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Unlocking SDG potentials through the synergy of public spending and governance: A district level analysis in Assam

Bhabesh Hazarika *, Ankit Singh

National Institute of Public Finance and Policy (NIPFP), 18/2, Satsang Vihar Marg, Special Institutional Area (Near JNU), New Delhi 110067, India

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ABSTRACT

The Sustainable Development Goals (SDGs) provide a global framework to address critical issues such as poverty, inequality, and climate change by 2030. India has been adopting a localization strategy towards implementing SDGs with Assam emerging as one of pioneer states in articulating localized strategy. Despite its abundant natural resources, Assam faces considerable developmental challenges in health, education, poverty, gender inequalities and others due to limited fiscal capacity. The inter-district variations also raise concerns whether such disparities are due to inadequate resource allocation or underlying governance issues, or both? Based on district level data, the present paper analyses the intricate interplay between public spending and governance quality in shaping SDG outcomes specially in the social sector. Such understanding is crucial as districts are the implementing unit when it comes to public spending. Regression results show that a 1% increase in per capita social-sector spending raises the social-sector SDG index by about 8.2%. The positive and significant interaction with governance quality (elasticity = 0.075) indicates that districts with stronger institutions achieve substantially higher SDG gains from public expenditure. This study advances the existing literature by providing sub-national evidence on the nexus between public spending, governance quality, and SDG outcomes at the district level in Assam, India. By analyzing the uneven distribution and effectiveness of public expenditure in critical sectors, it contributes to understanding the institutional and fiscal drivers of inter-district disparities in SDG achievements and underscores the need for a dual strategy of equitable financing and governance reform to accelerate progress.

Introduction

The Sustainable Development Goals (SDGs), introduced by the United Nations in 2015, provide a global framework to address critical issues such as poverty, inequality, and climate change by 2030. India, as one of the signatories to this global agenda, has embraced a strategy of localizing the SDGs, recognizing the vast geographic and demographic diversities among its states, each presenting unique issues, needs, and resource availability. While the central government spearheads initiatives and offers incentives to facilitate this localization process, realizing the SDGs hinges on commitment and proactive actions of local governments and administrations. Assam, situated in the northeastern parts of India, has emerged as a proactive participant in localizing sustainable development efforts. This engagement is evidenced by formulating SDG-aligned vision documents, adopting tailored State Indicator Frameworks, and establishing SDG cells and keen institutional structures [1].

Despite its abundant natural resources, Assam faces considerable developmental challenges due to limited fiscal capacity and pronounced internal disparities [2], which hinder the effective integration of SDGs into state planning and budgeting processes. The Central Government of

* Corresponding author.
E-mail address: bhabesh.hazarika@nipfp.org.in (B. Hazarika).

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India has attempted to mitigate these challenges by implementing favourable funding mechanisms and mandating specific budgetary allocations.[1] At the same time, the state has also been making efforts to augment own resources and allocate more resources towards development priorities. The adoption of outcome-based budgeting by the Government of Assam in recent years is intended to enhance decision-making by focusing on measurable results rather than traditional input-driven methods.[2] Despite these efforts, the state continues to lag in critical sectors such as poverty, health, education, and infrastructure, with significant disparities across its districts. For example, the state stands 3rd in maternal mortality ratio, 2nd in infant mortality rate, and 6th highest in poverty head count ratio among the Indian states [3,4]. There are considerable variations in development levels among districts, indicating a need for a deeper analysis of factors influencing SDG achievements at the local level. The recent Northeastern Region (NER) District SDG Index Report and Dashboard 2021–22 reveal that there has been a notable disparity in SDG achievement across the districts in the state [5]. Along with the size of budgetary allocation, the efficiency of public spending matters where the quality of governance plays the most critical role, and it is more vital to a State like Assam, which faces a weak fiscal space. This raises important questions about the effectiveness of current strategies: Are these disparities due to inadequate resource allocation, underlying governance issues, or both?

Against the above backdrop, the present study explores the intricate interplay between public spending and governance quality in shaping SDG outcomes at the district level. This is crucial as the district is the implementing unit when it comes to social sector spending. The focus is examining how variations in public expenditure, specifically derived from critical areas such as affordable housing, rural employment, social security, and health, affect social sector SDG achievements across districts in Assam.

To the best of our knowledge, this is the first of its kind of study that tries to analyze the linkage between public spending and governance with the SDGs at the district level. Literature on governance in the Indian context is scanty, largely concentrated on a state level, and primarily looking at it as outcome indicators [7–10]. These studies mainly focused on ranking the states with respect to governance and development outcomes. The work of Bhanumurthy et al. [11] is one of the kinds that attempted to establish a causal association between governance parameters and MDG outcomes. However, the aspects of good governance at the district level explaining the regional disparity in SGD achievement are missing in the literature.

This study advances the existing literature by providing subnational evidence on the nexus between social sector public spending, governance quality, and SDG outcomes at the district level in Assam, India. By examining the uneven distribution and differential effectiveness of public expenditure across districts, the present study addresses a critical gap in understanding the institutional and fiscal factors that drive inter-district disparities in SDG achievements. Focusing on Assam, a state marked by limited fiscal capacity, persistent social sector challenges, and sharp developmental inequalities, offers a unique empirical setting to investigate how governance quality conditions the effectiveness of public spending in achieving SDG targets. In doing so, the study contributes to broader debates on the role of governance as a multiplier of fiscal effectiveness and extends the empirical literature on SDG localization within developing-country contexts.

Literature review

Public spending for SDG achievement

To meet the Sustainable Development Goals (SDGs) by 2030, unprecedented investments from both public and private sectors are essential, with annual costs projected to be in the trillions [12]. Global estimates suggest that SDG-related infrastructure alone requires between USD 5 to USD 7 trillion annually, while developing countries need between USD 3.3 and USD 4.5 trillion but a shortfall of USD 1.9 to USD 3.1 trillion [13,14]. Disaggregating these figures, the IMF [23] estimates that low-and-medium income countries will require an 0.5 trillion annually while emerging economies face gap of USD 2.1 trillion annually. In relative terms, this translates to financing needs equivalent to about 4 % of gross domestic product (GDP) for the emerging economies with significant regional variations [14]. For example, Vietnam's needs are similar to those of emerging countries, while nations like Rwanda and Benin face more significant financial gaps [13]. Additional challenges, such as climate change and biodiversity conservation, further heighten these financial requirements [15,16].

