Vol.2 Issue 1, May 2026

North East Economic Review

A Biannual Publication of NEEA

North Eastern Economic Association

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Editorial

Our North Eastern Economic Association is entering its 26th year of existence. Through our annual conferences NEEA has provided a forum for economists of this region to reflect on the socio economic realities. A few proceedings of the conferences have been published. Considering the need for bringing out a journal of NEEA, the first issue of the North East Economic Review (NEER) was launched in December,2016. Unfortunately the journal did not take off and the project remained shelved for many years despite several attempts to bring out new issues. Finally with the full support of the association we are bringing out the first issue of the second volume of the journal. It is being relaunched with a sense of responsibility. The enthusiasm of the authors , advisory committee members and our esteemed reviewers made this happen. We intend to make it a part of NEEA's academic calendar making NEER a worthy platform where we can share our ideas on socio-economic reality of the region. Out of the four sections One section will be devoted to issues of the region. Another section will be devoted to survey of economic research in the North east. Another section will be devoted to review of books preferably on the socio economic issues of the region. This will enable research scholars have a holistic view of the issues.

There is no single perspective. We believe in the more, the better. We would be delighted to have your feedbacks so that we can improve in later issues.

E. Bijoy kumar Singh,
Chairman, Editorial Board, NEER

Editorial Office

NORTH EASTERN ECONOMIC REVIEW

Journal of the North Eastern Economic Association, India

Development of Eco-friendly and Cost-effective Tourism in Northeast India –An Introspection

Amitava Mitra[1]

Introduction

The traditional theory of international trade – Heckscher Ohlin (HO) or Factor Endowment – asserts that trade takes place between nations as a result of the differences in factor endowments and relatives costs. In the tourism context, one can conceptualize that a nation endowed with attributes such as snowcapped mountains, lush green forest, amazing valley, rich culture heritage, etc. will export tourism services, and those nations lacking such resource endowments will import tourism services. Thus, trade in tourism obeys the general properties of the orthodox trade theory and demand-adjusted factor supply differences are the basic determinants of trade/tourist flows. However, the implied supply-side reasoning poses some difficulties in understanding the nature of tourist trade, as two-way trade is common. (Tisdel et al. 1988)

The existence of two-way (intra-industry) trade indicates that variations in factor supply are not the sole cause of trade. Recent literature offers many explanations, such as product differentiation, transport costs, and imperfect substitutability as to the existence of two-way trade patterns (Bhagawati et al., 1971; Dixit and Norman, 1980; Helpman and Krugman, 1985; Krugman and Obstfeld, 1991). Among the different explanations, it appears that the relative significance of specific factors required to provide tourist services – which are one of either an inadequate supply or a complete lack in the importing country – is the most revealing explanation of two-way trade in tourism. More specifically, each supplying nation has its own negatively sloped demand schedule. This implies given taste pattern of consumer, each country with specific factors or attributes will enjoy some degree of market power. This power can be exploited to increase the gains from tourist trade and hence economic welfare of the country

With this theoretical background, let me analyze the potential of

1 Presidential Speech , 24th Annual Conference of NEEA held on 9Th February,2024 at S.B.Deorah College,Ulubari,Guwahati amitrargu@rediffmail.com

tourism in North Eastern Region of India which have a number of natural and cultural attributes. In fact, with more than 220 different ethnic groups living in the North East of the country, it is considered as one of the most culturally diverse and vibrant regions of the world. The unique natural beauty along with cultural diversity may help each state of Northeast India to export tourism services.

India received 677.63 million domestic tourists in 2021, an increase of around 11 percent over the last year in the background of pandemic. According to the Ministry of Tourism, around 6.19 million foreign tourists arrived in India. As a result, tourism continues to play an important role as foreign exchange earner for the country. For example, tourism sector in India earned US $16.926 million foreign exchange in 2022 and it became third largest foreign exchange earner item in India's foreign trade. However, India's share of world tourism arrivals is only 1.64 percent which is much less as compare d to other Asian countries like China(5.1 percent),Thailand(3.9 per cent),Japan(3.2 per cent) etc. At the same time tourism development of India is purely region specific. This is clear from the fact that if we examine the share of different regions of India in arrivals of total tourists, it is found that the most attractive region is Southern region (48.77%) followed by Northern region (27.47%), the Western region (13.89%), Eastern region (5.03%)and central region(4.47%)..However, the share of Northeastern region is only 0.37%. In recent years, the World Travel and Tourism Council forecasts that the Indian tourism sector will grow at an annual growth rate of 7 percent for the next 10 years. That means that the projections for the number of tourist arrivals in the north eastern states will be a part of the growth of the sector.

In recent years there is a change in trend towards eco-friendly and green products, services and consumer choices (Garrod, 2003). Today, most of tourists who visit a place want a reason to remember the places to feel the touch of nature. To arouse the growing needs of tourist enthusiasts, it is essential to inculcate eco-friendly ways to cater to the needs of tourists. But at the same time, it needs to be cost effective. In view of this, north eastern states need appropriate tourism policy under which eco-friendly destinations may be promoted with proactive involvement of local people along with cost effective tourism destinations in the region. Therefore, special emphasis needs to be done in all identified tourist destinations of the region to provide the

possibilities of eco- friendly and cost-effective tourism promotion. Let us now have a bird's eye view of the current status of tourism in individual states of Northeast India.

Tourism of Sikkim

Sikkim is the one of the most visited domestic tourist destinations in

Table 1: Tourist Arrivals in Different States of North Eastern Region of India, during 2008 to 2021

State	2008	2018	2021
Arunachal Pradesh	149292 (2.90)	520089 (5.20)	103097(4.07)
Assam	3617306 (70.31)	5893128 (58.87)	1409697(55.71)
Manipur	112151 (2.18)	182500 (1.82)	50019(1.98)
Meghalaya	549936 (10.69)	1216454 (12.15)	154820(6.12)
Mizoram	55924 (1.09)	77518 (0.77)	87466(3.46)
Nagaland	46513 (0.90)	106598 (1.06)	24293(0.96)
Sikkim	368451 (7.16)	1497299 (14.96)	523177(20.68)
Tripura	245438 (4.77)	517249 (5.17)	177821(7.03)
NER	5145011 (100)	10010835 (100)	2530390(100)

Source: Indian Tourism Statistics, Different Years.

North East India and its share shows an increasing trend over a few decades. In fact the state is the most visited foreign tourist destination of the region. It shares around 83.09 percent of total foreign tourist arrivals in the region in 2021. Further, on the basis of available data it was found that eco-friendly and cost-effective tourism in Sikkim has become a major alternative to mass tourism, supporting livelihood, generating employment opportunities, and initiating the practices of preservation and conservation of many rare indigenous species of flora and fauna.

There is an increasing volume of tourist that travels to these villages and has formed an off-beat eco-friendly and cost-effective tourist circuit with proximity, price, natural environment and bio-diversity being the main reasons for it. There are several sustainable tourism case studies of Sikkim which provides insights into pragmatic successful tourism models. But the potential

for wellness tourism remains unexplored and for this, the local government's interventions are also required. There is also a need for policy intervention to measure, assess, control and report its outcome to reduce the negative impacts of tourism.

Tourism of Assam

Assam is the most visited tourist destination by Indian tourist among the north eastern States of India. It has not only places of natural beauty and wildlife reserves but also places of historical, cultural and architectural significance.

In fact, Assam in North East India is a treasure trove of natural beauty and diverse history. Known as the land of 'Blue Hills and Red Rivers', the state is the home to wild forests, mighty rivers and tea plantations. The state has a number of pilgrimages, wild life and archeological sites.However,its share in region tourism arrivals has declined steadily over a couple of years

Dima-Hasao and KarbiAnglong are the two hill districts of Assam which have a potential for eco- friendly and cost-effective tourism. The future prospect also depends on the state government and its strategies to implement a holistic tourism planning. Tourism development plans have been drawn to strengthen tourism sector with the help of Forest Department to make the district eco- friendly especially Haflong,Jatinga,Panimur and Maibang etc.The future prospect of tourism in Assam will brighten if such emerging eco-friendly tourist destinations are explored and developed

Tourism of Meghalaya

Tourism industry is contributing more than 10 percent to the GDP in Meghalaya and it has a potential to increase further if the local communities, villagers and vendors are made aware of the benefits of the eco-friendly and cost-effective tourism. The policy of Meghalaya tourism is very much inclined to promote and develop ecotourism with proactive involvement of local community. The Rural Tourism under the Cooperative Sector is known as "*Explore Exotic Meghalaya*". It was initiated by the State's Cooperation Department in the year 2012-13 in collaboration with the State's Tourism department, and the Meghalaya Village Development and Promotion of Tourism Cooperative Society Ltd.

Tourism of Arunachal Pradesh

Arunachal Pradesh is rich in forest resources and biodiversity. Arunachal

Pradesh has some of the thickest surviving forests in the country. Therefore, it can constitute one of the most important ecotourism circuits in the region. Further, Arunachal Pradesh is a land of more than one hundred tribes and each tribemaintained their own distinct culture and belief systems.

Arunachal Pradesh is recently gaining popularity as a tourist destination due to its cultural heterogeneity, monasteries, mountains, snow clad peaks, crystal clear lakes and rich biodiversity. The State has huge potential for development of adventure tourism like mountaineering, trekking, boating, river rafting and angling. Its share in arrival of tourists in the region has increased significantly over the decades.

Tourism of Tripura

The share of tourist arrivals in Tripura has steadily increased over the last few decades, due to its vast potential Ecotourism has been adopted by the Government of Tripura, in its Tourism Policy 2020-2025, to promote sustainable use and management of nature, land, wildlife resources or employment and revenue generation in the state. With the above concept in mind, the Government of Tripura, as per their VISION 2030, LAKSHYA, 2047 have been taking several steps to create infrastructure and develop potential tourist areas to make the experience world class with due focus in generating income, revenue and livelihood for the local people. Further Tripura, being topographically easily accessible for patients from Bangladesh can explore cost-effective medical tourism provided proper health infrastructure is developed.

Tourism of Nagaland

With tourism growing in Nagaland, it has opened up a lot of doors for possible opportunities for the locals to make it a source of their livelihood without tarnishing their unique culture and the natural environment in which they have lived in for entire generations. Nagaland's Dimapur, which acts as the gateway into the state, is well connected by air, rail and road and the tourist who visit the heritage village of Kisama for the popular Hornbill Festival held in December each year, find it very stunning, beautiful and rich in culture. Tourism destinations and attractions of Nagaland are suitable to be promoted and branded as an eco-friendly tourist destination. Therefore, indexing of sites with potential for attracting tourism is important. However, at present tourist arrivals in the state are not significant.

Tourism of Manipur

Manipur is one of the states in Northeast India that could be promoted for tourism by exploring the potentials of tourism such as natural scenic beauty, rich culture, religious place, adventure and sports as well as rural tourism. However, its share in tourist arrival among the north eastern States is negligible at present.

Tourism of Mizoram

Known for its evergreen hills and dense bamboo jungles, Mizoram lies in the southernmost tip of North East India. The geographical and cultural diversity makes it one of the most beautiful places to visit in Northeast India. With a wide array of festivals, dances, handicrafts, flora and fauna, natural scenic beauty and pleasant climate, Mizoram has much offer to its visitors. In fact, the State is rich in bird diversity which has potentials to make it a major bird watching destination.

Tourism in North Eastern Region

A brief glances of tourism potential in each individual State of the region shows that the North East India has enormous potential of ecotourism. However, its share of India's tourist arrival is only 0.37 percent (0.36 percent in case of domestic tourists and 1.31 percent in case of foreign tourists). It may be noted that the region constitutes around 8 percent of total area of the country but boasts of 65 percent of total forest area of the country as per data based on satellite imaginary. With regard to the economic benefits from the tourism industry to the North Eastern states, a few states like Sikkim, Assam, and Meghalaya, the tourism sector has been contributing ranging from 5 per cent to 10 per cent to the GDP whereas the tourism industry's contribution in the GDP of Arunachal Pradesh, Tripura and Nagaland ranges from 2 to 5 percent.(Government of India,2022) Despite the significant contribution of the tourism industry in the majority of the state's economy, the budget allocation for the tourism sector is not significant. For example, in North Eastern States together the budget allocation in tourism sector is around 3 per cent. Firstly, it calls for an enhancement of allocation in each states budget in tourism sector. Secondly, it is highly needed to identify eco-friendly and cost-effective tourist destinations for each state of the region (Government of India, 2022).Keeping this in view, an attempt is made to identify eco-friendly and cost effective tourist destinations of Arunachal Pradesh which may be taken as an example

for the region in general.

Indexing of Eco-friendly Tourist Destinations

In order to identify major eco-friendly tourist destinations an attempt is made to identify and rank them on the basis of nine indicators. These indicators are as follows:

- Presence of snow-capped mountains (1 for Yes, 0 for No)
- Presence of nearby forest (1 for Yes, 0 for No)
- Presence of River-valley (1 for Yes, 0 for No)
- Diversity of Plants and Animals (1 for Yes, 0 for No)
- Presence of National Parks / Sanctuaries (1 for Yes, 0 for No)
- Presence of Heritage / Historical sites (1 for Yes, 0 for No)
- Presence of Cultural Diversity (1 for Yes, 0 for No)
- Presence of Museum (1 for Yes, 0 for No)
- Superior Air Quality (1 for Yes, 0 for No)

The presence or absence of any particular indicator of any particular site is assigned the value of (1 or 0) respectively. Then a simple arithmetic mean is calculated of the values obtained. Like Human Development Index (HDI), it varies between zero to one. Keeping this in view, index values are categorized as (i) high ie relatively more eco-friendly (between 0.75 to 1), (ii) medium ie moderately eco-friendly (0.50 – 0.75) and (iii) low ie least eco-friendly (less than 0.50).

On the basis of categorization, out of fifteen identified tourist destination, three tourist destinations are the most eco-friendly and six of them are moderately eco-friendly. Hence, nine tourist destinations can be regarded as major eco-friendly tourist destinations.On the basis of index values calculated from nine indicators, Bomdila, Bhalukpong , Roing , Pasighat, Ziro, Tawang, Daporijo, Mechukha and Dirang have been identified as major eco-friendly tourist destinations in Arunachal Pradesh.

Indexing of Cost-effective Tourist Destinations

In addition to it an attempt is also made to rank the identified tourist spots of the different districts on the basis of cost-effective index by taking eight relevantindicators. These indicators are as follows

- Distance from Airport (1 for located within 50 km, otherwise is zero)
- Distance from Railway station (1 for located within 50 km otherwise

zero)

- Directly connected by Railway from Delhi/Guwahati (1 for Yes, 0 for No)
- Connected by Highways (1 for Yes, 0 for No)
- Availability of Public Means of Transport (1 for Yes, 0 for No)
- Availability of Home stay (1 for Yes, 0 for No)
- Availability of Tourist lodge / Budget hotels (1 for Yes, 0 for No)
- Number of Activities (1 for two or more activities and 0 for otherwise)

On the basis of eight indicators and index value as identified in case of eco-friendly tourist destinations the cost-effective tourist destinations are also categorized into three parts i)relatively more cost effective ie (between 0.75 to 1) (ii) moderately cost effective medium (0.50 – 0.75) and (iii) least cost effective ie low (less than 0.50). On the basis of index values, it is found that three tourist destinations are falling under the most cost-effective and five are falling under moderately cost effective. The three most cost-effective destinations are; Itanagar, Pasighat and Bhalukpong. The five moderately cost-effective destinations are; Ziro, Roing, Bomdila, Tawang and Likabali. These eight tourist spots can be regarded as major cost-effective tourist places in the state.

Similar index for eco-friendly tourist destinations and cost effective tourist destinations on the basis of different state relevant indicators need to be constructed for each state of the region For example, if the composite Index value of the eco-friendly components is low for a particular destination, it is high time to concentrate on revamping the ecology and environmental sustainability of the region through coherent and collaborative assignments like emphasis on forestation and zero tolerance on cutting trees, stopping of unplanned earth cutting, no human interventions to disrupt the free flow of river / fountain water etc. If the composite Index value of the cost-effective components is low for a particular destination, it is high time to concentrate on creating cost effective tourism infrastructure in the region through coherent and collaborative assignments like establishing regular services of railways, airways and other forms of public transportation system, the construction of hotels and home stays etc. in a planned way.

Further the destinations are mapped using both the dimensions using 'Issues Priority Matrix' to determine the comprehensive clustering of destinations as follows:

		Composite Index Value of Cost Effective (CE) Components of a Destination		
		High	Medium	Low
Composite Index Value of Eco-friendly (EF) Components of a Destination	High	High Priority EF: High CE:High	High Priority EF: High CE: Medium	Medium Priority EF: High CE: Low
	Medium	High Priority EF: Medium CE: High	Medium Priority EF: Medium CE: Medium	Low Priority EF: Medium CE: Low
	Low	Medium Priority EF: Low CE: High	Low Priority EF: Low CE:Medium	Low Priority EF: Low CE: Low

It is emergent to create the State specific 'Eco-friendly and Cost-effective Tourist Destinations Mix' which may be integrated with other Northeastern States to attract nature lover domestic as well as international tourists. The State as well as region specific 'Eco-friendly and Cost-effective Tourist Destinations Mix' may be assimilated in the pan India Himalayan Tourism constellations. This shall be well connected in all possible forms so that the movement of visitors throughout the Himalayan Corridor will be indeed a rare, lifetime and memorable experience for the tourists. The showcasing of various rich cultural diversities and indigenous practices coupled with eco-friendly and cost-effective tourism would promote substantial growth of tourism in the northeast region.

Further tourism in Northeast India suffers from seasonality constraints. Rainy season is not so popular for the tourists. If these challenges can be converted into opportunities by introducing innovative approaches, the tourism of the region can be enhanced even during the lean periods. Aspiring Tourists from less rainfall or drought prone areas may be attracted to spend good times with the 'Rain QueenNER'. The scope of such sectoral or special

segment tourism may be explored.

The massive attack of COVID-19 pandemic has ruined the tourism sector worldwide. The global community has developed the new ways and means to survive. The normalcy of life has returned and now tourist arrivals have increased. At this juncture, the prospective tourists would prefer to visit emerging spots or less crowded destinations. Eco-friendly and cost-effective dimensions would essentially rule the tourism business in future. There would be higher scope for North East Tourism to flourish in the post pandemic situations if appropriate preparedness and strategies are adopted

Conclusion

The powerful message emanating from the present study is that North Eastern Region of India has tremendous potential for developing ecotourism but its potentials is yet to be utilized. Finally, the study recommended for various eco-friendly activities like trekking, promoting home stays, local cuisine, organic food etc., in eco-friendly tourist destinations which can be as money spinner for the local economy. On the other hand, in cost effective tourist destinations the study recommended for construction of tourist lodges, budget hotels and strengthening public transportation system which can provide employment opportunities among the local people in hotel industry, transportation sector etc. However, in both the destinations it calls for promotion of local handicrafts and textiles which might lead to demand stimulus of local handicrafts and textiles so that it can help the regional economy in terms of generation of additional income and employment. Thus tourism can help the local people provided it is properly managed. At the same time local people can help to protect forests and biodiversity provided they reap direct economic benefits of tourism. Finally, if tourism is to be sustainable then there is a strong need for development of a strategic partnership between public and private sector as well as strong involvement of the local community. However, it is to be noted that the paradox of tourism is that the product needs to be consistently protected as it is being marketed. Unregulated tourism endangers and depletes the very resources and attributes that attract tourists.

