

Enhancing Financial Inclusion in Bihar Through Efficient Resource Allocation: A Slack- Based DEA Framework

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Abstract

Problem: An inclusive financial system is crucial for a country's economic development. To achieve this, every state must optimize the utilization of available resources for long-term sustainability. This study focuses on evaluating the input-output efficiency of financial inclusion in Bihar for a period of five financial years, starting from 2016-2017 to 2020-2021. This study aims to address the issue of resource utilization in financial inclusion and identify districts that employ more effective policies than others. **Approach:** This study proposes a framework to assess the efficiency of financial inclusion in Bihar using data envelopment analysis (DEA) and slack-based DEA measures. DEA is a non-parametric method that measures the efficiency and productivity of decision-making units (DMUs). The analysis considers 38 districts of Bihar as DMUs and evaluates their input-output efficiency in financial inclusion. By adopting data envelopment analysis and slack-based measures, this study goes beyond theoretical and conceptual approaches, allowing for a practical and empirical evaluation of financial inclusion growth. **Findings:** The empirical results reveal significant variations in the utilization of financial inclusion resources among the 38 districts of Bihar. Some districts demonstrate efficient resource utilization, whereas others follow ineffective policies. The study found that, while some districts demonstrated consistent efficiency, others showed room for improvement. Notably, districts such as Arwal, East Champaran, Gaya, Jamui, Kaimur, Rohtas, and Saran maintained perfect efficiency scores, providing an example for others to follow. However, the overall average efficiency of financial inclusion in Bihar was 23.68%, indicating considerable scope for enhancement. Data envelopment analysis helps identify districts that achieve higher efficiency in financial inclusion, providing valuable insights for policymakers to improve resource allocation and decision-making. **Conclusion:** This study's unique inquiry into evaluating the efficiency of financial inclusion in Bihar contributes to the existing literature, which has primarily been theoretical and conceptual. By employing data envelopment analysis and slack-based measures, this study offers a practical assessment of financial inclusion growth. These findings emphasize the importance of optimizing resource utilization for sustainable economic development. Policymakers can utilize this study's insights to address inefficiencies in certain districts and develop targeted strategies to enhance financial inclusion across Bihar. Ultimately, achieving an inclusive financial system in Bihar is crucial for the overall economic development of the state and the country as a whole.

Keywords: Financial Inclusion, Data Envelopment Analysis, Inclusion Efficiency, Projection Value, Slack Based Value, Bihar

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1. Introduction

Financial inclusion refers to the process of providing access to affordable and appropriate financial products and services to all segments of society, especially to underserved and marginalized populations (Bhanot et al., 2012). It aims to ensure that individuals and businesses have access to formal financial institutions, such as banks, credit unions, and insurance companies, enabling them to participate in economic activities and save, invest, and manage risks effectively (Allen et al., 2015). Financial inclusion is considered a vital component of sustainable economic development as it fosters wealth creation, poverty reduction, and economic stability. DEA is a non-parametric mathematical method used to evaluate the relative efficiency of decision-making units (DMUs) in the presence of multiple inputs and outputs. (Coelli et al., 2005). In the context of this study, DMUs would represent the 38 districts of Bihar. DEA compares the efficiencies of different DMUs by calculating their efficiency scores and identifying the most efficient units. It helps to measure how effectively resources are utilized by each unit and provides valuable insights into areas that need improvement (Banker et al., 1984).

This study focuses on the efficiency theory, which is a broader economic concept that evaluates the optimal use of resources to achieve desired outcomes. In the context of financial inclusion, the efficiency theory posits that the effectiveness of financial inclusion policies and practices can be measured by how well financial resources are utilized to improve access to financial services and promote economic development (Honohan, 2008). Efficient financial inclusion practices ensure that financial services reach those that need them the most and contribute to the overall stability and growth of the economy. By combining these theoretical concepts, this study aims to apply DEA as a tool for assessing the efficiency of financial inclusion in Bihar. The underlying assumption is that financial inclusion can contribute significantly to economic development and poverty reduction, and DEA will enable a practical evaluation of how efficiently resources are used to achieve these objectives in different districts of Bihar. This study seeks to bridge the gap in the literature by providing empirical evidence of the effectiveness of financial inclusion policies and practices in the state, thus contributing to the overall theoretical understanding of the link between financial inclusion, resource utilization, and sustainable economic growth. These theories provide the foundation for understanding the significance of financial inclusion, the methodology used in DEA, and the broader economic implications of efficient financial inclusion. By combining these theories, this study bridges the gap in the literature by providing empirical evidence on the relationship between financial inclusion, resource utilization, and economic development in Bihar.

