Using Data Envelopment Analysis (DEA) to determine Investment decision: A case for South Korea and Northeast India.

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Abstract
This study explores the rationale for Korean investment in Northeast India by utilizing (Green) Macroeconomic Performance indices. These indices are constructed by employing data envelopment analysis (DEA) approach, using a comprehensive range of macro, fiscal, and environmental indicators such as economic growth, price stability, unemployment, fiscal balance, and forest cover. The findings of this study underscore the importance of diversifying Korean investment across various industries and geographical locations within India. Northeast India's strategic location, coupled with its growing market demand and cultural affinities with South Korea, positions it as an appealing investment destination.

Key Words: Macroeconomic Performance Index, Data Envelopment Analysis, International Investment, State and Local Government, South Korea, India, Northeast India.
JEL Codes: E60, C14, F21, H70

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Conflict of Interest Statement

On behalf of all authors, the corresponding author states that there is no conflict of interest.

1. Introduction

The Republic of Korea (RoK) - India relations have witnessed remarkable progress in recent years, evolving into a multidimensional partnership driven by converging interests, mutual goodwill, and high-level exchanges. This positive momentum was bolstered by aligning RoK's "New Southern Policy" with India's "Act East Policy." The signing of the Comprehensive Economic Partnership Agreement (CEPA) in 2009 led to deepening economic integration and transformative links.

Bilateral cooperation has flourished in various sectors, such as energy, electronics, shipbuilding, information technology, and cyber security.

Trade volume between the two countries has surged from $804 million in 1991 to $27.8 billion in 2022, with a trade surplus of approximately $10 billion for Korea. In 2021-2022, India exported 3335 commodities to Korea while importing 3688 commodities from Korea,[i] contributing to the expansion of trade between the two nations. Furthermore, South Korean FDI in India increased from $2.6 million in the 1990s to nearly $855 million in 2019,[ii] as India liberalized its regulations for FDI inflows. Recognizing the immense potential for further growth, India and South Korea have set a bilateral trade target of $50 billion by 2030. Negotiations are ongoing to expand the scope of collaboration to include supply chain, climate change, emerging technologies, vaccines, public health, digital technology, defense, infrastructure projects, and more.

Studies on bilateral trade and investment indicate that the current size of trade and investment between the two countries needs to be higher compared to their respective economies' structural complementarities and economic potential. In addition, policymakers and researchers express concerns about India's growing trade deficit. Most items traded between India and Korea are in the manufacturing sector, although those in non-manufacturing sectors have increased consistently. Trade in manufacturing is characterized by complementary technology levels, with Korea excelling in high and medium-high technology industries, while India demonstrates competitiveness in medium-low and low-technology industries. The imbalance in the share of medium and low-technology industries, compared to high and medium-high technology, is the primary driver of India's trade deficit.[iii]

India is one of the fastest-growing economies, offering significant investment and trade opportunities. It requires substantial investments to achieve its medium-term target of a $5 trillion economy by 2024–2025. Korean FDI in India, mostly in the manufacturing sector, is led by large enterprises like Hyundai Motor Group, Samsung Electronics, LG Group, and, more recently, small and medium-sized enterprises. So far, major centers of Korean investment in India have been concentrated in the National Capital Region (NCR), Chennai, Mumbai, and Pune. Lack of information and research highlighting the feasibility and attractiveness of investment destinations might have contributed to the concentration of Korean investment in certain regions. However, both countries stand to gain if Korean investment diversifies across industries and spreads geographically throughout India. India can facilitate diversification by improving infrastructure and streamlining bureaucratic systems in other regions. The Indian government's initiatives, such as "Make in India" and improvements in the ease of doing business, have created a conducive environment for foreign enterprises to conduct business activities in India.

This research paper aims to address this specific issue by providing an empirical analysis and economic justification for investing in different states of India, specifically Northeast India. Therefore, the focus of this research is to explore avenues for Korean investment in India, particularly in Northeast India, and provide a rationale for such investments. The empirical analysis is done by constructing robust macroeconomic performance (MEP) indices for the Indian States using the Data Envelopment Analysis (DEA) approach.

This research contributes to filling the empirical research gap regarding Korean investment in Northeast India and provides a comprehensive understanding of the economic viability and justification for such investments. By shedding light on the potential opportunities and avenues for economic cooperation, the findings hold for any country considering investment in India. Furthermore, the study underscores the significance of Northeast India as an economic corridor connecting India, Myanmar, Bangladesh, ASEAN, and the potential benefits of deepening economic ties between South Korea and this region. Finally, the study has constructed various MEP indices for understanding the performance of 28 Indian states, covering the period from 2011-12 to 2020-21, a novel attempt that has not been addressed by earlier literature.

The subsequent sections of this paper include a literature review in Section 2, followed by a discussion of the data and methodology in Section 3. Section 4 provides an overview of the empirical techniques and results of the research. Section 5 discusses the case for Northeast India, while Section 6 presents the rationale for Korean investment in Northeast India. The paper concludes in Section 7.

2. Literature review

Understanding and analyzing the MEP is crucial for studying the overall economic performance of a country or region. This composite MEP index may yield practical solutions for elusive policy issues in complicated situations when different individual macro-indicators give conflicting signals about the economic performance of a country (Destefanis, 2003; Ekren et al., 2017; Lovell, 1995; Lovell et al., 1995; Setterfield, 2009). India's domestic consumption-driven economic growth is relatively less prone to various external crises, thus offering numerous opportunities for global investors to invest. The rating of an emerging country like India based on its economic performance assumes considerable importance in the era of globalization and liberalization. Rating agencies find the MEP approach suitable for rating different countries, and foreign investors may use the MEP index to plan their investments.