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Youth in the North Eastern Region of India

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Abstract

The role of youth in nation building is very important. In the days of the fast demographic transition youths of age 10-24 will be pivotal in most of the countries specifically the developing countries which are going to tap the demographic dividend. In the context of India this is more important since the country has the vision of Vikshit Bharat. In this context it is important to understand how many persons got married so that they can fulfil the social obligation to reproduce enough number of children which is defined as having a TFR of 2.1. How many people are engaged in gainful activity depends on the number of vacancies available in the economy. How many persons are availing of the start-up programmes that the government of India is promoting for self-employment or generation of jobs in the private sector is highly correlated with the level of education that people in this age group so that they can match the required knowledge and skill as desired by the employers. The literacy rate of the region is quite comparable to the national level but whether the population has acquired the required level of education is a question. Here education is not sufficient because jobs demand the skill specific to that job. The current paper is an attempt to link and find the opportunities of the young population in the North eastern region of India.

Keywords: *young, North eastern state, population pyramid*

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Introduction

According to the convention of the United Nations, youth comprises of the population in the age group 15-24. "The United Nations, for statistical purposes, defines 'youth', as those persons between the ages of 15 and 24 years, without prejudice to other definitions by Member States." Adolescents comprise of the age group 10-19 years... The UNICEF/WHO/UNFPA use the definitions of adolescent as in age category of 10–19, young in age category 10–24, and youth in age category 15–24 group. In this present study it is attempted to give a focus on the age 10-24[1].

The special focus on this age category is imperative in the context of India's journey towards fulfilling the population stabilisation by 2045 as per the National Population Policy 2000 and the mission approach of Vikshit Bharat by 2047. In this connection the youth of today will be mature and responsible citizens of India heavily reliant on the inner strength of the country.

Demographics of the Young population:

As per the estimate by Population Division UN, the population of the world by July 2025 is projected to be 8.232 billion ,out of which 6.944 billion live in the less developed countries (84.36%). Among the less developed countries having high population India and China are notably contributing 35.07% of the global population (17.20% by China and 17.78% by India). Globally the share of the 10-24 age group is 23.94% while in India it is 25.94% and in China it is 17.92%. The share of the young population in China is declining at a faster rate than in India . The importance of this age group is two-fold. This age group is entering the labour force by actively searching for vacancies around. At the same time this age group is entering the reproductive life. They are facing a lot of psychological stress which impact their life in a significant manner. They need a lot of guidance .

North Eastern Region of India:

North Eastern Region of India (NER) comprise of eight states Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura located in the north eastern part of India. It is surrounded by five neighbouring

countries namely Bangladesh, Myanmar, China, Bhutan and Nepal. "This region is culturally and ethnically diverse having more than 200 ethnic groups which have distinct languages, dialects and socio-cultural identities. The Region covers 7.97% of the country's geographical area and 3.78% of its population. It has 5,484 km of international border viz. Bangladesh (1,880 km), Myanmar (1,643 km), China (1,346 km), Bhutan (516 km) and Nepal (99 km)." The region geographically contributes about 7.98% of India and 3.78% of the total population of India.

These states are land locked and agriculture is the way of life in these states. Except for Assam there is little industrialisation. The sectoral growth also is in favour of the tertiary sector whereby the scope of industrialisation is very much limited due to the poor capital formation in the region. Keeping aside the basic concept of the vicious cycle of poverty the modern concept of the endogenous growth model has become very important. In such a poor region where the tapping of the natural resources is very meagre the best alternative is the creation of human capital. But the formation of human capital also requires a great amount of resources which also takes a long time to yield the return. Nevertheless, this is a long term goal for the nation and specially for the region where the human capital can be exported elsewhere to enhance the quality of life.

Table-1 Population of the Northeastern region

States	Population (as per Census 2011)	Area (sq km)	Percentage All India		Density of Population (per sq km)
			Population	Area	
Arunachal Pradesh	13,83,727	83,743	0.11	2.55	17
Assam	3,12,05,576	78,438	2.58	2.39	398
Manipur	28,55,794	22,327	0.24	0.68	115
Meghalaya	29,66,889	22,429	0.25	0.68	132
Mizoram	10,97,206	21,081	0.09	0.64	52
Nagaland	19,78,502	16,579	0.16	0.50	119
Sikkim	6,10,577	7,096	0.05	0.22	86
Tripura	36,73,917	10,486	0.30	0.32	350

Total NER	4,57,72,188	2,62,179	3.78	7.97	173
All India	1,21,08,54,977	32,87,263	-	-	382

Source :https://www.mha.gov.in/en/commoncontent/north-east-division

The distribution of young population comprising of 10-24 age group is presented in Table-2. It shows a clear picture that the 10-14 year old population has been increasing over time in both India and regional level. However, it gives a clear picture that the level of fertility in terms of the number of births per woman in her life time has been declining in India and the states of the region. The pace of decline in total fertility rate (TFR) is not uniform but there is evidence of decline over the years. It becomes more pronounced in the 21st century. The share of the age group 10-24 years in the total population is about 30% in India and the NER which has not changed substantially over the years. The decline in births is observed for sure as shown by the population pyramid (Fig.1 to Fig. 6) which is a typical graph of the age and sex distribution of population. The bars for both male and female have been squeezed over time and there is visible expansion of ages 5-19 years in both India and NER. This pattern is more evident in 2011 pyramid.

Fig. 1: Population pyramid of India, 1991

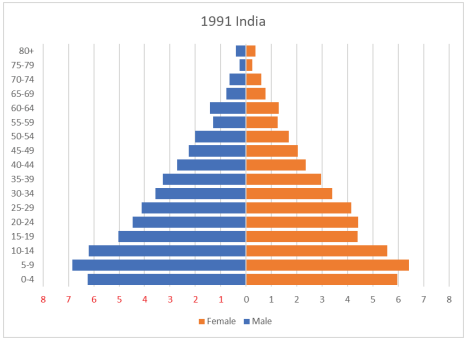

Fig. 2: Population pyramid of NER, 1991

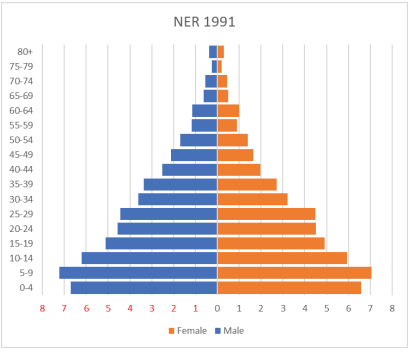

Fig. 3: Population pyramid of India, 2001

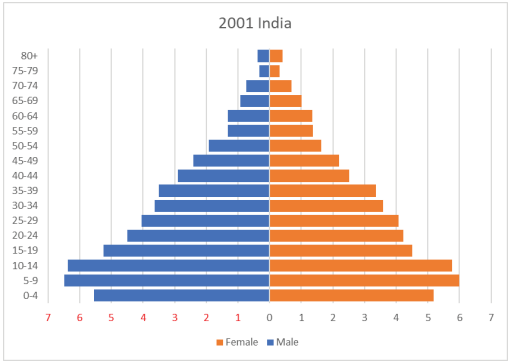

Fig. 4: Population pyramid of NER, 2001

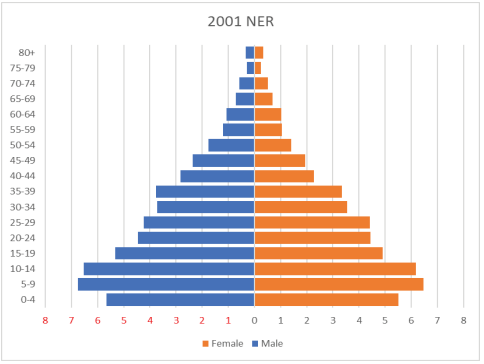

Fig. 5: Population pyramid of India, 2011

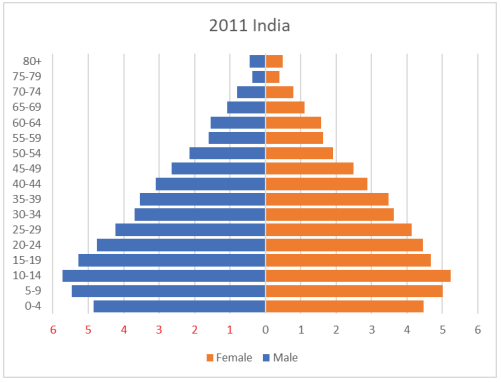

Fig. 6: Population pyramid of NER, 2011

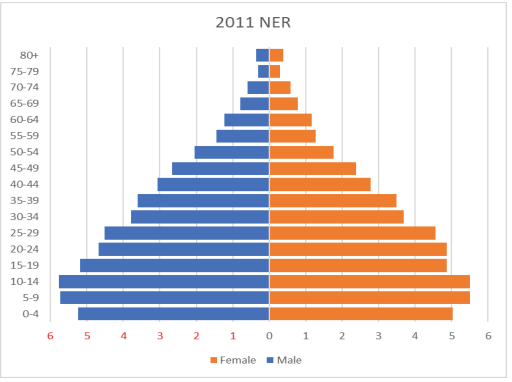

Table-2 Distribution of population by age in India and NER

Year	Age Group	India	NER	India	NER
1991	10-14	98691898	3880074	11.8	12.1
1991	15-19	79034929	3199434	9.4	10.0
1991	20-24	74472704	2900073	8.9	9.1
1991	10-24	252199531	9979581	30.1	31.2
2001	10-14	124846858	4934858	12.1	12.7
2001	15-19	100215890	3976729	9.7	10.2
2001	20-24	89764132	3451716	8.7	8.9
2001	10-24	314826880	12363303	30.6	31.8
2011	10-14	132709212	5157720	11.0	11.3
2011	15-19	120526449	4602476	10.0	10.1
2011	20-24	111424222	4364440	9.2	9.5
2011	10-24	364659883	14124636	30.1	30.9

Source: Author's calculation from the 1991, 2001 and 2011 Census Tables

Marital Status of the young population

Marriage is one of the events of life which bring a massive change in the roles in the society and responsibilities assigned to a person. Once married the person has to undergo a lot of changes in the sphere of the social environment. One of the biggest hitting points is the curtailing of education which is supposed to be compulsory in India till the individual is 14 years since six years of age. This data is tabulated across the last three censuses of 1991 to 2011 and it is observed

that in the early age of 10-14 almost all the adolescents are remaining unmarried within a range for 95.4% (female, 1991) to 99% (male, 2001) in India as a whole. The corresponding figures in the NER are from 99.5% (male, 2001) to 97.9% (female, 2011). However, this table conveys a great message that as population shifts to older ages 15-19 and 20-24 the proportion remaining unmarried declines very sharply particularly among those in 20-24 age in both the India and the NER.

Table-3: Proportion of Never married

	India			**NER**		
1991	Total	Male	Female	Total	Male	Female
10-14	96.7	97.8	95.4	98.6	99.1	98.2
15-19	78.3	90.5	64.3	88.1	97.4	78.4
20-24	38.6	59.9	17.0	57.1	79.4	34.5
2001						
10-14	98.3	99.0	97.4	99.0	99.5	98.4
15-19	85.7	94.7	75.1	89.9	97.5	81.7
20-24	44.8	65.2	23.0	59.2	78.5	39.9
2011						
10-14	97.8	98.4	97.1	98.5	99.1	97.9
15-19	88.1	95.1	80.1	88.1	96.2	79.5
20-24	50.4	69.1	30.4	54.8	73.4	36.9

Source :

The table also shows that in India women get married relatively younger than the counterpart males. In 1991 among the female of age 20-24 category only 17% remained as unmarried while 60% of males in the same year and age

remained unmarried. This proportion has increased steadily over time and same figures rose to 30.4% and 69.1% in 2011 census. In the north eastern region marriage is practised somewhat in the later age. This is shown by the census data. Even in 1991 the proportion remaining unmarried among the females in age 20-24 was 34.5% which was twice the size of all India level while among male it was 79.4. In other words, only 20% of males in the NER got married. However, in the 2011 census the figures of unmarried reduced to 73.4% among males and 36.9% among females in the higher age category of 20-24. Through the study period of last three censuses it is seen that about 20% of the females got married in the age bracket of 15-19 but when women got older above 20 years the proportion rises to 60 % while among males it is about 25% in the NER.

It implies that women shoulder a high level of responsibility of the family during early phase of reproductive life compared to the males. Once a female changes her status, it can be summarily assumed that she has forfeited the opportunities of gaining education in many aspects.

Education

Education is one of the key indicators of the level of development more so in terms of human development. In table 4 the literacy level is shown and in the NER the level of literacy is at par with the national level. However a noticeable difference is the gender difference in the literacy rate whereby the overall literacy rate of India among male is better in all the three censuses but in terms of the female literacy rate the NER has outperformed the national female literacy rate. Only in the last census the literacy rate of females in the broad age groups under study have shown a better level at the national level though the difference is marginal.

Table-4 Literacy rate by age and sex in India and NER

		India				NER		
		Total	**Male**	**Female**		**Total**	**Male**	**Female**
1991	All ages	52.2	64.1	39.3		54.5	63.2	44.9
1991	10-14	68.8	77.0	59.7		69.7	73.9	65.3
1991	15-19	65.8	75.3	54.9		67.2	72.8	61.4
1991	20-24	57.8	71.5	43.8		59.5	69.3	49.7
2001	All ages	64.8	75.3	53.7		65.1	72.6	57.0

2001	10-14	81.7	86.0	77.0		76.5	78.4	74.5
2001	15-19	79.3	85.0	72.7		77.5	80.3	74.3
2001	20-24	73.2	83.3	62.5		73.9	80.3	67.4
2011	All ages	73.0	80.9	64.6		74.6	79.8	69.1
2011	10-14	91.1	92.2	90.0		88.5	88.6	88.3
2011	15-19	88.8	91.2	86.2		87.0	88.0	85.9
2011	20-24	83.2	88.8	77.3		82.0	85.7	78.5

Sources: Author's calculation from the Census Tables

The message of the table is clear that even in 21st century the female literacy rate in the NER is far from comprehensive and complete. In 2011 after sixty years of Indian independence the overall literacy level of NER is 74.6% and for females it is only 69.1%. This implies that 30% of the females of the NER are still not able to read and write. In this line of argument it will be better to examine the age 10-14 who are covered by the Right to Education Act of 2009. Here the gender difference of education is mitigated but still 11% of the adolescents of this age group irrespective of gender are not able to read and write while they are supposed to complete the middle level of education. However, decade after decade there has been improvement in literacy rate of this age group for boys and girls while the pace of improvement among the girls is really commendable.

In the context of NER there is also a wide gap in the level of education particularly of age 10-14 where in 1991 only 49% have completed primary and middle level education while only 16% have completed the middle level of education. Surprisingly this percentage of completing middle level education among 10-14 remain unchanged over the census period. The attainment of middle level education improves over time among the females compared to that of male. One solace is the improvement of level of literacy in this age groups over the consecutive censuses. The proportion completing the high school (secondary) level education has improved from 1991 census in both the 2001 and 2011 censuses and interestingly the gender difference in getting this level of education has come to parity in both 2001 and 2011censuses. Among the 20-24 age group there has been an increase in the higher secondary level and graduate level of education. From 6.1% in 1991 it rose to 10.8% and 19.3% in 2001 and 2011 censuses respectively. The achievement by females

has doubled from 1991 to 2001 and from 2001 to 2011. However, the only a small fraction of the 20-24 have completed the graduate and above education in the NER. But at least some of the sections of the society have attained this level of education.

Engagement in active work

Active participation in the economic life is a necessity. Once people have found suitable jobs they tend to join the job. In India and also in the NER the main job provider is the government and a lot of job security is ensured by the government sector. As a result people prefer the government job which is relatively more stable and secure. Taking this cue almost everybody is after the government job. But government has a limit to create jobs for all the job seekers. Taking account of this situation government has taken up a great scheme named as Startup scheme in January 2016 which can support a venture by any private individual. The main aim of this programme is to make people participate in the active work life not depending only on the government.

Child labour participation was observed in India. The 1991 census clearly shows that 5.4% of children under 15 years are engaged in work with a similar proportion in the NER also. Boys are higher in proportion. Surprisingly the proportions seeking for some openings in this group of population were 0.8% and 1.3% at the national level and the NER respectively. Despite the fact that according to the Kothari Commission in 1986 all children should be given free and compulsory education there has been pressing need for the children to come out for active participation in economic activities. This continues till the census of 2011.

Even among the 15-19 years of age the proportion engaged in work has been fairly high in 1991 compared to 2001 and 2011. The work participation rate has to be carefully examined to check where these people have gone into. There is a need to examine the distribution of workers as the structure of the economy changes. While the share of agriculture is falling and the share of tertiary sector is increasing the share of manufacturing has been stagnant However, a large proportion of the workers in India is in the agriculture sector. This leads to disguised unemployment.

As adolescents get older and transit to 20-24 years age group the work participation rate has increased considerably. This happens in both national and the north eastern region.