This study addresses the lack of practical and empirical evaluations of financial inclusion efficiency in Bihar. While theoretical and conceptual studies exist, there is limited research that applies data envelopment analysis (DEA) and slack-based measures to measure the efficiency of financial inclusion growth. This study seeks to fill this gap by providing concrete evidence of how financial resources are utilized across different districts in Bihar, and identifying areas where improvement is needed. Additionally, it aims to provide valuable insights for policymakers to optimize resource allocation and decision-making, ultimately fostering sustainable economic development through inclusive financial practices. The research objectives of this study are to assess the input-output efficiency of financial inclusion in Bihar over five financial years, identify districts with effective resource utilization, apply data envelopment analysis (DEA) and slack-based measures for evaluation, contribute empirical evidence to the existing literature, and offer insights for policymakers to enhance the impact of financial inclusion on sustainable economic development in Bihar.

The remainder of this paper is organized as follows. The second section describes the empirical literature. The third section presents the methodology of the SBM-DEA. Section four describes the results and discusses the 38 districts of Bihar. The last section presents the conclusions of the study.

2. Survey of literature

2.1 Financial Inclusion and Banking Efficiency

The optimal utilization of banking resources is important for a country because it increases and widens the practice of inclusion in Maity and Sahu (2021), Saha and Ravisankar (2000), and Swain et al. (2017). A study

conducted by [Muthia et al. \(2019\)](#) conducted a study to know the effect of financial inclusion on banking efficiency that reveals that Financial inclusion has a positive and considerable impact on banking efficiency. [Debasish \(2006\)](#) research revealed that old banks were less efficient than new banks. He further believes that the banking sector's efficiency evaluation has grown its importance. This suggested that modifying the banking system procedure will result in higher efficiency in financial inclusion sustainability. He further believes that the banking sector's efficiency evaluation has grown in importance. This suggests that modifying the banking system procedure results in higher efficiency in financial inclusion sustainability. [Saha and Ravisankar \(2000\)](#) asserted to evaluate the relative efficiency of Indian commercial banks through the DEA approach. Furthermore, they found that India remained at the bottom of the relative efficiency scales for commercial banks throughout the research period. [Maity and Sahu \(2020\)](#) conducted a study two times, the first acted as a pre-introduction, and the second acted as a post-introduction to know the effect of PMJDY. They found that there was a significant difference between public sector banks and between the two time period i.e., 2010-2011 to 2013-2014 and 2014-2015 to 2017-2018. [Maity and Sahu \(2021\)](#) by extending their study where the focus was to know the efficiency of three bank groups in the states of India. For the period 2009-2010 to 2018-2019 it has been found that foreign banks worked more efficiently than public and private sector banks. [Maity \(2020\)](#) uses DEA to visualize the difference between private and public sector banks in terms of efficiency over ten years from 2009 to 2018. According to the results, public-sector banks were less efficient than private-sector banks. The study conducted by [Yeh \(1996\)](#) illustrates the disadvantages of using financial ratios instead of evaluating performance. He explained how to use DEA in relation to financial ratios to assist in efficiency and inefficiency among Taiwanese banks. [Mostafa \(2007\)](#) highlighted the significance of encouraging increased efficiency by analyzing cross-sectional data from the top 50 GCC banks via DEA for the year 2005 throughout the GCC banking industry. [Halkos and Salamouris \(2004\)](#) asserted to determine the efficient working of Greek commercial banks from 1997 to 1999 using financial efficiency criteria. As a result, they highlight that greater overall asset size and a reduction in the number of small banks as a result of M&A s will contribute to greater efficiency. [Emrouznejad and Anouze \(2010\)](#) employed a mix of classification and regression trees with DEA to determine the causes of efficient and inefficient banking sectors in Gulf Corporation Council nations. [Grigorian and Manole \(2002\)](#) by applying DEA model, estimated indicators of commercial bank efficiency to bank data from a variety of transition countries. Existing evidence shows that commercial bank efficiency has improved because of the controlling power of foreign ownership enterprise restructuring. Furthermore, the efficiency of banking operations has improved through consolidation. Consistent with various scholars [Banna and Alam \(2020\)](#), financial inclusion is important for long-term development. The data show that the efficiency trend of Islamic banks in most countries has been inconsistent since the global financial crisis. He seeks to ascertain how financial inclusion and its connection with GDP development affect Islamic banking efficiency in achieving inclusive and sustainable growth.

