Linkage between Income and Government Expenditure at Indian Sub-nationals: A Second-Generation Panel Co-integration Techniques

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Linkage between Income and Government Expenditure at Indian Sub-nationals: A Second-Generation Panel Co-integration Techniques

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Abstract

The present paper examines whether the Wagner's law that represents the long-run relationship between income and public expenditure holds at the subnational level in India. The paper covers 21 Indian States and a time-period of 40 years from 1980-81 to 2019-20. The validity of the law was examined for nine different panels of states broadly under income categories and geographical regions. Unlike first-generation panel techniques which fails to account the aspects of cross-sectional independence and heterogeneity, the present study tests the validity of the Wagner's law using the second-generation panel unit root method and cointegration approach. The analysis adopts Panel Dynamic Ordinary Least Square to test the evidence of Wagner's law hypothesis. The findings reveal that Indian states are heterogeneous in terms of public expenditure, and there exists cross-sectional dependence. There also exists a long-run cointegrating relation between state-level income and state-level public expenditure. For the full sample, while this study finds holding Wagner's law, there is a mixed validity of the law at different panels across income categories and regions. In addition, it is observed that the validity of Wagner's law in the Indian Subnational context is mainly driven by the high-income major states, and it is more capital outlay centric.

Keywords: Wagner's Law; Second Generation Panel Root and Co-integration Tests; Indian States

JEL Classification: C23; H30; H72

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1. Introduction

The causal relationship between public expenditure and income has been an active research agenda since Wagner (1883) postulated his famous law on increasing public expenditure. Based on inter-temporal data on several developed countries, Wagner's law states that as an economy develops, the share of public expenditure tends to increase. Essentially, this law implies that public expenditure increases at a faster rate than the growth of national income. In fact, the increase in income at the community level in relation to the national income leads to an increase in public expenditure as people demand more services which are consistent with their needs (Barra et al., 2015). Since then, there have been numerous empirical studies on testing the law in different contexts applying both time-series and panel data. Generally speaking, the empirical findings on Wagner's law applying the concept of cointegration (linear/nonlinear) and causality are mixed and contradictory. While a set of literature found support for the law (Ram, 1986; Kolluri et al., 2000; Bruckner et al., 2012), several others did not found support in favour of the Wagner's law (Iyare & Lorde, 2004; Wahab, 2004; Narayan et al., 2008b). In Indian context too, the evidence on Wagner's law has been mixed both at the national and subnational context (Narayan et al., 2012; Kaur & Afifa, 2017; Nirola & Sahu, 2020; Rani & Kumar, 2020; Rastogi et al., 2021). An understanding of the relationship between public expenditure and national income is of policy interest for the debate of sustainability of public finances especially during the phases when governments struggle to restrain the size of the government sector.

The present study attempts to provide a detailed understanding of the relationship between public expenditure and income in India. More specifically, it focuses on investigating the relationship between these two at the subnational level constructing various panels based on geographic locations, level of income, and category of states. Overall, we have panels of states representing Northern, Southern, Eastern & Central, Western, North-eastern India, panels of states representing high-income major states and low-income major states across major and other States. An understanding of Wagner's law at the subnational level especially in a country like India is important for several underlying reasons. First, in the Indian context, it is a diverse country representing different culture, language, and institutional setups making the states more heterogeneous which implies possible heterogeneity in the relationship between public expenditure and level of income across the states (Narayan et al., 2012). Using sub-national data also provides the means to exploit the cross-sectional dimension, while minimizing the effects of cultural and institutional differences.

Second, as public expenditure, primarily the development expenditure, is mostly entrusted on the subnational government in Indian fiscal federalism, analysing the nexus between public expenditure and income at the subnational level is critical for policy implications, especially in identifying the fiscal policy stance adopted by the state government due course of time (Kumar et al., 2012). Third, unlike the defence expenditure, which comprises a significant proportion of public expenditure of the union budget union government, there is no expenditure dedicated to the military front at the subnational level giving the states an edge in their budget exercise. Fourth, while the expenditure of the Union Government is sensitive to the global economic outlook, such adverse effects of international economic events potentially be minimized through the public expenditure activities at the sub-national level. Fifth, in addition to testing Wagner's law for a full panel of States, the law can be tested for smaller panels corresponding to the Northern, Southern, Eastern & Central, Western, North-eastern regions of India. The Western and Southern States of India have relatively high real per capita incomes as compared to the less developed Eastern and North-eastern States. While India as a whole is a developing country, using subnational data provides an interesting perspective as it offers a means to test Wagner's law for panels of states within the same country which are at different stages of economic development.

Finally, there has also been an evolving question around testing Wagner's law whether the law is revenue expenditure or capital expenditure specific? While the literature argued that the multiplier effect of capital expenditure on economic growth is much higher as compared to revenue expenditure (Bose & Bhanumurthy, 2015), there is no reason to believe that as the economy grows, the share capital expenditure increases in the total budgetary outlay. However, a growing economy is often accompanied by an increase in budgetary allocation in critical infrastructures like utility and transportation (Guellec & Wunsch-Vincent, 2009; Wu, 2010). On the other hand, another set of argument claim that the revenue expenditure tends to grow as the size of public expenditure increases with more allocation towards wages and salaries (Narayan et al., 2012). Thus, it is critical to test whether the Wagner’s law is associated with capital expenditure or revenue expenditure at the subnational level.

The findings of the present study reveal that Indian states are heterogeneous in terms of public expenditure and there exists cross-sectional dependence. There also exists a long-run cointegrating relation between state-level income and state-level public expenditure. The results from the panel estimation model depict that while the Wagner’s firmly hold for the full panel of 21 states, a piece of mixed evidence is observed at panels across income categories and regions. In addition, it is observed that the validity of Wagner’s law in Indian Subnational context is mostly driven by the high-income major states, and it is more of capital outlay centric. The rest of the paper is organized as follows. Section 2 gives an overview of literature both at the cross-country and subnational settings. Section 3 gives an overview of the state-level expenditure in India. Section 4 discusses the empirical model and data. It also presents the detailed methodology and the results of second-generation tests. Section 5 presents the estimation results of the Wagner’s law and Section 6 concludes the results.

2. Review of literature

2.1. Literature on cross-country context

Wagner (1883) was the first to postulate the law which essentially implies that public expenditure increases at a faster rate than the growth of national income. Following it, numerous studies have focused their attention on testing the validity of Wagner’s law in different contexts but with no unanimous evidence. While a few studies in cross country context found supports to the Wagner’s law (Kolluri et al., 2000; Akitoby et al., 2006; Bruckner et al., 2012; Kumar & Cao, 2019), a few other found no support to the law (Afxentiou & Serletis, 1996; Ansari et al., 1997). On the other hand, a few other have found mixed evidence for the applicability of the law (Abizadeh & Gray, 198; Ram, 1986; Iyare & Lorde, 2004; Wahab, 2004).