Table-5 Educational attainment in NER

			Literacy rate			Primary			Middle			High school/ Sec			Hr. Secondary			Graduate +		
			Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
1991	India	All ages	52.2	64.1	39.3	15.0	17.5	12.3	10.9	13.6	8.0	6.9	9.2	4.4	2.8	3.9	1.7	3.0	4.1	1.8
1991	India	10-14	68.8	77.0	59.7	34.7	38.9	30.0	12.7	14.1	11.2									
1991	India	15-19	65.8	75.3	54.9	15.0	16.3	13.6	23.6	27.9	18.7	14.5	17.1	11.6	5.8	6.6	5.0			
1991	India	20-24	57.8	71.5	43.8	12.8	14.2	11.4	14.2	17.6	10.8	11.5	15.1	7.8	7.4	10.3	4.4	5.6	6.8	4.4
1991	NER	All ages	54.5	63.2	44.9	15.2	17.2	13.0	14.3	16.5	11.9	6.4	8.1	4.6	2.2	2.9	1.4	2.2	3.1	1.3
1991	NER	10-14	69.7	73.9	65.3	33.1	35.4	30.7	16.0	16.7	15.3									
1991	NER	15-19	67.2	72.8	61.4	14.6	16.0	13.2	30.7	32.6	28.6	12.5	13.7	11.2	2.6	2.9	2.2			
1991	NER	20-24	59.5	69.3	49.7	12.0	13.2	10.8	18.9	21.4	16.4	12.8	15.6	10.0	6.1	7.9	4.2	3.3	4.0	2.6
2001	India	All ages	64.8	75.3	53.7	17.0	18.7	15.1	10.4	12.5	8.2	9.2	11.5	6.7	4.4	5.5	3.2	4.4	5.7	2.9
2001	India	10-14	81.7	86.0	77.0	39.8	42.1	37.2	11.1	11.6	10.7									
2001	India	15-19	79.3	85.0	72.7	18.5	19.4	17.3	23.0	25.8	19.8	21.5	22.9	19.8	6.8	7.0	6.6			
2001	India	20-24	73.2	83.3	62.5	14.8	15.5	14.1	14.1	16.7	11.3	14.2	17.1	11.2	12.3	14.6	9.8	7.5	8.4	6.6
2001	NER	All ages	65.1	72.6	57.0	15.6	16.8	14.2	12.0	13.1	10.9	9.9	11.4	8.2	3.6	4.4	2.8	3.4	4.5	2.2
2001	NER	10-14	76.5	78.4	74.5	35.1	35.9	34.3	10.9	10.7	11.1									
2001	NER	15-19	77.5	80.3	74.3	18.4	19.7	17.1	25.2	25.5	24.9	19.1	19.3	18.8	3.4	3.5	3.2			
2001	NER	20-24	73.9	80.3	67.4	13.8	14.7	12.9	16.6	17.3	16.0	17.5	19.1	15.8	10.8	12.6	8.9	4.7	5.2	4.1
2011	India	All ages	73.0	80.9	64.6	17.6	18.5	16.7	12.8	14.4	11.1	10.1	11.9	8.3	7.4	8.6	6.2	6.5	7.8	5.1
2011	India	10-14	91.1	92.2	90.0	46.9	47.2	46.5	17.0	16.9	17.0									
2011	India	15-19	88.8	91.2	86.2	16.0	16.3	15.7	25.0	26.1	23.7	27.9	28.4	27.3	11.8	11.8	11.8			
2011	India	20-24	83.2	88.8	77.3	14.9	15.1	14.6	15.1	16.6	13.6	12.5	13.5	11.4	18.1	19.8	16.4	11.8	12.2	11.4
2011	NER	All ages	74.6	79.8	69.1	17.1	17.9	16.3	16.3	16.9	15.7	6.6	7.2	5.9	8.8	10.0	7.5	4.3	5.3	3.4
2011	NER	10-14	88.5	88.6	88.3	45.0	44.7	45.3	15.2	14.4	16.0									
2011	NER	15-19	87.0	88.0	85.9	18.1	19.3	16.9	31.9	31.1	32.8	17.3	17.0	17.6	8.4	8.3	8.5			
2011	NER	20-24	82.0	85.7	78.5	15.4	16.0	14.8	19.6	19.5	19.7	8.8	9.3	8.2	19.3	21.0	17.7	5.4	5.4	5.3

Table 6: Work participation rate in India and NER

			Population			Worker			% Seeker		
			P	M	F	P	M	F	P	M	F
1991	India	5-14	209986630	109366790	100619840	5.4	5.7	5.1	0.8	0.8	0.7
1991	India	15-19	79034929	42231074	36803855	35.6	43.8	26.2	3.1	3.4	2.7
1991	India	20-24	74472704	37514223	36958481	54.2	74.7	33.5	3.9	4.5	3.3
1991	NER	5-14	8446984	4298420	4148564	5.3	6.2	4.3	1.3	1.3	1.3
1991	NER	15-19	3199434	1631744	1567690	33.6	40.4	26.5	3.0	3.4	2.5
1991	NER	20-24	2900073	1455279	1444794	52.8	67.0	38.5	4.3	5.2	3.4
2001	India	5-14	253163648	132367710	120795938	5.0	5.1	4.9	1.5	1.6	1.3
2001	India	10-14	124846858	65632877	59213981	8.7	8.8	8.5	2.2	2.4	2.0
2001	India	15-19	100215890	53939991	46275899	32.3	38.9	24.6	12.6	13.8	11.2
2001	India	20-24	89764132	46321150	43442982	53.7	70.7	35.6	13.4	14.2	12.6
2001	NER	5-14	10070465	5158539	4911926	5.6	6.2	4.9	2.3	2.4	2.3
2001	NER	10-14	4934858	2537875	2396983	9.4	10.5	8.1	3.5	3.5	3.4
2001	NER	15-19	3976729	2068115	1908614	29.2	35.4	22.4	18.1	18.2	17.9
2001	NER	20-24	3451716	1730235	1721481	47.7	61.1	34.3	20.4	20.3	20.5
2011	India	5-14	259637338	135719301	123918037	3.9	4.1	3.6	1.5	1.6	1.4
2011	India	10-14	132709212	69418835	63290377	5.7	6.1	5.3	2.2	2.3	2.0
2011	India	15-19	120526449	63982396	56544053	25.1	30.8	18.6	12.6	13.2	11.9
2011	India	20-24	111424222	57584693	53839529	49.8	66.0	32.4	14.1	13.2	15.2
2011	NER	5-14	10298907	5262328	5036579	4.6	5.2	4.0	2.6	2.6	2.5
2011	NER	10-14	5157720	2640168	2517552	7.2	8.2	6.0	3.7	3.8	3.6
2011	NER	15-19	4602476	2372408	2230068	27.0	34.1	19.4	19.7	19.0	20.3
2011	NER	20-24	4364440	2138546	2225894	48.8	64.7	33.4	21.4	18.4	24.3

This is because by this age majority of the population have already completed the higher secondary level and graduate level of education. Therefore, it is high time for them to find a life partner and a suitable job. Males take pride to be the breadwinner while women fall into the homemaking role. Therefore, by this age it is observed that one-third (67%) of male in 20-24 have joined the work force. In 2001 and 2011 the percentage of workers among male reduced to 61% and 64.7% respectively. Work participation among females in all the

given age categories is less than that of male but notably in all the censuses one-third of the women in this age group are working. This can be explained by the fact that as Table-3 shows within a range of 60-65% of women in this age group are married and they are in the initial phase of family building process whereby a handful of women getting job in the organised sector must have reported to be working.

One of the interesting findings is the proportion of people seeking jobs. The proportion of this section of population is much higher in the NER compared to the India level. In the censuses of 2001 and 2011 the percentage of job seekers had reached 20%. In one sense this implies high volume of unemployment persisting in this part of India. There is gender parity among seeking jobs. This gives a very important clue that a sizeable proportion of people in the NER are suffering from the frustration due to inability to get a breakthrough in attaining a meaningful and fulfilling life.

Conclusion

Globally one-fourth of the population is concentrated in age group of 10-24 years and in India it is about 26% compared to 17% in China. In the context of India the north eastern region comprising of 8 states makes up 8% of the total geographical area contributing 3.8% of the total population by 2011 census. In the NER the 10-24 age group contributes about 31% of the total population. Using the census data of 1991, 2001 and 2011 it is found that the size of the population of young population comprises of almost one quarter. The growth rate of the 10-24 age group in the NER is found to be 2.14% between 1991-2001 and 1.33% during 2001-2011. These figures are marginally slightly lower than the national level. In this paper, three major characteristics are studied such as marital status, education and work participation.

It is observed that a fair proportion of women get married in NER .It is more than 60% when they are in age group 20-24. Marriage before age 20 was fairly less in the region at about 20%. Proportion remaining single is quite high in the NER even for women. As for male in age 20-24 about 27% of the males get married in 2011 which is highest in the last three censuses. The marriage should also correlate with the two other characteristics – education and work participation. No doubt, education plays a pivotal role whereby higher level of education ensure longer time in school and colleges which postpones marriage. At the same time with the higher level of education the likelihood of getting

a better job also increases. On the basis of the available data this cannot be proven but it is a significant relationship to be established. From the limited data it is not clear at what level of qualification people are getting a better job and in which sector they are absorbed. A further study at the level of industry and occupation is needed.

In this context it is equally important to study the youth or young population for various reasons. Youths are a force in demography in terms of size and the role assigned to them and social responsibility they have to bear. They are the agents of change. In this they have to be well equipped with the modern knowledge and skill. They are equally responsible for healthy and clean environment by taking up the practices which must be beneficial at global level. Unlike earlier generations it is the age of technology whereby innovation must be a key cornerstone of life. Here lies the importance of the entrepreneurship which they must inculcate to become an employer rather than a mere job seeker. It is observed that among age 20-24 in the NER a huge proportion of people is searching for jobs. If they are not employed they will be frustrated and their investment in human capital formation will be wasted. The society will again be trapped in a vicious cycle of poverty and inefficiency.

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Infrastructural development in North-east region post 2014: A Policy and performance oriented comparative study of UPA & NDA Regime

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Abstract

The North-eastern states of India is attributed the title of "Ashtalakshmi states" by our honourable Prime Minister, Shri Narendra Modi and the terminology accurately portrays the economic preminence of the states. Nevertheless, the region possessed a glorious history of robust connectivity via trade routes, a global trade hotspot and an inventory of raw materials, factors like harsh geographical terrain and remoteness from the mainland India led to its utter neglect till 2014. Furthermore, these factors fueled major reluctances in injecting capital and investments in the region till the early 2010s which led to sluggish development of the region. The absolute absence or poorly developed infrastructure in the region is to be attributed to the operation of these factors itself. Subsequently, the focus is to be shifted to the efforts that were being made pre and post 2014, so as to tackle and resolve these challenges and ensure rapid infrastructural development in the region. With the utilization of secondary data and an illustration oriented approach, this study aimed at evaluating the scale, efficiency and adequacy of infrastructural development in the north-east region post-2014 relative to the pre-2014 era. Thorough analysis reveals vital outcomes, highlighting the major divergence in the development pace in both the regimes. The factors fuelling this pivotal contrast in the pace of development is evaluated upon and requisite conclusions are drawn. Furthermore, the shortcomings of the development operations undertaken post 2014 is identified and discussed upon. In condensation, the paper identifies, evaluates and proclaims the differences in the pace, status and nature of infrastructural development in both the regime, thus outlaying a comparative analysis of the two deemed time period

Keywords: *Terrain-Induced Underdevelopment, Comparative Policy Evaluation, Infrastructure Deficit Indexing*

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Introduction

The North-eastern states of India is attributed the title of "Ashtalakshmi states" by our honourable Prime Minister, Shri Narendra Modi and the terminology accurately portrays the economic prominence of the states. Notably, the region shares 4500 kilometres of external border with Bhutan, China, and Myanmar, which offer substantial trade opportunities in the region. Furthermore, the region's history states the presence of robust integration of the region with trade routes that passed through Burma, Bhutan, and Tibet, reaching as far as China. The northern highlands of Assam were also connected by routes that linked the area to regions such as Afghanistan and the western parts of the Indian subcontinent. These trade routes facilitated the trade of local goods that were product of the native handicraft and craftsmanship skills. The region is major inventory of natural resources including oil, coal, minerals etc designating it as a potential supplier of raw materials for major booming industries. The region is rich in cultural and traditional heritage and is a home to a number of heterogenous communities and tribes, each with their own unique culture and traditions. These aspects carve the region as a potential goldmine for industries and economic operations. However, there exist a number of bottlenecks that severely hinder the realisation and utilization of the full economic potential of this region. The North-eastern states have a long history of neglect and the situation worsened post-partition and formation of Bangladesh. Post partition, the region was majorly isolated from mainland India as it was left with just a 22-kilometer link to the Indian mainland through the Siliguri corridor, also known as the "Chicken's Neck corridor". This posed as the major drawback for the region and made it majorly vulnerable. This gave rise to major reluctances in injecting capital and investments in the region till the early 2010s which led to sluggish development of the region. Furthermore, the geographical structure of the region posed as a major challenge in setting up industries, and the remoteness of the region from the mainland India made transportation and logistics both uneconomical and challenging. This neglect of the North-eastern states for a substantial period post-independence has further propelled the poor development or an absolute absence of necessary infrastructure to support industrial and economic operations. However, the scenario has underwent major transformations in the recent decades. Dedicated ministries like Ministry of Development of North Eastern Region

(MDoNER) and **Ministry of Home Affairs (MHA) – North East Division have been setup** to fuel development in the region. Numerous steps and policies like surges in budget allocation, Look east policy (later Act east Policy (AEP)), North East Special Infrastructure Development Scheme (NESIDS), North East Road Sector Development Scheme (NERSDS) have been enacted aiming at fulfilling the infrastructural deficiency of the region. The paper aims to assess the progression, efficiency and status of development of vital infrastructures ,following various development initiatives.

Literature Review

The North-East region of India, has historically lagged behind the rest of the country in infrastructure development, despite being rich in natural and human resources. Scholars and policy analysts have attributed this underdevelopment to a combination of historical neglect, difficult terrain, insurgency problems and political instability. Over the years, successive governments have launched various policies and programs to bridge this gap. This literature review compares the infrastructure initiatives taken during the United Progressive Alliance (UPA) and National Democratic Alliance (NDA) regimes, drawing from both academic and policy-based evaluations.

A. UPA Era (2004–2014): Expansion with Constraints

During the UPA tenure, the government undertook several flagship initiatives aimed at improving connectivity and infrastructure in the North-East. The North Eastern Region Vision 2020, released in 2008, served as a roadmap for integrated development across the region. This document highlighted infrastructure — particularly roads, railways, and power — as the foundational pillars for development .

A study by Singh and Dutta (2012) notes that while road development under schemes like the Special Accelerated Road Development Programme for North-East (SARDP-NE) began under the UPA, implementation faced persistent delays due to bureaucratic bottlenecks and insurgency-related disruptions. Additionally, while the railway network saw some expansion, connectivity remained limited in comparison to other parts of India. According to Baruah (2013), the rail lines were often planned without considering local needs, reflecting a top-down planning approach.

In terms of power infrastructure, the UPA government emphasized hydroelectric potential but failed to translate many projects into reality due

to environmental and inter-state disputes. While funding mechanisms like the Non-Lapsable Central Pool of Resources (NLCPR) were strengthened, scholars like Borthakur (2014) argue that funds were underutilized due to lack of local capacity and institutional constraints.

B. NDA Era (2014–Present): Targeted Push and Geostrategic Emphasis

With the NDA coming to power in 2014, infrastructure development in the North-East was repositioned as part of a broader "Act East" policy framework. This marked a shift from purely developmental motives to also strategic and geopolitical imperatives. The establishment of the Ministry for Development of North Eastern Region (DoNER) was further empowered, with a strong push for connectivity and border infrastructure .

Under NDA, the pace of road and bridge construction notably accelerated. According to government data, over 3,800 km of roads were constructed under SARDP-NE Phase A and B by 2021, nearly double the pace during the UPA years . Projects such as the Bogibeel Bridge (completed in 2018) — India's longest rail-road bridge — became symbols of NDA's infrastructural ambition.

In railways, the NDA government emphasized connecting all NE state capitals with broad-gauge lines. As per Sharma (2020), there has been a visible increase in rail penetration and electrification projects under this regime, although challenges remain in hilly terrains .

The NDA government also invested heavily in air connectivity, launching the UDAN (Ude Desh ka Aam Nagrik) scheme, which improved airport infrastructure in places like Pakyong (Sikkim) and Hollongi (Arunachal Pradesh).

Furthermore, scholars such as Goswami (2021) argue that the NDA has adopted a decentralized approach, promoting local entrepreneurship and digital infrastructure through programs like Digital North East 2022 . This marks a significant departure from the UPA's more centralized planning model.

C. Comparative Evaluation

A comparative analysis of UPA and NDA regimes reveals both continuity and divergence. The UPA focused on policy frameworks and conceptual roadmaps, laying the groundwork for development. However, execution was hampered by delays and limited political prioritization. On the other hand, the NDA adopted an execution-driven model, emphasizing timelines,

geostrategic integration, and regional security considerations.

Critics argue that while NDA's model has delivered faster and more visible infrastructure outputs, it sometimes overlooks social and environmental safeguards. For instance, large projects in Arunachal Pradesh have faced resistance from local communities over displacement and ecological concerns . The literature indicates that while both regimes contributed to the North-East's infrastructure development, the NDA's tenure witnessed greater implementation efficiency and scale, influenced by both developmental and strategic motives. The comparative analysis underscores the importance of balancing infrastructure growth with inclusive, sustainable, and locally sensitive planning. However, a comparative analysis encompassing all the aggregate variables simultaneously with the consideration of major sectors, thus highlighting the comparative pace and progression of development with special emphasis being laid upon the infrastructural aspect was lacking, which gives rise to a potential research gap and this paper aims at addressing the very same.

Objectives

To evaluate the scale, adequacy and efficiency of development of vital infrastructures in North-eastern region post 2014

To compare the budget allocations towards development of vital infrastructures of North-East region pre and post 2014

Methodology

The objective of this study is to assess the scale, adequacy and efficiency of infrastructural development in North-eastern region while extracting the differences of budget allocation towards infrastructural development of North-East region, both with regards to time periods: pre and post 2014. Majorly secondary data is utilized with appropriate precautions in place to prevent any potential complications. Microsoft Excel has been utilized to perform and compute necessary operations in order to analyse the collected data and derive relevant conclusions.

Analysis and Findings

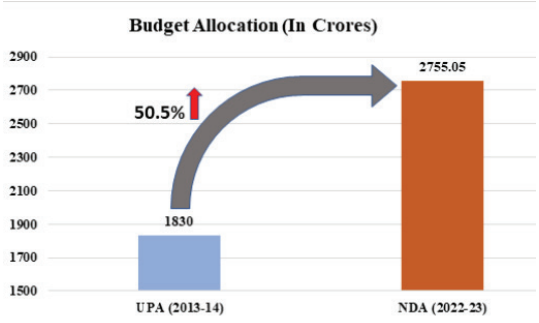
Infrastructure is one of the most vital requisites to fuel the development of any state or region. It lays the foundation that facilitates the establishment of industries and advanced economic operations. With special allusion to the North-eastern states, the state of infrastructure has been fairly grim since

a substantial period post-independence. Amongst the numerous factors determining the state of infrastructure, the budget allocated to fund the construction of infrastructure is of prime significance. Thus, the evaluation of the trends of budget allocation for infrastructural development for the time period under consideration is crucial if the deficit infrastructure is owed to sluggish economic assistance and efforts from the governments. However, it is to be noted that, "Infrastructure" is an umbrella term which includes an array of subjects and sectors. and evaluating each specific sector and aspect is beyond the scope of this study. Thus, certain vital sectors have been shortlisted and the trends of infrastructural development shall be evaluated with regard to these specific sectors. The sectors are Railways, Roadways, Waterways and Healthcare and some other miscellaneous sectors. These sectors are crucial as they are concerned with logistics and human resource well-being, and the adequate presence of these infrastructures are a major attraction for industries and firms to invest in the region.

1. Budget allocation to the Ministry of *Development of North Eastern Region (DoNER)*

The Ministry of Development of North Eastern Region established in September 2001, initially operated as a department and was later upgraded to full-fledged ministry in 2004, serves as the **nodal ministry** for coordinating and facilitating development efforts in the North-eastern region. The trend of union budget allocation to this ministry reflects the importance of the region. The trend is demonstrated diagrammatically as follows:

FIG: 1 Budget Allocation to the Ministry of Development of North Eastern Region (DoNER) 2013-14 vs 2022-23



Source: *PURVODAYA – Fulfilling the Aspirations of the Ashtalakshmi States., Pg no 12, Public Policy Research Centre, June 2023.*

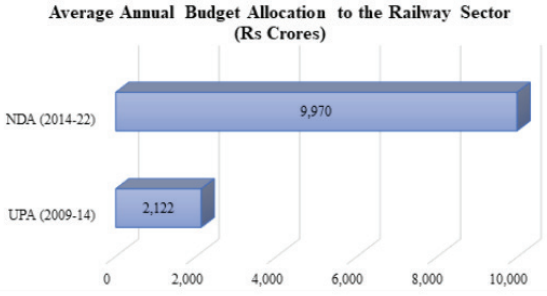
Observation of the diagram reflects a major surge in the budget allocation to the ministry in nominal terms which stands at about 50.5%. However, in real terms the budget allocation of 1830 crores in 2013-14 stands at approximately 3090 crores when adjusted for inflation in 2022-23. Thus, in real terms the budget allocated has decreased by about 10.9%. This may indicate towards potential hindrances in the expenditure incurred towards

infrastructural development and thus a fatigued state and pace of development. However, the actual impact shall be determined by the evaluation of the efficiency and scale of utilization of the allotted resources, as coupling higher allocated funds with poor utilization shall imply a poorer state of development as compared to a scenario of lower fund allocation but efficient utilization.