Given these financing challenges, the role of governments appears central, as public spending, typically 15 % to 30 % of GDP, remains the primary instrument for mobilizing and directing resources towards SDG priorities [17]. Public spending is particularly critical for advancing social sector goals such as health, education, and sanitation where private financing often remain inadequate. While external development assistance and private sector investment are important, the ability of governments to allocate and use public spending efficiently is crucial in bridging financing gaps.

Government interventions that prioritize pro-poor support, responsiveness to local issues, and community engagement are critical for addressing specific needs. Research consistently emphasizes the importance of increased public spending in advancing SDGs [18–21]. Akenroye et al. [18] stress that effective policy prioritization and efficient budget utilization, while Mate et al. [22] show that centrally sponsored schemes in India positively impacted SDG outcomes. At local level, Sisto et al. [23] observed a positive correlation between budgetary provisions and SDG targets in Spain and Tyagi et al. [24] demonstrated that public investment in education and skills reduces gender inequalities in India. However, the impact of government spending on SDG outcomes remains mixed. Osuji and Nwani [25] found that increased spending can reduce poverty in the short term but exacerbate it over the long term. Similarly, Ochinyabo [26] highlighted Nigeria's SDGs progression is hindered by corruption, weak governance, and economic volatility calling for reforms to strengthen governance, enhance environmental investments, and combat corruption.

Guerrero and Castaneda [27] argue that development gaps will persist despite increased public spending by 2030. Their simulations suggest that while a 50 % increase in per capita expenditure reduces the SDG gap, such measures alone are insufficient. This underscores the need for not only increasing spending but also more efficient allocation and improved expenditure quality [28–30]. The Finance Commission of India likewise stresses on enhancing quality of public expenditure to improve developmental outcomes [31].

Governance for sustainabledevelopment

The relationship between economic growth and government effectiveness is a prominent topic in academic discourse, with considerable evidence suggesting that governance quality significantly influences development outcomes [32,33]. Effective governance generally

[1] Assam being a special category state, receives a 90:10 funding ratio for central assistance, wherein the Central Government of India bears 90% of the funding burden, and states contribute the remaining 10%. Additionally, each Central Department/Ministry is directed to allocate 10% of its Gross Budgetary Resources (GBS) towards schemes explicitly targeting the development of the Northeastern region.

[2] The state of Assam has seen considerable growth in overall public spending. The government budget has increased from INR 29,122 crore in 2011-12 to 1,02,778 crore in 2023-24 [6] but uneven across the sectors of the economy. The share of social services in the total expenditure has reduced from 39.93% in 2011-12 to 35.21% in 2021-22 [2]. It is evident that per capita spending on the social sector in Assam was lower in 2015-16 than the all-state average spending on the social sector [7].

promotes economic growth, but the reverse whether growth improves governance is less precise [32]. Some theories argue that entrenched interest groups can maintain power that is detrimental to governance while achieving economic expansion. For instance, despite limited democratic governance and rule of law, China achieved notable economic growth in the 1970s and 1980s. Conversely, it is argued that democratic governments might hinder growth by diverting resources from investment to consumption [34]. Nevertheless, democracies are often seen as better suited for sustainable growth, as evidenced by the experiences of the United States and India [35–37].

Governance quality is crucial for development as it impacts economic performance and social progress [38]. Corruption, lack of transparency, accountability deficits, legal irregularities, and political manipulation hinder effective governance. Poor governance mainly affects vulnerable populations, exacerbating challenges like bureaucratic inefficiency, corruption, insecure property rights, and weak financial management [39]. In contrast, improvements in governance could substantially increase per capita income over time [40,41]. Cooray [41] found a strong correlation between GDP per capita and governance quality in less affluent nations. Khan [42] critiques market-driven approaches to governance, advocating instead for targeted institutional support to strengthen state-led growth strategies.

Development agencies increasingly view good governance as central to achieving developmental outcomes [43]. In countries with weak governance including high corruption often result in misallocated funds, undermining productive investments [44,45] whereas stronger governance can significantly enhance development outcomes by strengthening revenue collection and public spending. Globally, effective governance is now essential for advancing sustainable development [46–49]. It encompasses planning and consistent efforts to meet SDGs targets, requiring active participation from state and non-state actors [50]. However, despite this centrality, governance mechanisms often fail to drive significant developmental progress [51]. Meadowcroft [52] describes sustainability governance should be understood as sociopolitical processes involving deliberate interventions rather than relying on spontaneous social change. In this sense, governance for SDGs extends beyond administrative efficiency to encompass normative and prescriptive approaches that addresses both economic and social dimensions of sustainable development [53,54].

Studies indicate that good governance positively correlates with sustainable development [55], while corruption hampers it [56]. Effective governance, characterized by transparent policies and accountability, is essential for sustainable development. However, inefficiencies in public spending due to corruption and mismanagement undermine development outcomes [55,56]. Improving public expenditure efficiency is crucial for SDG achievement, with governance playing a central role [11,28,63]. Effective governance optimizes public spending, particularly in health, to achieve development goals and reduce poverty [44]. Ensuring alignment between aid allocation and SDG priorities, alongside fostering stable global conditions, is essential for sustainable growth and SDG attainment.

Public spendingand governanceinteractionfor developmentoutcomes

Literature documented that public spending on SDG-related interventions is often not optimally distributed with considerable heterogeneity in SDG outcomes across countries [28]. The efficiency and effectiveness of such spending depend critically on the governance quality and several studies demonstrate strong links between governance, public spending, and development outcomes [11,44,55]. Governance mechanisms exert both direct and indirect effects on development outcomes such as health, education, and poverty [57–60]. Makuta and O'Hare [60] demonstrated that with same level of public health spending is nearly twice as effective in reducing under-five mortality and improving life expectancy in better-governed countries compared to poorly governed ones. Improved governance thus enhances resource allocation, making the positive effects of public spending far more pronounced.

Several studies further highlight the mediating role of governance in analyzing the relationship between public spending and developmental outcomes such as health. Public health spending has a more significant impact in reducing child mortality where corruption is lower and institutional governance is stronger [61–63], while poor governance leads to resource leakage limiting the policy effectiveness [44]. Likewise, education spending reduces primary school failure rates in well-governed countries but has little effect in contexts with weaker governance [44]. These insights underscore the critical role of good governance in ensuring that public spending translate into tangible improvements in human development.

Beyond the social sectors, governance also shapes broader macroeconomic outcomes. d'Agostino et al. [64] demonstrate that corruption exacerbated the detrimental effects of military spending on economic performance. Therefore, anti-corruption measures and regional security agreements could directly enhance economic growth. In a similar line, Fournier and Johansson [65] highlighted that oversized governments can stifle potential growth unless governed effectively.