The literature suggests different ways of constructing summary measures of MEP. For example, Okun's misery index calculates the sum of the unemployment and inflation rates; the Calmfors index combines the unemployment rate and trade balance. The Organization for Economic Cooperation and Development (OECD) "Magic Diamond" index is based on four macro parameters: economic growth rate, trade balance, inflation rate, and unemployment rate.

Studies have examined the MEP of different economies using various methodologies. For instance, Lovell et al. (1995) analyzed the MEP of 10 Asian economies from 1970 to 1988 using the output-oriented Free Disposal Hull (FDH) model. Cherchye (2001) empirically measured and compared the MEP for 20 OECD countries using different variants of DEA-based models. Ramanathan (2006) studied the economic and social performance of 18 Middle East and North African countries using DEA with seven performance attributes. Setterfield (2009) developed an MEP index for the United States and seven advanced capitalist economies based on five components: unemployment, inflation, growth, economic inequality, and economic insecurity. Ekren et al. (2017) constructed an MEP index for Turkey, Brazil, and Poland using five indicators: inflation, growth, employment, long-term interest rates, and exchange rate.

In the Indian context, Sahoo and Acharya (2012) constructed a robust MEP index for 22 Indian states from 1994-1995 to 2001-2002, using both radial and non-radial DEA models. They utilized three macroeconomic indicators to construct the MEP index: growth in gross state domestic product (GSDP), price stability, and fiscal balance. Other studies examined specific aspects of economic performance at the state level in India, such as fiscal discipline (Dholakia, 2005), public expenditure on the social sector (Mohanty & Bhanumurthy, 2020b), and sectoral growth (Chaudhuri, 2004). Bhide and Panda (2002) evaluated the quality of budgets at the national level using a composite index. Mohanty et al. (2020a) demonstrates the positive impact of MEP and Eco-MEP on private investment, foreign investment inflows, and foreign direct investment while showing a negative effect on the current account deficit.

Indian studies are scarce on the Macro Performance Index (MEP) at the state level. This study aims to fill this research gap by extending the existing studies to the Indian states. By doing so, valuable insights can be gained regarding regional disparities, investment potential, fiscal management, and social development. These insights are crucial for policymakers, investors, and analysts as they seek to comprehend the economic and social dynamics at the state level, thereby enabling effective decision-making and targeted interventions. Furthermore, this study could help identify regions where investments would be most beneficial, promoting balanced and inclusive development across the country. The following section discusses the data and methodology.

3. Data Source and Methodology

3.1 Data

The study has constructed the MEP for 28 Indian states, covering the period from 2011-12 to 2020-21.[iv] The MEP index is based on economic growth, price stability, unemployment rate, fiscal balance, and forest cover. Economic growth (GR) is measured by the per capita GSDP growth rate at a constant price. Price stability (PS) is calculated in two steps. First, the inflation rate is determined as the annual percentage change in the GSDP deflator. Then, the price stability indicator is defined as one minus the GSDP deflator's growth rate, following Sahoo and Acharya's approach (2012). The unemployment rate (UR) is derived by dividing the number of unemployed individuals by the total number of employed and unemployed persons. Similarly, fiscal balance (FB) is captured by the fiscal deficit as a percentage of GSDP. Finally, forest cover (FC) is represented by the ratio of the total forest area to the total area (in square kilometers).

Data on GSDP, GSDP per capita, fiscal balance, and the unemployment rate have been obtained from the Economic and Political Weekly Research Foundation (EPWRF) database. Information on forest cover is sourced from the India State of Forest Report 2001-2021, published by the Forest Survey of India, Ministry of Environment, Forest and Climate Change.

3.2 Methodology

In the literature, DEA and econometric approaches are used to construct MEP. However, the DEA has a distinct advantage over the econometric approach in the generation of unequal weights for various individual indicators depending on their relative importance (Acharya & Sahoo, 2017; Cherchye, 2001; Cherchye et al., 2008; Cherchye et al., 2007; Fusco et al., 2017; Sahoo & Acharya, 2010, 2012; Sahoo et al., 2017). Thus, this study uses the DEA approach to calculate the MEP for Indian states. Four separate MEP indices have been estimated using DEA models to measure the performance of Indian states.

First, the MEP index is constructed using three economic indicators: economic growth (GR), price stability (PS), and unemployment rate (UR). Subsequently, the model is extended by including an additional indicator, fiscal balance. This extension is motivated by adopting the Fiscal Responsibility and Budget Management Act (FRBMA, 2003), which requires Indian states to reduce their fiscal deficits and maintain a fiscal deficit-to-GSDP ratio of 3%. With this inclusion, the study examines whether fiscal commitment leads to better state performance.

Furthermore, forest cover is introduced as an additional indicator alongside economic growth, price stability, and unemployment rate. The rationale is the recommendations of the Fourteenth and Fifteenth Finance Commissions suggesting the inclusion of forest cover in the tax devolution formula for sharing taxes among Indian states. These commissions proposed an increased weightage for forest cover from 7.5% to 10% within the tax devolution formula, indicating the significance of forest cover in tax sharing. While a large forest cover provides substantial ecological benefits, it also comes with an opportunity cost, as the area is unavailable for other economic activities. Therefore, incorporating forest cover in the MEP index enables a more comprehensive assessment of overall economic performance.