2. Budget allocation to the Railways

Railways has been the most crucial mode of logistics since the British era. The British had primarily developed the Railway infrastructure to facilitate trade at a global scale. This itself is the testimony of significance of the sector. The technology associated with any modern sector is dynamic and so is the case of Railways. The technology associated with Railways undergoes significant advancements over time .Thus, allocating budget so as to facilitate adaptation, keeping pace and implementation of these advancements is crucial for adequate infrastructural development of the sector. Thus, the trend of Budget allocation shall provide potential clues towards the scale of the progression of the sector in the two time periods under consideration and the same is diagrammatically portrayed as follows:

FIG:2 Budget Allocation to the Railway sector 2009-14 vs 2014-22



Source: *PURVODAYA – Fulfilling the Aspirations of the Ashtalakshmi States., Pg no 13 Public Policy Research Centre, June 2023.*

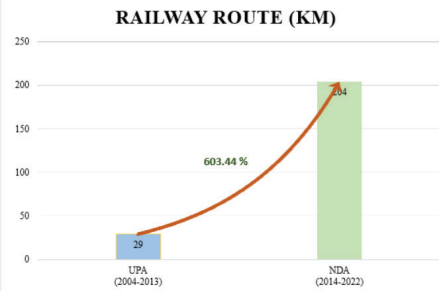
Careful observation of the diagram reveals several key insights. It can be observed that, there is a major surge in the budget allocation in 2014-22 as compared to the previous time period at the rate of 370% in nominal terms and about 191% in real terms (adjusted for inflation). This increment has potentially broadened the scope and possibility of development of railways infrastructure and services. A developed infrastructural framework shall facilitate logistic support to emerging industries and flourish trade and commerce fuelling overall regional development of the North-east region.

It is to be noted that budget allocation itself is not the sole indicator of the efficiency of infrastructural development. Even with limited budget allocation ,efficient implementation and utilisation of funds may usher in much of desired development. Thus, even though sectors like Railways have witnessed a major surge in budget allocation, the same should be backed by efficient execution so as to realise its potential to the fullest. Thus , analysing actual implementation at the field level alongwith budgetary allocations is important .

1. Development of Railway routes

The primary objective and function of the railway sector is to enhance the interconnectivity of every region of the state. To facilitate the same, construction of railway routes needs to be undertaken and construction of routes is perhaps most vital infrastructural development concerning the railway sector. With special emphasis on the North east region .the geographical landscape enhances the suitability of railways as compared to other modes of logistics and transportation, but not universally. Consequently, the scale of construction undertaken during the two time periods under consideration is diagrammatically shown as follows :

FIG: 3 Railway route constructed in 2004-13 vs 2014-22



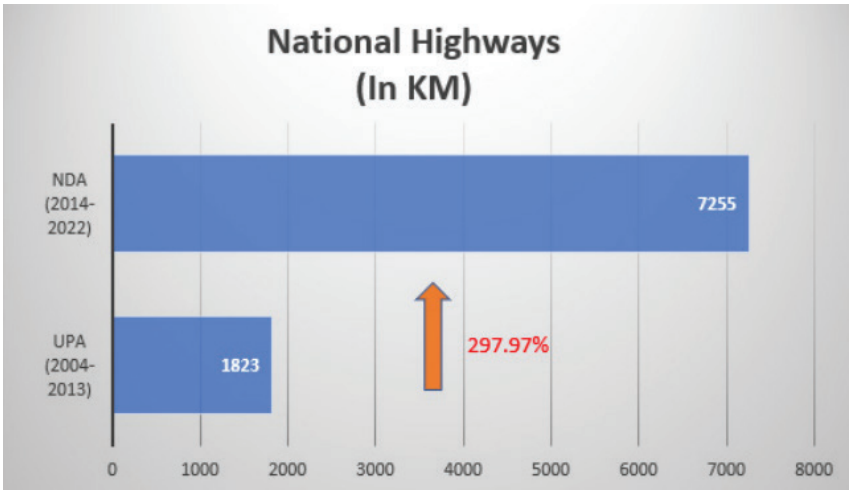
Source: *PURVODAYA – Fulfilling the Aspirations of the Ashtalakshmi States., Pg no 14, Public Policy Research Centre, June 2023.*

From the diagram it is clearly that there is a major surge in the railway routes in 2014-22 as compared to 2004-13. It is claimed that while Arunachal Pradesh and Manipur witnessed increments in their railway route from 01km to 12kms and 13kms respectively, Meghalaya got connected via railway route post 2014, as it got no railway connectivity since independence till 2014. Furthermore, new railway lines and capital links were undertaken. For instance, Itanagar and Agartala got to New Delhi via broad gauge (2015 and 2016 respectively), Dhansiri–Kohima railway line under construction to link Nagaland's capital, laying down of 111 km Jiribam–Imphal route with multiple tunnels and bridges to connect Manipur, Mizoram witnessing construction of 51 km broad-gauge Bairabi–Sairang line which is nearing completion and expected to reach Aizawl by mid-2025 and work on the Tetelia–Byrnihat–Shillong line has seen about 10 km finished so far. It may be mentioned here that Sikkim still has no rail connectivity which is a drawback worth highlighting. Nonetheless, it can be claimed that considerable developmental activities concerning the railway infrastructure has been undertaken post 2014 that has significantly enhanced the railway connectivity of the region and that the pace of development was quite slow in the period 2004-13.

2. Development of Roadways (National Highways)

Development of roadways is crucial as it is the primary mode of transportation and logistics. Better roadways ensure enhanced connectivity of the region with the rest of the sub-continent. Poor roadways infrastructure is a major hindrance for the growth of trade and commerce of a region. The geographical terrain of the North East region is a major challenge in establishing intra region connectivity. Under such circumstances, the development of adequate road infrastructure is crucial to ensure adequate intra region connectivity so that the vital sectors like tourism may flourish that shall reveal the aggregate development of road infrastructure of the region. It is diagrammatically presented as follows:

FIG: 4 National Highway constructed in 2004-13 vs 2014-22



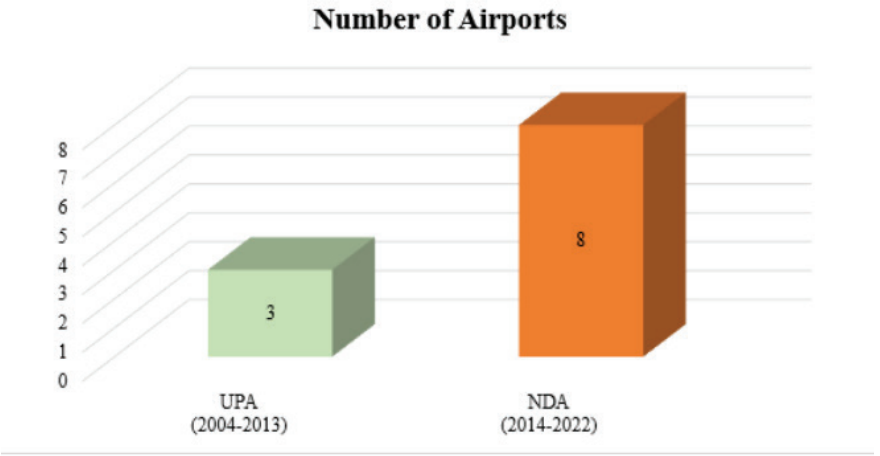
Source: *PURVODAYA – Fulfilling the Aspirations of the Ashtalakshmi States., Pg no 14, Public Policy Research Centre, June 2023.*

The diagram indicates a major surge in the construction of National highways in the region, with a 297.97% increase over the previous regime. Furthermore, the rate of construction increased from 0.6km per day in 2004-13 to 1.5km per day in 2014-22. This establishes the fact that National highways in the North-East flourished post 2014, thus impacting the vital sectors of the region like tourism and paving the path of establishment of industries thus boosting trade and commerce.

3. Development of Aviation sector

The aviation sector is perhaps one of the most crucial sectors of any modern economy. It majorly boosts the operations of an economy and enhances interconnectivity of across region. With special emphasis upon the North-East region, the aviation sector may potentially stand out as the most vital sector concerning transportation and logistics due to the major presence of hilly terrain in the region. The infrastructural development in the Aviation sector majorly encompasses the establishment of Airports.

FIG: 5 Number of Airports constructed in 2004-13 vs 2014-22



Source: *PURVODAYA – Fulfilling the Aspirations of the Ashtalakshmi States., Pg no 15, Public Policy Research Centre, June 2023.*

Diagram reveals that, the number of airports increased from 3 to 8 in 2014-22 which is more than double and close to thrice of the latter which itself explains the pace of development and construction concerning the Aviation sector.

4. Development of Health Infrastructure

A fast pace development of the health sector is crucial to ensure the well-being of the population, thus facilitating the adequate presence of a fit human resource inventory in the region. Since human resource is one of the most crucial elements of economic prosperity, poor health infrastructure shall majorly impact the health of the population leading to degraded efficiency of their productive services, thus hindering the overall development. The development efforts undertaken in each respective time periods are tabulated as follows:

TABLE I : Healthcare infrastructure 2004-13 vs 2014-22

Dimension	2004–2013	2014–2022
Health Facilities (PHCs, CHCs, Sub-Centres)	PHCs: ~1,430–1,450 CHCs: ~220–230 Sub-Centres: ~5,700 District Hospitals: ~36 Sub-divisional Hospitals: ~19	PHCs: ~1,560 CHCs: ~288 Sub-Centres: ~5,930 District Hospitals: ~37 Sub-divisional Hospitals:~22

Medical Colleges & Tertiary Care	3 Medical Colleges (Guwahati, Silchar, Assam Med) No AIIMS Minimal super-specialty care	6 new Medical Colleges (Tezpur, Diphu, Nagaon, Kokrajhar, Nalbari, AIIMS Guwahati) AIIMS OPD started in 2023 Super-specialty introduced
Outreach & Rural Access	GNRC Medireach (2012–13) Limited e-health coverage	Expanded MMUs Health & Wellness Centres under Ayushman Bharat Telemedicine pilots launched
Budget & Investments	Avg. ₹400 crore/year Initial planning of new colleges RSBY limited insurance coverage	Avg. ₹7,500 crore/year JICA, World Bank supported projects (Assam Health Project, ASSIST) Ayushman Bharat, Atal Amrit, Basundhara
Outcomes & Indicators	IMR: ~66–68 Institutional Deliveries: ~40% Low doctor-population ratio	IMR: ~36 Institutional Deliveries: 75%+ Improved MBBS seats and ratios
Overall Summary	Basic expansion Low investment Foundational improvements	Modernisation phase Tertiary infra boom Large-scale access and digitisation

The analysis of the data reveals that there has been no major development in health facilities including PHCs, CHCs and health centres with the increments being very marginal. However, with regards to the establishment of medical colleges and tertiary care infrastructures, notable accomplishments can be observed. Six new medical colleges have been opened and AIIMS had been inaugurated on 14th April, 2023 which is a big achievement for the region. Furthermore, other developments included expansion of MMUs and major increments in budget allocation. The impact of these developments is reflected by the indicators like IMR and percentage of institutional deliveries.

The infrastructural development that is being witnessed by the region is primarily backed by the implementation and execution of appropriate initiatives. These initiatives have made crucial contributions in the fast-paced infrastructural development of the region. Mere theoretical efforts levy very

little ground impact but post 2014, theoretical planning is affixed with on-field operations that has resulted in the prosperous development pace. A few vital initiatives undertaken during this period are highlighted as follows:

I. Establishment of new Industrial training institutes

One of the major initiatives undertaken to tackle unemployment and meet industry demand is the establishment of new Industrial Training Institutes (ITI). 30 new industrial training institutes have been setup in assam which is a major infrastructural development benefitting industries and the youth population of the state

II. Focus upon culture preservation in the state of Assam

Major emphasis has been laid upon preserving the cultural legacy of the state and the same is being facilitated by the establishment of various cultural centres in the state of Assam. This effort shall assist the blend of culture with the economy of the region and shall benefit the local craftsmen.

III. Development of roadways

The bulk of the **East-West Corridor**, popularly known as the **Mahasadak is completed by 2016, the full functional completion in the Northeast** especially in tough stretches near **Silchar and Imphal** was closer to **2018–2019**.

IV. Construction of Bridges

At least 5 bridges have been constructed over the Barak River to facilitate smooth conveyance. Furthermore, the work to transform 120 bridges into RCC bridges is underway.

V. Development of Housing Infrastructure

The government of assam under the Pradhan Mantri Awas Yojana has achieved a milestone of constructing nearly 5.19 lakh houses in a stretch of 4 years.

VI. Development in the Aviation sector

Significant efforts are being made to develop the aviation sector. The Airports Authority of India has undertaken operations to upgrade the Lokpriya Gopinath Bordoloi Airport and construct a new integrated terminal building which is expect to handle 4300 domestic and 200 international passengers during peak hours and 10 million passengers annually.

VII. Developments in the Railway sector

The prime minister has inaugurated the Bogibeel bridge which is

India's longest rail-road bridge. Furthermore, significant amount of budget is allocated to construct two bridges connecting North Guwahati to curb high congestion of traffic and facilitate the expansion of the north bank.

VIII. Emphasis on the Energy sector

Major emphasis is being laid upon the energy sector with significant proposals being made by the government in the sector, specifically, the operationalization of the Namrup Replacement powerplant and Myntriang small hydroelectric power project.

These initiatives provide adequate testimonial of the efforts that has been made by the government towards facilitating infrastructural development in the region.

Conclusion

The North-east region has potential to host modern economic operations and emerge as an economic hotspot. However, till 2014, lack of adequate infrastructure posed as a major bottleneck and the resolution of the same required major efforts .Nonetheless, analysis reveals that in the pre-2014 era, the efforts that were being made were substantially theoretical, and adequate plans were being laid down that mapped the journey of infrastructural development of the region. But the authorities back then majorly failed in the execution aspect and the plans never made out of the papers onto ground reality. This was coupled with ominous budget allocations that failed to economically assist the operations. Apparently, the pace of development of infrastructure was too sluggish. However, prolonged evaluations unveils that the scenario underwent major transitions post 2014. The state witnessed major surges in the budget allocation of sectors like railways, roadways and healthcare, which paved the way to implement and execute the planned measures and endeavours. This is further reinforced by the accomplishments that unfolded at the simultaneous time-period and all the sectors witnessed major infrastructural developments as compared to the previous regime. Thus, the scale, efficiency, adequacy and efficiency of infrastructural development has significantly improved in the post 2014 era and the same is accomplished with the active assistance of i increased budget allocation. The major bottlenecks that persisted in the pre-2014 era, i.e., poor budget allocation and degraded efficiency of operations is tackled and resolved to a large extent in the latter period that has facilitated the achievement of this milestone. However, it is to be noted that this era too

is not completely devoid of bottlenecks and inefficiencies. Analysis reveals that the increments in budget allocation to the Ministry of Development of North Eastern Region is inadequate and it is decreased in real terms despite of a nominal surge. Furthermore, quite a few numbers of projects are still underway and haven't been completed which is a drawback, however subjected to the fact that they have exceeded their stipulated and estimated duration of completion. The overall infrastructure status of the region has undergone major developments as compared to the pre-2014 era.

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On Comparing the Research Efficiency of Several Agricultural Stations: An Application of Data Envelopment Analysis

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Abstract

This study measures the efficiency of Zonal Research Stations (ZRS) affiliated with Assam Agricultural University (AAU) using Data Envelopment Analysis (DEA), a non-parametric method widely applied in operational research. The prime objective is to assess the relative performance of these research stations in utilizing resources such as scientist, area of cultivable land on total land, and experience as multiple inputs to achieve maximum research outputs like publications and salient advancements. The analysis classifies the research station on the level of their efficiency, providing insights into resource allocation, gaps, and areas for improvement. Among the six zonal research stations, Titabar and Shillongoni are found to be efficient research stations in terms of research outputs. This finding will help Assam Agricultural University for optimal resource uses across different zonal stations, enhancing the effectiveness of agricultural research and its impact on regional development.

Key Words: Data Envelopment Analysis, Linear Programming, Operation Research, Performance Measurement

1. Introduction

Agriculture plays a vital role in shaping the state's economy in Assam like several other Indian states. From the year 2016 to 2017, agriculture accounted for roughly 19 percent of the Gross State Domestic Product (GSDP), directly or indirectly employing nearly 70 percent of the population[8]. Assam Agricultural University (AAU) being the premier institution of northeastern India

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coordinates with six (6) zonal agricultural research stations which look after the research activities in the field of Agriculture in Assam. These six research stations are constantly making their efforts to address the issues in all possible areas. These six zonal research stations are situated in different zones of Assam *viz.* (i) Titabar in Jorhat district (ii) Shillongoni in Nagaon district (iii) North Lakhimpur in Lakhimpur district (iv) Gossaigaon in Kokrajhar district (v) Diphu in Karbi Anglong district and (vi) Karimganj district. The efforts were made by AAU in the field of agricultural research and disseminating generative technologies to the stakeholders through emphasizing agricultural development in Assam. It started with the establishment of rice experimental research stations at Karimganj and Titabar in the years 1913 and 1923 respectively. Thereafter the rest of the four (4) regional research stations were established under administrative control of Assam Agricultural University.

These zonal research stations are strategically located across different agro-climatic zones of Assam to serve diverse agricultural needs. Some of the crucial points concerning the agricultural needs for different zones of Assam are presented below:

- Each station focuses on addressing the unique challenges and opportunities presented by the local environmental conditions, soil types, and cropping patterns.
- These research stations play a crucial role in developing and disseminating innovative agricultural technologies, practices, and solutions that can enhance productivity, sustainability, and flexibility in farming communities.
- They also serve as centers for training and capacity building for farmers, extension workers, and agricultural professionals.
- These stations serve as hubs for conducting experiments, trials, and studies related to crop cultivation, pest management, soil health, and other agricultural aspects specific to their respective zones.

This study specifically concentrates on measuring the efficiency of these six AAU zonal research stations, since their role in the different zones is substantial towards the agricultural expansion of Assam and the overall development of Assam in general. Here the word "efficiency" refers to the ability to achieve a desired outcome with the minimum use of resources or effort. In general, it measures how well minimum utility of inputs are converted

into maximizing the outputs. To measure the efficiency of the zonal research stations, a non-parametric technique called Data Envelopment Analysis (DEA) is used. DEA constitutes an exceptionally adaptable instrument concerning the varieties of inputs and outputs in terms of their units of measurement. It is also not necessary to conform to any uniform standard, thereby rendering DEA suitable for a diverse array of organizations or regional research facilities. Being a non-parametric method to assess the efficiency of Decision-Making Units (DMUs), DEA does not require any functional form like parametric statistical method. Traditional efficiency measures often focus on a single input-output relationship, but DEA allows multiple input-outputs through a complex process and making it particularly useful in real world scenarios. It evaluates the relative efficiency of each DMU by comparing it to the best-performing units called the efficient frontier. The peer comparison provides meaningful insights into where inefficiencies exist and identifies best practices within the dataset that can be used as benchmarks. However, the input and output measures or factors must be identical while comparing the efficiency of the different DMUs. This technique not only provides an overall efficiency score for each DMU (*i.e.* zonal research station) but also helps to identify specific sources of inefficiency in zonal research stations which are considered for the study. For example, a particular zonal research station might be overusing certain inputs or underperforming in terms of research outputs relative to peers. This diagnostic capability is valuable for decision-makers looking to improve the performance of underperforming zonal research stations. Therefore, from their (*i.e.* zonal research stations) establishment under AAU, this study tries to examine the efficiency of six AAU zonal research stations using data envelopment analysis (DEA) through a common set of inputs and outputs.