Data and methodology

Data

The present study uses secondary data encompassing a range of documents such as government annual reports, statistical reports, and factsheets, which are available in the public domain [2,3,5,6,66–69]. The computation of the social sector SDGs and governance indices necessitates extensive data covering diverse aspects at the district level. The selection of indicators in the present study is guided district level data availability. Wherever possible, the most recent estimates, surveys, or departmental records are used. In the absence of such updated information, data from the Census of India 2011 and population projection have been considered.[3] While Assam consists of 35 districts, given the paucity of data, the present study could consider 27 districts in the present analysis.

Quantitative measurementof SDGs, spending,and governance

For the computation of SDG scores for the social sector at the district level, the present study largely follows an input-output-outcome-oriented framework, especially regarding SDGs indicators considered [65,70). Given the data limitation on public spending on several aspects at the district level, the present study focuses on SDGs, governance, and public spending variables in the social sector only. Out of the 17 SDGs, the analysis focuses on seven social sector–relevant goals: SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), SDG 5 (Gender Equality), SDG 10 (Reduced Inequalities), and SDG 16 (Peace, Justice, and Strong Institutions).

Within these goals, the present study considers 51 indicators to compute the composite social sector SDG score [listed in supplementary file 1]. These indicators have been initially normalized into a standard scale of 0 to 100 to ensure comparability among the indicators with diverse units of measurement following the goalpost-based methodology adopted by UNDP in the Human Development Reports (71). For indicators where higher values mean a better performance, the following formula is used:

$$x' = \frac{x - \min(x)}{T(x) - \min(x)} \times 100$$

[3] The sources of various data are listed in supplementary file.

Where x is the raw value; min(x) is the minimum observed value of the indicators in the data series; T(x) is the targeted value of the indicator[4] and x' is the normalized value. The use of (x) rather than max(x) ensures that a normalized score of 100 consistently reflects achievement of the policy or SDG target, rather than the maximum observed value, which may be either below or above the intended goal. Similarly, for indicators where the higher values imply lower performances, the following formula is used:

$$x' = 1 - \frac{x - T(x)}{max(x) - T(x)} \times 100$$

Where max(x) is the maximum observed value of the indicators in the data series and the rest are as mentioned above. In the normalized range (0 to 100), 0 indicates the lowest performance and 100 suggests that the target has been achieved. The social sector sustainability index is computed using the formula given below:

$$SSSDG_i(N_i,\ I_{ik}) = \sum_{k=1}^{N_i} \frac{1}{N} I_{ik}$$

Here, $SSSDG_i$ is the social sector SDG score of the district i, N_i is the number of indicators for district i, and I_{ik} is the normalized value of the district i of indicator k. It should be noted that while computing, the indicators have been given equal weights.[5] In a similar fashion, the social sector governance quality index, which is one of the independent variables of interest, is constructed using 30 indicators covering several aspect including public health, judiciary and public safety, welfare and development, resource and development, women empowerment, economic governance, and agriculture and allied sector [listed in supplementary file 1].

Empirical framework for estimating spending–governance effects on SDGs

The main focus of the present study is to understand the impact of public spending and social sector governance. Per capita public spending reflects the financial resources allocated per individual within a district, providing a measure of the intensity of public expenditure. Similarly, the social sector governance is captured through an index value representing the quality of governance in the social sector, which is crucial for understanding how effectively these financial resources are utilized. Both variables are transformed using the natural logarithm to normalize their distributions, facilitating a more robust and meaningful analysis. Additionally, the study includes an interaction term between public spending and governance quality to explore how governance mediates the effectiveness of public spending on SDG achievements. This interaction term is critical for understanding whether the impact of public spending on sustainable development is amplified or diminished by varying levels of governance quality across districts in Assam.

In this study, we draw on the empirical frameworks of Rajkumar and Swaroop [44] and Bhanumurthy et al. [11], both of which emphasize the interaction between public spending, governance quality, and development outcomes. Rajkumar and Swaroop [44] show at the cross-country level that the effectiveness of public expenditure depends on governance, with accountability and transparency shaping how resources translate into outcomes. Bhanumurthy et al. [11] extend this perspective to India, examining fiscal transfers and governance and their joint influence on development, including district-level MDG outcomes in Madhya Pradesh. Building on these approaches, our study applies the framework to the district level in Assam, with a focus on multiple SDG indicators. We hypothesize that stronger governance—reflected in greater accountability, transparency, and administrative capacity—enhances the positive impact of spending on SDG outcomes, while weak governance dampens or offsets these effects. Compared to Rajkumar and Swaroop [44], who analyze governance–spending dynamics at the cross-country level, our study situates the analysis within a single state, capturing subnational heterogeneity. In contrast to Bhanumurthy et al. [11], whose district-level study in Madhya Pradesh is limited to MDG outcomes and a narrower set of indicators, our analysis explicitly integrates a governance index and a broader range of SDG indicators, thereby offering a more comprehensive assessment of how governance conditions the effectiveness of social sector spending.

Following Rajkumar and Swaroop [44] and Bhanumurthy et al. [11], the causal relationship between public spending, level of governance, and SDGs at the district level will be estimated using a linear regression model as specified below.

$$SSSDG_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{1i} X_{2i} + \delta Z + \varepsilon_i$$

Where, $SSSGD_i$ is the Social Sector Sustainable Development Goal (SSSDG) outcome i, X_{1i} is the per-capita public spending (PCPS) of the district on Social Sector, X_{2i} is the social governance index (SGI), and $X_{1i}X_{2i}$ is the interaction term of per-capita public spending and social governance index, $\beta_0,\ \beta_1,\ \beta_2,\ and\ \beta_3$ are the estimated coefficients of the SSSDG, PCPS, SGI, and the interaction terms, Z is the vector of controlled covariates, δ is the vector of coefficients of the controlled covariates, and ε_i is the error term. All variables are used with the natural logarithm transformed forms, allowing us to elucidate the relative elasticities of each factor in achieving sustainable development outcomes while controlling for a set of district-specific variables. The description and the measurement of the variables are given in Table 1.

The covariates included in the regression model are essential for capturing socio-economic, demographic, environmental, and infrastructural factors that influence sustainable development outcomes at the district level. Larger populations affect demand for social services,

Table 1
Description and measurement of the variables considered in the regression model.