Testing Wagner's law of increasing state activity using panels of 55 countries for the period 1963–1979, Abizadeh and Gray (1985) found support for Wagner's law in the richer countries, but not in poorer countries. Similarly, Ram (1986) found support in about 60% of the countries and little evidence in the remaining 40% of the 115 countries over the period of 1950-1980. There has been a weak support for Wagner's law for developing countries while there is stronger support for the law in industrialized countries (Akitoby et al., 2006). In the same line, Chang et al. (2004) found only mixed support for the law while testing Wagner's law for nine western industrialized countries and three newly industrialized countries in Asia. Testing the validity of the law for 10 OECD countries, Funashima (2017) found that the law is less valid in the earliest stage of economic development as well as in the advanced stages which tends to exhibit an inverted U-shaped pattern with economic development. Another work by Wahab (2004) found limited support for Wagner's law in a study of 30 OECD countries. Analysing six versions of Wagner's Law on nine Caribbean countries, Iyare and Lorde (2004) found that a long-run equilibrium relationship between income and public expenditure does not exist for the countries studied, with the exceptions of Grenada, Guyana, and Jamaica for a particular formulation of the Law. While the direction of causality runs from national income to public expenditure only for Guyana, the causality runs in the other direction for Grenada and Jamaica. Moreover, the evidence for short-run causality is mixed, but the predominant causal relationship appears to run from national income to public expenditure.

Examining the relationship between the public expenditures and national income using time-series data drawn from seven industrialized countries Kolluri et al. (2000), whereas, found that the public expenditure tends to be national income elastic in the long-run. Analysing the cross-country panel data covering 142 countries over the period of 1960-2007, Buckner et al. (2012) found that the average size of public expenditure increases by more than a quarter of a percent in response to one percent increase in the national income. However, they found the income elasticity of public expenditure to be somewhat smaller in high-income countries compared to low- and medium-income countries. Moreover, they also found the income elasticity of consumption expenditure to be lower as compared to investment expenditure. Examining the structural breaks in the relationship between public expenditure and national income for a few East Asian countries, Kumar and Cao (2019) found supports in favour of Wagner’s law. While Thornton (1999) found validity of the Wagner's law in six European countries employing nineteenth-century data, Afxentiou and Serletis (1996) found no support for Wagner's law in multi-European countries using data from the twentieth century. Similarly, Ansari et al. (1997) found no support for Wagner's law in a study of three African countries, namely Ghana (1963–1988), Kenya (1964–1989), and South Africa (1957–1990). They concluded that the public expenditure in these three countries had deviated substantially and persistently from the national income.

There are also several studies concentrating on testing the law in a single country context. Some of these include studies for developed countries such as the United States (Islam, 2001); Canada (Afxentiou & Serletis, 1991; Biswal et al., 1999); the United Kingdom (Chaw et al., 2002; Paparas et al., 2019); New Zealand (Kumar et al., 2012, 2019), Italy (Magazzino, 2012; Barra et al., 2015; Pistoresi et al., 2017), Sweden (Henrekson, 1993), Japan (Nomura, 1995), and Spain (Garcia, 2020). There are also studies for emerging countries such as Greece (Courakis et al., 1993, Hondroyiannis & Papapetrou, 1995, Chlestos & Kollias, 1997); Iraq (Asseery et al., 1999); Pakistan (Khan, 1990); Mexico (Hayo, 1994, Lin, 1995); Nigeria (Babatunde, 2011), Ethiopian (Menyah & Wolde-Rufael, 2013), Malaysia (Govindaraju, 2011), and India (Kaur & Afifa, 2017; Rani & Kumar, 2020). With a few exceptions, most of these country-specific studies confirm the validity of the Wagner's law.

2.2. *Literature on subnational context*

While researchers mostly investigate the law using cross-country or single country-specific data, a recent direction in the literature on Wagner's law focuses on testing at the subnational or provincial level. Like cross-country literature, the evidence on the validity of the law has also been mixed at the subnational level (Abizadeh & Yousefi, 1988; Narayan et al., 2008a, 2008b, 2012; Nirola & Sahu, 2020; Rastogi et al., 2021). In this dimension, Abizadeh and Yousefi (1988) was the pioneer who tested Wagner's law at the subnational level using time-series data for 10 US states for the period 1950–1984 which found support in favour of the law. Similarly, Abizadeh and Gray (1993) found that the provincial public expenditure had grown in proportion to the provincial domestic income, and most of these provincial public expenditures had been stimulated by the social sector spending and federal transfers payments.

Applying a panel unit root, panel cointegration, and Granger causality analysis, Narayan et al. (2008a) examined the law based on data from Chinese provinces. Their study reveals that there is less support for Wagner's law for China as a whole or for the higher income eastern provinces. There is mixed support for the law in the less developed, lower income central and western panels. While the elasticity of public expenditure with respect to income is about one in both cases, there is long-run unidirectional Granger causality that runs from provincial income to public expenditure. In contrast, Wu and Lin (2012) found no support for the law in the Chinese provincial context and concluded that expenditure decentralization and revenue decentralization contribute to the expansion of public expenditure in the Chinese provinces. Using the data for Fiji Islands for the period of 1970-2002, Narayan et al. (2008b) found support for the law. Taking into account the effect of federal transfers on the public spending, Funashima and Hiraga (2017) found support in favour of Wagner's law in the US while they found an inverse in the context of Germany. For Germany in specific, they found that soft budget constraints can cause significant negative correlation between government size and national income. In contrast, Sagdic et al. (2020) found a strong support for the validity of Wagner's law for Turkey's provinces for the period 1992 to 2013.

There are also a few studies exploring the validity of the law in the Indian subnational context (Narayan et al. 2012; Nirola & Sahu, 2020; Rastogi et al., 2021). Using panel-data techniques, Narayan et al. (2012) investigated the law for the 15 Indian states between 1986–1987 and 2008–2009 and divided the panel into categories based on income, public expenditure, and geographical locations. The results of panel cointegration revealed a long-run relationship between public expenditure and income at the sub-national level. However, Wagner's law was found weak for middle income, western and southern panel of states. In a similar front, analysing the validity of the law in a panel of only developing Indian States, Rastogi et al. (2021) found mixed evidence. They found support for the law in case of public expenditure on the social sector and economic services for Odisha and West Bengal. Rajasthan was found to follow the law with respect to revenue expenditure on social sector and capital outlay in economic services increases with the growth in output. Accounting for the cross-sectional dependence, Nirola and Sahu (2020) employed second generation panel unit root and cointegration tests and found that Wagner's law holds at an all-India level with respect to all three components of public expenditure (aggregate, revenue, and capital). In the sub-group analysis, their results exhibit long-run elasticity less than one for the States with above-average income across all components of public expenditure while states with below-average income level exhibit long-run elasticity greater than one across all categories of public expenditure.