2. Review of Literature

One of the most widely used methods for comparing efficiency between units is Data Envelopment Analysis (DEA), a non-parametric linear programming technique introduced by Charnes, Cooper, and Rhodes (1978). Data Envelopment Analysis (DEA) can be applied in a large range of fields to assess the performance or efficiency of different decision-making units (DMUs) e.g. companies, departments, hospitals, schools, or other organizational units through a common set of measures or factors. DEA is particularly valuable for organizations with multiple units because it accommodates multiple inputs

and outputs, offering a nuanced picture of performance across different contexts (Thanassoulis, 1993). Efficiency is defined as the ability to maximize outputs while minimizing inputs, and it is a key indicator of an organization's operational performance (Farrell, 1957). Efficiency is a critical metric for organizations, reflecting how well resources are utilized to achieve output. As organizations strive for competitiveness, sustainability, and operational excellence, comparing the efficiency of different units becomes essential. This practice allows organizations to assess performance, identify best practices, allocate resources efficiently, and address inefficiencies, ultimately leading to improved overall performance. This literature review explores the necessity of comparing the efficiency of different units within the same organization, supported by relevant theoretical and empirical studies.

Recently, several studies have used DEA techniques to assess university performance and rankings. In healthcare organizations, DEA has been used to compare the efficiency of different hospitals or departments, helping management identify areas where resource use can be optimized (Ozcan, 2014). This model provides actionable insights by highlighting which units are performing well and which ones need to improve, making it a valuable tool for organizations in various industries. Data envelopment analysis was used by the State Agrarian University of Moldova to analyze the academic departments' performance and efficiency (Cercel *et al*, 2019). The input and output criteria are developed and assessed using the academic staff performance measurement scheme of the department. Twelve inputs and two outputs that significantly affected the productivity of the academic departments were selected. After a productive investigation, academic departments were assessed according to their performance efficiency, and a goal efficiency score was established (Sirbu, 2016). DEA has also been employed at Turkey's Dokuz Eylul University to gauge departmental performance levels. Based on technical and scale ratings, Goksen *et al.* (2014) examined the main causes of inefficiency. A noteworthy signal that requires a thorough evaluation is the teaching performance metric. Performance metrics can be established by utilizing DEA models to construct the instructional performance index. Zhang *et al.* (2019) looked at 24 Chinese colleges and universities to evaluate the distinctiveness and effectiveness of each institution. While teaching performance analysis's unique adjustment values and progress trajectory are highlighted by DEA analysis. There is an

interesting relationship between the multi-objective linear programming (MOLP) problem and the DEA problem. The common weight method to DEA that is based on MOLP has been used by several writers. Also, Zhang *et al.* (2019) presents a new linear programming problem to compute the efficiency of a decision-making unit (DMU). Unlike other multi-objective DEA models now in use, the suggested model's objective function is the difference between inputs and outputs rather than the ratio of inputs to outputs. Then, based on the established linear programming problem, a MOLP problem is designed to compute the common weights for all DMUs. More precisely, the modified Chebychev distance and the ideal point of MOLP are used to derive common weights. The dual problem is also investigated in relation to this paradigm. The paper's concluding case study, which assesses the R&D productivity of ten Taiwanese TFT-LCD businesses, serves as an example of this innovative approach. Their multi-objective DEA model performs better than the traditional DEA model and some of the most important multi-objective DEA models that are currently available (Chen *et al.*, 2009).

The piece-wise linear approximation of the production frontier provided by DEA is useful in cases of economies of scale or specialization. If the genuine border is not concave, the approximation is typically not very good. Kuosmanen *et al.* (2002) suggest extending DEA towards a more general piece-wise quadratic approximation, termed Quadratic Data Envelopment Analysis (QDEA), to increase the empirical fit and improve the flexibility of the DEA frontier. They demonstrated that for any production frontier with constrained Hessian eigenvalues, QDEA provides statistically consistent estimates. When compared to typical DEA models, Monte-Carlo simulations indicate that QDEA can significantly enhance efficiency estimation in finite samples. Another issue is that the progress ratings and attractiveness of the original context-dependent DEA may have been meaningless. It might not be fair to say that a DMU is more attractive only because it has a higher attractiveness score, for the same reasons that it is inappropriate to compare the performance of inefficient DMUs only based on their efficiency scores. The DEA model that integrates cross-efficiency analysis addresses the shortcomings of the original context-dependent DEA (Lim, 2012).

The Times League Table's ability to sway applicants' decisions is assessed in a case study of applicants at a UK comprehensive school. It illustrated how

DEA may be applied to the creation of customized individual league tables as a decision support tool to assist potential students in making an educated choice (Sarrico, 1997). Rates of change of outputs with respect to inputs along efficient facets of the Pareto-optimal frontier shared by several empirical production possibility sets are computed using DEA. As a prerequisite, a theoretical study to identify the efficient features is provided. The non-negativity of these rates of change was described by Huang (1997) using "one direction" to explain changes in the input and output spaces. The choice of variables in DEA is a subject of continuous debate because there are no diagnostic checks for model misspecification. The data are modelled using Cobb-Douglas production processes with varying returns-to-scale (RS): constant, increasing, and decreasing. For constant and decreasing RS processes with irrelevant inputs, DEA tends to overestimate efficiency in almost all production units.

As organizations expand, they often create new units or divisions, each with unique challenges and opportunities (Lovell & Pastor, 1999). Regularly comparing the efficiency of these units helps ensure that growth is managed effectively and that all units are aligned with the organization's overall strategic objectives. Efficient units often follow processes, utilize technologies, or adopt strategies that could be replicated by less efficient units (Luo & Donthu, 2006). By comparing units, organizations can benchmark their operations and establish the best practices that drive overall improvement. Best practice identification is an important step in continuous improvement programs such as Total Quality Management (TQM) and Lean Six Sigma (Ritchie & Dale, 2000). These methodologies rely heavily on the identification and standardization of efficient processes, which can only be achieved through comparative analysis across units. Benchmarking is closely linked to efficiency comparisons. Efficiency comparison highlights disparities in performance that may arise from differences in management practices, technologies used, or the skill levels of employees (Banker, Charnes, & Cooper, 1984).

In any organization, resources such as capital, labor, and technology are limited, and their allocation has a direct impact on overall performance (Coelli, Rao, O'Donnell, & Battese, 2005). By comparing the efficiency of units, management can prioritize resources toward areas that offer the greatest return on investment. Moreover, if one unit consistently outperforms others in terms of output relative to input, it may be a candidate for scaling or further

investment, while underperforming units may require restructuring or even downsizing (Sherman & Zhu, 2006). When units are evaluated against each other, it fosters a competitive environment where managers are incentivized to improve efficiency and innovate (Nguyen & Truong, 2020). Establishing clear benchmarks ensures that each unit is held accountable for its resource use and outputs. Performance-based incentives, such as bonuses or recognition, can be tied to efficiency metrics, encouraging managers to optimize their operations (Harris, 2001). Efficiency comparison reveals where these inefficiencies exist, providing management with the information needed to make targeted improvements (Cook, Tone, & Zhu, 2014). This process not only enhances the performance of individual units but also improves the overall efficiency of the organization (Fried, Lovell, & Schmidt, 2008).

The necessity of such a study lies in its ability to illuminate disparities in resource use and output across departments, which often operate under unique constraints and objectives. Academic institutions face increasing pressures to optimize resources and demonstrate value, particularly as educational standards and accountability rise. By identifying inefficiencies and areas of high performance, DEA can offer actionable insights for university administrators aiming to improve resource distribution, promote best practices, and foster an environment of continuous improvement. Furthermore, efficiency comparisons have broader implications for strategic decision-making, helping to inform policies related to faculty incentives, resource prioritization, and potential restructuring.

This analysis of efficiency also aligns with the university's objectives to elevate research standards and quality. DEA studies, such as those conducted in other universities, reveal patterns that correlate high efficiency with innovative practices, effective resource use, and targeted faculty or scientist's support. Thus, by focusing on zonal research stations efficiency of Assam Agricultural University, the study enables the identification and replication of successful practices across the research stations, contributing to institutional growth and competitive positioning within the educational landscape.

3. Objective of the Study

The main objective of the study is to measure the efficiency of AAU zonal research stations through some common set of factors and to identify the best performing zonal research stations affiliated to Assam Agricultural University

in terms of research outputs.

4. Data and Methodology

4.1 Data Collection

In DEA, the concept of input and output variables is essential to comprehend the significance of these variables to interpret the findings made by this analytical technique. Usually, the resources of each decision-making unit used to produce goods or services are referred to as inputs and the results that these inputs create are known as outputs. The evaluation of efficiency for decision-making units is based on the relationship between inputs and outputs. A unit is deemed efficient if it utilizes limited input resources to achieve the specific levels of outputs or generates the highest outputs. The careful selection and explanation of these variables or factors ultimately enhance the insights gained through DEA, promoting more informed decision-making and effective organizational performance.

The selection of appropriate factors to assess the performance of AAU (Assam Agricultural University) zonal research stations is a critical aspect in conducting Data Envelopment Analysis (DEA). In this study, six AAU zonal research stations under the administrative purview of Assam Agricultural University are considered.

Table 1: Factors for AAU Zonal Research Stations to Measure Efficiency

AAU Zonal Research Stations	Employees (X_1)	Cultivable Area (X_2)	Experience (X_3)	Distance (X_4)	Achievements (Y_1)	Projects (Y_2)
Titabar	12	40	100	19.5	232	105
Diphu	8	5.31	50	153.7	2	4
Gossaigaon	5	113	39	501.1	1	23
Karimganj	4	13	50	430.3	2	9
North-Lakhimpur	6	11	43	157	45	19
Shillongoni	16	5.71	50	236	591	29

The factors chosen to capture the operational scope and performance of the research stations include: Scientists (comprising Chief Scientist, Principal Scientist, Senior Scientist, and Junior Scientist), Cultivable Area (area of cultivable land on total land), Experience (number of years of operation since the station's establishment), Distance (from the AAU main campus in Jorhat), Achievements (as measured by key outputs such as salient achievements,

research articles, books, book chapters, and theses), and Projects (both ongoing and completed). Among these factors Scientists, Cultivable Area, Experience, and Distance - serve as input variables and Achievements and Projects - are designated as output variables under DEA. These factors were sourced from the official AAU website (*www.aau.ac.in*) and reflect the progress and operational performance till 26th January 2023 (*cf.* Table 1).

3.2 Data Envelopment Analysis

The Data Envelopment Analysis (DEA) is a way in which efficiency can be increased of a unit called as the Decision-Making Unit or DMU. The idea of DEA is –

$$Efficiency\,(E) = \frac{Output}{Input} \quad \text{or} \quad = \frac{Weighted\ sum\ of\ outputs}{Weighted\ sum\ of\ inputs} \qquad \ldots (1)$$

Thus, the aim in DEA is to maximize the efficiency that is called *E*. More precisely, there are (say) *n* identical decision-making units and if $u_{1q}, u_{2q}, \ldots u_{qn}$ are *m* inputs and $v_{1q}, v_{2q}, \ldots v_{q}$ are the *r* corresponding outputs of the q^{th} DMU (q = 1, 2, ..., n) then we define the efficiency *E* of the q^{th} DMU as

$$E_q = \frac{\sum_{k=1}^{r} w_k v_{kq}}{\sum_{j=1}^{m} w_j u_{jq}} \qquad where \quad 0 \le E \le 1$$

where w_j (j = 1, 2, ..., m) is the weight associated with the j^{th} input and w_k (k = 1, 2, ..., r) is the weight associated with the k^{th} output.

The evaluation of the efficiency of the unit U_q by a DEA model consists of maximization of its efficiency score under the constraints that the efficiency score of all other units can't be greater than 1 (100 %). The weights of all inputs and outputs must be greater than zero for the model to include all the characteristics. Such a model can be formulated as follows –

$$Z = Maximize \frac{\sum_{k=1}^{r} w_k v_{kq}}{\sum_{j=1}^{m} w_j u_{jq}}$$

subject to constraints

$$\frac{\sum_{k=1}^{r} w_k v_{kq}}{\sum_{j=1}^{m} w_j u_{jq}} \leq 1 \quad for\ q = 1,2,\ldots,n$$

$$w_j > 0 \quad for\ j = 1,2,\ldots,m$$

$$w_k > 0 \quad for\ k = 1,2,\ldots,r$$

The above model is being run in the ***R*** software with the packages called "**rDEA**" and "**knitr**" to get the desired results and it is presented in the succeeding section along with the tables as well as casual graphical representation. The corresponding code is provided in the Appendix-A of the paper.

5. Results and Discussions

Now by maximizing the equation (3), we could attain the efficiency score of each DMUs which lies between 0 and 1. The results obtain from the ***R*** software is presented in Table 2 where efficiency scores and lambda values are present for each DMUs. Each lambda value (also called as shadow prices) shows how much weight or influence a particular DMU has in determining the efficiency score of another DMU under evaluation. If a DMU's efficiency is being analyzed and its DEA solution includes high lambda values for certain peer DMUs, those peers closely represent the efficiency benchmark for that DMU. Lambda values thus help to identify the efficient "peer group" or reference set against which inefficient DMUs are compared. This approach enables DEA to identify best-performing units and to provide insights on how inefficient units can improve by examining efficient peers.

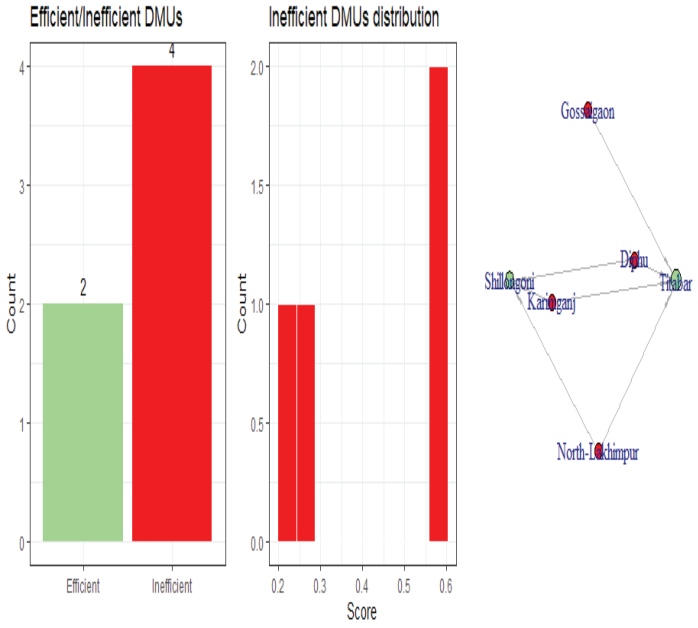
Table 2: Efficiency Score and Lambda Values Results of DEA

	Efficiency	**Lambda Values**					
		Titabar	**Diphu**	**Gossaigaon**	**Karimganj**	**North Lakhimpur**	**Shillongoni**
Titabar	1.0000	1.00	0	0	0	0	0.00
Diphu	0.1978	0.01	0	0	0	0	0.09
Gossaigaon	0.5617	0.22	0	0	0	0	0.00
Karimganj	0.2630	0.09	0	0	0	0	0.00

North Lakhimpur	0.6027	0.15	0	0	0	0	0.11
Shillongoni	1.0000	0.00	0	0	0	0	1.00

The lambda values are the constraints limiting the efficiency of each DMU that are less than one (< 1). Now if we look at the "Efficiency" column of the Table 2, we could find that ZRSs Diphu, Gossaigaon, Karimganj and North-Lakhimpur have efficiency value less than one (i.e. $E < 1$). So, these zonal research stations are not efficient in comparison to ZRS Titabar and Shillongoni. To improve the efficiency level of ZRSs Diphu, Gossaigaon, Karimganj, North-Lakhimpur one can take the help of lambda values from Table 1. For example, for the inefficient DMU North-Lakhimpur, the benchmark DMUs are ZRS Titabar and Shillongoni. Their corresponding lambda values are 0.15 (Titabar) and 0.11 (Shillongoni) respectively. Thus, the recommendation for North-Lakhimpur can be computed as given in Table 3.

Figure 1: Casual Loop Diagram of Efficient and Inefficient Research Stations



The above casual loop diagram depicts comparisons among different research stations. The green colour bubbles represent the efficient DMUs, and the red colour bubbles represents the inefficient DMUs. These interactions

can encourage inefficient DMUs like Noth-Lakhimpur, Karimganj, Diphu and Gossaigaon to adopt best practices observed in the efficient DMUs like Titabar and Shillongoni. However, inefficiencies may also lead to adjustments in operations, aiming to push the inefficient research station towards efficiency.

Table 3: Use of Resources by ZRS North-Lakhimpur

	Titabar			Shillongoni			Total Sum	North Lakhimpur	Uses
	Values (1)	Lambda (2)	Total (1) × (2)	Values	Lambda	Total			
X_1	12	0.15	1.8	16	0.11	1.76	3.560	6.000	2.440
X_2	40	0.15	6	5.71	0.11	0.6281	6.628	11.000	4.372
X_3	100	0.15	15	50	0.11	5.5	20.500	43.000	22.500
X_4	19.5	0.15	2.925	236	0.11	25.96	28.885	157.000	128.115
Y_1	232	0.15	34.8	93	0.11	10.23	45	45.000	0
Y_2	105	0.15	15.75	29	0.11	3.19	19	19.000	0

Thus, the ZRS North-Lakhimpur is using excess of Employees, Cultivable Area, and Experience which needs to be reduced by 2.44, 4.372, and 22.5 units respectively and attain the same output and hence attain the same efficiency as the ZRS Titabar and Shillongoni. However, there is less practice of Achievements which needs to be increased by 54.81 units.

Note that for the factor distance no conclusion is being drawn from Table 2 as the value of this factor cannot be changed but it needs to be considered to measure the efficiency level of the zonal research stations. Similarly, we could have table for ZRSs Diphu, Gossaigaon and Karimganj as well.

Table 4: Use of Resources by ZRS Diphu

	Titabar			Shillongoni			Total Sum	Diphu	Uses[1]
	Values (1)	Lambda (2)	Total (1) × (2)	Values	Lambda	Total			
X_1	12	0.01	0.120	16	0.09	1.440	1.560	8.000	6.440
X_2	40	0.01	0.400	5.71	0.09	0.514	0.914	5.310	4.396
X_3	100	0.01	1.000	50	0.09	4.500	5.500	50.000	44.500
X_4	19.5	0.01	0.195	236	0.09	21.240	21.435	153.700	132.265
Y_1	232	0.01	2.320	93	0.09	8.370	11	3	-8
Y_2	105	0.01	1.050	29	0.09	2.610	4	4	0

So, ZRS Diphu is using excess of Employees, Cultivable Area, and Experience which needs to be reduced by 6.440, 4.396, and 44.500 units respectively and attain the same output and hence attain the same efficiency as the ZRS Titabar and Shillongoni. However, there is a less practice of Achievements which needs to be increased by 8 units to attain the same efficiency level of ZRS Titabar and Shillongoni.