2.2 Financial Inclusion and Micro Finance Institution

According to [Bharti and Chitnis \(2016\)](#); [Nguyen \(2019\)](#); [Nourani et al. \(2021\)](#), the effective operation of microfinance organizations would result in greater financial inclusion. Microfinance is a critical instrument for increasing access to financial services such as savings, credit, insurance, and remittances. Microfinance achieves operational efficiency by providing financial assistance to the unbanked population. In contrast, DEA has been widely employed to assess the effectiveness of MFIs. [Bharti and Chitnis \(2016\)](#) by categorizing MFIs as small, medium, and big investigated the relationship between the size and efficiency of MFIs. They determined the most efficient MFIs in each area as well as the average and lowest efficiency of these categories by utilizing DEA as an analysis method for 89 MFIs. They found a significant relationship between organizational size and efficiency. [Nourani et al. \(2021\)](#), used network DEA analysis and a unique production approach to measure the operational, financial, and outreach efficiency of 90 MFIs from 2013 to 2018. According to the findings, operational efficiency was substantially higher and remained high among the regulated MFIs. [Anh and Nguyen \(2019\)](#) contributed to the examination of the efficiency of microfinance institutions in Vietnam that are typically efficient with high overall technical efficiency, the efficiency scores have revealed a substantial gap between social and financial performance. [Zerai & Rani, 2012](#) this study aims to assess the technical efficiency of Ethiopian Micro Finance institutions (MFIs) from 2004 to 2009 using the Stochastic Frontier Analysis (SFA) model. The analysis indicated an average technical efficiency of 71.72%, suggesting room for improvement without additional resources. Factors such as asset

management, operational sustainability, inclusion of women, outreach depth, and trends significantly influence efficiency. These findings highlight the need for MFIs to balance efficiency with scalability and social goals for sustainable growth.

2.3 Efficiency and Economic Development

In 2006, 2010, and 2014, [Ambarkhane et al. \(2020\)](#) attempted to use DEA to assess the effectiveness of Indian states in reducing poverty. Despite fluctuating ranks, Assam, Bihar, Jharkhand, and Uttar Pradesh were consistently efficient over the three years. However, in a few other states such as Kerala, Odisha, Rajasthan, and West Bengal, the efficiency rating has shifted from efficient to inefficient. All the other states were consistently inefficient in 2006, 2010, and 2014. As per [Albagoury \(2021\)](#), the link between growth and poverty was conditional and mostly determined by the state of income distribution in India; that is, if growth was accompanied by a major improvement in distribution, poverty would be reduced. [Takouda et al. \(2020\)](#) performed a study, which was unusual as it intended to analyze the level of financial inclusion in WAEMU nations using a DEA approach. A multidimensional composite index is introduced. A genuine CCR (Constant Return to Scale) DEA model was employed in this study. They discovered that between 2010 and 2017, all eight nations consistently increased their participation percentage. Five of the 64 DMUs were relatively efficient, with scores of 100 percent. The remaining 59 were found to be inefficient. [Vong et al. \(2014\)](#) attempted to fill a vacuum in the research of financial inclusion procedures by conducting a study on women micro entrepreneurs in Indonesia and to provide benchmarks for financial inclusion programs. Further, according to both desk and field studies, financial exclusion is connected to financial education, rural Indonesian cultural norms, high banking costs, and mobile payments.

There is no question that many studies have been undertaken to assess the efficiency of financial or banking institutions, but there is little information that compares financial inclusion efficiency at the district or state level.