Finally, the MEP index is constructed by incorporating fiscal balance and forest cover, economic growth, price stability, and unemployment rate. Different MEP indices are constructed to investigate whether fiscal commitment and the inclusion of forest cover in the tax devolution formula have a noticeable impact on the MEP of the Indian economy.

Before setting up the formal DEA model to construct the MEP index, the original indicators are first normalized so that the values of the normalized indicators lie between zero and one, corresponding to the worst performance and the best performance in the sample, respectively. Following Cherchye (2001), the normalizations of the selected variables, i.e., GR, PS, UR, FB, and FC for each year "*t*" (*t* = 2011-12, 2015-16, and 2020-21), are computed as follows.

$$GR_t^n = \frac{GR_t - GR_{min}}{GR_{max} - GR_{min}} \tag{1}$$

$$PS_t^n = \frac{PS_t - PS_{min}}{PS_{max} - PS_{min}} \tag{2}$$

$$UR_t^n = \frac{UR_{max} - US_t}{UR_{max} - UR_{min}} \tag{3}$$

$$FB_t^n = \frac{FB_{max} - FB_t}{FB_{max} - FB_{min}} \tag{4}$$

$$FC_t^n = \frac{FC_t - FC_{min}}{FC_{max} - FC_{min}} \tag{5}$$

Note that of the five indicators used, three indicators, namely economic growth, price stability, and forest cover, are considered "economic goods." At the same time, the unemployment rate and fiscal balance are categorized as "economic bads." Constructing the MEP index within the DEA framework requires expressing all indicators as "economic goods." Therefore, the "economic bads," namely the unemployment rate and fiscal balance, are converted into "economic goods."

Following the approaches of Sahoo and Acharya (2012), Acharya and Sahoo (2017), and Mohanty et al. (2020a), this study combines various macro indicators, including economic growth, price stability, unemployment rate, fiscal balance, and forest cover, which are influenced by the changing economic environment and decisions made by the Indian state governments. These indicators are combined into a single summary measure, the MEP index, without considering resources. Here, the objective function can be interpreted as some utility level associated with holding the optimal portfolio of macro aggregates for a given period, and their respective weights reflect the underlying assumption that good performance reflects high policy priority. This study adopts the following output-oriented slacks-based model (SBM) approach to construct all the MEP indices for Indian states, [v] under the variable returns to scale to compute the MEP index for Indian states (MEP_x) as follows:

$$(MEP_x)^{-1} = max \;\; 1 + \frac{1}{3}\left(\frac{s^{GR}}{GR_x^n} + \frac{s^{PR}}{PR_x^n} + \frac{s^{UR}}{UR_x^n}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

subject to

$$\sum_{j=1}^{28}\sum_{j=1}^{10} GR_j^{nt}\lambda_j^t - s^{GR} = GR_x^{nt} \;;$$
$$\sum_{j=1}^{28}\sum_{j=1}^{10} PS_j^{nt}\lambda_j^t - s^{PS} = PS_x^{nt} \;;$$
$$\sum_{j=1}^{28}\sum_{j=1}^{10} UR_j^{nt}\lambda_j^t - s^{UR} = UR_x^{nt} \;;$$
$$\sum_{j=1}^{28}\sum_{j=1}^{10} \lambda_j^t = 1 \;; \lambda_j^t \geq 0 \; (\forall_j, t)$$

Here, λ_j^ts, the intensity coefficients, are interpreted as the shadow prices, and s^{GR}, s^{PS}, and s^{UR}. are, respectively, the slacks in normalized macro indicators - GR_x^{nt}, PS_x^{nt}, and UR_x^{nt}. State “x” is efficient if MEP_x = 1; and $MEP_x = 1$ if the slacks are all zero. i.e., $s^{GR} = 0, s^{PS} = 0 \; and \; s^{UR} = 0$. If any of these slacks is non-zero, then State "x" is inefficient.

The MEP scores can be computed analogously from the same LP program (6) but by adding the fiscal balance (FB) constraint, i.e., $\sum_{j=1}^{28}\sum_{j=1}^{10} FB_j^{nt}\lambda_j^t - s^{FB} = FB_x^{nt}$.

Again, the MEP scores can be computed analogously from the same LP program (6) but by adding the Forest cover (FC) constraint, i.e., $\sum_{j=1}^{28}\sum_{j=1}^{10} Fc_j^{nt}\lambda_j^t - s^{FC} = FC_x^{nt}$.

Furthermore, finally, the MEP scores can be computed analogously from the same LP program (6) but by adding both FB & (FC) constraints, i.e., $\sum_{j=1}^{28}\sum_{j=1}^{10} FB_j^{nt}\lambda_j^t - s^{FB} = FB_x^{nt}$ & $\sum_{j=1}^{28}\sum_{j=1}^{10} Fc_j^{nt}\lambda_j^t - s^{FC} = FC_x^{nt}$.