Table 5: Use of Resources by ZRS Gossaigaon

	Titabar			Gossaigaon	Uses
	Values (1)	**Lambda (2)**	**Total (1) × (2)**		
X_1	12	0.22	2.640	5.000	2.360
X_2	40	0.22	8.800	113.000	104.200
X_3	100	0.22	22.000	39.000	17.000
X_4	19.5	0.22	4.290	501.000	496.710
Y_1	232	0.22	51.040	5	-46
Y_2	105	0.22	23.000	23.000	0

Hence, ZRS Gossaigaon is using excess of Employees, Cultivable Area, and Experience which needs to be reduced by 2.360, 104.200, and 17.000 units respectively and attain the same output and hence attain the same efficiency as the ZRS Titabar. However, there is very little practice in Achievements, which could be increased by 46 units. Therefore, there are lot of opportunities for ZRS Gossaigaon to work on publication of research articles, books and book chapters along with salient achievements like copyright and patent publications so that the efficiency score could be improved to level with ZRS Titabar.

Table 6: Use of Resources by ZRS Karimganj

	Titabar			Karimganj	Uses
	Values (1)	**Lambda (2)**	**Total (1) × (2)**		
X_1	12	0.09	1.080	4.000	2.920
X_2	40	0.09	3.600	13.000	9.400

X_3	100	0.09	9.000	50.000	41.000
X_4	19.5	0.09	1.755	430.000	428.245
Y_1	232	0.09	20.880	3	-18
Y_2	105	0.09	9.000	9.000	0

Therefore, ZRS Karimganj uses an excess of Employees, Cultivable Area, and Experience which needs to be reduced by 2.920, 9.400, and 41.000 units respectively and attain the same output and hence attain the same efficiency as the ZRS Titabar. However, there is less practice in Achievements, which could be increased by 18 units like ZRS Gossaigaon.

5. Conclusion and Future Scope of the Study

The study utilized Data Envelopment Analysis (DEA) to evaluate the efficiency of Zonal Research Stations (ZRS) affiliated to Assam Agricultural University (AAU), such as Titabar, Diphu, Gossaigaon, Karimganj, North-Lakhimpur, and Shillongoni. The efficiency scores, derived through DEA, indicate that only ZRS Titabar and Shillongoni operate at full efficiency with a score of unity (100 %), while the other research stations exhibit inefficiencies, as their efficiency scores fall below unity. The inefficiency of ZRS Diphu, Gossaigaon, Karimganj, and North-Lakhimpur suggests that these stations could enhance their performance by optimizing resource usage and aligning more closely with the practices of the benchmark efficient units, ZRS Titabar and Shillongoni. The analysis highlighted the need for resource adjustments across the inefficient stations. For instance, ZRS North-Lakhimpur requires reductions in the usage of Employees, Cultivable Area, and Experience while also increasing the practice of Achievements to match the efficiency levels of the benchmark stations. Similarly, ZRS Diphu needs to decrease its excess use of Employees, Cultivable Area, and Experience, while enhancing its Achievements. The ZRS Gossaigaon and Karimganj also exhibit similar patterns, with a need to reduce the use of excessive resources and increase the underutilized practices to achieve optimal efficiency.

The findings of the study provide insights for enhancing the performance of inefficient ZRS by identifying specific areas of resource adjustments, thereby fostering a more balanced and effective use of available resources.

By adopting the practices of the efficient ZRS, the inefficient zonal research stations can potentially improve their productivity and overall performance. This study's insights can be extended in several ways to enhance the efficiency and performance of Zonal Research Stations. Future research could explore dynamic models of DEA to assess efficiency over time, capturing variations in performance due to temporal changes in resource allocation and operational strategies.

The approach outlined for evaluating efficiency in AAU zonal research stations using Data Envelopment Analysis (DEA) and benchmarking against international standards can be applied to numerous other sectors and areas too.

- It can be used to compare the efficiency of hospitals, both within a region or within a country. Input variables might include the number of medical staff, bed count, and funding, while output variables could be patient outcomes, service quality, and recovery rates.
- Universities and schools can use DEA to measure the efficiency of different campuses or departments. Inputs could be faculty numbers, funding, and student enrolment, while outputs might include graduation rates, publications, and employment outcomes.
- In manufacturing, DEA could be applied to compare production units in terms of input factors like labour, energy, and raw materials, while output measures could include product quality, volume, and profitability.
- Banks can be evaluated based on their branch-level performance, with inputs such as workforce size, branch infrastructure, and capital, and outputs like customer satisfaction, profitability, and loan disbursements.

In the current work, incorporating additional factors, such as technological advancements, financial management practices, and external environmental factors, could offer a more holistic evaluation of the stations' efficiency. The integration of such variables might reveal deeper insights into the underlying causes of inefficiency and highlight areas where strategic interventions could be most effective. Additionally, there are scope for employing other advanced techniques like Artificial Neural Networks (ANN) and Machine Learning (ML) models in conjunction with DEA. These models can help to predict future efficiency scores based on past data, assisting in proactive decision-making and strategic planning for resource optimization.

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***

Appendix-A

```
library(rDEA)                          ###  Calling the package rDEA
library(knitr)                         ###  Calling the package knitr
library(readxl)                        ###  Calling the package readxl
data <- read_excel("C:/Users/HP/Desktop/DEA_ZRS_Data.xlsx")
view(data)                             ###  View the data in R import from Excel
Y=data[c("Achivements","Projects")]###  Define output variables
X=data[c("Employees","Cultivable Area","Experience","Distance")]
                                       ###  Define input variables
model=dea(XREF=X, YREF=Y,X=X[,],Y=Y[,],model="input",RTS="constant")
                                       ###  running DEA model based on input
                                            and output variables
result=cbind(round(model$thetaOpt,4), round(model$lambda,2))
                                       ###  getting results from DEA model
rownames(result)=data [[1]]            ###  assigning row names for result
                                            matrix
colnames(result)=c ("Efficiency", rownames(result))
                                       ###  assigning column names for result
                                            matrix
kable (result [,])                     ###  displaying the result in matrix form
library(deaR)                          ###  calling the package deaR for
                                            graphical output
data_graph <- make_deadata(datadea = data,inputs = 2:5,outputs = 6:7)
                                       ###  creating a casual loop diagram using
                                            deaR pcakage
result <- model_basic(data_graph)      ###  saving the graph in result
plot(result)                           ###  output of the casual loop diagram
```

Appendix-B

AAU Zonal Research Station Karimganj: This station became part of the university in the year 1973 to conduct research in the districts of Cachar, Karimganj, and Hailakandi which make up the Barak Valley Zone (BVZ) of Assam. The research station is still primarily focused on rice research.

AAU Zonal Research Station Titabar: The station is situated in Titabar town which is 20 kilometers south of the AAU main campus in Jorhat. It has become part of the university in the year 1980 to carry out rice research in the Upper Brahmaputra Valley Zone (UBVZ), which includes the districts of Tinisukia, Dibrugarh, Sivasagar, Jorhat, and Golaghat.

AAU Zonal Research Station Shillongoni: It is situated around 5 km northwest of Nagaon town and was incorporated into Assam Agricultural University in 1985. It consists of the districts of Nagaon, Morigaon, and Hojai. It is in Assam's Central Brahmaputra Valley Zone, which is highly conducive to farming.

AAU Zonal Research Station North-Lakhimpur: It is near the Gorumuria village, five kilometers east of the Lakhimpur town. This station coverups the six districts of Assam viz. Darrang, Udalguri, Sonitpur, Biswanath, Lakhimpur, and Dhemaji. With its abundance of ecologies—deep water, semi-deep water, lowland, and highland areas—the station is perfect for conducting rice research, especially rice grown under stress situation.

AAU Zonal Research Station Diphu: This station has been serving the three hill districts of Assam viz. Karbi Anglong, West Karbi Anglong and Dima Hasao in many different aspects of Agriculture under administrative control of AAU since the year 1973. The entire hill zone receives varying climates in different regions of the districts due to the huge variations in topology. There is a mix of dry belt zone and rain shadows. A fully developed vegetation is a blessing despite the odds, and the research station Diphu has managed to continue many more ongoing projects and developments to this day.

AAU Zonal Research Station Gossaigaon: The Lower Brahmaputra Valley Zone (LBVZ), which includes the districts of Kamrup, Nalbari, Borpeta, Goalpara, Kokrajhar, and Dhubri, is served by this station in Gossaigaon. It was founded in 1980 under the administration of AAU. When it comes to agricultural research, this is the leading station in all of Assam for crops like buckwheat, niger, linseed, etc.

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NSDP in the pre and post-DoNER periods for the North Eastern States of India: A Structural Break Analysis

Heisnam Deepak Singh & Tennyson Pangambam[9]

Abstract

This paper examines the impact of the establishment of the Ministry of Development of North Eastern Region (DoNER) in 2001 by analysing its impact on the economic growth of seven Northeastern states of India - Arunachal Pradesh, Assam, Manipur, Meghalaya, Nagaland, Sikkim and Tripura. The objective of this paper is to explore how DoNER has affected economic growth in the seven Northeastern states of India, compared to the limited federal support these areas received prior to DoNER's establishment. This study utilizes a comparative analysis by collecting data for Net State Domestic Product (NSDP) of pre-DoNER starting from 1980-81 to 2000-2001 time period and post-DoNER NSDP from 2001-2002 to 2022-2023 time period from data released by the RBI. Further, this study uses the Augmented Dickey-Fuller (ADF) test to determine if a unit root is present in this time series model. After this stationary test, the Chow-test is used to check for structural break corresponding to the establishment of DoNER in all the seven states considered. The major finding of this study is that only Assam experienced a statistically significant structural break in its NSDP 2001. Every state has shown an increasing NSDP growth but without a structural break in their NSDP growth. Only Assam reflects a significant impact of the establishment of DoNER whereas we cannot conclude the same for the other states. Finally, a two-samples t test employed for Assam also finds a significant increase in the mean NSDP in the post-DoNER period as compared to the pre-DoNER period.

Keywords: Net State Domestic Product, DoNER, Augmented Dickey-Fuller test, Chow test, Structural Break, two-samples t test.

Introduction

The North Eastern Indian States, comprising eight states, have been a focal point

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for economic development in recent years. The region has faced numerous challenges, including geographical constraints, inadequate infrastructure, and lack of resources. The North Eastern Region (NER) has, however, shown tremendous potential for growth, and various initiatives have been undertaken to stimulate the economy.

The Department of Development of North Eastern Region (DoNER) set up in 2001 coordinates the development efforts in the NE region. It was converted into a Ministry in 2004. The North Eastern Council, Shillong, set up in 1971 is under the administrative control of Ministry of DoNER. It is the only Ministry which has a territorial jurisdiction. Ministry of Development of North Eastern Region implements, through State Governments and some Central Ministries, Schemes of Non-Lapsable Central Pool of Resources (NLCPR) and funds for Special Packages are provided. North Eastern Council (NEC) is a statutory Regional Planning Body. It also provides financial assistance for a variety of projects including infrastructure projects like construction of roads, improving air connectivity etc. through State Governments. The Ministry aims to give focused attention to address the special needs of the region. It coordinates with various Ministries/ Departments primarily concerned with development activities in NER. However, respective Ministries/Departments will remain responsible for implementation of programmes in their respective fields.

VISION:

- Transforming North East Region through Development, in Sustainable yet Accelerated manner, affording comprehensive growth and access to ease of living to all its citizens.

MISSION:

- Synergize policies, plans and execution for rapid development of NE Region through.
- Collaborating with Central Ministries, States, Agencies & Expert Stakeholders.
- Ensuring full utilization of 10% GBS and other budgetary resources for NER.
- Promoting investment in the NER, including public, private, corporate & multilateral funding.
- Developing infrastructure to mitigate connectivity and social sector deficits of the region.

- Strengthening institutions and networks for livelihood, social services, skills and capacity.

Literature Review

State gross domestic product (GSDP) is a monetary measurement of the total value of goods and services produced within a state during a specific period of time. State gross domestic product (GDP) is important because it is a measure of a state's economic activity and performance. It is used to assess the health of the economy and to inform decisions made by policymakers, businesses, and others. Analysing the economic growth rate of the Northeastern states of India helps us know how it is improving in a slower, faster or constant rate.

Ghosh (2024) finds that the Northeastern Indian (NEI) states have failed to catch up with the rest of India in terms of economic growth, with the per-capita NSDP growth rate remaining below the national average, and the region's economy shifting from agrarian to service-driven, but with slow growth in industrial and manufacturing sectors. According to Gogoi and Rana (2022) Sikkim achieved the highest growth rate in gross state domestic product (GSDP) and per capita growth rate in gross state domestic product (PCGSDP) compared to other states in the Northeast region during the period 1980 to 2019. The service sector performed better than the agriculture and industry sectors. And the agriculture and allied activities sector has a lower economic growth compared to the industrial and service sectors in the NER of India during the period 1980 to 2019. Assam achieved the lowest economic growth. The sector specific growth of the states in the region are different. The investigation confirmed that sectoral economic growth is different for different sectors during different periods. The industry and service sectors are well-performed compared to the agriculture sector. Roy and Debnath (2010) in their study find that the post-reform period (1991-2007) has witnessed a significant increase in economic growth rates in the Northeast region, with the Net State Domestic Product (NSDP) growing at an average annual rate of 5.6% compared to 3.4% in the pre-reform period (1971-1991). The per capita NSDP has also increased, indicating an improvement in the standard of living of the people. The study also analyzes the sectoral growth rates and finds that the service sector has been the driving force behind the economic growth in the

region, followed by the industrial sector.

Roy and Dastidas (2016) find that there is a huge variability in infrastructure index in NE states compared to advanced Indian states, which may be a reason for low growth in NE states. Non-utilization of Central Govt. funds for productive purposes by state Govt. is another factor responsible for falling economic growth in NE states. The study analyzed the Net State Domestic Product (NSDP) data of the north eastern states and advanced Indian states from 1999 to 2005-06. The growth curves were estimated using the Gompertz growth equation, and the results showed that the average growth in the north eastern states was higher than the advanced states in 2000-01, but fell continuously from 2000-01 to 2005-06. Basumatary and Panda (2020) highlights the limitations of the existing development initiatives in Northeast India, including the lack of investment, infrastructural deficit, and governance deficits. The study suggests the need for further research on the institutional and developmental issues in the North-Eastern Region of India, particularly in addressing the gaps in governance, infrastructure, and social and economic development. Sarma (2015) in his paper examines the trend and growth of inter-state income inequality in the North Eastern region of India. The study finds that the extent of inequality has continuously declined from 1980-81 to 1999-00, but then shows an increasing trend in 2004-05, which further aggravated in 2012-13. The study finds that the average growth of GSDP of the region is below the national average, but it has shown signs of improvement in the post-reform period. Some states in the region, such as Arunachal Pradesh, Sikkim, and Tripura, have recorded higher levels of growth compared to the national growth rate.

All the above studies show the economic growth trend in the post and pre reform period for NE states whereas it does not explain that the economic growth is due to establishment of Ministry of DONER. Many studies have shown that there are structural changes in the economy of NE region but does not explain that there is structural break in the pre and post DONER period. Economic growth tends to grow due to time but does not explain the impact of DONER in this growth.

Analysis and Interpretation

In order to thoroughly understand the impacts of DONER on the economies of the North Eastern states, we conduct the Chow structural break

test. This is preceded by the Augmented Dickey Fuller (ADF) test for stationary in light of the fact that the data collected is a time-series data for each of the states.

The ADF Test

State	ADF statistic		
	NSDP (0)	NSDP (1)	NSDP (2)
Arunachal Pradesh	-1.64	-1.96	-8.07***
Assam	3.43	-4.36***	-
Manipur	2.92	-4.95***	-
Meghalaya	-1.84	-6.12***	-
Nagaland	-1.82	-1.50	-9.42***
Sikkim	-0.23	-5.76***	-
Tripura	-0.42	-3.34*	0.85

Table 1: The ADF test results.
Source: Authors estimation on Eviews.

Note: NSDP (0), NSDP (1) and NSDP (2) represent the level, 1st difference and 2nd difference forms of the NSDP respectively. Further, * implies significant at 10% level of significance and *** implies significant at 1% level of significance.

As seen in table 1, the NSDP variable is stationary at the 1st difference for the states of Assam, Manipur, Meghalaya, Sikkim and Tripura (although at the 10% level of significance for Tripura). For Arunachal Pradesh and Nagaland, the NSDP variable is significant at the 2nd difference. Furthermore, it is noteworthy that none of the states have their respective NSDP variable significant at levels form.

The ADF test results are crucial in the sense that the NSDP variable has to be appropriately transformed in accordance with the results of the ADF test before conducting the Chow test for structural break. The Chow test is then conducted by first running an OLS regression by taking the NSDP variable for each state as the dependent variable and time (year) as the independent variable and then testing for a structural break in the data.

The Chow Test

A structural break test is conducted in order to check whether there is a change in the trend of the variable under consideration. This change in trend

can be in terms of an increasing or a decreasing trend, with or without changes in the sign of the trend itself. In common practice, a structural break in the time series data is confirmed to occur when the mean value or expected value of the variable in consideration significantly deviates from the original mean value after passing a certain threshold point of time.

With 2001 being the threshold point of time where the structural break is tested, the analysis then implicitly assumes the time periods – 1980 to 2001 and 2001 to 2023 – as two different linear regressions for two different data sets. If these two regressions are found to be significantly different from each other, we conclude that there is a structural break at 2001. This is done for each of the North Eastern states.

State	Chow Test F-Statistic
	H_0 *: No structural break at 2001*
Arunachal Pradesh	0.06
Assam	5.03***
Manipur	0.221
Meghalaya	0.364
Nagaland	0.396
Sikkim	0.747
Tripura	0.463

Table 2: The Chow test results.
Source: Authors estimation using Eviews.

As seen in table 2, the Chow test yields an interesting result. With the null hypothesis that there exists no structural break at 2001, the F-statistic value for Arunachal Pradesh, Manipur, Meghalaya, Nagaland, Sikkim and Tripura result in this hypothesis being accepted for these states. That is, there is no evidence of structural break in the NSDP variable for Arunachal Pradesh, Manipur, Meghalaya, Nagaland, Sikkim and Tripura in 2001. However, the F-statistic value for Assam is significant at 1% level of significance. Thus, only Assam experienced a structural break in the NDSP variable in 2001, indicating the fact that DONER benefited Assam more than the other North Eastern States.
The Independent Samples t test: Assam's Case

With Assam being the only state with a structural break, an independent samples t test is conducted to check whether there exist any significant difference in the NSDP growth rate of Assam in the pre-DoNER and post-DoNER periods.

	Pre-Doner	Post-Doner
Mean	*0.030258*	*0.052519*
Variance	0.000771	0.000619
Observations	21	21
Pearson Correlation	-0.01288	
Hypothesized Mean Difference	0	
df	20	
t Stat	-2.71893	
P(T<=t) two-tail	*0.013218*	
t Critical two-tail	2.085963	

Table 3: Results of the independent samples t test.