The emerging body of panel data econometrics literature concludes that panel-data models are likely to exhibit substantial cross-sectional dependence in the errors. Most of the literature except Nirola and Sahu (2020) have ignored the aspect of cross-sectional dependence in validating Wagner's law in the Indian context. India being diverse in terms of culture, language, and institutional set ups across the States, there may be a high degree of unobserved cross-sectional dependence in the data. This paper extends the validity of Wagner's law accounting for the cross-sectional dependence and heterogeneity in the different panels of Indian States.

Table 1: Trend in Public Expenditure at Subnational Level in India (%NSDP)

State	1981-1990	1991-2000	2001-2010	2011-2020	1981-2020
Andhra Pradesh	32.29	29.52	24.76	18.78	26.34
Assam	17.91	18.22	21.70	25.68	20.88
Bihar	27.87	20.66	24.30	27.87	25.17
Goa	34.31	29.03	25.53	21.77	26.49
Gujarat	17.76	17.36	18.40	14.28	16.95
Haryana	19.11	19.81	16.84	15.37	17.78
Himachal Pradesh	28.35	31.10	32.22	29.38	30.26
Jammu & Kashmir	25.04	35.23	41.05	46.60	36.98
Karnataka	14.38	13.19	15.27	15.23	14.52
Kerala	15.43	15.19	15.74	17.26	15.91
Madhya Pradesh	22.96	17.90	21.71	24.85	21.85
Maharashtra	16.61	14.03	15.14	13.61	14.85
Manipur	39.79	39.15	50.08	54.32	45.83
Meghalaya	31.88	29.49	27.45	37.30	31.53
Odisha	17.55	20.13	21.49	23.81	20.75
Punjab	17.98	17.98	20.57	18.83	18.84
Rajasthan	18.98	18.81	21.29	21.69	20.19
Tamil Nadu	16.57	15.68	16.53	16.19	16.24
Tripura	38.07	44.12	39.52	35.10	39.20
Uttar Pradesh	17.37	18.08	23.23	25.16	20.96
West Bengal	14.85	15.72	19.26	18.93	17.19
All	***22.77***	***22.88***	***24.38***	***24.86***	***23.73***

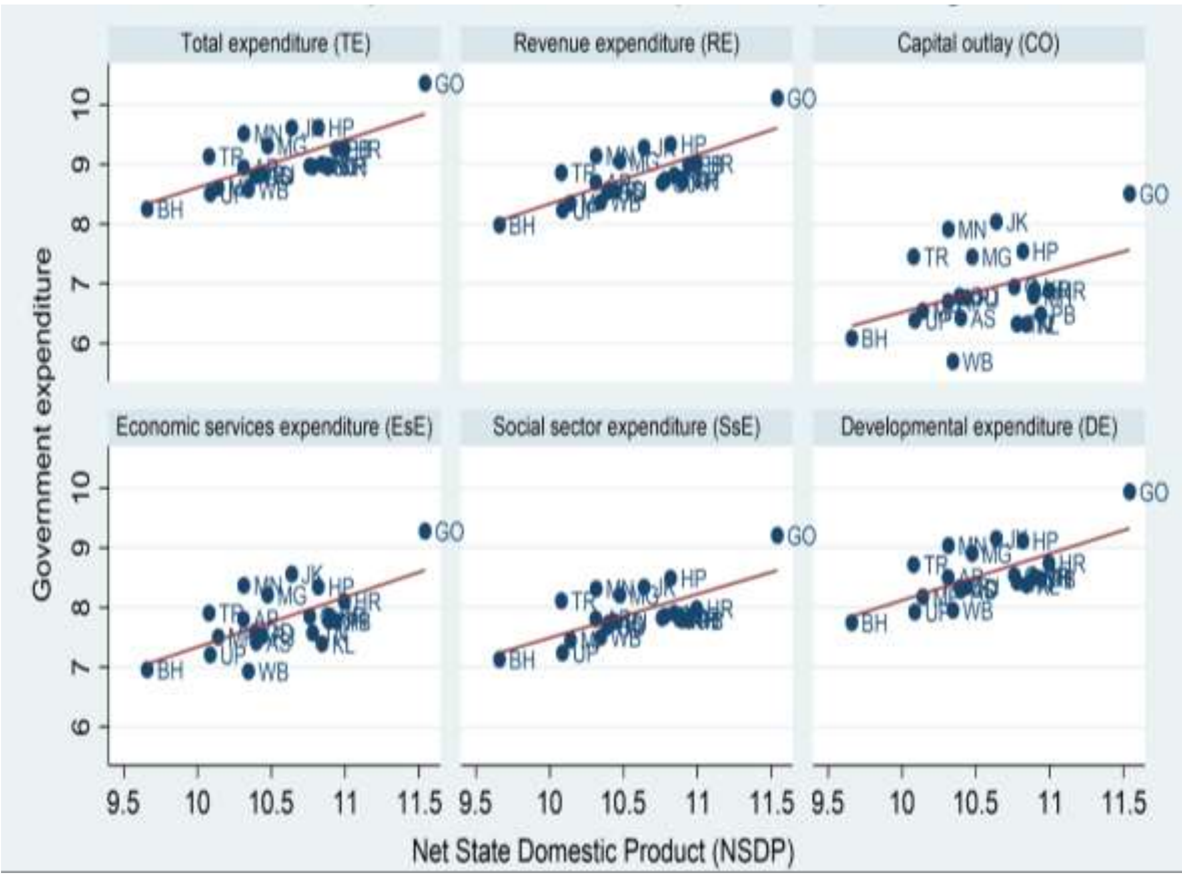
Source: Authors' calculation using EPWRF time series database.