3. Research Methodology

3.1 Slack Based model of DEA

Data Envelopment Analysis (DEA) is a mathematical programming technique that evaluates the efficiency of decision-making units (DMUs) in comparison to other similar DMUs, with the simple constraint that all DMUs must be on or below the efficiency frontier ([Ramanathan 2003](#)). There are two types of models for measuring DMU efficiency: radial and non-radial. The CCR (Charnes-Cooper-Rhodes) model represents radial models. They primarily deal with proportional changes in the inputs or outputs. As a result, the CCR score reflects the maximum proportional input (output) reduction (expansion) rate that is shared by all inputs (outputs) ([Cooper et al., 2006](#)). However, not all inputs (outputs) behave proportionally in real-world business. Another disadvantage of radial models is that they do not account for slack when reporting the efficiency scores. Therefore, if these slacks play an important role in evaluating managerial efficiency, the radial approach may mislead decisions when the efficiency score is used as the sole index for evaluating DMU performance. Non-radial models eliminate this disadvantage of radial models ([Muhammad et al., 2018](#)). Non-radial SBM models, on the other hand, disregard the assumption of proportionate changes in inputs and outputs, and deal with slacks directly. This may result in varying proportions of the original inputs and outputs being discarded ([Morita et al., 2005](#)).

This model has the following structure: Suppose we have a set O of n DMUs denoted by j ($j=1, \dots, n$), each having m inputs and outputs.

Let the input and output vectors of DMU $_j$ be $X_j = (x_{1j}; x_{2j}; \dots; x_{mj})^T$ and $Y_j = (y_{1j}; y_{2j}; \dots; y_{sj})^T$ respectively.

DEA analysis was carried out in two stages. Initially, certain key input and output variables that could be used to evaluate the relative efficiency of Bihar districts in terms of financial inclusion were identified. In the second stage, a slack-based output-oriented DEA model is applied to the selected variables. Initially, the following four input variables and six output variables were used in the present study to evaluate the inclusion efficiency level of Bihar. Table 1 lists the input and output variables used in this study.

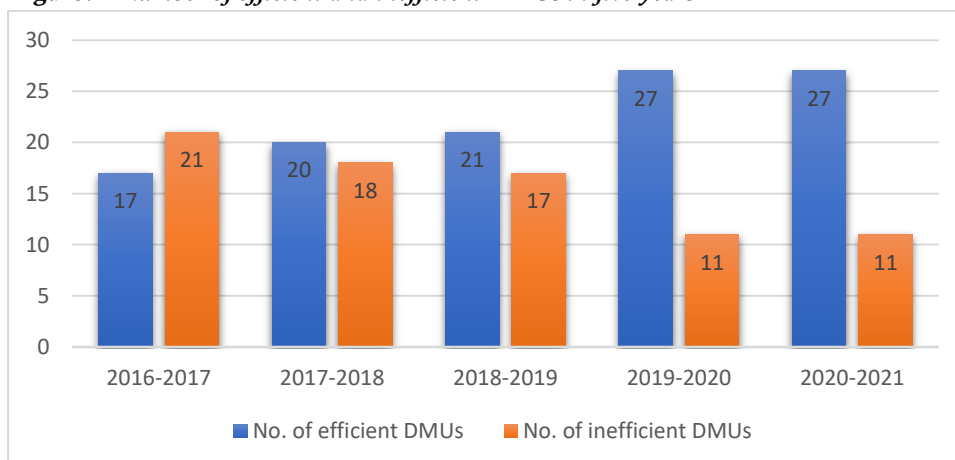
Dimensions	Indicators	Input and Output Model
Availability	No. Of Bank Branches (NOBB)	INPUT VARIABLES
	No. Of ATM (NOATM)	
Accessibility	No. Of Bank Mitra Engaged (NOBME)	
Awareness	No of Training Program Organized (NOTPO)	
Usage	No. Of Accounts Opened by Bank Mitra Engaged (NOAO)	OUTPUT VARIABLES
	Amount Accumulated by Bank Mitra Engaged (AABME)	
	No. Of ATM Card (NOATMC)	
	Volume of Deposit (VOD)	
	Volume of Credit (VOC)	
	Number of Persons Trained from the Training Program Organized (NOPT)	

Source: Author

4. Result and discussion

The dataset used in this study was obtained from the database of the State Level Banker's Committee Report for the period of five financial years from to 2016-2017 to 2020-2021. The number of efficient and inefficient DMUs is shown in Figure 1. In this study, the dataset comprised of 38 DMUs. Because we have reliable data extracted directly from the government report, we eliminate the risk of biased data that may distort the estimation result.