Variable	Description	Measurement
Dependent Variable		
Social Group SDG Index	Index value of social sector SDGs of the district	Natural logarithm of index value
Covariables		
Per Capita Social Sector Public Spending	Per capita public spending of the district in Social Sector	Centered value of natural logarithm of per-capita social sector public spending
Social Sector Governance	Index value of social sector governance of the district	Centered value of natural log of index value
Control Variables		
Population	Population size of the district	Natural logarithm of population
Gender Parity in Enrolment	Gender Parity in Enrolment in High School and above of the district	Natural logarithm of gender parity value
Per Capita Income	Per capita income of the district	Natural logarithm of per-capita income
Rainfall	Annual rainfall in the district (2019–20)	Natural logarithm of annual rainfall
Presence of Highway	Length of Highways in the districts	Natural logarithm of length of highways
Loss of Crop due to natural calamities	ratio of crop lost area of cultivation due to natural calamities to total cultivation area	Natural logarithm of the ratio
Population Density	Population Density 2019–20	Natural logarithm of the population density

Source: Authors' compilation based on literature.

[4] The target value of each indicator is taken from NITI Aayog [5].

[5] Given the scope and degree of heterogeneity of the covered sustainability goals, the question of the criteria's applicability is complicated. As a result, it is difficult to predict how the market will perform in the future. Prioritizing one indicator over another is seen as undesirable because all of these indicators work together to holistically point towards sustainability.

infrastructure, and resources, and districts with bigger populations often display unique social and economic dynamics that can influence SDG performance independently of governance and spending. Empirical analyses of Indian districts confirm that population size correlates with variations in health, education, and poverty reduction outcomes across regions [21,71]. Including population thus controls for scale effects and heterogeneity in development pathways.

Gender parity in education is another critical factor for sustainable development. Higher parity in enrolment at secondary and higher levels signals equality in opportunities, which is strongly linked not only to education and gender equality but also to wider growth and inclusion. Studies of India's SDG progress show that districts with higher gender parity consistently perform better on composite SDG indices and socio-economic indicators, highlighting its importance as a control [72,73].

Per capita income acts as a proxy for district economic well-being. Higher incomes typically improve access to resources, raise living standards, and increase the ability to invest in sustainable development. Research shows a positive and significant relationship between per capita income and outcomes in health, education, and poverty alleviation [74–76]. Including this variable helps situate governance and fiscal capacity within the broader economic context. Rainfall is an exogenous factor that shapes agricultural productivity, water availability, and climate resilience. Stable and adequate rainfall supports SDG performance, while deficits or variability are associated with setbacks in food security and related outcomes [77,78]. Including rainfall ensures the model accounts for natural environmental variability across districts.

Infrastructure, particularly highways, is fundamental for connectivity, trade, and service delivery. Better road networks are consistently associated with stronger economic and social outcomes in developing contexts. Studies show that improved transportation infrastructure facilitates growth and human development [79,80]. Highway length thus serves as a proxy for physical accessibility and structural capacity. Natural calamities disrupt agriculture, economic stability, and welfare, with lasting effects on poverty and food security. Including crop loss due to calamities accounts for district vulnerability to shocks. Prior evidence highlights that resilience and disaster preparedness policies are essential to maintaining development trajectories [81,82].

Finally, population density captures demographic concentration effects. High-density districts face challenges of congestion and resource strain, while low-density areas often struggle with access and service provision. Empirical studies show density exerts significant nonlinear influences on outcomes in health, education, and environmental sustainability [83,84]. Including density allows the model to reflect spatial-demographic pressures on SDG achievements. Together, these controls provide a balanced framework to capture district-level heterogeneity, ensuring that estimates of governance and spending effects on SDG outcomes are robust and policy-relevant.

Results and discussions

Level of publicspending

As discussed in the methodology, given the paucity of district level data, the social sector public spending is proxied through public spending on four critical areas, namely affordable housing (PMAY), rural jobs (MGNREGA), social security (NSAP), and health (NHM). Table 2 provides public spending across the districts of Assam for 2019–20 and 2020–21 and reveals substantial regional disparities in social sector spending. Between 2019–20 and 2020–21, the average allocations under the Pradhan Mantri Awas Yojana (PMAY) at district level fell sharply from INR 662 million to INR 396 million, with some district such as Baksa experienced steep while others like Barpeta recorded significant. In contrast, spending under Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) increased on average from INR 401 million to INR 644 million, reflecting an overall expansion in rural employment support.

The spending under National Social Assistance Programme (NSAP) nearly doubled, while public spending under National Health Mission

Table 2
Public spending in selected component of social sector spending (in INR million).

INR in Lakh	PMAY		MGNREGA		NSAP		Health		Total	
District	2019–20	2020–21	2019–20	2020–21	2019–20	2020–21	2019–20	2020–21	2019–20	2020–21
Baksa	543	282	471	407	80	169	63	131	1156	989
Barpeta	586	880	651	1130	67	147	112	261	1417	2417
Bongaigaon	221	250	148	359	45	97	59	122	473	828
Cachar	1306	437	841	1237	98	206	142	289	2387	2168
Chirang	333	155	455	375	26	57	43	83	857	670
Darrang	585	477	229	708	57	123	76	158	946	1466
Dhemaji	911	261	531	936	52	108	65	127	1558	1432
Dhubri	657	1037	616	1338	90	219	117	280	1480	2874
Dibrugarh	1137	390	324	586	72	152	132	255	1665	1384
Dima Hasao	313	71	57	167	13	24	50	56	433	318
Goalpara	482	466	140	407	71	158	92	207	785	1239
Golaghat	899	507	293	467	69	144	90	164	1350	1281
Hailakandi	236	210	166	596	56	113	63	129	520	1048
Jorhat	287	87	183	297	91	179	105	204	665	766
Kamrup (Rural)	1024	567	445	982	192	332	135	248	1796	2130
Kamrup (Metro)	105	12	27	29	24	48	94	254	251	343
Karbi Anglong	409	204	257	648	30	68	89	163	785	1083
Karimganj	981	351	519	944	67	147	92	194	1659	1637
Kokrajhar	711	459	461	510	79	165	76	162	1326	1295
Lakhimpur	942	294	964	1096	84	174	80	177	2069	1741
Morigaon	453	787	366	718	87	183	63	143	969	1831
Nagaon	1677	1071	631	1049	173	357	198	396	2678	2873
Nalbari	315	338	523	890	99	202	77	127	1014	1557
Sivasagar	283	66	120	195	67	140	101	177	571	577
Sonitpur	871	450	519	629	86	177	136	276	1613	1531
Tinsukia	1090	412	168	441	80	168	107	203	1445	1225
Udalguri	524	187	733	251	54	124	71	134	1382	696
All Districts	**17,879**	**10,706**	**10,836**	**17,389**	**2008**	**4180**	**2525**	**5120**	**33,248**	**37,395**
Mean	**662**	**397**	**401**	**644**	**74**	**155**	**94**	**190**	**1231**	**1385**
CV	**58.01**	**70.19**	**60.86**	**54.83**	**51.87**	**47.27**	**36.63**	**39.12**	**48.93**	**49.24**

Source: Statistical Handbook of Assam and NHM.