Table 3 presents the results of the independent samples t test. The independent samples t test is used to test whether the difference in the mean of the variable of interest between two samples or groups is statistically significant or not. In this context, it is used to check whether the mean growth rate of NSDP for Assam in the pre-DoNER period (1980-2001) is statistically different from the mean growth rate of NSDP for Assam in the post-DoNER period (2001-2023). With the t statistic of the test being statistically significant at the 5% level of significance (p value < 0.05), we can conclude that there is indeed a statistically significant difference in the mean NSDP of Assam in the pre-DoNER and post-DoNER time periods. Furthermore, in the post-DoNER period, Assam registered an average NSDP growth rate of 5.25% annually as compared to just 3.02% in the pre-DoNER time period.

Findings and Conclusion

This paper analyses the impact of DoNER on the North Eastern states of India individually by determining whether there is evidence of a structural break in the period after the DoNER was established in 2001. Using the Chow test for structural break, after the NSDP variable was made stationary

through the ADF test for each of these states, this paper finds that only the NSDP of Assam experienced a structural break in 2001 while the NSDPs of the remaining states of Arunachal Pradesh, Manipur, Meghalaya, Nagaland, Sikkim and Tripura showed no evidences of the presence structural break. This finding indicates how the major impact of DoNER was felt in Assam and not in the other states. Furthermore, by examining the case of Assam more closely by using the independent samples t test to segregate the pre-DoNER and posr-DoNER time periods, this paper also finds that the average NSDP growth rate of Assam had increased by almost 2.3 percentage points in the post-DoNER period as compared to the pre-DoNER period. This highlights not only the presence of a structural break in the NSDP of Assam but also a sustained increase in its growth rate of NSDP after the establishment of DoNER. Therfore, this findings of this paper is a testament to the fact that there exists plenty of scope and room for improvement in terms of improving the economies of the remaining North Eastern states through the mechanisms of DoNER.

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Impact Of Innovation And Trade Openness On Economic Growth In Asia: Evidence From Panel Regression Analysis

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Abstract

Using panel data covering the years 1996–2018 and the Feasible Generalised Least Squares (FGLS) regression approach, the current study examines the effects of innovation and trade openness on economic development in the top five richest Asian countries. The findings show that innovation and trade openness have significant favourable impact on the economic development of the top five Asian countries after accounting for the primary drivers of economic growth. Even without accounting for the primary variables, the results are significant and robust. Additionally, whether or not the controlled variables are present, the interaction between innovation and trade openness prominently boost economic growth. The findings indicate that these Asian countries could accelerate their economic growth by focusing their efforts on R&D expenditures among other things and facilitate favourable trade relations.

Keywords: Economic Growth, Innovation, Trade openness, Asian, Panel Data, FGLS

Introduction

The relationship between trade openness, innovation, and economic growth has been the topic of extensive study (Grossman & Helpman 1991; Aghion & Howitt 1997; Rodrik 2007; Romer1990

One of the main arguments in favour of trade openness is it encourages innovation by exposing domestic companies to global competition, information exchange, and educational opportunities (Coe & Helpman 1995; Keller 2004; Acemoglu, Aghion & Zilibotti 2006). Cohesively, efficacy and productivity of current assets, such as labour, capital, or natural resources, are increased through innovation, resulting in lower costs, higher profits, and more output

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from the same inputs (Romer 1990). Innovation and economic growth are linked and mutually reinforcing processes that promotes human development and well-being (UNDP 2001;OECD 2010). Furthermore innovation raises the standard and diversity of products and services offered to consumers in addition to fostering social and environmental advantages such bettering health, education, or environmental protection (Sen 1999).

Studies show that trade openness promotes higher levels of productivity, efficiency, and innovation as well as lower costs and better goods and services (Grossman & Helpman 1991). By reducing market inefficiencies and boosting competitiveness via trade, economic performance and resource allocation are improved (Goldberg,Khandelwal,Pavcnik & Topalova 2010). Trade openness encourages economic growth by allowing nations to tap into larger markets, benefit from economies of scale, concentrate on industries where they have a competitive edge, and embrace new technology and ideas from other nations(Frankel & Romer 1999;Wacziarg & Welch 2008; Dollar & Kraay 2004).

Trade openness encourages competitiveness, efficiency, and institutional quality in domestic markets, which increase productivity and innovation (Aghion et al 2005;Rodrik Grossman& Helpman 1991,Subramanian & Trebbi 2004;Goldberg et al 2010). In particular, trade openness is one of the many factors influencing growth and poverty outcomes in developing countries (Dollar & Kray 2004; Grossman & Helpman 1991). Trade openness encourages enterprises to increase their R&D expenditures by increasing market size and innovation returns (Grossman & Helpman 1991;Romer 1990). In addition to boosting productivity and growth, trade openness allows countries to benefit from economies of scale, specialization, and comparative.(Rivera-Batiz & Romer 1991 ;Krugman 1980)

However, it is argued in the literature that the relationship between innovation, trade openness, and economic growth is not always positive or linear as too much innovation may disrupt existing industries and result in unemployment or inequality (Acemoglu & Robinson 2019;Autor et al 2020;Frankel & Rose 2005;Rodrik 2018) Together, too much trade openness may expose domestic firms to unfair competition or environmental degradation. Furthermore, excessive economic expansion may lead to pollution or the depletion of natural resources (Grossman & Krueger 1995 ;Stern, Common& Barbier 1996).Even more, economists claim that trade openness has an

uncertain or adverse impact on economic growth since it exposes nations to external shocks, instability, and unfair competition from more developed or subsidised economies. (Rodrik 1999;Stiglitz 2002) .Trade openness may have a negative or insignificant impact on GDP growth, depending on various factors like the level of human capital accumulation (HCA), the quality of institutions, and the severity of market distortions.(Sachs et al 1995;Mallick & Behera 2020;Moketheti & Nchake 2019) Therefore, if trade openness is promoted without taking into accountthese factors or the unique needs and circumstances of each country, it could potentially be harmful to economic growth (Mallick & Behera, 2020).

As a result, the relationship between trade openness and economic growth in emerging nations is ambiguous. It depends on each country's unique background, circumstances, policies, and institutions, as well as the institutions that support trade liberalisation. Specifically, for the developing countries, a number of studies have found positive and significant effects of trade openness on economic growth in developing countries e.g., Raghutla(2020) for five emerging market economies; Jamilah et al(2016) for 20 OECD countries), Rani & Kumar(2018) for BRICS nations, while others have found mixed or inconclusive results e.g., Keho &Wang (2017) for Cote d'Ivoire; Mallick & Behera (2020)for India. Apparently, a recent study by Fatima et al (2020) discovered an intriguing indirect relationship between trade openness and GDP growth, i.e., trade openness may have a negative impact on GDP growth when countries exhibit a low level of HCA, as they may not be able to benefit from the opportunities and challenges of trade integration.

Therefore, this research attempts to contribute to the body of literature by examining the impact of innovation and trade openness as well as other characteristics such as the Gini index, CO2 emissions, and corruption index on the economic growth of top 5 Asian countries. The paper is structured as follows: the introduction, the study methodology, the results and discussion, and its conclusion with recommendations for policy implications.

Methods

Data sources

The entire analysis is based on secondary sources of information from 1996 to 2018 from the sources given in table 1. The top 5 richest Asian nations are chosen based on the GDP data calculated using international $ purchasing

power parity (PPP), 2020 by the World Bank. The five nations chosen based on these are India, China, Japan, Turkey and South Korea. Based on the data's availability, the nations and time frame were chosen to ensure homogeneity and strong balance across all the variables.

Variables and sources

Descriptions of the variables and data sources are given in Table 1.

Table 1 Description of variables and data

Variables	Proxy	Description and source
Economic growth (GDPPC)	Per capita gross domestic product at purchasing power parity constant 2017 $	Per capita GDP based on purchasing power parity. (The World Bank)
Innovation (INN)	Research and development expenditure (% of GDP)	Percentage of gross domestic product expenditures made on research and development (R&D) of a country. (The World Bank)
Trade openness (TO)	Trade openness (% of GDP)	Sum of exports and imports of goods and services (% of GDP). (The World Bank)
CO_2 emission (CO_2)	CO_2 emissions (kt)	Carbon dioxide emissions from burning of fossil fuels and cement production including co2 emissions due to the use of solid, liquid, and gas fuels and gas flaring (The World Bank).
Income inequality (GINI)	Gini index	Income inequality measured by Gini index. (World Inequality Database)
Corruption (COR)	Control of corruption index	It determines how much public power is utilized for personal gain including both minor and major corruption, as well as the takeover of the system by elites and private interests. (The World Bank)

Source: Authors' compilation

Econometric model

To analyse the interrelationship between innovation, trade openness and economic growth, the augmented Cobb-Douglas aggregate production function growth model is formulated to find out the effect of innovation and trade openness on economic growth in Asian nations. In this growth model, Co_2 emission, Gini index and corruption index are included as control variables as the inclusion of these variables also helps to capture the extent of such relationship. Additionally the functional form of such specification help to identify the multiplicative relationship among these variables. Therefore the augmented production function (C-D) is expressed as

$$Y = INN^{\alpha} TO^{\beta} Co2^{\gamma} Gini^{\delta} Cor^{\theta} INN * TO^{\sigma}$$

Taking log on both sides and adding the error term the econometric model is specified as

$$lnY = \alpha lnINN + \beta lnTO + \gamma lnCo2 + \delta lnGini + \theta lnCor + \sigma lnINN * TO + \varepsilon$$

For the panel data above equation is re-written as

$$lnY_{it} = \alpha lnINN_{it} + \beta lnTO_{it} + \gamma lnCo2_{it} + \delta lnGini_{it} + \theta lnCor_{it} + \sigma lnINN * TO_{it} + \varepsilon_{it}$$

Where the parameters are the elasticity of economic growth with respect to independent variables.

Model 1:

For the present study, this paper considers four regression models i.e. with and without control variables.

$$lnY_{it} = \alpha lnINN_{it} + \beta lnTO_{it} + \gamma lnCo2_{it} + \delta lnGini_{it} + \theta lnCor_{it} + \varepsilon_{it}$$

Model 2:

$$lnY_{it} = \alpha lnINN_{it} + \beta lnTO_{it} + \varepsilon_{it}$$

Model 3:

$$lnY_{it} = \sigma lnINN * TO_{it} + \gamma lnCo2_{it} + \delta lnGini_{it} + \theta lnCor_{it} + \varepsilon_{it}$$

Model 4:

$$lnY_{it} = \sigma lnINN * TO_{it} + \varepsilon_{it}$$

Where, $it\ it$ indicates combination of both time series and cross sectional series; $lnln$ represents transformation of the variables into natural log to reduce the problem of skewness; $\alpha, \beta, \gamma, \delta, \theta\ and\ \sigma\ \alpha, \beta, \gamma, \delta, \theta\ and\ \sigma$ are the coefficients of innovation, trade openness, CO_2 emission, income inequality, corruption and interaction of innovation and trade openness respectively; and $\epsilon\epsilon$ is the error term. GDPPC is the dependent variable and INN, TO, CO2, GINI, COR and INN*TO are the independent variables. We considered CO2, GINI and COR as control variables because in the literature these variables are found as important factors that affect economic growth. Variables having negative values i.e. control of corruption in our study are transformed into positive values to generate log of the data using the method used by (Busse & Hefeker, 2007): $y = \ln(x + \sqrt{(x^2 + 1)}y = \ln(x + \sqrt{(x^2 + 1)}$.

Results and Discussion

Descriptive statistics and correlation matrix of the study variables are given in table 2. The correlation matrix in table 2 indicates several captivating relationships between the variables. A higher GDP per capita is linked to more innovation and less corruption, for instance, where lnGDPPC is positively and strongly connected with lnINN and lnCOR. On the other hand, lnGDPPC is negatively and strongly connected with lnCO2 and lnGINI, suggesting that greater GDP per capita is linked to lower CO2 emissions and reduced income inequality.

Table 2 Descriptive statistics and correlation matrix

	lnGDPPC	lnINN	lnTO	lnCO2	lnGINI	lnCOR
Mean	9.404	0.344	3.781	13.874	-0.621	0.137
Std. Dev.	0.972	0.715	0.409	1.101	0.116	0.585
Min	7.432	-1.016	2.897	12.13	-0.828	-0.576
Max	10.67	1.508	4.659	16.167	-0.451	1.298
lnGDPPC	1					
lnINN	0.738*	1				
lnTO	0.190*	0.082	1			

lnCO2	-0.310*	0.168*	-0.197*	1		
lnGINI	-0.218*	-0.613*	-0.199*	0.034	1	
lnCOR	0.784*	0.757*	-0.237*	-0.250*	-0.396*	1

Note: *** p<0.01, ** p<0.05, * p<0.1

Panel unit root test

To check the issue of unit root in the series Levin-Lin-Chu (LLC) unit root test is applied (Levin, Lin, & Chu, 2002). Table 3 shows the interpretation of unit root test using LLC unit root test. The result shows that GDPPC, INN, TO, and INN*TO are stationary at level; while CO2, GINI, and Corruption are stationary at first difference i.e., the series are integrated of order I(0) and I(1) when trend is included.

Table 3 LLC unit root test

Variables	**Without trend**		**Including trend**	
	At level	**1st difference**	**At level**	**1st difference**
lnGDPPC	-1.2282	-3.9895***	-2.9967***	
lnINN	-1.6362*		-2.1622**	
lnTO	-1.3669*		-2.1697**	
lnCO2	-0.4164	-5.5423***	-1.0089	-5.4583***
lnGINI	-2.0977**		-0.3112	-1.3762*
lnCOR	0.0437	-3.5577***	1.2065	-3.5765***
lnINN*lnTO	-1.4517*		-1.6663**	

Source: Authors' calculation. Note: *** p<0.01, ** p<0.05, * p<0.1

Checking for appropriate regression model

Generally in panel data, the results can be estimated using fixed effect (FE) and random effect (RE) model. However, to choose the most appropriate model among these two effects, Hausman test proposed by (Hausman, 1978) is applied. The Hausman test presented in table 4 reveals that FE model is suitable for column 3 and RE model is suitable for column 1, 2, and 4. But the results of these FE and RE cannot be interpreted if there is presence of autocorrelation and heteroskedasticity in the estimation. So the estimated results by these

methods may provide biased and ineffective results (Greene, 2000). The robustness results of the series i.e., the test of autocorrelation proposed by (Wooldrige, 2002) and the test of heteroskedasticity proposed by (Greene, 2000) is shown in the table 5. The result of robustness presented in table 5 shows the presence of autocorrelation and heteroskedasticity. Therefore, to adjust all these problems FGLS regression is applied for the present study (Beck & J.N., 1995).

Table 4 Choosing appropriate panel regression model

Model	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Hausman test (H0: RE model is appropriate)	7.48	0.08	90.88***	0.02
	Robustness Check			
Wooldridge test for autocorrelation (H0: no first-order autocorrelation)	33.531***	22.127***	105.375***	40.697***
Modified Wald test for heteroskedasticity (H0: homoscedasticity)	274.80***	1104.25***	48.29***	223.57***

Source: Authors' calculation. Note: *** p<0.01, ** p<0.05, * p<0.1

FGLS regression

From table 5 the FGLS regression in model 1 and model 2 reveals that, innovation and trade openness have significant and positive impact on the economic growth of the top 5 Asian countries. The results indicate that expenditure on research and development and trade openness enhances the economic growth in the selected Asian nations. The findings support the assertion that innovation and trade openness both serve as catalysts that boost economic growth by encouraging productivity and innovation in the leading Asian nations. Trade openness is one of many factors influencing growth and poverty outcomes in developing countries, according to earlier studies (Aghion et al 2010;Rodrik,Subramanian & Trebbi 2004; Goldberg et al 2010 ,Dollar & Kraay 2004).

The results from model 3 and 4 show that interaction of innovation and trade openness has a significant and positive impact on the economic

growth of the Asian nations. It indicates that collectively an increase in expenditure on research and development as well as better trade relations could increase the economic growth rate of these Asian nations. As previously stated, trade openness fosters innovation (Grossman & Helpman 1991;Coe & Helpman 1995;Acemoglu& Robinson 2019). It is irrefutably true that trade openness encourages innovation and emboldens enterprises to increase their R&D expenditures and reap the benefits. Worldwide, economies of scale, specialization, and comparative advantage have been advantageous to countries, in addition to increasing productivity and growth through innovation and trade openness (Rivera-Batiz &Romer 1991;Krugman 1980).

Table 5 FGLS Regression

Variables	FGLS			
	Model 1	**Model 2**	**Model 3**	**Model 4**
lnINN	.901378** (10.77)	.9894892*** (11.74)	-	-
lnTO	.2759881* (1.91)	.3088644*** (2.10)	-	-
lnCO2	-2.797262** (-2.17)	-	-4.454857*** (-3.51)	-
lnGINI	-14.93585** (-3.51)	-	-12.42202*** (-2.81)	-
lnCOR	-.5228517 (-0.81)	-	-.3222473 (-0.48)	-
lnINN*lnTO	-	-	.725958*** (10.24)	.810325*** (10.81)
Constant	8.217759*** (15.15)	7.896291 (14.13)	6.614776*** (21.24)	6.061647*** (19.21)

Source: Authors' calculation. Note: *** p<0.01, ** p<0.05, * p<0.1

However, in both models 1 and 3, it is revealed that Co_2 emission and Gini index have a significant and negative impact on the economic growth of Asian nations. The results indicate auxiliary Co_2 emission and larger inequality in a nation could decrease the economic growth of the selected Asian nations. Theoretically the relationship between environmental degradation (Co_2) and economic growth (GDP) is examined using inverted U-shape or the

Environmental Kuznets curve. And it has been proven, this relationship is valid for various regions such as US, China and South Africa (Jeon 2022;Chen & Yan 2022;Saba 2023)

Conclusion

The FGLS regression results show that innovation and trade openness are positively and significantly associated with economic growth in the top 5 Asian countries. This implies that investing more in research and development and improving trade relations can boost the economic performance of these countries. The interaction term of innovation and trade openness also shows positive and significant effect on economic growth in models 3 and 4. This suggests that the combined effect of increasing research and development expenditure and trade openness favourably proliferates the economic growth of top selected Asian nations. On the other hand, Co_2 emission and Gini index have negative and significant effects on economic growth as shown in models 1 and 3 in the top selected Asian nations. In line with this, the economic progress of the chosen Asian countries may be hampered by increased levels of income disparity and environmental pollution. These elements have the potential to raise the costs associated with the social and environmental systems, lower productivity and efficiency levels, and erode public confidence in the economy. Therefore it is often recommended with focus on clean energy source and renewables for green and sustainable economic growth which are less Co_2 emitting .As inherently higher emission of CO_2 into the atmosphere attracts higher expenditure to mitigate the ill effects and so the expenditures meant for economic growth is curtailed. Therefore, this research suggests that policymakers should focus on a comprehensive approach of investment in research and development and reduction of inequality in addition to boosting trade liberalisation.

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Measuring Technical Efficiency in Northeastern states of India: A Systematic Review using Parametric and Non-Parametric Methodologies

Sorokhaibam Aguraj Singh [12]

Abstract

This review paper examines the evolving methodologies used in efficiency analysis, highlighting the trade-off between structural rigour and analytical flexibility, and emphasising studies from Northeast India. Both parametric and non-parametric methods are reviewed with the PRISMA framework. The literature reflects growing methodological refinement through robustness-enhancing techniques and a shift from two-stage procedures toward integrated models that incorporate inefficiency determinants directly within the frontier. The increasing inclusion of contextual and environmental variables further emphasizes efficiency as a context-dependent outcome, with important implications for empirical interpretation and policy relevance.