3. Public expenditure at subnational level in India

The aggregate public expenditure as a percentage of net state domestic product (NSDP) at subnational level in India is presented in Table 1. It presents 10-year averages for the period 1980-81 to 2019-20 for each of the 21 Indian states considered in the present study. At all India level, it reveals an increasing trend in the state activities from 22.77% during 1980-90 to 24.86% during 2011-20. Comparing the first decade (1980-81-1989-90) to the most recent decade (2011-12-2019-20), while the public expenditure as a percentage of NSDP has increased for most of the states, there has been a decline in a few States such as Andhra Pradesh, Goa, Haryana, Gujarat, and Maharashtra. In contrast, a few states such as Jammu & Kashmir, Manipur, Uttar Pradesh, Assam, Odisha, and West Bengal experienced the largest increase. For a few states such as

Haryana, Gujarat, Maharashtra, Tamil Nadu, Punjab, Kerala, Rajasthan, West Bengal, and Odisha, the public expenditure as a percentage of NSDP has been consistently lower than the all-India average. In a nutshell, States appear to be heterogeneous in terms of the average public spending. Fig. 1 also confirms the heterogeneity in terms of average public spending across the states. Ascertaining the heterogeneity of states is crucial as it gives credence to our approach of testing Wagner's law at the subnational level for India.

Fig 1: Per Capita Income and Per Capita Public Spending: Component-wise



Note: AP - Andhra Pradesh, AS – Assam, BH – Bihar, GO – Goa, GJ – Gujarat, HR – Haryana, HP - Himachal Pradesh, JK - Jammu & Kashmir, KR – Karnataka, KL – Kerala, MP - Madhya Pradesh, MH – Maharashtra, MN – Manipur, MG – Meghalaya, OD – Odisha, PB – Punjab, RJ – Rajasthan, TN - Tamil Nadu, TR – Tripura, UP - Uttar Pradesh, and WB - West Bengal.

Source: Authors' estimation

4. Data and empirical model

4.1. Data

The data being used in this study were obtained from EPWRF time series that provides time series data facilitating research across various sectors of the Indian Economy.[1] Annual data on for the period from 1980-81 to 2019-20 had been used for the 21 Indian states. To proxy the state income, we used the net state domestic product (NSDP) and per capita net state domestic product (PCNSDP). For the last three years i.e., 2017-18, 2018-19, and 2019-20, we have used data

[1] https://epwrfits.in/index.aspx

published by the Reserve Bank of India for both the state income and expenditure.[2] Similarly, population data for 2019-20 was updated from Census Projection. Four states namely Chhattisgarh, Jharkhand, Uttarakhand, and Telangana, were part of Madhya Pradesh, Bihar, Uttar Pradesh, and Andhra Pradesh, respectively, during the 80s, 90s, and 20s. So, these are added to their original states for the purpose of analysis. In addition, four North Eastern States namely Arunachal Pradesh, Mizoram, Nagaland, and Sikkim were excluded from the current analysis due discrepancies in their NSDP and public expenditure data.

4.2. Model

In subnational literature, the increased state activities are commonly represented through two proxies: public expenditure and NSDP (Narayan et al. 2012; Nirola & Sahu, 2020; Rastogi et al., 2021). In line with this, this paper examines Wagner's law with the underlying panel data model for six pairs of relationship for nine panels.

$$lnPE_{it} = \alpha_i + \beta_i lnNSDP_{it} + \varepsilon_{it} \quad \cdots (1)$$

Where PE_{it} represents the proxies for per capita public expenditure for state 'i' in the year 't'. $NSDP_{it}$ represents per capita net state domestic product (NSDP) of state 'i' at year t. Since Eq. (1) is in the logarithm terms, the coefficient of $NSDP_{it}$ represents the elasticity of public expenditure. If β_i is positive and significant, then it implies the presence of Wagner's law i.e., public expenditure increases at a faster rate than income. In the present study, six pairs of relationships have been tested as follows, all are scaled for per capita real terms and log form. The state level deflators have used to derieved the values in real terms:

Model 1: State level income and state level public expenditure

Model 2: State level income and State level revenue expenditure

Model 3: State level income and state level capital outlay

Model 4: State level income and State level public expenditure on economic services

Model 5: State level income and State level public expenditure on social services

Model 6: State level income and state level expenditure on developmental sector.

4.3. Cross-sectional dependence

Prior to the estimation of Eq. (1), it is important to test whether there exists a long run relationship between real per capita public expenditure and real per capita NSDP. In doing so, the first step is to examine the existence of cross-sectional dependence in panel data i.e., whether cross-sectional units (States) are independent of each other or not. Such cross-sectional dependence may arise as a result of the presence of common shocks and unobserved components that ultimately become part of the error term, spatial dependence, and idiosyncratic pair-wise dependence in the disturbances with no particular pattern of common components or spatial dependence (Anselin, 2001; Pesaran, 2004; Baltagi, 2008; Eberhardt & Teal, 2011). As a result, the standard panel unit root and cointegration tests (referred as the first-generation panel unit root and cointegration tests) produce biased and inconsistent estimates in the presence of cross-sectional dependence (Phillips & Sul, 2003; Sarafidis & Robertson, 2006; De Hoyos & Sarafidis, 2006). According to Phillips and Sul (2003), if there is sufficient cross-sectional dependence in

[2] NSDP data are not available for 2020-21 for all the state. Moreover, 2020-21 was an abnormal year given the unprecedented Covid19 pandemic. Therefore, we have excluded 2020-21 from the current analysis.

the data and estimates produced, ignoring cross-sectional dependence results in a significant loss of estimation efficiency. Hence, the pooled (panel) least-squares estimator may provide little gain over the single-equation ordinary least squares. Ignoring dependence and applying tests belonging to first-generation panel unit root to a data series with cross-sectional dependence results in size distortions and low power, i.e., there would be an increased probability of rejecting the true hypothesis (O'Connell, 1998). Thus, it is imperative to check such cross-sectional dependence and account for the same while exercising a panel analysis if it exists.

To identify whether there exists any cross-sectional dependence in the data used, the present study follows the test of error cross-section dependence (CD) proposed by Pesaran (2004). The CD test is based on an average of pair-wise correlation coefficients of OLS residuals from the individual regression in the panel. The CD test statistics is given as follows:

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\widehat{\rho_{ij}}\right) \quad \cdots (2)$$

Where $\widehat{\rho_{ij}}$ is the sample estimate of the pair-wise correlation of the residuals state 'i' with state 'j'. A higher correlation coefficient reflects a stronger cross-sectional dependence among the residuals.

4.4. Second-generation panel unit root test

To ascertain the panel integrational properties of data series to be used in the estimation model, the cross-sectionally augmented Dicky-Fuller (CADF) test as suggested by Pesaran (2007) is employed for testing unit root in the presence of cross-sectional dependence. The CADF test takes into account the cross-sectional dependence based on the existence of one single common factor that exists across the states affecting the per capita real public expenditures and per capita real NSDP. The common factor is proxied by the cross-section mean values of Y_{it} and its lagged values as well as the first difference of the variable. It is based on the unit root hypothesis on the t-ratio of the OLS estimate of b_i in the CADF regression:

$$\Delta y_{it} = a_i + b_i y_{i,t-1} + c_i \underline{y_{t-1}} + d_i \Delta \underline{y_t} + e_{it} \quad \cdots (3)$$

Where $\underline{y_{t-1}}$ is the cross-section means of lagged values, $\Delta \underline{y_t}$ is the cross-section mean of the first difference of y_{it}.