Figure: 1 Number of efficient and inefficient DMUs in five years



Source: Author's Calculation

Figure 1 shows a significant increase in the number of efficient DMUs from the years 2018-2019 to 2019-2020. The empirical analysis using DEA reveals the number of efficient and inefficient districts in Bihar concerning financial inclusion over five years. The increase in the number of efficient DMUs from 17 to 27 and the decrease in inefficient DMUs from 21 to 11 over the years suggests an overall improvement in the efficiency of financial inclusion practices in the state. The results indicate that more districts in Bihar effectively utilize available resources to achieve their financial inclusion objectives, leading to higher output levels without an increase in inputs. At the same time, fewer districts are deemed inefficient, indicating progress in optimizing resource utilization and enhancing financial inclusion growth.

Table: 2 Efficiency Score and Rank under the SBM-oriented CCR model of DEA

DMU	2016-2017		2017-2018		2018-2019		2019-2020		2020-2021	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Araria	0.424	23	0.773	30	0.620	36	0.8731	30	1	1
Arwal	0.293	25	1	1	1	1	1	1	1	1
Aurangabad	0.205	30	0.819	26	0.781	28	1	1	1	1
Banka	1	1	0.569	38	0.577	38	0.691	35	0.432	36
Begusarai	1	1	0.656	35	1	1	1	1	0.453	35
Bhagalpur	1	1	0.585	37	0.670	32	1	1	0.296	37
Bhojpur	0.188	32	0.817	27	0.651	35	0.753	34	0.503	33
Buxar	1	1	0.910	22	0.868	24	0.923	28	0.678	30
Darbhanga	0.162	34	0.864	23	0.823	25	0.665	36	0.693	29
East Champaran	1	1	1	1	1	1	1	1	1	1
Gaya	1	1	1	1	1	1	0.865	31	1	1
Gopalganj	0.586	18	0.732	31	0.603	37	0.633	37	1	1
Jamui	1	1	1	1	1	1	1	1	1	1
Jehanabad	0.151	36	0.695	33	0.706	31	1	1	0.539	32
Kaimur	1	1	1	1	1	1	1	1	1	1
Katihar	0.192	31	1	1	0.958	22	1	1	1	1
Khagaria	0.496	19	0.691	34	0.651	34	1	1	1	1
Kishanganj	1	1	1	1	1	1	0.891	29	1	1
Lakhisarai	1	1	1	1	1	1	1	1	1	1
Madhepura	0.219	29	0.839	24	1	1	1	1	1	1
Madhubani	1	1	0.782	29	0.719	30	1	1	0.767	28
Munger	0.264	27	1	1	1	1	0.606	38	1	1
Muzaffarpur	0.095	38	0.714	32	0.743	29	1	1	1	1
Nalanda	0.283	26	0.825	25	0.655	33	0.817	33	0.613	31
Nawada	0.454	21	1	1	1	1	1	1	1	1
Patna	1	1	1	1	1	1	1	1	1	1
Purnea	0.308	24	0.794	28	0.821	26	1	1	1	1
Rohtas	1	1	1	1	1	1	1	1	1	1
Saharsa	0.159	35	1	1	1	1	1	1	1	1
Samastipur	0.428	22	1	1	0.797	27	0.861	32	0.457	34
Saran	1	1	1	1	1	1	1	1	1	1
Sheikhpura	1	1	1	1	1	1	1	1	0.285	38
Sheohar	1	1	1	1	1	1	1	1	1	1
Sitamarhi	0.187	33	1	1	1	1	1	1	1	1

Siwan	0.476	20	0.628	36	0.868	23	1	1	1	1
Supaul	0.226	28	1	1	1	1	1	1	1	1
Vaishali	0.114	37	0.942	21	1	1	1	1	1	1
West Champanan	1	1	1	1	1	1	1	1	1	1

Source: Author's Calculation

The results of the SBM-DEA efficiency scores and ranks during the study period are presented in Table 2. Efficiency scores indicate how well each district utilizes its resources to achieve its financial inclusion objectives. A score of 1 means that the district operates at full efficiency, producing the desired outputs with minimum required inputs. Scores below one suggest that some districts do not utilize their resources optimally and have room for improvement in their financial inclusion practices.