For example, it could be as follows.

$$(MEP_x)^{-1} = max \;\; 1 + \frac{1}{5}\left(\frac{s^{GR}}{GR_x^n} + \frac{s^{PR}}{PR_x^n} + \frac{s^{UR}}{UR_x^n} + \frac{s^{FB}}{FB_x^n} + \frac{s^{FC}}{FC_x^n}\right)$$

subject to

$$\sum_{j=1}^{28}\sum_{j=1}^{10} GR_j^{nt}\lambda_j^t - s^{GR} = GR_x^{nt} \;;$$

$$\sum_{j=1}^{28}\sum_{j=1}^{10} PS_j^{nt}\lambda_j^t - s^{PS} = PS_x^{nt} ;$$
$$\sum_{j=1}^{28}\sum_{j=1}^{10} UR_j^{nt}\lambda_j^t - s^{UR} = UR_x^{nt} ;$$
$$\sum_{j=1}^{28}\sum_{j=1}^{10} FB_j^{nt}\lambda_j^t - s^{FB} = FB_x^{nt} ;$$
$$\sum_{j=1}^{28}\sum_{j=1}^{10} FB_j^{nt}\lambda_j^t - s^{FB} = FB_x^{nt} ;$$
$$\sum_{j=1}^{28}\sum_{j=1}^{10} \lambda_j^t = 1 ; \lambda_j^t \geq 0 \ (\forall_j, t)$$

4. Empirical Analysis

As discussed earlier, the first MEP index (MEP^I) is constructed using economic growth, price stability, and the unemployment rate. The MEP^{II} is measured by incorporating economic growth, price stability, unemployment rate, and fiscal balance. The MEP^{III} includes economic growth, price stability, unemployment rate, and forest cover. Finally, MEP^{IV} is constructed considering economic growth, price stability, unemployment rate, fiscal deficit, and forest cover.[vi] Hence, four MEP indices are derived based on the selected indicators. States that achieve unit efficiency scores are considered efficient or perform optimally. In contrast, states with efficiency scores below unity are deemed to operate sub-optimally for the given set of attributes. Let us analyze the results obtained from DEA.

4.1 The results of MEP^I and MEP^{II}

Table I summarizes the MEP^I and MEP^{II} scores of Indian states. The MEP^I index uses the indicators of GR, PS, and UR. In 2011, the efficient states were Goa, Himachal Pradesh, Jharkhand, Meghalaya, Mizoram, and Punjab, demonstrating high-performance levels across the selected indicators. However, in 2015, the efficient states were Assam, Chhattisgarh, Gujarat, Jammu & Kashmir, and Odisha, indicating improved performance. By 2020, Mizoram and Sikkim emerged as efficient states, suggesting their outstanding performance in terms of economic growth, price stability, and unemployment rate. The MEP^{II} index constructed using GR, PS, UR, and FB indicators shows that 11 states were identified as efficient in 2011. However, in 2015, the efficient states were Assam, Chhattisgarh, Goa, Gujarat, Jammu & Kashmir, Mizoram, and Odisha. In 2020, only four states, namely Gujarat, Maharashtra, Mizoram, and Sikkim, maintained their efficiency status.

Table I: Score of MEP^I and MEP^{II} indices

States	MEP^I Score(Rank)			MEP^{II} Score(Rank)		
	2011	2015	2020	2011	2015	2020
Andhra Pradesh	0.77(11)	0.92(9)	0.31(14)	0.81(16)	0.78(14)	0.36(14)
Arunachal Pradesh	0.25(27)	0.50(25)	0.26(20)	0.25(27)	0.57(21)	0.50(7)
Assam	0.36(20)	1.00(1)	0.39(8)	0.54(20)	1.00(1)	0.33(19)
Bihar	0.32(24)	0.75(17)	0.38(9)	0.40(23)	0.70(16)	0.33(17)

Chhattisgarh	0.55(17)	1.00(1)	0.46(6)	1.00(1)	1.00(1)	0.44(9)
Goa	1.00(1)	0.56(24)	0.37(10)	1.00(1)	1.00(1)	0.39(12)
Gujarat	0.92(7)	1.00(1)	0.54(3)	1.00(1)	1.00(1)	1.00(1)
Haryana	0.78(8)	0.91(10)	0.20(23)	0.91(14)	0.57(23)	0.25(25)
Himachal Pradesh	1.00(1)	0.11(29)	0.28(18)	1.00(1)	0.14(29)	0.33(18)
Jammu & Kashmir	0.18(28)	1.00(1)	0.29(17)	0.22(28)	1.00(1)	0.32(20)
Jharkhand	1.00(1)	0.56(23)	0.31(13)	1.00(1)	0.47(25)	0.41(10)
Karnataka	0.27(26)	0.97(6)	0.46(5)	0.40(24)	0.96(8)	0.54(6)
Kerala	0.35(21)	0.49(26)	0.12(27)	0.42(21)	0.47(26)	0.15(28)
Madhya Pradesh	0.77(10)	0.85(14)	0.35(11)	0.95(13)	0.79(12)	0.40(11)
Maharashtra	0.61(12)	0.88(11)	0.05(28)	0.82(15)	0.86(9)	1.00(1)
Manipur	0.60(15)	0.86(13)	0.26(19)	0.30(26)	0.85(10)	0.31(21)
Meghalaya	1.00(1)	0.60(21)	0.04(29)	1.00(1)	0.62(18)	0.05(29)
Mizoram	1.00(1)	0.93(8)	1.00(1)	1.00(1)	1.00(1)	1.00(1)
Nagaland	0.61(13)	0.59(22)	0.22(22)	0.66(19)	0.59(20)	0.25(24)
Odisha	0.57(16)	1.00(1)	0.25(21)	1.00(1)	1.00(1)	0.31(23)
Punjab	1.00(1)	0.65(20)	0.32(12)	1.00(1)	0.59(19)	0.39(13)
Rajasthan	0.33(22)	0.87(12)	0.29(16)	1.00(1)	0.49(24)	0.35(16)
Sikkim	0.61(14)	0.37(27)	1.00(1)	0.72(17)	0.43(27)	1.00(1)
Tamil Nadu	0.28(25)	0.84(15)	0.41(7)	0.41(22)	0.79(13)	0.47(8)
Telangana	-	0.94(7)	0.16(25)	-	0.81(11)	0.21(27)
Tripura	0.46(19)	0.13(28)	0.52(4)	1.00(1)	0.16(28)	0.57(5)
Uttar Pradesh	0.54(18)	0.68(19)	0.30(15)	0.67(18)	0.57(22)	0.36(15)
Uttarakhand	0.78(9)	0.71(18)	0.19(24)	0.98(12)	0.68(17)	0.24(26)
West Bengal	0.33(23)	0.77(16)	0.16(26)	0.39(25)	0.73(15)	0.31(22)

Note: Ranks are shown in the ( ).
Source: Author's calculation.