4.5. Testing for cointegration

Given that the variables under consideration are stationary either at level I(0) or at first difference I(1), one may proceed to exercise panel cointegration to test whether there is any co-integrating relationship between public expenditure and income at the state level. The present study employs error-correction based panel cointegration test as proposed by Westerlund (2007) that accounts for the unobserved factors. Apart from coping with cross-sectional dependence, the Westerlund test allows for a large degree of heterogeneity both in the long-run cointegrating relation and short-run dynamics. The test provides four normally distributed test statistics in two categories namely group mean tests and panel test. The group mean tests (Ga, Gt) are computed with standard error estimated in a standard way. Whereas panel tests (Pa, Pt) are computed using Newey and West (1994) standard error adjusted for heteroskedasticity and autocorrelations. The Westerlund (2007) test is performed using the following equation.

$$\Delta PE_{i,t} = c_i^{PE} + \lambda_i^{PE}\left(PE_{i,t-1} - \beta_i^{PE} NSDP_{i,t-1}\right) + \sum_{j=1}^{n} \delta_{i,j}^{PE} \Delta PE_{i,t-j} + \sum_{j=1}^{n} \phi_{i,j}^{PE} \Delta NSDP_{i,t-j} + e_{i,t} \quad \cdots (4)$$

Where PE refers to each category of public expenditures in per capita real term, NSDP is the per capita real net state domestic product, λ_i^{PE} is the error-correction term that provides the speed of error-correction towards the long run equilibrium for state i, and $e_{i,t}$ are the white noise random error term.

4.6. *Estimation of Wagner's law*

Given that a long-run cointegrating relationship exists between the state-level public expenditure and state-level income, the Wagner's law is estimated using the equation (1). For this, the present paper employed between dimension group mean Panel Dynamic Ordinary Least Squares (PDOLS) put forward by Pedroni (2001). This is a simple yet efficient single-equation estimate of the cointegrating vector. Given our context of possible endogeneity between public expenditure and state level income, the use of PDOLS is justified as it possesses a few features. It allows for direct estimation of I(0) and I(1) variables, performs well in small samples, and does not require exogeneity assumptions. Further, PDOLS estimator is asymptotically unbiased and normally distributed even in the presence of endogenous variables. Moreover, the group-mean PDOLS estimator is super-consistent under cointegration and is robust to any omitted variable bias that does not form part of the cointegrating relationship. PDOLS procedure also allows time-demeaning the variables to take care of certain forms of cross-sectional dependence in the panel. PDOLS is a panel extension of the individual time series Dynamic Ordinary Least Square (DOLS) of Stock and Watson (1993). The DOLS in the present scenario can be given as follow:

$$PE_{i,t} = \alpha_i + \beta_i NSDP_{i,t} + \sum_{j=-P_i}^{P_i} \gamma_{ij} \Delta NSDP_{i,t-j} + \mu_{it}^{*} \quad \cdots (5)$$

Where PE refers to each category of per capita real public expenditures in logarithmic form, NSDP is the per capita real NSDP in log form , β_i is the slope coefficient, and 'i', 'j', and 'p' are respectively, the number of units in the panel, number of time periods, and number of lags and leads in the DOLS regression. The β coefficients and associated t statistics are then averaged over the entire panel by using Pedroni's group mean method. The between estimator β can be estimated as:

$$\hat{\beta} = \frac{1}{N}\sum_{i=1}^{N} \widehat{\beta_i} \quad \cdots (6)$$

where $(\widehat{\beta_i})$ is the conventional DOLS estimator applied to the ith state of the panel.

4.7. *Causality analysis*

The presence of cointegrating relationships between NSDP and public expenditure at the subnational level implies the existence of Granger causality at least in one direction. The present study employs the test built by Dumitrescu and Hurlin (2012), which is an extension of Granger (1969) methodology designed to detect causality in panel data. The DH test assumes that there can be the causality for some individuals but not necessarily for all. The DH test has three advantages over other panel causality tests: a) consideration is made of cross-sectional dependency; (b) the time dimension and the size of the cross-section relative to each other are irrelevant; and (c) effective results are achieved in unbalanced panels (Dumitrescu & Hurlin, 2012). Under the assumption that the individual Wald statistics ($\bar{W}$) are independently and identically distributed, the standardized statistics $\bar{Z}$ when $T \rightarrow \infty$ and N→ ∞ follows a standard normal distribution:

$$\bar{Z} = \sqrt{\frac{N}{2K}} \times (\bar{Z} - K) \xrightarrow[T,N \to \infty]{} N(0,1) \qquad \cdots (7)$$

For a fixed T dimension with $T > 5 + 3K$, the approximated standardized statistic $\bar{Z}$ follows a standard normal distribution:

$$\tilde{Z} = \sqrt{\frac{N}{2K} \times \frac{T-3K-5}{T-2K-3}} \times \left(\frac{T-3K-5}{T-2K-3} \times \bar{W} - K\right) \xrightarrow[T,N \to \infty]{} N(0,1) \qquad \cdots (8)$$

In order to capture the aspect of cross-sectional dependence, the present study computes bootstrapped critical values for $\bar{Z}$ and $\tilde{Z}$ instead of asymptotic critical values as suggested by Dumitrescu and Hurlin (2012).

5. Results and discussions

Table 2 presents the Pesaran CD test statistics for all the panels under consideration. Most of the cells across models indicate cross-sectional dependence across the panels of states indicating applying first-generation tests would result in inconsistent results. Therefore, the present study applies second-generation unit root tests allowing for cross-sectional dependence in the data.

Table 2: Pesaran (2004) CD Test to Detect the Presence of Cross-sectional Dependence

Model	Full Sample (21)	MSHI (7)	MSLI (7)	OS (7)	Northern (6)	Southern (4)	Central & East (4)	Western (3)	Northeast (4)
1	10.359***	3.056***	9.807***	14.337***	1.885*	4.509***	3.173***	2.912***	0.513
2	11.333***	2.309**	9.942***	15.460***	2.383**	2.934***	2.398**	4.591***	-0.757
3	5.560***	0.152	4.464***	5.723***	0.301	-0.899	3.640***	0.003	1.614
4	6.671***	-0.466	7.987***	7.606***	0.398	-1.595	4.851***	-0.045	1.311
5	8.214***	4.478***	11.461***	17.086***	-0.908	4.662***	7.071***	2.939***	1.993**
6	7.979***	0.054	10.001***	14.429***	-0.018	0.199	5.964***	1.540	1.874*

Note: Null hypothesis: Pesaran's test statistics is of cross-sectional independence. ***, ** and * denotes significance level respectively at 1%, 5% and 10% error respectively, and it rejects null hypothesis of cross -sectional independence.

