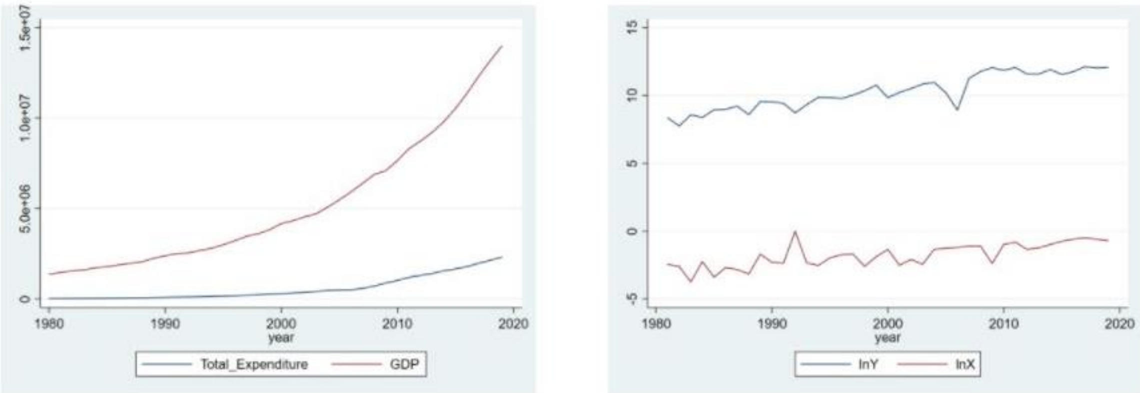
$Y_t = \frac{GDP_t}{N_t} - \frac{GDP_{t-1}}{N_{t-1}} \times 100$ and, $X = \Delta\left(\frac{GDP_t}{N_t}\right)$

Table 1: Summary Statistics of Variables

Variable	Observations	Mean	Std. Dev.	Min	Max
Total Expenditure	41	638642.2	744322.9	17787	2698552
GDP	41	5412488	3837327	1371980	1.46e+07
lnY	40	10.3476	1.34831	7.751905	12.85694
lnX	40	-1.764853	0.8785817	-3.740667	0

In the Figure 2, we can see that in both figures, the curves are positively related concerning time which shows there is some positive relationship with our variables with each other. In Figure 2(a), we can see that the total expenditure curve is relatively flatter than the GDP at constant prices. This is why we choose the growth rate of total expenditure concerning the first difference of gross domestic product. In Figure 2(b), our variables seem to be stationary. Still, we need to be entirely sure about that to check the unit-root test for our dependent and independent variables in the following sections.

Figure 2: Growth Path with respect to Years from 1980−2020



((a)) Total Expenditure and GDP ((b)) Dependent and Independent Variables

3.2 Empirical model and methodology

Now that we have described the data, we test our hypothesis that whether the percent increase in first difference GDP impacts the percent increase in the growth rate of expenditure or not by using the following empirical model:

$$ln(Y_t) = \beta_0 + \beta_1 ln(X_t) + u_t \quad \text{Eq. 10}$$

We use OLS estimation, Unit root test, Cointegration, and Vector Error Correction Mechanism to estimate the relationship between the variables for our model. By using OLS estimation, we assume that all the Classical Linear Regression Model assumptions are satisfied.

We discussed the results of this model in the next section.

4 Results

4.1 Regression analysis

Figure 3 presents the regression results. We perform the OLS regression for the above model in equation 10. In the regression results, coefficient β1 is statistically significant at 1% level of significance. It explains the elasticity i.e. 1% increase in first difference of per-capita GDP causes 1.19% increment in growth rate of total expenditure on an average. Also, R2 is equal to 0.5665 which means there is 56.65% variations explained by the explanatory variable on the dependent variable. Model is also statistically significant at 1% level of significance as p-value of F-statistic is 0.

Figure 3: Regression Results

Source	SS	df	MS			
				Number of obs	=	39
				F(1, 37)	=	48.35
Model	38.6210893	1	38.6210893	Prob > F	=	0.0000
Residual	29.5571214	37	.798841118	R-squared	=	0.5665
				Adj R-squared	=	0.5548
Total	68.1782107	38	1.79416344	Root MSE	=	.89378

lnY	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnX	1.198001	.172296	6.95	0.000	.8488965	1.547106
_cons	12.55787	.343145	36.60	0.000	11.8626	13.25315

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Number of gaps in sample:  1

Durbin-Watson d-statistic(  2,    39) =    1.4384

Ramsey RESET test using powers of the fitted values of lnY
       Ho:  model has no omitted variables
                  F(3, 34) =      0.44
                  Prob > F =      0.7237
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Also, durbin-watson d statistic is equal to 1.4384 which doesn't imply that there exists positive autocorrelation. Also, we did omitted variable test in ST AT A to check for the validation and reliability for our results and we can conclude that we do not reject null hypothesis which means model has no omitted variable bias.