Keywords: Data envelopment analysis, Stochastic frontier analysis, technical efficiency

Introduction

Efficiency measurement has become a central analytical tool in empirical economics, operations research, and performance analysis. The idea is that observed performance should be evaluated relative to a **best-practice frontier** rather than an average benchmark. Early conceptualisation framed efficiency as a relative and multidimensional construct, separating technical efficiency from allocative considerations (Farrell, 1957). Rather than focusing on absolute productivity levels, efficiency approaches benchmark observed performance against an estimated best-practice frontier.

Over time, a diverse methodological literature has emerged, encompassing parametric frontier models, non-parametric approaches, and hybrid frameworks. However, the rapid expansion of applications has also led to methodological fragmentation, with studies differing widely in

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modelling choices, assumptions, and estimation strategies. This has made it increasingly difficult to assess methodological consistency and comparability across efficiency studies. By systematically organizing efficiency measurement methodologies, the review provides a reference framework for researchers and practitioners engaged in productivity and performance evaluation, benchmarking, and efficiency assessment.

Against this backdrop, the present review systematically synthesises efficiency measurement methodologies using a PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) -based approach. Rather than evaluating empirical outcomes, the review focuses on **how efficiency is measured**, examining the evolution, strengths, and limitations of dominant methodological frame works within productivity and performance management research, with a particular emphasis on the North East states of India namely Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura hereafter NE states comprising of 131 districts. This study contributes by offering a methodology-focused systematic review, shifting attention from sector-specific findings to the analytical foundations of efficiency measurement within productivity and performance management research.

The paper is organized as follows: Section 2 describes the conceptual foundations of efficiency measurement Section 3 Methods i.e., PRISMA-based review protocol; Section 4 Findings review the papers; Section 5 Discussions of the findings; and the final sections present conclusions.

Conceptual foundations of efficiency measurement

In microeconomic theory before the late 1960s, empirical studies mostly used least-squares procedures to estimate production function, producing response or average functions rather than optimal production frontiers (Battese, 1992). Farrell's (1957) seminal paper, measures the efficiency level of a firm is relative to other firms, and it is done through constructing a frontier production function. Assuming production function is known, Farrell postulates three concepts to measure efficiency: i) technical efficiency, ii) price efficiency, and iii) overall efficiency. A firm is said to be technical efficient when it can produce maximum level of output(s) the inputs(s). Price or allocative

efficiency is when the output price is reduced given the input price. Overall efficiency is the product of technical efficiency and allocative efficiency.

Though there are multiple ways to measure efficiency, such as free disposal hull (FDH), data envelopment analysis (DEA), stochastic frontier approach (SFA), corrected ordinary least squares (COLS), etc. This review paper focuses on two methods: DEA and SFA.

Data envelopment analysis

DEA is a non-parametric method for measuring the relative efficiencies of the firms. The proliferation of DEA in literature is mainly due to its connection between theory and practice. It was developed by Charnes et al. (1978) and is a non-parametric linear programming method for measuring the relative efficiency of decision-making units (DMUs, which refer to the entity under consideration), based on the work of Farrell (1957). The BCC DEA model, introduced by Banker et al. (1984) extends the original CCR DEA framework to account for variable returns to scale (VRS). The BCC model allows for efficiency evaluations under the assumption that production technologies may exhibit increasing, constant, or decreasing returns to scale. The efficiency score in the BCC model is decomposed into two components: technical efficiency (TE), which corresponds to the CCR model, and scale efficiency (SE), which captures inefficiencies arising from deviations from optimal scale.

Stochastic Frontier Approach

The SFA technique of measuring efficiency is attributed to Aigner et al. (1977) and Meeusen and van Den Broeck (1977). The model estimates the efficiency of firms by a "frontier" representing optimal performance. It utilises a production or cost function to determine the maximum output or minimum cost possible for a given set of inputs. The analysis incorporates two error terms and outlines the connection between input and output levels. One error term is considered technical inefficiency, and the other is the usual noise term. This makes it possible to establish efficiency scores, which indicate the proximity of each firm from the frontier, with values closer to 1 indicating higher efficiency.

Methods

This study follows the PRISMA guidelines. A systematic literature search was conducted across two major academic databases i.e., google scholar and web of science, from 2015 to 2025. The search focused on peer-reviewed articles employing DEA and SFA approaches to measure technical

efficiency. The objective is not to evaluate sectoral performance outcomes but to examine methodological evolution, modelling choices, and estimation strategies employed in efficiency analysis.

Keywords used included combinations of "technical efficiency", "data envelopment analysis" AND "north east India", data envelopment analysis" AND "north eastern region of India", "stochastic frontier analysis" AND "north east India", "stochastic frontier analysis" AND "north eastern region of India", "technical efficiency" AND "north east India", "technical efficiency" AND "north eastern region of India".

The studies were included if they explicitly applied efficiency measurement methodologies. Use of SFA or DEA frameworks, Sufficient methodological detail to allow replication or comparison and importantly, whether NE states are included. Studies were excluded if they were descriptive, lacked frontier estimation, or focused purely on conceptual discussion without empirical implementation, and only one state in the Northeast was included in the major state analysis.

Literature review

The findings obtained from the articles are presented. The methods used for the analysis are broadly categorised into two sections, one involving the use of DEA and the other SFA.

DEA method

Das (2015) used DEA to measure efficiency of ten Microfinance Institutions in Assam, Manipur and West Bengal and found that Bandhan Bank in West Bengal, Kanaklata Mahila Urban Co-Operative in Assam lies on the frontier and among them Chanura Microfinance Manipur in Manipur scored lowest in VRS DEA model.

Yadava and Neog (2019) applied DEA with input and output orientation to assess the performance and efficiency of the public sector in 19 Indian states. In both models, the finding shows that from the NE states, Manipur and Nagaland are the most efficient states, and Tripura is at the bottom level.

Goyal and Dutta (2020) evaluated the relative efficiency of 28 Indian states using DEA. In terms of social infrastructure investments Mizoram was found to be the most efficient state and Haryana the lower most, Andhra Pradesh and Telangana scored highest in investments in economic infrastructure. Lastly in co-operative efficiency for less populated regions, top performers

were Mizoram for 2011 and Nagaland for years 2013 and 2015.

Singh and Yadava (2021) applied DEA to assess the technical efficiency of financial inclusion of the states of India and found that Goa is the most efficient state while Manipur, Assam and Bihar are the least efficient states.

Dey et al. (2023) also applied DEA to evaluate 427 handloom micro-entrepreneurs from Assam and revealed that 75% are technically efficient. Further, the results of the bootstrap truncated regression indicate that the technical efficiency of handloom businesses is significantly influenced by prior experience, education, ICT, bank loans, current technology, training, gender, and location.

To examine the efficiency of social welfare programme of India such as Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) among the states using DEA, Nateshan and Marathe (2017) found that among the Northeast states Assam is the inefficient state while Nagaland Sikkim Tripura are the efficient states. Ahmed and Kumar (2024) also found that among the states Tripura lies on the frontier. Bose and Bhowmick (2019) specifically focuses on the NE states and found that Tripura is the most efficient and Arunachal Pradesh at the bottom.

Also, Mohanty and Bhanumurthy (2021) conducted another study on Indian states that adopted DEA and assessed the efficiency of public expenditure on health and education in the states of India. Their results on health spending efficiency show that Kerala, Maharashtra, and Haryana are the most efficient states, while states like Madhya Pradesh, Orissa, Assam, Uttar Pradesh Rajasthan, and Bihar are the least efficient. Further, overall, western states are more efficient than the other regions in public expenditure and identify that the variation could be due to the extent of good governance, economic growth, and the mother's schooling in the states.

Kaur (2021) measured the technical efficiency of higher education in India from 2011-12 to 2015-16. An output-oriented CRS and VRS model with input as higher education public expenditure and faculty members number for output enrolment number and pass-out students. Efficiency results show that only Uttar Pradesh is efficient throughout the study period. The Northeastern states (i.e., Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Sikkim and Tripura) all showed varied results, with the efficiency of Arunachal Pradesh equal to one in the year 2012-13. The overall efficiency results for the 28 states

show that 24 states are inefficient during the five years.

Pareek (2021) used DEA to measure the efficiency of four Central Armed Police Forces (CAPFs) i.e., Assam Rifles, Central Reserve Police Force (CRPF), Indo-Tibetan Border Police (ITBP), Sahastra Seema Bal (SSB) in implementing Civic Action Programme CAP in the North Eastern Region. The output-oriented CCR result revealed that SSB lies on the frontier and Assam Rifles the least efficient among them.

Gurung and Choubey (2023) using DEA calculated technical, scale, and pure technical efficiencies for 20 Farmer Producer Organisations (FPOs) in Sikkim. The results showed that the performance of FPOs in Sikkim was unsatisfactory, as only 25% of the state's sampled FPOs were efficient. The FPOs' mean TE, PTE, and SE values were 0.656, 0.819, and 0.769, respectively. Every country feels the adverse impact of the COVID-19 pandemic, and it has overwhelmed the health system. The government of different countries tried their best to mitigate the spread of this virus, but how well or, more specifically, how technically efficient numerous researchers study the countries or states/ provinces in controlling the virus. Some of the works are highlighted briefly below: For the states in India, Maity et al (2020) examined the comparative efficiency among 22 Indian states in combatting COVID-19 by using DEA and a stochastic approach. Tamilnadu topped the list with an efficiency score of 0.949, and Manipur, with a score of 0.078, came last. The efficiency score and ranking among the NER states in the group are as follows: Meghalaya 0.706 15th, Arunachal Pradesh 0.697 16th, Assam 0.217 21st, Manipur 0.078 22nd. Further, Singh and Singh (2023) estimated the efficiency confined only to the NE states and found that Mizoram and Tripura performed the best. Deka and Mahanta (2024) measures the technical efficiency of 22 private hospitals in Kamrup (Metro) District of Assam using DEA and revealed that 32% can become efficient by little improvement and small size hospitals achieved better efficiency than larger hospitals.

SFA method

SFA is applied by various research to the measures the technical efficiency. For instance, in the agriculture sector, Bhattacharyya and Mandal (2016) examined the technical inefficiencies of Assamese rice farming by collecting data from 310 households from Cachar, Morigaon, Dhubri, and Dibrugarh districts. The mean technical inefficiency of farms in the sample is

8.5%, according to the study's findings.

Das and Das (2020) studied technical efficiency based on primary data of 210 small tea growers from five districts of Assam. The result showed that technical inefficiency exist and main reason are the age of farmers and farm.

Further, Mandal and Maity (2021) used DEA to assess the crop diversification on technical efficiency for Cachar, Morigaon, Dhubri, and Dibrugarh districts of Assam. The result revealed that crop diversification increases the efficiency. Also, Bordoloi and Lama (2022) applied SFA to measure technical efficiency in potato farming from 410 households Barpeta, Nagaon, Biswanath and Sonitpur districts of Assam.

Baruah and Saha (2024) evaluate the technical efficiency of 312 micro-level handloom businesses located in four districts of Assam using primary data. Analysis is done using the stochastic frontier production with an inefficiency effects model. The sample handloom enterprises exhibit a wide range of technical efficiency, with the average technical efficiency of all enterprises being 0.67.

Das and Mazumder (2024) investigate technical efficiency of lower primary schools with government aided in Hailakandi district of Assam. The sample consists of 95 schools. The findings show that the composite output index is positively and significantly impacted by inputs like the quality of school infrastructure and the amount of time teachers spend interacting with students.

Sharma et al (2025) analysed the technical efficiency of black and normal rice cultivators of 180 rice producers from Imphal East and Imphal West of Manipur and found that it is more profitable to cultivate black rice compared to normal rice.

Discussion

A key methodological insight emerging from the review is the trade-off between structure and flexibility. Parametric frontier models, particularly SFA, offer a statistically grounded framework that distinguishes inefficiency from random noise. This feature is especially valuable in empirical contexts characterized by measurement error, environmental shocks, or data volatility. Many papers also applied this method but still scant at the macro level. However, the reliability of SFA estimates remains sensitive to distributional assumptions, functional form specification, and model selection, which can

influence both efficiency levels and rankings. In contrast, non-parametric approaches such as DEA provide greater flexibility by avoiding a priori functional form assumptions and accommodating multiple inputs and outputs simultaneously. This flexibility has made DEA particularly attractive for benchmarking and performance evaluation. Nevertheless, the deterministic nature of DEA implies that all deviations from the frontier are attributed to inefficiency, rendering results vulnerable to outliers and noise. The reviewed literature demonstrates growing awareness of these limitations and highlights methodological refinements—such as bootstrapping that aim to improve robustness. An important methodological convergence identified in this review is the shift toward two-stage procedures that has gradually given way to models that incorporate inefficiency determinants directly within the frontier specification. This transition reflects improved econometric rigor and addresses long-standing concerns regarding bias and inconsistency in post-estimation analysis of efficiency scores. The incorporation of environmental, climatic, and contextual variables represents another significant methodological advance. Rather than treating external conditions as exogenous noise, contemporary efficiency models increasingly recognize efficiency as a context-dependent phenomenon. This has important implications for interpretation, as it reduces the risk of conflating structural disadvantage with managerial or technical inefficiency. The review also underscores that methodological choice materially affects empirical conclusions.

Conclusions

This review article provides a comprehensive and systematic synthesis of methodologies used for measuring efficiency, focusing on parametric and non-parametric frameworks. By adopting a PRISMA-based approach and concentrating exclusively on methodological contributions, the review clarifies how efficiency measurement has evolved and where critical challenges remain. The findings highlight that no single methodology dominates across all analytical contexts. SFA models offer statistical rigor and the ability to disentangle inefficiency from random noise, while DEA provides flexibility and suitability for multi-dimensional performance assessment. Despite notable advancements, efficiency measurement continues to face unresolved methodological challenges, including sensitivity to assumptions, vulnerability to data quality issues, and limited comparability across studies due to

heterogeneous model specifications.

Overall, this review contributes to the literature by organizing and critically evaluating efficiency measurement methodologies as an evolving analytical field in context of the papers that used NE states. By synthesizing methodological developments rather than empirical outcomes, the review provides a reference framework for researchers seeking to select, apply, or extend efficiency measurement techniques in future studies.

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Book Review

India@100 Envisioning Tomorrow's Economic Powerhouse
Krishnamurthy Subramanian, Rupa 2024, 497pp, ₹995

Everyone is talking about Viksit Bharat @2047 . The gigantic effort that would be needed to become a developed nation by 2047 jump frogging from lower middle income to high income category can question our seriousness to become a $30 trillion economy in 24 years. The uniqueness of this book is it spells out the policies for realizing VB@2047 and it is strongly argued that it is feasible. When even the target of US$30 trillion by 2047 is raising eyebows , this book shows that India@100 can be a $55 trillion economy . by following the sound economic policies implemented since 2014 . It is better than Ernst & Young's $26 trillion by 2047 and Global investment Bank's Goldman Sachs forecast of $50 trillion by 2075. Considering the demographic dividend and the considerable potential for productivity growth within the formal sector as well as formalization of the informal sector India has the potential to grow at 8 5 per annum for the next two decades. It has 27 chapters spread over five sections. The whole effort is based on four pillars- macroeconomic focus on growth and growth alone, social and economic inclusion, ethical wealth creation and virtuous cycle ignited by private investment. The book starts with an optimistic attempt to describe India@100's economic landscape including a recalculation of India's GDP in US$ in 2047 at a decent US$55 trillions . This will lead to a significant increase in GDP per capita with substantially higher quality of living. In the pessimistic, realistic and optimistic scenarios India's GDP per capita would grow to $20043, $28532 and $39144 respectively. The book shows that these targets are attainable if the following policies are earnestly pursued. There should be sharp focus on growth at macroeconomic level along with socio economic inclusion at micro level. High rates of growth would generate the resources for further sustainable growth. The microeconomic focus on socio-economic inclusion will involve reducing income inequality and providing equal opportunities for all citizens. All citizens should have access to necessities and opportunities to lead a decent life. Wealth should be created ethically. Wealth creation is a boon and wealth creators should not be attacked. The idea of ethical wealth creation is a noble human pursuit and

profit should not be viewed as a dirty word. The government should provide an enabling environment for the private sector by leading in investment in physical and digital infrastructure. The government should do what it should do and relinquish activities that are better done by the private sector. Public expenditure on physical and digital infrastructure which will crowd in private investment constitutes the core of virtuous cycle driven by private investment. The virtuous cycle driven by private investment can lead to explosive growth in India as consumption and investment interact symbiotically. The discussion of the first pillar covers issues pertaining to inequality and growth,debt sustainability,judicial and bureaucratic reforms and paradigm shifts in bureaucratic processes. The author moves effortlessly from Kautilya to Romer covering almost every issue of concern to any economist. The second pillar deals with issues such as good jobs, make in India for the world,digital public infrastructure , agrarian renaissance ,Thalinomics and nudging. The third pillar deals with responsible prosperity, liberalization, creative destruction for wealth creation, entrepreneurship, innovation and privatization. The fourth pillar deals with virtuous cycle of growth driven by private investment. It also deals with Make in India and human capital formation through health care and education. While discussing knowledge catalyst the author makes an interesting point that a high quality teacher is a sufficient condition for a child to learn well ,but not a necessary one. Quality of teaching should be improved. Standardized teaching manual should be developed to have quality teaching by giving appropriate incentives for the personnels involved. Another interesting point relates to the parameters of FRBM Act in terms of GDP fiscal deficit (3%)and debt to GDP (66%). These thresholds are the outcome of the Maastricht treaty involving European countries without taking into account the greater need for india to invest in infrastructure . Thus higher deficit may be acceptable and the risk to debt sustainability is less given India's higher growth potential. There is also no optimal level of debt for any country. This argument is significant as fiscal consolidation and investment in infrastructure constitute important aspects in the fiscal policy architecture towards Viksit Bharat @2047 . our tradition celebrates wealth that is created ethically , not wealth that is accumulated by any means. Ethical behaviour in the Indian economy can be promoted by strengthening intrinsic motivation, reducing information asymmetry and enhancing quality of supervision. It is argued

that pro business policy and creative destruction are necessary to unleash and sustain the competitive market . while discussing credit as a driver of growth the author has flagged the huge difference between the north eastern region and the rest of India., The author argues that we should learn from the unique supply side and demand side economic policies pursued during the covid 19 pandemic that are tailored to India's economic realities. Regarding the question of middle income trap preventing us from attaining high income , the author argues that India can avoid obstacles by weaning away government support to the sectors that helped it rise to middle income status, more exposure to foreign competition, greater orientation towards export and participation in global value chains, higher investment in its manufacturing capabilities, improvements in rules of law and reduction in corruption and enhancement in quality of human capital through investment in education and healthcare. It is argued that for a developing country like India with high growth potential and the scope for significant poverty reduction the focus must be on economic growth not on redistribution. Poverty alleviation through economic growth should be India's economic strategy.

Because of its comprehensiveness and relevance in the debate on Viksit Bharat this must be read by all economists in general and economists of this region in particular to understand the regional implications of this policy.

E. Bijoykumar Singh

Information for Contributors

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