Over the years, there have been notable changes in the MEP rankings of different states. Several states have improved their MEP scores, reflecting their efforts in enhancing economic performance. Karnataka, Tamil Nadu, Bihar, Tripura, Sikkim, Assam, Chhattisgarh, Jammu & Kashmir, Arunachal Pradesh, Rajasthan, Gujarat, and Uttar Pradesh have witnessed significant improvements in their MEP^{I} rankings from 2011 to 2020. These states have made strides in achieving higher economic growth, maintaining price stability, and reducing unemployment rates. Conversely, Meghalaya, Telangana, Himachal Pradesh, Maharashtra, Haryana, Uttarakhand, Jharkhand, Punjab, Goa, and Nagaland have witnessed a significant fall in their MEP^{I} rankings over the study period. This decline suggests challenges in achieving desirable levels of economic growth, price stability, and addressing unemployment in these states. Madhya Pradesh and Mizoram have maintained relatively stable ranks throughout the study period, demonstrating the effectiveness of their policies and strategies.

The MEP^{II} results highlight the significant impact of including the fiscal balance indicator in the MEP index. Gujarat and Mizoram stand out as the most consistent states retaining their ranks throughout the study period. Assam, Andhra Pradesh, and Madhya Pradesh did not experience substantial rank changes during these years. Furthermore, Arunachal Pradesh, Karnataka, Sikkim, Maharashtra, Tamil Nadu, Jammu & Kashmir, Bihar, Manipur, Uttar Pradesh, West Bengal, Andhra Pradesh, and Madhya Pradesh improved their rankings from 2011 to 2020. However, Meghalaya, Telangana, Odisha, Himachal Pradesh, Rajasthan, Uttarakhand, Punjab, Goa, Haryana, Jharkhand, Chhattisgarh, Kerala, Nagaland, and Tripura observed a significant decline in their MEP rankings.

4.2 The results of MEP^{III} and MEP^{IV}

The findings of the MEP^{III} index that incorporates GR, PS, UR, and FC indicators show that in 2011, efficient states included Goa, Himachal Pradesh, Jharkhand, Meghalaya, Mizoram, Punjab, and Tripura. Similarly, in 2015, the efficient states were Assam, Chhattisgarh, Goa, Gujarat, Jammu & Kashmir, Karnataka, Manipur, Mizoram, and Odisha. In 2020, Meghalaya, Mizoram, and Sikkim emerged as efficient states.

It is worth noting that both Meghalaya and Mizoram exhibited consistency as efficient states throughout the study period. The results demonstrate that Karnataka, Tamil Nadu, Assam, Sikkim, Chhattisgarh, Haryana, Arunachal Pradesh, Jammu & Kashmir, Madhya Pradesh, and Gujarat improved their rankings from 2011 to 2020. Conversely, Punjab, Himachal Pradesh, Jharkhand, Maharashtra, Kerala, Nagaland, Uttarakhand, Telangana, Goa, and Tripura experienced a decline in their MEP^{III} rankings over the years. Meanwhile, Andhra Pradesh, Rajasthan, Gujarat, Manipur, and Odisha did not undergo significant rank changes during this period.

Table II: Score of MEP^{III} and MEP^{IV} indices

States	MEP^{III} Score(Rank)			MEP^{IV} Score(Rank)		
	2011	2015	2020	2011	2015	2020
Andhra Pradesh	0.43(15)	0.54(16)	0.27(16)	0.50(18)	0.54(16)	0.30(19)
Arunachal Pradesh	0.37(19)	0.64(13)	0.31(13)	0.35(23)	0.68(11)	1.00(1)
Assam	0.38(18)	1.00(1)	0.39(7)	0.58(17)	1.00(1)	0.32(18)
Bihar	0.15(24)	0.17(25)	0.15(24)	0.18(25)	0.20(24)	0.16(26)
Chhattisgarh	0.49(14)	1.00(1)	0.48(5)	1.00(1)	1.00(1)	0.46(8)
Goa	1.00(1)	1.00(1)	0.42(6)	1.00(1)	1.00(1)	0.43(10)
Gujarat	0.20(23)	1.00(1)	0.18(21)	1.00(1)	1.00(1)	1.00(1)
Haryana	0.01(28)	0.00(29)	0.20(19)	0.01(28)	0.00(29)	0.23(22)
Himachal Pradesh	1.00(1)	0.14(26)	0.29(14)	1.00(1)	0.17(26)	0.33(16)
Jammu & Kashmir	0.15(25)	1.00(1)	0.18(20)	0.18(26)	1.00(1)	0.21(23)
Jharkhand	1.00(1)	0.49(18)	0.32(11)	1.00(1)	0.43(22)	0.41(11)
Karnataka	0.26(21)	1.00(1)	0.35(9)	0.42(21)	1.00(1)	0.45(9)
Kerala	0.39(16)	0.48(19)	0.14(25)	0.45(19)	0.45(20)	0.17(25)
Madhya Pradesh	0.55(12)	0.56(14)	0.36(8)	0.81(14)	0.56(14)	0.40(12)
Maharashtra	0.38(17)	0.41(23)	0.06(27)	0.61(16)	0.44(21)	1.00(1)
Manipur	0.67(10)	1.00(1)	0.32(12)	0.42(20)	1.00(1)	0.36(14)
Meghalaya	1.00(1)	0.71(10)	1.00(1)	1.00(1)	0.68(10)	1.00(1)
Mizoram	1.00(1)	1.00(1)	1.00(1)	1.00(1)	1.00(1)	1.00(1)
Nagaland	0.82(8)	0.68(12)	0.25(17)	0.82(13)	0.64(13)	0.28(20)
Odisha	0.51(13)	1.00(1)	0.27(15)	1.00(1)	1.00(1)	0.32(17)
Punjab	1.00(1)	0.43(22)	0.00(29)	1.00(1)	0.39(23)	0.00(29)
Rajasthan	0.05(27)	0.05(28)	0.05(28)	1.00(1)	0.06(28)	0.07(28)
Sikkim	0.62(11)	0.44(20)	1.00(1)	0.76(15)	0.46(18)	1.00(1)
Tamil Nadu	0.26(22)	0.51(17)	0.33(10)	0.41(22)	0.53(17)	0.38(13)