The results show that there are nine out of thirty-eight DMUs that score 1 for all five financial years. The average efficiency score showed a frontier shift during these years. This indicates how the technology changed during the given period. Various government policies have worked positively in this area, but the result is not satisfactory, as only 23.68% of the total DMUs are efficient for the five years. This development shows that, on average, Bihar is considered inefficient. The results show that the average efficiency was highest in the financial year 2019-2020 which (0.9363) and lowest in 2016-2017 which (0.6028).

In the financial years 2016-2017, 2017-2018, 2018-2019, 2019-2020, and 2020-2021, the districts of Arwal, East Champanan, Gaya, Jamui, Kaimur, Rohtas, and Saran consistently achieved perfect efficiency (score of 1) and held the top rank (rank of 1), indicating that they were the most efficient districts in terms of financial inclusion practices during these years. Other districts have also demonstrated varying levels of efficiency over the years. Some districts consistently improved their efficiency, moving towards a score of 1, while others fluctuated in their performance. Districts with higher ranks in certain years suggest areas for improvement in their financial inclusion strategies to achieve better efficiency levels.

Overall, the empirical results suggest that certain districts in Bihar consistently performed well in terms of financial inclusion efficiency, whereas others showed room for improvement. Policymakers can use these insights to identify best practices in efficient districts and develop targeted strategies to enhance financial inclusion in less efficient districts, ultimately contributing to sustainable economic development and inclusive growth across Bihar.

Table: 3 Projection output in a percentage

	ATM Card Diff. (%)	NOPT Diff. (%)	NOA Diff. (%)	Amount Diff. (%)	VOD Diff. (%)	VOC Diff. (%)
2016-17	11.483	7.393	6.472	1125.935	7.260	7.101
2017-18	8.057	9.921	24.862	33.112	11.725	10.913
2018-19	5.390	11.856	34.731	30.35	10.954	10.236
2019-20	4.581	1.307	12.445	26.7999	4.634	3.919
2020-21	4.064	13.209	26.179	142.685	1.603	6.567

Source: Author's Calculation

Note: NOPT: Number of persons trained; NOA: Number of Accounts opened by Bank Mitra Engaged; Amount: amount accumulated by Bank Mitra Engaged; VOD: Volume of Deposit and VOC: Volume of Credit

From Table 3, we can determine the average percentage of output resources needed by the DMUs to shift toward the efficient frontier. The percentages provided in the table represent the differences between the actual output levels of the observed Decision-Making Units (DMUs) and the output levels they would need to reach the efficiency frontier in their respective years. The efficiency frontier represents the most efficient performance level a DMU can achieve given its input resources. Positive percentages indicate the gap between the observed output and the efficiency frontier, while negative percentages would imply that the DMU is already operating efficiently, or

even surpassing the frontier. The results show that the ATM card needed by DMUs decreases over time, which signifies that the increasing number of ATM card users in Bihar has grown positively. The same can be observed for other output resources, with some slight variations. Overall, the positive percentage differences in most categories indicate that the observed DMUs have room for improvement in various aspects of their operations in order to reach the efficiency frontier. These findings can guide DMUs in identifying areas for enhancement and in implementing strategies to optimize their resource utilization and achieve higher levels of efficiency in their respective years.

Table: 4 *Slack values of the input resources*

	ATM	Number of training organized	Bank Mitra Engaged	Branch
2016-2017	2.296	0.183	39.847	5.619
2017-2018	0.694	0.363	46.846	1.338
2018-2019	2.013	0	3.535	2.106
2019-2020	2.400	0	51.369	0.612
2020-2021	0.299	0	50.848	5.838

Source: Author's calculation

Table 4 provides the average number of input resources that remained unutilized over the years for the given variables, namely ATM, number of training organized, Bank Mitra engaged, and branch. These numbers indicate the extent to which the input resources are not fully utilized by the Decision-Making Units (DMUs) over the specified period.