In the next section, we will check for the augmented dickey fuller unit-root test to account for the stationarity for our dependent and independent variables.

4.2 Augmented dickey-fuller test for unit root

In the following Figure 4, we account for the stationarity for our variables in which null hypothesis is stated that variable has a unit root i.e. non-stationary and alternative hypothesis is model doesn't have a unit root i.e. stationary.

Figure 4: Augmented Dickey Fuller Test

Dickey-Fuller test for unit root Number of obs = 39

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-1.222	-3.655	-2.961	-2.613

MacKinnon approximate p-value for Z(t) = 0.6642

Dickey-Fuller test for unit root Number of obs = 39

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-3.405	-3.655	-2.961	-2.613

MacKinnon approximate p-value for Z(t) = 0.0108

We can see in the above results p-value equals to 0.6642 for ln(Y) variable which is high enough so that we can't reject our null hypothesis. Hence we can say that ln(Y) is non-stationary whereas p-value for ln(X) variable is lower than the 5% level of significance which signifies that our independent variable is stationary. Since our dependent variable is non-stationary then we will check for the cointegration between the variables and if the cointegration doesnˆat exit, that means there are shocks to the system and the model is not likely to converge in the long-run. In addition, if there is no cointegration, only the short run vector autoregressive model should be estimated.

In the next Section, we will check for the cointegration of the two variables by using Johansen Test.

4.3 Johansen test for cointegration

Cointegration implies that if the variables in the model are non-stationary but the linear combination of those stationary variables is stationary. That is, even if there are shocks in the shortrun, which may affect movement in the individual series, they would converge with time (in the long run). The linear combination here means by the following equation:

$$u_t = ln(Y_t) - \beta_0 - \beta_1 ln(X_t) \qquad \text{Eq. 11}$$

Figure 5: Johansen Test for Cointegration

Johansen tests for cointegration

Trend: constant Number of obs = 38
Sample: 4 - 41 Lags = 2

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	6	-74.224174	.	19.9067	15.41
1	9	-64.788157	0.39142	1.0347*	3.76
2	10	-64.270828	0.02686		

In the above test, we can clearly see that trace statistic is greater than the 5% critical value i.e. 19.9067 > 15.41.

Hence, we can reject the null hypothesis at 5% level of significance so that we can say that there exists the cointegration between the variables which means variables are going to be in the equilibrium in long run. Therefore, we have to estimate the Vector Error Correction Mechanism to know the long run relationship between the two variables. In other words, due to cointegration residuals are stationary as it is the linear combination.

In the next section, we discussed the Vector Error Correction Mechanism using STATA.

4.4 Vector error correction mechanism

As we have found the cointegration between the variables so vector error correction model can be used. This method is also known as augmented Granger causality test. In this approach, error correction term (ECT) is added to the VAR system. The coefficient ECT signifies that there is an evidence of the long- run relationship causality between the variables. The VEC has cointegration relations built into the specification so that it restricts the long-run behavior of the endogenous variables to converge to their cointegrating relationships while allowing for short-run adjustment dynamics. The cointegration term is also known as the error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments. In other words, it is a dynamical system that forecasts both the impact of one variable on another by directly indicating the speed of adjustments of one variable to restore equilibrium after the change in another variable (Greene, 2003) which can be represented by the following equation:

$$\Delta y_t = \sigma + \sum_{i=1}^{k-1} \gamma_i \Delta y_{t-i} + \sum_{j=1}^{k-1} \eta_j \Delta X_{t-j} + \sum_{m=1}^{k-1} \epsilon_m \Delta R_{t-m} + \lambda ECT_{t-1} + u_t \qquad \text{Eq. 12}$$

$ln(Y)$ as the target variable in the above model which can be seen in the following equation after substituting the values.

$$\Delta ln(Y_t) = 0.147 - 0.278\Delta ln(Y_{t-1}) - 0.094\Delta ln(X_{t-1}) - 0.262ECT_{t-1} \qquad \text{Eq. 13}$$

This means the adjustment term (-0.262) is statistically significant at the 5% level of significance, suggesting that previous year's errors (or deviation from long-run equilibrium) are corrected for within the current year at a convergence speed 26.2%.