Telangana		0.54(15)	0.17(22)		0.54(15)	0.20(24)
Tripura	1.00(1)	0.17(24)	0.58(4)	1.00(1)	0.19(25)	0.62(7)
Uttar Pradesh	0.11(26)	0.10(27)	0.09(26)	0.14(27)	0.12(27)	0.12(27)
Uttarakhand	0.72(9)	0.70(11)	0.23(18)	1.00(1)	0.65(12)	0.27(21)
West Bengal	0.26(20)	0.44(21)	0.17(23)	0.32(24)	0.46(19)	0.33(15)

Note: Ranks are shown in the ( ).

Source: Author's calculation.

The results of the MEP^{IV} index that encompasses all five indicators (GR, PS, UR, FB, and FC) indicate that there were twelve efficient states in 2011, as shown in Table II. In 2015, efficient states included Assam, Chhattisgarh, Goa, Gujarat, Jammu & Kashmir, Karnataka, Manipur, Mizoram, and Odisha. In 2020, efficient states were identified as Arunachal Pradesh, Gujarat, Maharashtra, Meghalaya, Mizoram, and Sikkim.

Throughout the study period, Gujarat, Meghalaya, and Mizoram emerged as the most consistent and efficient states. In addition to these states, Madhya Pradesh, Andhra Pradesh, Assam, and Bihar did not experience significant rank changes over the years. On the other hand, Arunachal Pradesh, Maharashtra, Sikkim, Karnataka, Tamil Nadu, West Bengal, Haryana, Manipur, Jammu & Kashmir, and Madhya Pradesh improved their rankings. However, Punjab, Rajasthan, Uttarakhand, Odisha, Himachal Pradesh, Jharkhand, Goa, Telangana, Chhattisgarh, Nagaland, Kerala, Tripura, Andhra Pradesh, Assam, and Bihar observed a decline in their MEP rankings.

The empirical analysis conducted above sheds light on the efficiency rankings of Indian states using different variations of the MEP index. The findings highlight the impact of different indicators on efficient scores across the years. Notably, the inclusion of fiscal balance and forest cover indicators significantly influenced the rankings. Gujarat and Mizoram emerged as the most consistent and efficient states throughout the selected period, indicating their sustained performance. Additionally, states like Karnataka, Tamil Nadu, Assam, and Madhya Pradesh improved their rankings, demonstrating their efforts toward enhancing efficiency. Conversely, states like Punjab, Rajasthan, Odisha, and Goa have experienced declining efficiency rankings over the years. These findings provide valuable insights into the performance and relative efficiency of Indian states, assisting policymakers in identifying areas for improvement and sharing best practices among states.

5. Performance of the North-Eastern States?

The empirical findings demonstrate the resilience and improving performance of north-eastern states in India (Table III). Regarding the MEP^{I}, these states accounted for 28 percent of efficient states in 2011 and reached 100 percent representation in 2020. Including additional indicators in the MEP^{II}, MEP^{III}, and MEP^{IV} models still showed a significant presence of north-eastern states among the efficient states, ranging from 27 to over 66 percent representation. Mizoram emerges as the most consistent and high-performing state in the region. Meghalaya, Nagaland, and Tripura also demonstrate improvements in their rankings, showcasing their investment potential. However, Sikkim, Arunachal Pradesh, and Assam (except in the MEPIV model) experienced a decline in their rankings. These findings suggest that northeast India presents a promising destination for foreign investment, particularly considering the region's resilience and the positive trends observed among the states.

Table III: Share of North-eastern Efficient States in all Efficient States

Index	2011	2015	2020

	Number of Efficient States	Efficient North-East States (Percentage Share)	Number of Efficient States	Efficient North-East States (Percentage Share)	Number of Efficient States	Efficient North-East States (Percentage Share)
MEP^{I}	7	Meghalaya, Mizoram **(28.57)**	5	Assam **(20.0)**	2	Mizoram, Sikkim **(100)**
MEP^{II}	11	Meghalaya, Mizoram, Tripura **(27.3)**	7	Assam, Mizoram **(28.6)**	4	Mizoram, Sikkim **(50)**
MEP^{III}	7	Meghalaya, Mizoram, Tripura **(42.9)**	9	Assam, Manipur, Mizoram **(33.3)**	3	Meghalaya, Mizoram, Sikkim **(100)**
MEP^{IV}	12	Meghalaya, Mizoram, Tripura **(25)**	9	Assam, Manipur, Mizoram **(33.3)**	6	Arunachal Pradesh, Meghalaya, Mizoram, Sikkim **(66.7)**

Source: Author's calculation.