(NHM) grew modestly from INR 1280 million to INR 1410 million indicating gradual increase in the health sector financing. As indicated by the coefficient of variation (CV) values Persistently high variation in PMAY allocations contributed disproportionately to overall disparities in district-level spending, while the distribution of MGNREGA, NSAP, and NHM allocations became more uniform, suggesting a gradual move toward greater equity in rural employment, social protection, and health financing.

The disparities in social sector SDGs achievements and governance quality across districts in the state are evident from Table 3. While there is relatively lower disparity among districts in SDG performance, the governance quality reveals greater variability across the districts. Districts like Nalbari and Goalpara, rank high in SDG scores but markedly different governance rankings, indicating that strong SDG performance does not always correspond with equally strong governance. Conversely, districts with both low SDGs and governance scores such as Karimganj and Kokrajhar, exhibit how poorer governance quality tends to constrain the development outcomes. At the same time, districts with better governance, like Sivasagar are likely to manage resources more effectively and able to perform better in SDG scores.

Fig. 1 illustrates the association between per capita public spending and Governance Index in social sector across districts. The downward trend suggests that higher spending is not necessarily associated with better governance, in fact, districts with relatively higher per capita allocations often display weaker governance performance. This pattern implies possible inefficiencies or challenges in translating financial resources into effective governance outcomes. At the same time, the dispersion of data points indicates that increased spending is not the sole factor: several low spending districts achieve relatively high governance scores due to other factors, such as administrative efficiency, policy reforms, and local leadership, while certain high spending districts exhibit weaker governance level, suggesting inefficiencies in translating financial resources into outcomes.

Table 3
Levels of social sector SDG achievements and governance quality across districts.

Sl. No.	Districts	SDG Score	Rank	Governance Score	Rank
1	Baksa	56.00	26	58.06	17
2	Barpeta	62.24	6	59.19	16
3	Bongaigaon	58.51	18	63.24	5
4	Cachar	59.37	16	53.72	24
5	Chirang	57.46	21	62.99	7
6	Darrang	61.69	8	53.37	25
7	Dhemaji	60.84	12	55.63	23
8	Dhubri	57.22	23	55.94	21
9	Dibrugarh	62.88	4	62.49	8
10	Dima Hasao	56.42	25	59.69	14
11	East Karbi Anglong	57.35	22	66.03	2
12	Goalpara	63.08	2	63.89	4
13	Golaghat	60.96	10	65.57	3
14	Hailakandi	56.92	24	48.89	28
15	Jorhat	59.63	14	61.65	11
16	Kamrup Metropolitan	62.32	5	62.30	9
17	Kamrup Rural	60.59	13	61.90	10
18	Karimganj	59.20	17	51.48	26
19	Kokrajhar	55.90	27	50.60	27
20	Lakhimpur	62.10	7	63.02	6
21	Morigaon	62.90	3	60.52	12
22	Nagaon	60.94	11	59.36	15
23	Nalbari	64.12	1	60.13	13
24	Sivasagar	59.43	15	67.85	1
25	Sonitpur	61.22	9	57.28	19
26	Tinsukia	57.82	19	56.72	20
27	Udalguri	57.74	20	55.89	22
	Mean All Districts	59.81		59.16	
	SD	2.43		4.86	
	CV	4.07		8.22	

Source: Authors' Calculations.

Similarly, Fig. 2 reveals a slightly positive slope, suggesting that districts with better governance in social sectors such as health, education, and social protection tend to have higher SDG achievement scores in social sector. This relationship indicates that effective governance in social sectors, which includes efficient service delivery, equitable resource allocation, and proactive policy measures, can positively influence the achievement of SDGs related to social equity and wellbeing.

Summary statistics

Table 4 provide summary statistics of the key variables involved in analyzing the impact of public spending, governance, and SDG achievement at the district level in Assam. The variable of interest, the Social Group SDG Index, has a mean of 59.81 with a standard deviation of 2.43, indicating relatively low variability around the mean. The minimum and maximum values for this index are 55.90 and 64.12, respectively, reflecting a moderate range in SDG achievement scores among the districts.

Meanwhile, the Social Sector Governance scores display a greater variability with a range from 34.82 to 78.68, indicating significant differences in governance quality across districts. Per Capita Public Spending also shows notable variation around a mean of Rs. 521.77. Accordingly, the interaction term between the public spending and governance indicates plausible varying degrees of combined effects on the social sector SDG Index.

Looking at the control variables, both the population size and gender parity in enrolment in high school education and above at the district level (in natural log scale) reveals considerable variation across the sample districts. The per capita income (natural log scale) has a mean of 10.98 and a standard deviation of 0.597, suggesting income differences among districts. Rainfall averages 7.719 (natural log scale) with low variability and differences in infrastructure presence reflected in highway length.

Loss of crops due to natural calamities also indicate a considerable variation in agricultural vulnerability. Population Density with a range from 3.784 to 7.180, reflecting different population concentrations in some districts than others. These statistics provide a detailed landscape of the various factors potentially influencing the Social Group SDG Index across the districts in Assam.

Impact of publicspendingon SDG achievementsat the districtlevelin Assam

Table 5 presents a sequence of hierarchical linear regression models, designed to progressively analyse how public spending, governance quality, and their interaction shape the social sector SDG level at the district level. This approach enables both a granular assessment of variable of interest and an understanding of how explanatory power evolves as additional covariates. Model 1 and Model 2 provides the empirical baseline estimate of the bivariate causal relationship of public spending and governance level with social sector SDGs achievement, respectively. These initial models isolate the stand-alone influence of each key predictor, providing a diagnostic benchmark against which more complex specifications can be evaluated.

Model 3 and Model 4 extend the models by incorporating a set of controlled covariates indicating robustness of the baseline estimates addressing the potential omitted-variable bias and assessing whether governance or spending retains explanatory power. Model 5 introduces the interaction between governance quality and public spending, thereby engaging directly with the theoretical proposition that governance conditions the effectiveness of public spending. It allows for an assessment of whether stronger institutional capacity enhances the marginal returns to public expenditure, a question of substantive importance for state-level resource allocation and institutional strengthening.