Source: Authors' computation

Table 3 presents the second-generation panel unit root test following Pesaran (2007). It was conducted for each of the variables under consideration, and the variables are found to be stationary either at level I(0) or at first difference I(1).

Table 3: Second-generation Unit Root Test (Pesaran, 2007)

Category	Variables	NSDP	TE	RE	CO	EsE	SsE	DE
Full Sample (21)	C	I(1)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
	C & T	I(1)	I(1)	I(1)	I(1)	I(0)	I(0)	I(0)
MSHI (7)	C	I(1)	I(0)	I(0)	I(1)	I(0)	I(0)	I(0)
	C & T	I(1)	I(0)	I(1)	I(1)	I(0)	I(0)	I(0)
MSLI (7)	C	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)
	C & T	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)
OS (7)	C	I(1)	I(1)	I(0)	I(1)	I(0)	I(1)	I(1)
	C & T	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)
Northern (6)	C	I(1)	I(0)	I(0)	I(1)	I(0)	I(0)	I(0)
	C & T	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)	I(0)
Southern (4)	C	I(1)	I(0)	I(0)	I(1)	I(0)	I(0)	I(0)
	C & T	I(1)	I(0)	I(0)	I(1)	I(0)	I(0)	I(0)
Central & East (4)	C	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
	C & T	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
Western (3)	C	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
	C & T	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
Northeast (4)	C	I(1)	I(1)	I(0)	I(1)	I(1)	I(0)	I(1)
	C & T	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)	I(1)

Note: I(0) indicates stationary at level, and I(1) indicates stationary at first difference at significance level of 5% error; Variables are in terms of real per capita log form.

Source: Authors' computation

Table 4a-4f present the results of cointegration tests are performed with constant, and constant with a trend. Results from all the models indicate that there is a long-run relationship between the public expenditure at subnational level (aggregate, revenue, capital outlay, economic services, social sector, and development expenditure) and subnational income both across states and within states as well. Overall, the existence of cointegration shows that there is a stable long run relationship among variables (per capita state income and per capita state public expenditure and its components).

Table 4a: Westerlund (2007) Cointegration Test for Model 1

Statistics	Gt		Gα		Pt		Pα	
Category	C	C & T	C	C & T	C	C & T	C	C & T
Full Sample (21)	-2.583***	-2.854***	-17.981***	-22.636***	-11.123***	-13.938***	-15.727***	-22.687***
MSHI (7)	-2.976***	-2.885**	-20.510***	-22.561***	-7.956***	-8.547***	-22.875***	-26.974***
MSLI (7)	-2.021	-2.403	-15.123***	-19.672***	-4.375	-6.127	-10.579***	-16.755***
OS (7)	-2.753***	-3.274***	-18.319***	-25.741***	-8.030***	-9.985***	-17.380***	-26.512***
Northern (6)	-3.151***	-3.727***	-17.876***	-24.789***	-7.788***	-10.036***	-18.218***	-29.079***
Southern (4)	-2.636**	-2.735	-21.628***	-24.874***	-5.393***	-6.226**	-21.682***	-28.101***
Central & East (4)	-1.865	-2.103	-13.680***	-17.397**	-2.809	-4.221	-8.349**	-14.391**
Western (3)	-2.226	-2.380	-16.322***	-23.625***	-3.393	-3.893	-16.419***	-21.970***
Northeast (4)	-2.664**	-2.769	-19.976***	-21.703***	-6.629***	-7.825***	-21.238***	-23.364***

Note: C indicates constant, and C & T: constant and trend; ***, ** and * denotes significance level respectively at 1%, 5% and 10% error respectively

Source: Authors' estimation

Table 4b: Westerlund (2007) Cointegration Test for Model 2

Statistics	Gt		Gα		Pt		Pα	
Category	C	C & T	C	C & T	C	C & T	C	C & T
Full Sample (21)	-2.577***	-2.730**	-17.154***	-21.036***	-9.934***	-11.996***	-14.662***	-19.253***
MSHI (7)	-3.002***	-3.249***	-18.482***	-26.055***	-7.158***	-7.324**	-17.985***	-25.377***
MSLI (7)	-2.145	-2.233	-17.188***	-23.244***	-4.685	-5.950	-13.217***	-21.740***
OS (7)	-2.584***	-2.708	-15.762***	-26.659***	-5.737**	-7.096**	-13.346***	-22.087***
Northern (6)	-2.782***	-3.042**	-13.868***	-24.286***	-5.204*	-6.448*	-12.189***	-22.045***
Southern (4)	-3.028***	-3.196**	-22.452***	-31.161***	-6.018***	-6.659***	-24.026***	-34.166***
Central & East (4)	-1.768	-1.730	-14.039***	-18.907**	-2.612	-3.792	-9.215**	-17.838***
Western (3)	-2.849**	-2.941	-17.020***	-23.844***	-4.058*	-3.912	-15.993***	-19.740***
Northeast (4)	-2.423*	-2.640	-19.996***	-28.439***	-5.397***	-5.546*	-20.861***	-24.434***

Note: C indicates constant, and C & T: constant and trend; ***, ** and * denotes significance level respectively at 1%, 5% and 10% error respectively

Source: Authors' estimation

Table 4c: Westerlund (2007) Cointegration Test for Model 3

Statistics	Gt		Gα		Pt		Pα	
Category	C	C & T	C	C & T	C	C & T	C	C & T
Full Sample (21)	-2.782***	-2.908***	-14.523***	-15.925***	-12.020***	-12.561***	-10.956***	-12.060***
MSHI (7)	-3.281***	-3.437***	-19.129***	-20.353***	-8.509***	-8.966***	-15.248***	-16.291***
MSLI (7)	-2.596***	-2.805*	-11.432**	-13.401	-6.634***	-6.854*	-9.563***	-10.755
OS (7)	-2.467**	-2.483	-12.976***	-13.980	-5.923**	-6.221	-9.980***	-10.659
Northern (6)	-3.706***	-3.721***	-23.710***	-24.215***	-8.365***	-8.418***	-16.706***	-17.004***
Southern (4)	-2.907***	-3.198**	-12.452**	-14.577	-7.525***	-7.990***	-16.409***	-17.802***
Central & East (4)	-2.154	-2.725	-8.314	-12.201	-3.722	-4.089	-6.563	-7.822
Western (3)	-2.768**	-2.665	-15.359***	-15.090	-3.757	-3.977	-11.501***	-11.318
Northeast (4)	-1.908	-1.765	-8.429	-9.157	-4.208	-4.189	-8.835**	-9.444