Analyzing the rank differences between 2011 and 2020 for the northeastern states (summarized in Table IV), Mizoram emerges as the region's most consistent and high-performing state. Mizoram's focus on environmental sustainability, particularly in forest conservation and renewable energy, contributes to its consistent performance. Meghalaya demonstrates similar positive trends, while Nagaland and Tripura have improved their rankings. However, Sikkim, Arunachal Pradesh, and Assam (except in MEP^{IV}) have experienced a decline in their rankings. Of the eight northeastern states analyzed, five of these states exhibit signs of improvement, making the region an attractive destination for foreign investment within India. Supplemented by these findings, let us analyze why Korea should consider investing in Northeast India in the next section.

Table IV: The rank difference between 2020 and 2011 of the North-eastern states

States	MEP^{I}	MEP^{II}	MEP^{III}	MEP^{IV}
Arunachal Pradesh	-7	-20	-6	-22
Assam	-12	-1	-11	1
Manipur	4	-5	2	-6
Meghalaya	28	28	0	0
Mizoram	0	0	0	0
Nagaland	9	5	9	7
Sikkim	-13	-16	-10	-14
Tripura	-15	4	3	6

Source: Author's calculation.

6. Rationale for Korean investment in Northeast India.

Research has established the positive impact of the MEP and Eco-MEP on private investment, foreign investment inflows, foreign direct investment, and a negative effect on the current account deficit (Mohanty et al., 2020a). Our research builds upon this foundation and focuses on different states of India, providing a composite MEP index that can be utilized by foreign investors, rating agencies, private investors, and policymakers in their planning and decision-making processes. While the findings apply to any country interested in investing in

India, this paper specifically focuses on South Korea as a source for FDI and the northeastern states of India as an investment destination.

Northeast India has become a focal point for India's planning and development priorities, intending to make it the growth engine of 21st-century India. The region has witnessed consistent efforts to promote peace, improve infrastructure, and enhance connectivity, with a substantial budgetary allocation of 10 percent of the national budget.[vii] The government of India has allocated over Rs 4 lakh crore for the northeast region in the last decade.

Northeast India is yet to attract any substantial FDI. However, the hosting of G20 summits by the northeastern states, as India assumes the G20 presidency in 2023, has piqued the interest of many countries in investing in the region. The Northeast serves as the entry point to ASEAN countries and aligns perfectly with Korea's "New Southern Policy" and India's "Act East Policy." Collaboration between India, Korea, and ASEAN nations is crucial for all parties' economic development. Korean culture already has a strong presence in northeast India, making it even more advantageous to expand economic ties. South Korea plans to invest in pharmaceuticals, food processing, tourism, healthcare, and infrastructure sector in Sikkim and Assam.

The lack of research on Northeast India and South Korea has been a major hurdle in expanding Korean presence in Northeast India, despite the region being a significant market for Korean products. The Embassy of the Republic of Korea, the Korean Trade Investment Promotion Agency (KOTRA), the Korea Start-up Centre, K-Sure, the Korea International Trade Association (KITA), the India Korea Business Cooperation Centre, the Korea Chamber of Commerce and Industry in India (KOCHAM), and the Korea India Research and Innovation Centre are actively spearheading the spread of Korean presence in India, with a particular focus on the Northeast.

As part of India's Act East policy, various incentive schemes are available for investment in Northeast India. A compelling case exists for investing in Northeast India because of the region's resource abundance, locational advantage, and human capital. Investment in the Northeast has both economic and socio-political justifications. By investing in the region, Korean companies can not only tap into a growing market but also contribute to the region's socio-economic development and strengthen bilateral ties between South Korea and India.

In addition to the efficiency-based rationale derived from the DEA model, the investment climate in Northeast India is improving. Some states in the Northeast have performed exceptionally well and ranked amongst the top performers in India on various indicators. The resilience and improving efficiency of the northeastern states, particularly exemplified by Mizoram and Meghalaya, make them promising investment destinations. The region's focus on environmental sustainability and its potential for sustainable tourism and ecotourism further enhance its appeal. Investing in Northeast India can not only contribute to the economic development of the region but also foster mutually beneficial partnerships between Korea and the Indian states, leveraging their respective strengths and promoting sustainable growth.

7. Conclusion

Korean investment in Northeast India presents an opportunity for mutual benefits. For Korean investors, it offers access to new investment avenues due to the region's strategic proximity to ASEAN and neighbouring South Asian countries. The region's existing demand for Korean products, combined with the Indian government's increasing focus on the development of Northeast India, creates favorable conditions for investment and strengthens economic ties between India and South Korea. Moreover, the cultural ties between Northeast India and Korea add an extra dimension of affinity and understanding.

The findings and analysis presented in this research paper carry policy implications for both South Korea and India. Firstly, South Korea can benefit by diversifying its investment portfolio into new industries and destinations. Secondly, the continued effort of the Indian government to improve its investment climate and ease of doing business can further enhance its appeal as an investment destination.