From Models 1 to 5, where the coefficients are expressed as elasticities. In the baseline specifications, governance (Model 1) and public

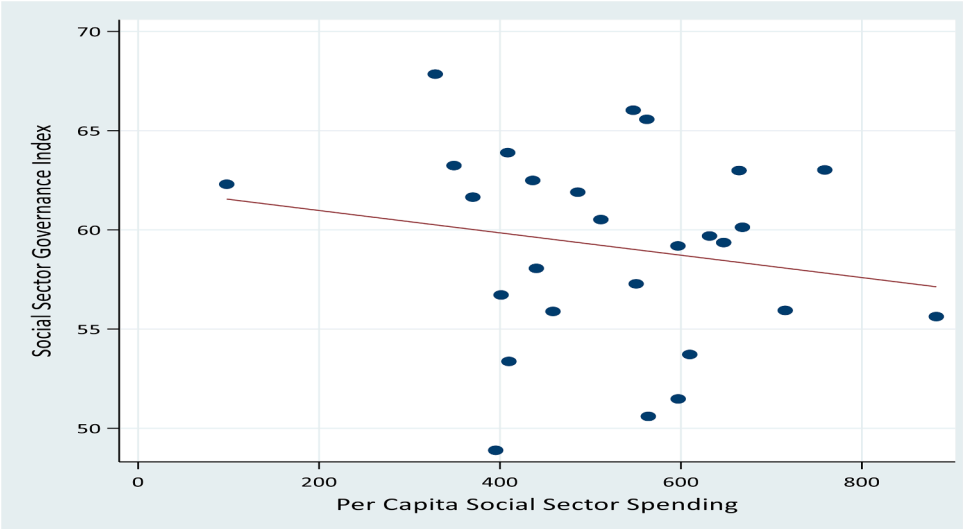

Fig. 1. Public spending and social sector governance across districts in Assam.
Source: Authors' estimates.

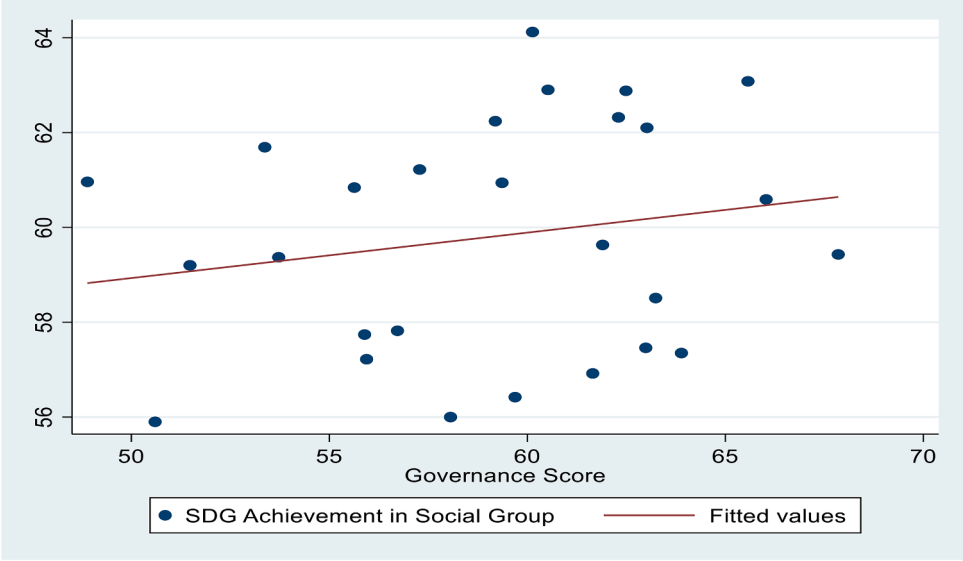

Fig. 2. Social sector governance and social group SDGs achievement across districts in Assam.
Source: Authors' estimates.

spending (Model 2) do not exhibit statistically significant effects on SDG outcomes, suggesting that neither variable on its own is sufficient to explain cross-district variation. Once district-level covariates are introduced, governance turns positive in Model 3, though the effect remains insignificant, indicating sensitivity to contextual factors but limited independent explanatory power. By contrast, public spending in Model 4 becomes positive and statistically significant at the 1 % level, highlighting the importance of controlling for socio-economic heterogeneity in uncovering its impact. Model 5 introduces the interaction between governance and public spending, which yields a positive and statistically significant coefficient, consistent with the hypothesis that governance enhances the marginal effectiveness of fiscal allocations. These results underscore that while spending alone matters only in the presence of controls, its developmental impact is substantially magnified when coupled with stronger governance institutions.

Model 6 syntheses public spending, governance level, the interaction term, and control variables, offering the most comprehensive specification. As such, it provides the definitive test of the theoretical framework and forms the primary basis for empirical interpretation and policy inference. The significant F-value of Model 6 indicates joint significance of the predictors while the R^2 value (0.517) shows that more than half of the variance in social sector SDG is explained. The RMSE (0.022) suggests that the model exhibits a reasonably high level of predictive accuracy, given the scale of the dependent variable.

The estimated coefficient of governance quality (−0.008) is small, negative, and statistically in significant indicating governance alone does not independently drive improvements in district-level SDG outcomes holding other covariates constant One plausible interpretation is that governance, while necessary to create an enabling institutional environment, requires complementary fiscal resources to yield tangible developmental gains; institutional reforms, in isolation, may not translate into measurable SDG progress without adequate financial support. In contrast, the positive and statistically significant coefficient for public spending reveals that the social sector SDG index tends to increase by 8.2 percent with a one percent increase in the per capita public spending. Compared with Model 4, this effect much larger reinforcing that the

Table 4
Summary statistics of the variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
Social Group SDG Index	27	59.809	2.434	55.900	64.120
Per Capita Social Sector Public Spending	27	521.775	159.591	97.920	882.270
Social Sector Governance	27	64.315	10.499	34.820	78.680
Ln (Social Group SDG index)	27	0.598	0.024	0.559	0.641
Centerd value ln (Social sector governance index)	27	0.000	0.190	−0.598	0.217
Centered value ln (Per capita public spending)	27	0.000	0.408	−1.611	0.588
Interaction term between centered values governance and public spending	27	0.040	0.153	−0.028	0.790
Population	27	13.983	0.411	12.602	14.578
Gender Parity in Enrolment	27	0.015	0.083	−0.113	0.168
Per Capita Income	27	10.979	0.597	9.644	12.158
Rainfall	27	7.719	0.283	7.163	8.198
Presence of Highway	27	4.350	0.673	2.941	5.315
Loss of Crop due to natural calamities	27	1.892	0.519	0.829	2.828
Population Density	27	6.030	0.683	3.784	7.180

Source: Authors' calculations.

inclusion of institutional interactions and controls for district heterogeneity strengthens the observed fiscal effect.