Note: C indicates constant, and C & T: constant and trend; ***, ** and * denotes significance level respectively at 1%, 5% and 10% error respectively
Source: Authors' estimation

Table 4d: Westerlund (2007) Cointegration Test for Model 4

Statistics	Gt		Gα		Pt		Pα	
Category	C	C & T	C	C & T	C	C & T	C	C & T
Full Sample (21)	-2.936***	-3.106***	-16.339***	-18.169***	-12.172***	-13.359***	-13.501***	-15.482***
MSHI (7)	-3.693***	-3.869***	-21.366***	-22.626***	-10.041***	-10.375***	-23.855***	-25.193***
MSLI (7)	-2.219	-2.500	-12.199***	-14.070	-5.561*	-6.491	-9.344***	-11.369
OS (7)	-2.896***	-2.948**	-15.432***	-17.803***	-7.125***	-7.622***	-14.361***	-16.270***
Northern (6)	-3.893***	-3.902***	-22.059***	-23.470***	-8.537***	-8.658***	-20.550***	-21.894***
Southern (4)	-3.921***	-3.975***	-24.872***	-25.422***	-7.969***	-8.085***	-24.614***	-25.241***
Central & East (4)	-1.813	-2.483	-8.163	-12.294	-3.446	-4.528	-7.255	-9.945
Western (3)	-2.744**	-3.074*	-13.547**	-15.956	-4.961***	-5.277**	-13.991***	-16.146**
Northeast (4)	-1.760	-1.689	-9.391	-10.417	-4.705**	-4.922	-11.103***	-11.989

Note: C indicates constant, and C & T: constant and trend; ***, ** and * denotes significance level respectively at 1%, 5% and 10% error respectively
Source: Authors' estimation

Table 4e: Westerlund (2007) Cointegration Test for Model 5

Statistics	Gt		Gα		Pt		Pα	
Category	C	C & T	C	C & T	C	C & T	C	C & T
Full Sample (21)	-2.602***	-2.562**	-20.934***	-22.595***	-10.487***	-10.564	-15.068***	-16.768***
MSHI (7)	-3.352***	-3.437***	-26.594***	-29.441***	-8.165***	-8.082***	-23.195***	-23.526***
MSLI (7)	-2.215	-2.173	-18.124***	-19.340***	-5.608**	-5.538	-13.758***	-15.327***
OS (7)	-2.238*	-2.077	-18.022***	-18.924***	-5.139	-5.317	-11.804***	-13.832**
Northern (6)	-2.809***	-2.935**	-23.305***	-30.378***	-5.719**	-6.654**	-13.027***	-18.517***
Southern (4)	-3.058***	-3.075**	-20.729***	-19.289**	-5.787***	-5.570*	-19.182***	-18.447***
Central & East (4)	-2.026	-1.970	-15.481***	-15.892	-3.867	-3.841	-12.032***	-13.866**
Western (3)	-2.435	-2.206	-17.916***	-17.356*	-3.501	-3.122	-14.747***	-14.135*
Northeast (4)	-2.536**	-2.350	-25.186***	-24.660***	-5.186**	-4.918	-20.858***	-19.867***

Note: C indicates constant, and C & T: constant and trend; ***, ** and * denotes significance level respectively at 1%, 5% and 10% error respectively
Source: Authors' estimation

Table 4f: Westerlund (2007) Cointegration Test for Model 6

Statistics	Gt		Gα		Pt		Pα	
Category	C	C & T	C	C & T	C	C & T	C	C & T
Full Sample (21)	-2.486***	-2.600*	-16.915***	-19.326***	-9.957***	-10.929*	-13.381***	-15.946***
MSHI (7)	-3.513***	-3.628***	-23.182***	-25.601***	-9.056***	-9.315***	-25.449***	-26.634***
MSLI (7)	-1.895	-2.077	-13.344***	-15.479*	-4.385	-5. 244	-9.579***	-12.740**
OS (7)	-2.052	-2.095	-14.161***	-16.844**	-5.680**	- 5.957	-12.753***	-14.704***
Northern (6)	-3.210***	-3.295***	-20.977***	-26.164***	-6.889***	-7.658***	-18.421***	-22.845***
Southern (4)	-3.162***	-3.222**	-22.404***	-21.388***	-6.445***	-6.469***	-22.595***	-21.592***
Central & East (4)	-1.585	-1.975	-9.843	-13.890	-2.654	-3.517	-7.195	-11.049
Western (3)	-2470*	-2.594	-15.280***	-16.924*	-4.279**	-4.065	-14.992***	-15.090**
Northeast (4)	-1.638	-1.564	-13.571***	-14.154	-4.433*	-4.377	-12.878***	-13.210*

Note: C indicates constant, and C & T: constant and trend; ***, ** and * denotes significance level respectively at 1%, 5% and 10% error respectively
Source: Authors' estimation

Table 5: PDOLS Results

Model	Full Sample (21)	MSHI (7)	MSLI (7)	OS (7)	Northern (6)	Southern (4)	Central & East (4)	Western (3)	Northeast (4)
	Panel 1	**Panel 2**	**Panel 3**	**Panel 4**	**Panel 5**	**Panel 6**	**Panel 7**	**Panel 8**	**Panel 9**
1	1.074***	0.970***	1.091***	1.160***	1.067***	0.960***	1.133***	0.819***	1.329***
2	1.156***	1.046***	1.132***	1.290***	1.173***	0.971***	1.158***	0.868***	1.531***
3	1.051***	1.063***	1.252***	0.837***	0.840***	1.294***	1.369***	0.853***	0.955***
4	0.928***	0.814***	1.023***	0.947***	0.902***	0.901***	1.118***	0.681***	0.988***
5	1.109***	1.023***	1.177***	1.125***	1.046***	0.969***	1.218***	0.932***	1.365***
6	1.026***	0.919***	1.108***	1.051***	0.976***	0.939***	1.178***	0.811***	1.198***

Note: *** denotes significance level respectively at 1% error
Source: Authors' estimation

Table 5 presents the 6 versions of equation (1) reflecting six components of state-level public expenditure. Column for panel of full sample in Table 5 indicates that the Wagner's law exists in India at the subnational for the full sample that comprises 21 states. For the full sample of 21 Indian states, an 1% increase in per capita NSDP results in a 1.07% increase in per capita aggregate public expenditure, 1.16% increase in per capita revenue expenditure, 1.05% increase in per capita capital outlay, 0.93% increase in per capita expenditure on economic services, 1.11% increase in per capita expenditure on social services and 1.03% increase in per capita developmental sector expenditure. It implies that states are trying to increase asset creation (capital outlay) more with an increase in the state-level income.