In 2016-2017, an average of 2.296 ATMs remained unutilized by the DMUs. Subsequently, there was a consistent reduction in the number of unutilized ATMs over the years, reaching 0.299 in 2020-2021. This suggests a positive trend in the utilization of ATMs by DMUs, indicating an improved efficiency in utilizing this resource. The average number of unutilized training sessions decreased progressively from 0.183 in 2016-2017 to 0 in 2018-2019 and 2019-2020. The overall trend indicated an initial improvement in training session utilization, but it declined significantly in the final year of observation. In 2016-2017, an average of 39.847 Bank Mitra engagements remained unutilized by the DMUs, and this figure increased to 46.846 in 2017-2018. No Bank Mitra engagements were recorded in 2018-2019 and 2019-2020, implying no utilization of this resource during those years. In 2020-2021, the number of unutilized Bank Mitra engagements rose to 50.848. The empirical results show fluctuations in Bank Mitra engagement utilization over the years. The average number of unutilized branches decreased slightly from 5.619 in 2016-2017 to 5.838 in 2020-2021. This suggests limited improvement in branch utilization over the observed period. Overall, the empirical findings reveal the dynamics of resource utilization by DMUs for each variable. These trends indicate both improvements and fluctuations in utilization over the years, providing valuable insights into areas where resources are not fully utilized.

5. Conclusion

This study focused on assessing the efficiency of financial inclusion in Bihar over five years using Data Envelopment Analysis (DEA) as a tool to measure resource utilization. Financial inclusion, which provides access to financial products and services to all segments of society, is crucial for sustainable economic development. DEA allowed us to compare the efficiency of different districts in Bihar as Decision-Making Units (DMUs) and identify the most efficient ones. The study found that, while some districts demonstrated consistent efficiency, others showed room for improvement. Notably, districts such as Arwal, East Champaran, Gaya, Jamui, Kaimur, Rohtas, and Saran maintained perfect efficiency scores, providing an example for others to follow. However, the overall average efficiency of financial inclusion in Bihar was 23.68%, indicating considerable scope for enhancement. The empirical results provide valuable insights into the utilization of various input resources, such as ATMs, training

sessions, Bank Mitra engagements, and branches. The positive trends observed in ATM utilization and training sessions demonstrate improvements in reaching underserved populations. However, the fluctuations in Bank Mitra engagements and branch utilization highlight areas that require attention to enhance their effectiveness. This study contributes to the literature by providing concrete evidence of the effectiveness of financial inclusion policies and practices in Bihar. Policymakers can use these findings to identify best practices in efficient districts and develop targeted strategies to enhance financial inclusion in less efficient districts, ultimately contributing to sustainable economic development and inclusive growth across the state.

This study underscores the significance of financial inclusion in fostering wealth creation, poverty reduction, and economic stability. By utilizing DEA as an evaluation tool, this study sheds light on the efficiency of financial inclusion practices in Bihar, offering guidance for resource optimization and decision-making. The empirical evidence obtained through this study is valuable for shaping effective policies and practices that promote inclusive financial services and contribute to sustainable economic growth in Bihar.