The coefficient of the interaction between public spending and governance quality (0.075) is found to be positive and significant, providing empirical support for the study's central theoretical proposition: the returns to public spending are amplified in districts with stronger governance. This result shows that the marginal effect of public spending on social sector SDG outcomes rises alongside improvement in the governance quality. From a policy standpoint, the findings underscore the complementarity between financial resources and institutional quality suggesting that public spending is most effective when coupled with robust governance, and that enhancements in one dimension alone are insufficient to realize optimal developmental outcomes.

Fig. 3 illustrates the Average Marginal Effects (AME) of public spending on social sector SDG) across varying levels of governance quality. The horizontal axis represents the governance quality index (centered and logarithmically transformed and ranging from −0.6 to 0.5), while the vertical axis displays the AME of public spending on social sector SDGs, with 95 % confidence interval. The trend observed in the graph is upward, indicating that as governance improves, the developmental returns to public spending on social sector SDGs increase. At weak governance levels the AMEs are near zero suggesting that fiscal resources in isolation fails to translate into meaningful improvements in SDG outcomes. By contrast, at higher levels of governance, the marginal effect rises steadily.

This evidence supports the literature on institutions and development, which shows that the effectiveness of public spending is contingent on the quality of governance [44,85]. Stronger accountability and administrative capacity enhance the productivity of fiscal inputs, while weak institutions dissipate their potential benefits. The figure thus provides subnational evidence of the complementarity between expenditure and institutional quality, with clear policy implications: in fiscally constrained states such as Assam, progress toward the SDGs requires not only higher social sector spending but also parallel governance reforms to strengthen transparency, accountability, and service delivery at the district level.

The inclusion of control variables across Models provides additional insights: Population size does not have a direct impact on SDG outcomes in this context. Gender parity in educational enrolment shows a potential positive influence on SDG outcomes, though statistically insignificant. Higher per capita income could positively affect SDG achievements, while adverse climatic conditions, indicated by the negative and significant coefficient for rainfall, could hinder SDG progress, emphasizing the need for climate resilience. Infrastructure development, suggested by the positive coefficients for the presence of highways, might contribute to better SDG outcomes. Crop loss due to natural calamities shows a negative impact, although statistically insignificant, pointing towards the adverse effects of natural calamities on development outcomes. Higher population density might be associated with better SDG outcomes, possibly due to more concentrated efforts in densely populated areas.

The findings of the study reveal that governance alone does not have a statistically significant impact on SDG outcomes in the districts of Assam. This suggests that the mere presence of governance structures does not substantially influence the achievement of SDGs. This observation is aligned with the initial portion of the graph, where the AME is near zero or negative at lower levels of governance. This finding is evident in the upward trend of the AME in the graph, reflecting that public spending tends to yield more substantial benefits as governance

Table 5
Regression estimates of public spending and governance on SDGs.

Variables	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coef.	RSE	Coef.	RSE	Coef.	RSE	Coef.	RSE	Coef.	RSE	Coef.	RSE
Public Spending			−0.002	(0.011)			0.029***	(0.014)	0.023	(0.014)	0.082**	(0.031)
Social Sector Governance	−0.024	(0.018)			0.002	(0.028)			−0.015	(0.024)	−0.008	(0.031)
Public Spending × Governance									0.077**	(0.032)	0.075**	(0.039)
Population					0.006	(0.019)	−0.004	(0.020)			0.003	(0.024)
Gender Parity in Educational Enrolment					0.019	(0.054)	0.041	(0.056)			0.043	(0.059)
Per Capita Income					0.008	(0.010)	0.012	(0.009)			0.012	(0.009)
Rainfall					−0.029	(0.018)	−0.043**	(0.018)			−0.039**	(0.019)
Presence of Highways					0.005	(0.009)	0.011	(0.008)			0.007	(0.009)
Crop Loss due to Natural Calamities					0.003	(0.010)	−0.003	(0.009)			0.004	(0.009)
Population Density					0.013	(0.014)	0.028	(0.017)			0.019	(0.019)
Constant	0.598***	(0.005)	0.598***	(0.005)	0.542	(0.334)	0.635*	(0.330)	0.595***	(0.005)	0.565	(0.390)
F-value	1.890		0.040		2.100		3.880		8.480		7.750	
P-value	0.182		0.843		0.091		0.008		0.001		0.001	
R-squared	0.035		0.001		0.297		0.425		0.132		0.517	
Adjusted R-squared	0.003		0.039		0.015		0.170		0.018		0.214	
RMSE	0.024		0.025		0.025		0.022		0.024		0.022	

Source: Authors' Calculation.
Note: Figures in the parenthesis represents robust standard error. ***, **, and * represents significant levels at 1 %, 5 % and 10 % respectively.

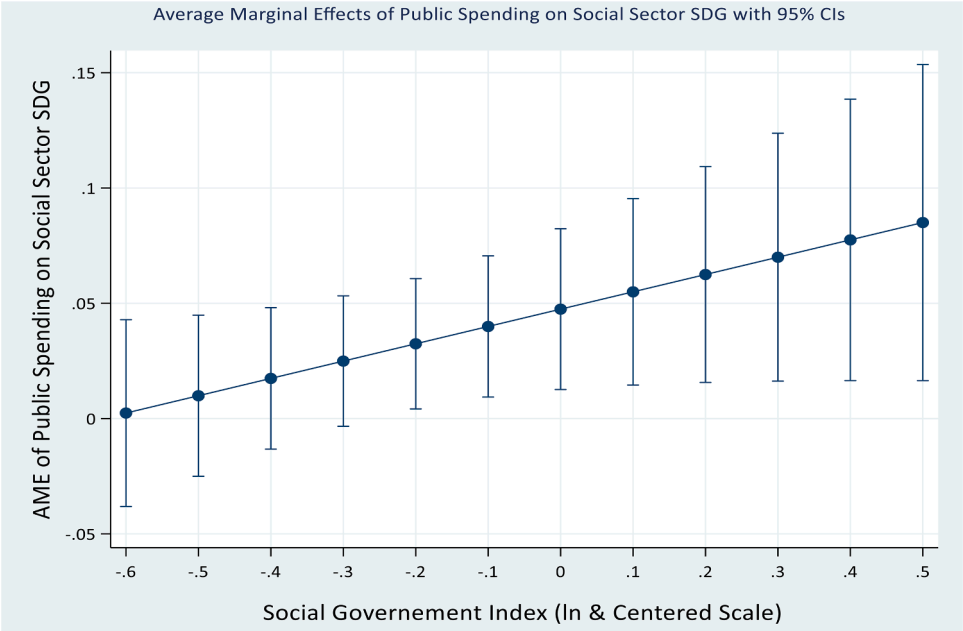

Fig. 3. Average marginal effects of public spending on social sector SDG with 95 % confidence intervals.

improves. These results corroborate existing literature, which posits that governance, while essential, requires effective implementation and support systems to influence development outcomes significantly.