Additionally, there is a need for more incredible research and information dissemination to highlight the economic potential and attractiveness of investment destinations beyond major metropolitan regions. Efforts should be made to showcase the opportunities available in India's Northeast, which has witnessed significant development interventions and is poised for growth. Collaboration between organizations and bodies involved in promoting Korean presence in India can play a crucial role in spreading awareness and facilitating investments.

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[i] https://www.ibef.org/indian-exports/india-korea-trade. Accessed on 9/06/2023.

[ii] South Korea is India's 13th largest FDI source, investing US$ 5.401 billion between January 2000 to December 2022. (source: https://dpiit.gov.in/sites/default/files/Table_No_3_DEC22.pdf) .

[iii] Bonwoo Ku (2018). "Determinants and linkages between intra-industry trade and foreign direct investment in manufacturing sector of South Korea and India since 1991," unpublished Ph.D. thesis submitted to Jawaharlal Nehru University, p. 92.

[iv] The MEP is constructed for 2011-12, 2015-16, and 2020-21 to verify the trends in the economic performance of Indian States.

[v] Though several variants of a DEA model (radial and non-radial models) are suggested by Cherchye (2001), we considered the non-radial slacks-based measure because it satisfies several desirable properties of an ideal efficiency measure such as indication, homogeneity, strict monotonicity, reference-set dependent, commensurability, and continuity.

[vi] Due to the inclusion of environmental indicators in the third and fourth MEP indices, we may call these indices Green MEP indices.

[vii] All Ministries/Departments (except those exempted by M/o DONER) are required to spend 10% of the Gross budget support from their allocation under Centrally Sponsored Schemes for the Northeastern Region. In the Union Budget 2019-20, 55 non-exempted Ministries/Departments (including M/o DONER) allocated Rs. 59,369.90 crores.

References

Acharya, D., & Sahoo, B. K. (2017). Dynamic macroeconomic performance of Indian States: Some post reform evidence. In A. Batabyal & P. Nijkamp (Eds.), *Regional Growth and Sustainable Development in Asia* (Chapter 9), New Frontiers in Regional Science: Asian Perspectives 7. Switzerland: Springer.

Bhide, S., & Panda, M. (2002). Evaluating quality of budgets with a composite index. *Economic and Political Weekly*, 37, 1177–1180.

Chaudhuri, S. (2004). A note on sectoral economic growth in the states. *ICRA Bulletin Money and Finance*, 2, 63–89.

Cherchye, L. (2001). Using data envelopment analysis to assess macroeconomic policy performance. *Applied Economics*, 33, 407–416.

Cherchye, L., Moesen, W., Rogge, N., & Puyenbroeck, T. V. (2007). An introduction to 'benefit of the doubt' composite indicators. *Social Indicators Research*, 82, 111–145.

Cherchye, L., Moesen, W., Rogge, N., van Puyenbroeck, T., Saisana, M., Saltelli, A., Tarantola, S. (2008). Creating composite indicators with DEA and robustness analysis: The case of the technology achievement index. *Journal of the Operational Research Society*, 59, 239–251.

Destefanis, S. (2003). Measuring macroeconomic performance through a non-parametric Taylor curve. *Centre for Studies in Economics and Finance*. Working Paper Number 95. Retrieved from http://www.csef.it/WP/wp95.pdf.

Dholakia, A. (2005). Measuring fiscal performance of states: An alternative approach. *Economic and Political Weekly*, 40, 3421–3428.

Ekren, N., Alp, E. A., & Yagmur, M. H. (2017). Macroeconomic performance index: A new approach to calculation of economic wellbeing. *Applied Economics*, 49, 1–15.

Fusco, E., Vidoli, F., & Sahoo, B. K. (2017). Spatial heterogeneity in composite Indicator: A methodological proposal. *Omega*, 77, 1–14.

Ku, B. (2018). Determinants and linkages between intra industry trade and foreign direct investment in manufacturing sector of South Korea and India since 1991," unpublished Ph.D. thesis submitted to Jawaharlal Nehru University, p. 92.

Lovell, C. A. K. (1995). Measuring the macroeconomic performance of the Taiwanese economy. *International Journal of Production Economics*, 39, 165–178.

Lovell, C. A. K., Pastor, J. T., & Turner, J. A. (1995). Measuring macroeconomic performance in the OECD: A comparison of European and non-European countries. *European Journal of Operational Research*, 87, 507–518.

Mohanty, R.K., Sahoo, B.K., & Chaudhury, P.K. (2020a). Assessing the (eco)macroeconomic performance index of India: A data envelopment analysis approach. *Journal of Public Affairs*, 21 (1), e2122. https://doi.org/10.1002/pa.2122.

Mohanty, R. K. & N. R. Bhanumurthy (2020b). Assessing public expenditure efficiency at the subnational level in India: Does governance matter?, *Journal of Public Affairs*, 21(2), e2173. https://doi.org/10.1002/pa.2173.

Ramanathan, R. (2006). Evaluating the comparative performance of countries of the Middle East and North Africa: A DEA application. *Socio-Economic Planning Sciences*, 40, 156–167.

Sahoo, B. K., & Acharya, D. (2010). An alternative approach to monetary aggregation in DEA. *European Journal of Operational Research*, 204, 672–682.

Sahoo, B. K., & Acharya, D. (2012). Constructing macroeconomic performance index of Indian states using DEA. *Journal of Economic Studies*, 39, 63–83.

Setterfield, M. (2009). An index of macroeconomic performance. *International Review of Applied Economics*, 23, 625–649.