References

1. Albagoury, S. H. (2021). African pathway to achieve inclusive growth: COMESA case study. *Journal of Humanities and Applied Social Science*, 3(2), 108–119.
2. Allen, F., Demircuc-Kunt, A., Klapper, L., Soledad Martinez Peria, M., & Peria, M. (2015). The Foundations of Financial Inclusion: Understanding Ownership and Use of Formal Accounts are in the Development. *Journal of Financial Intermediation*, 27, 1–30.
3. Ambarkhane, D., Singh, A. S., & Venkataramani, B. (2020). Measuring efficiency of Indian states for reducing poverty using data envelopment analysis. *Poverty and Public Policy*, 12(4), 357–385.
4. Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis. *Management Science*, 30(9).
5. Banna, H., & Alam, M. R. (2020). Islamic Banking Efficiency and Inclusive Sustainable Growth: The Role of Financial Inclusion. *Journal of Islamic Monetary Economics and Finance*, 6(1), 213–242.
6. Bhanot, D., Bapat, V., & Bera, S. (2012). Studying financial inclusion in north-east India. *International Journal of Bank Marketing*, 30(6), 465–484.
7. Bharti, N., & Chitnis, A. (2016). Size and efficiency of MFIs: A data envelopment analysis of Indian MFIs. *Enterprise Development and Microfinance*, 27(4), 255–272. <https://doi.org/10.3362/1755-1986.2016.017>
8. Coelli, T. J., Rao, P. D. S., O'Donnell, C. J., & Battese, G. E. (2005). *An Introduction to efficiency and productivity analysis* (2nd ed.). Springer Science and Business Media.
9. Cooper, W. W., Seiford, L. M., & Tone, K. (2006). Introduction to data envelopment analysis and its uses. In *springer* (Vol. 59).
10. Debasish, S. S. (2006). Efficiency Performance in Indian Banking—Use of Data Envelopment Analysis. *Global Business Review*, 7(2), 325–333
11. Emrouznejad, A., & Anouze, A. L. (2010). Data envelopment analysis with classification and regression tree - a case of banking efficiency. *The Journal of Knowledge Engineering*, 27(4), 231–246.
12. Grigorian, D. A., & Manole, V. (2002). Determinants of Commercial Bank Performance in transition: An Application of Data Envelopment Analysis. In *International Monetary Fund working paper* (Vol. 146).
13. Halkos, G. E., & Salamouris, D. S. (2004). Efficiency measurement of the Greek commercial banks with the use of financial ratios: A data development analysis approach. *Management Accounting Research*, 15(2), 201–224.
14. Honohan, P. (2008). Cross-country variation in household access to financial services. *Journal of Banking and Finance*, 32(11), 2493–2500.
15. Maity, S. (2020). Are private sector banks really more Efficient than public sector banks? - A comparative analysis using Dea. *NMIMS Management Review*, 38(2), 82–92.
16. Maity, S., & Sahu, T. N. (2021). How far the Indian banking sectors are efficient: An empirical investigation. *Asian Journal of Economics and Banking*, 2020

17. Morita, H., Hirokawa, K., & Zhu, J. (2005). A slack-based measure of efficiency in context-dependent data envelopment analysis. *The International Journal of Management Science*, 33, 357–362.
18. Mostafa, M. (2007). Modeling the efficiency of GCC banks: a data envelopment analysis approach. *International Journal of Productivity and Performance Management*, 56(7), 623–643.
19. Muhammad, A., Rao, T., & Farooq, Q. (2018). DEA Window Analysis with slack-based measure of Efficiency in Indian Cement Industry. *Statistics, Optimization and Information Computing*, 6(June), 292–302.
20. Muthia, F., Raneo, A. P., & Andaiyani, S. (2019). Financial inclusion and bank efficiency in Indonesia. *Journal of Advanced Research in Law and Economics*, 10(2–40), 595–602.
21. Nguyen, Q. A. M. (2019). Is there a Reciprocity between Social and Financial Efficiency? A Case of Vietnam Microfinance Institutions. *Research Journal of Finance and Accounting*, 10(20), 129–142.
22. Nourani, M., Malim, N. A. K., & Mia, M. A. (2021). Revisiting efficiency of microfinance institutions (MFIs): an application of network data envelopment analysis. *Economic Research-Ekonomika Istrazivanja*, 34(1), 1146–1169.
23. Saha, A., & Ravisankar, T. S. (2000). Rating of Indian commercial banks: a DEA approach. *European Journal of Operational Research*, 124(1), 187–203.
24. Swain, R. K., Sahoo, M., & Mishra, A. P. (2017). Non-Performing Assets of Scheduled Commercial Banks in India: Its Regulatory Frame Work. *Parikalpana: KIIT Journal of Management*, 13(2), 154.
25. Takouda, P. M., Dia, M., & Ouattara, A. (2020). Levels of Financial Inclusion in the WAEMU Countries: A case study using DEA. *2020 International Conference on Decision Aid Sciences and Application, DASA 2020*, 1274–1278.
26. Vong, J., Song, I., Salian, R. D., Kariath, R., & Bunyong, K. (2014). Improving the process of financial inclusion for women entrepreneurs in Indonesia. *International Journal of Process Management and Benchmarking*, 4(2), 167–185.
27. Yeh, Q. (1996). The application of data envelopment analysis in conjunction with financial ratios for bank performance evaluation. *Journal of the Operational Research Society*, 47(8), 980–988.
28. Zerai, B., & Rani, L. (2012). Technical Efficiency and its determinants of Micro Finance Institutions in Ethiopia: A Stochastic Frontier Approach. *African Journal of Accounting Economics, Finance and Banking Research*, 8(8).