Discussion

The present study focuses on social sector, examining how public spending and governance quality interact to shape social sector sustainable development goals (SDGs) in the districts of Assam. The findings reveal that while public spending in health, education, and other social services is a necessary condition for advancing outcomes, it alone is not sufficient to secure sustained improvements with complementary institutional support. This observation aligns with existing literature, underscoring the importance of public expenditure in critical social sectors such. For example, research by Makuta and O'Hare [60] demonstrates that increased public health spending significantly reduces under-five mortality and improves life expectancy, but only in contexts where the governance quality is high. This trend is reflected in Assam, where targeted investments in certain districts have shown beneficial outcomes, though these gains remain uneven.

A significant finding of this study is the positive impact of the interaction between public spending and governance quality. This implies that the quality of governance substantially influences the effectiveness of public spending and conditions whether the fiscal resources translate into measurable developmental progress. This finding corroborates earlier studies by Hu and Mendoza [62], Rajkumar and Swaroop [44], and Mohanty and Bhanumurthy [11], which have shown that public spending yields more substantial benefits in countries with lower levels of corruption and better institutional governance. For instance, districts such as Barpeta and Dhubri, which exhibit relatively higher governance quality, have been able to utilize public funds more effectively, resulting in more pronounced improvements in SDG outcomes. Conversely, districts with lower governance scores, like Darrang, demonstrate less significant progress despite comparable levels of public expenditure.

Rajkumar and Swaroop [44] argue that effective governance significantly enhances the impact of public spending on development outcomes by ensuring transparency, accountability, and efficient resource allocation. In Assam, the variability in governance quality among districts illustrates how governance mechanisms can influence the effectiveness of public expenditure. For instance, while districts like Lakhimpur and Morigaon show considerable progress in social sector outcomes due to better governance, others with less effective governance mechanisms struggle to achieve similar results. This heterogeneity underscores the critical role of local administrative and institutional capacity in determining how fiscal inputs are absorbed and converter into outcomes.

Supporting this perspective, d'Agostino et al. [64] found that reducing corruption enhances the benefits of public spending by minimizing resource leakage and improving efficiency. In Assam, districts with higher governance quality, such as Sonitpur and Golaghat, likely experience better outcomes due to more efficient use of public resources. Fournier and Johansson [65] further emphasize that effective governance reforms can boost economic growth and benefit disadvantaged populations by directing public spending towards areas of greatest need. This resonates with the findings of the present study, indicating that improving governance at the district level in Assam is not simply complementary to fiscal expansion but a necessary precondition for maximizing developmental impact.

These insights have profound policy implications for Assam. The observed positive interaction between public spending and governance quality indicates that achieving the SDGs requires a dual strategy of augmenting social sector expenditure while simultaneously strengthening governance mechanisms. Policymakers should prioritize enhancing transparency, strengthening accountability, and promoting stakeholder participation in governance processes. For instance, districts like Kamrup Metropolitan, with its lower governance quality, would benefit from targeted reforms to improve governance structures and institutional capacities. By strengthening governance frameworks and fostering a culture of accountability, Assam can ensure that public spending translates into meaningful progress in health, education, and overall social sector performance. Such measures will be instrumental in accelerating progress towards the social sector SDGs across the diverse districts in the state.

Conclusion

The empirical analysis underscores the complex and conditional interplay between public spending, governance quality, and Sustainable Development Goals (SDGs) outcomes at the district level in Assam. The

results reveal that while public spending is positively associated with SDG achievements, its effectiveness is significantly conditioned by the institutional environment in which it operates. Districts with stronger governance systems are able to leverage public spending more effectively i.e., translating similar or lower level of spending into substantial improvements in SDG outcomes. This interaction effect highlights that governance quality does not merely complement but actively amplifies the developmental returns to public spending. For instance, districts with higher governance scores, such as Barpeta and Dhubri, demonstrate more substantial progress in SDGs due to the efficient use of allocated resources, whereas areas with lower governance standards, despite similar levels of public spending, struggle to achieve comparable outcomes.

Moreover, the considerable disparities in public spending allocations across districts, evident from high coefficients of variation, underscore the uneven distribution of resources, which risks entrenching regional inequalities in SDG performance. The findings suggest that substantial regional variations in funding can exacerbate inequalities in development outcomes. Thus, policymakers must consider both the quantity and quality of public spending. Ensuring equitable distribution and simultaneously strengthening local governance are essential to guarantee that fiscal resources translate into meaningful and inclusive progress towards SDGs. This analysis emphasizes the importance of a dual strategy: targeted fiscal interventions combined with enhanced governance capacities to achieve balanced and sustainable development across all districts.

This study acknowledges certain limitations. A panel data analysis could have yielded more nuanced insights into the interplay between public spending, governance, and SDG achievement. However, the current research was unable to incorporate such an analysis due to the unavailability of data. The analysis is further restricted to district-level evidence within Assam, thereby limiting the generalizability of the findings to other regions of India or to broader contexts. Furthermore, the study could not conduct a disaggregated, SDG-specific analysis due to data constraints, which might have provided more granular insights into how public spending and governance interact across different dimensions of sustainable development. Future studies should prioritize overcoming these data gaps, for example through collaborations with local governments to construct more comprehensive datasets, thereby enabling a more detailed exploration of the factors influencing SDG outcomes at both the state and district levels. Such efforts would deepen understanding of how fiscal and institutional factors jointly shape development outcomes across varying contexts.

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CRediT authorship contribution statement

Bhabesh Hazarika: Writing – review & editing, Writing – original draft, Validation, Supervision, Software, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Ankit Singh:** Writing – review & editing, Methodology, Formal analysis, Data curation.

Declaration of competing interest

The authors declare that we have no conflicts of interest, financial or otherwise, that could have influenced the research, authorship, or publication of this work.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.wds.2026.100276.

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