Figure 6: VECM

Vector error-correction model

Sample: 4 - 41		Number of obs =	38
		AIC =	3.883587
Log likelihood = -64.78816		HQIC =	4.021581
Det(Sigma_ml) = .1037417		SBIC =	4.271437

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_lnY	4	.564842	0.2544	11.60307	0.0206
D_lnX	4	.639851	0.5068	34.93137	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_lnY						
_ce1 L1.	-.262141	.1032059	-2.54	0.011	-.4644209	-.0598612
lnY LD.	-.0946095	.1697987	-0.56	0.577	-.4274088	.2381898
lnX LD.	-.2780657	.1388467	-2.00	0.045	-.5502003	-.0059311
_cons	.1479462	.0933926	1.58	0.113	-.0351	.3309924
D_lnX						
_ce1 L1.	.4836296	.1169112	4.14	0.000	.2544878	.7127715
lnY LD.	-.2262606	.1923473	-1.18	0.239	-.6032544	.1507332
lnX LD.	-.0904859	.157285	-0.58	0.565	-.3987589	.2177871
_cons	.0801911	.1057948	0.76	0.448	-.127163	.2875451

We can interpret the speed adjustment of long-run equilibrium relationship between the two variables by the following equation:

$$ECT_{t-1} = [y_{t-1} - \eta_j X_{t-1} - \epsilon_m R_{t-1}] \quad \text{Eq. 14}$$

After substituting the values from Figure 7 in the above equation, we get

$$ECT_{t-1} = [1.000 ln(Y_{t-1}) - 1.789 ln(X_{t-1}) - 13.521] \quad \text{Eq. 15}$$

In this cointegrating equations, $ln(Y)$ positioned as the dependent variable. We have to also note that the sign of the coefficients are reversed in the long-run.

Therefore, in the long-run, $ln(X)$ has a positive impact on $ln(Y)$. The coefficient is statistically significant at the 1% level of significance.

We have supported the result by some more diagnostic tests such Autocorrelation, Normality Test of Residuals and Stability of *VECM* in *APPENDIX*.

Figure 7: Cointegrating Equations

Cointegrating equations

Equation	Parms	chi2	P>chi2
_ce1	1	50.87946	0.0000

Identification: beta is exactly identified

Johansen normalization restriction imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
lnY	1	.	.	.	.	.
lnX	-1.789594	.25089	-7.13	0.000	-2.281329	-1.297859
_cons	-13.52196	.	.	.	.	.

The next section concludes the study and provides some policy suggestions.

5 Conclusion

In this paper, we analyzed the validity of Wagner's law in India for 1980-2020. We have supported this law by the long data-set, which leads to consistent estimators that will be the main advantage of our study. Also, other diagnostic tests ensure the reliability of our empirical results.

We used recent econometric techniques to test if there is any long-run relationship between economic growth and government spending. We also examined the direction of the causality between these variables. Initially, we deploy the OLS technique to know the causation between the two variables.

From our analysis in this study, we saw that the first difference in per-capita GDP significantly impacts expenditure growth rate. The significant findings of the study contribute to the literature devoted to the validity of Wagner's law. We apply unit root tests without allowing structural breaks (ADF). Then, we deploy OLS and Johansen cointegration technique to see if there is a long-run relationship between the variables or not.

Moreover, during this period, the Indian economy faced increased economic growth, expanded public activities, included the phase of industrialization and urbanization of the economy and the increased population; therefore, all the assumptions of the original Wagner's hypothesis is satisfied.

We also established some causation of the elasticity between the two variables. Since our independent variable is the first difference in per-capita GDP, which indicates the economy's welfare. Therefore, our results provide substantial policy implications such as an increase in the economy's welfare leads to economic development.

We have found that there is a long-run relationship between the variables, and the results are robust. Thus Wagner's law is valid in our study. Thus, we encourage research in this respect to either confirm or contradict the result presented in this study relating to the variable mentioned above.

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APPENDIX

Note: All the tables are generated in STATA.

Table 2: Diagnostic Test

Source – chi2	Df	p
Heteroskedasticity – 2.55	2	0.2794
Skewness – 0.66	1	0.4171
Kurtosis – 1.82	1	0.1775
Total – 5.03	4	0.2846

Table 3: Jarque-Bera test

Equation	chi2	df	Prob > chi2
D_lnY	8.976	2	0.01124
D_lnX	13.611	2	0.00111
ALL	22.588	4	0.00015

Table 4: Eigenvalue stability condition

Eigenvalue	Modulus
1	1
-0.3929794	0.392979
0.04012107 + 0.3697352i	0.371906
0.04012107 – 0.3697352i	0.371906

The VECM specification imposes a unit modulus.

Table 5: Lagrange-multiplier test

Lag	chi2	Df	Prob > chi2
1	18.2322	4	0.00111
2	10.2252	4	0.03680

H0: no autocorrelation at lag order