Table 6: Summary of Results

Findings	Criteria	Panels	Remarks
Wagner's law exists	Beta > 0, positive and Significant	All	
Magnitudes of elasicity	Heterogeneous	Across all panels	
Aggregate spending	Descending order among Income levels	4>3>2	Although magintudes differs and follow a pattern, the inter-panels in terms of income level and inter-geographical comparison limits providing inter-state own fiscal capacities.
	Of Geographical regions	9>7>5>6>8	
Developmental sector expenditure	Descending order among Income levels	3>4>2	
	Of Geographical regions	9>7>5>6>8	
Panels are centric towards			
Revenue expenditure	Beta 2 > Beta3	1,4,5,8,9	Overall states in Indian subnational lagging spenindg in capital outlay, and panels including Other states, Northern, Westaern,and Northeastern as well.
Capital outlay	Beta 3 > Beta2	2,3,6,7,	
Economic Services	Beta 4 > Beta5	--	Public spending is social services centric
Social Services	Beta 5 > Beta4	1,2,3,4,5,6,7,8,9	

Source: Authors' estimation

A similar pattern has been observed for the high-income major states where the capital outlay is relatively elastic to the NSDP as compared to other components of public expenditure at the subnational level. As compared to high-income major states, however, the Wagner's law is comparatively weaker in the low-income major states. Also, there is no evidence of Wagner's law in the aspect of capital outlay which is a sharp contrast to the results that are found for high-income major states. Similarly, elasticities across the head of public expenditure in response to NSDP are comparatively lower in these states. Thus, it indicates that the validity of Wagner's law in Indian subnational context is mostly driven by the high-income major states, and it is more of capital outlay centric.

Table 7: Granger Causality Test Results (Dumitrescu & Hurlin, 2012)

Variables	Stat.	Full Sample (21)	MSHI (7)	MSLI (7)	OS (7)	Northern (6)	Southern (4)	Central & East (4)	Western (3)	Northeast (4)
TE, NSDP	$\bar{Z}$	↔	→	↔	↔	↔	↔	↔	→	↔
	$\tilde{Z}$	↔	→	↔	↔	↔	↔	↔	→	↔
RE, NSDP	$\bar{Z}$	↔	→	↔	↔	↔	→	↔	→	→
	$\tilde{Z}$	↔	→	↔	↔	↔	→	↔	→	→
CO, NSDP	$\bar{Z}$	↔	↔	→	→	→	↔	→	→	↔
	$\tilde{Z}$	↔	↔	→	→	→	↔	→	→	↔
EsE, NSDP	$\bar{Z}$	→	→	↔	→	→	→	→	→	→
	$\tilde{Z}$	→	→	↔	→	→	→	→	→	→
SsE, NSDP	$\bar{Z}$	↔	→	↔	↔	↔	→	↔	→	↔
	$\tilde{Z}$	↔	→	↔	→	↔	→	→	→	→
DE, NSDP	$\bar{Z}$	↔	→	↔	↔	↔	→	→	→	↔
	$\tilde{Z}$	↔	→	↔	→	↔	→	→	→	↔

Note: (1). NSDP – Net State Domestic Product, TE – Total expenditure, RE – Revenue expenditure, CO – Capital outlay, EsE – Economic Services Expenditure, SsE – Social sector expenditure, and DE – Developmental expenditure; (2). H0: does not Granger-cause; (3). Z-bar ($\bar{Z}$) and Z-bar tilde ($\tilde{Z}$) statistics are the standardized version of Wald-statistic ($\bar{W}$). (4) Causality test results are significant at 5% level of error; (5). → indicates direction of cause from NSDP to public expenditures, and ↔ indicates bi-directional causality.

Source: Authors' computation.

Coming to other states, which basically includes North-Eastern and the Hilly States and Goa, the expenditure components are more elastic as compared to high-income major states, except capital outlay and social sector. An 1% increase in per capita NSDP results in a 0.55% increase in per capita aggregate public expenditure, 0.46% increase in per capita revenue expenditure, 0.64% increase in per capita capital outlay, 0.31% increase in per capita expenditure on economic services, 0.55% increase in per capita expenditure on social sector and 0.44% increase in per capita development expenditure.

Looking at the geographical categories, mixed evidence for Wagner's law was observed. While the law holds for Northern, Western, and North-Eastern states, the law does not hold for Southern and Central & Eastern States. While the revenue expenditure is highly elastic in Western States, the Capital outlay is highly elastic in the Northern States, whereas no evidence of Wagner's law found for revenue expenditure in the North-Eastern States and for capital outlay in Western States. The elasticities of Development Expenditure, expenditure on Economic Services, and expenditure on social services were positive in all regions except Central and Eastern States.

The results from Table 7 show that there exists a bidirectional Granger causality between state-level income and all components of public expenditure for the full sample, except expenditure on economic services. In case of economic services, the causality runs from state-level income to public expenditure on (expenditure on economic services. For the other panels and specifications, while there exist bidirectional causalities in some cases, there is only unidirectional causality in the others that runs from state-level income to public expenditure.

6. Conclusion

The present paper re-examines the validity of the Wagner's law for India at the subnational level considering 21 states for the period of 1980-81 to 2019-20. Unlike a few earlier studies (Narayan et al., 2011; Rastogi et al., 2021) which ignored one of the crucial specifications of panel data models "cross-sectional dependence", the present study employs the second-generation panel unit root and panel cointegration techniques to capture the cross-sectional dependence and heterogeneity. The findings reveal that Indian states are heterogeneous in terms of public expenditure, and there exists cross-sectional dependence. There also exists a long-run cointegrating relation between state-level income and state-level public expenditure. The results from the panel estimation model depict that while the Wagner's law strongly hold for the full panel of 21 states, a shred of mixed evidence is observed at panels across income categories and regions. In addition, it is observed that the validity of Wagner's law in the Indian Subnational context is mostly driven by the high-income major states, and it is more of capital outlay centric. Thus, there is a responsive affiliation between public expenditure and state-level income in both long run and short run. The responsive affiliation between these variables comprehends the effectiveness of public expenditure as fiscal policy instrument in stimulating economic growth, and the contribution of economic growth in the budget exercise at the subnational level.

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