

## Impact of Crises on Efficiency, Effectiveness and Performance of Indian Banks: A Network Directional Distance Approach

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### ABSTRACT

**Purpose:** The purpose of the study is to evaluate how the exogenous crises like the Global Financial Crisis (GFC) and the COVID-19 pandemic have impacted the efficiency, effectiveness and performance of the Indian banking system.

**Design/Methodology/Approach:** A two-stage directional distance function-based network data envelopment analysis (DDF-NDEA) model is employed to calculate efficiency, effectiveness, and overall bank performance scores of each bank. The second stage employs bootstrapped truncated regression to study the impact of the crises on bank performance.

**Findings:** Empirical results highlight a notable difference in the impact of crises across ownership groups. In particular, public-sector banks exhibit a significant rebound in their overall performance following the GFC. Furthermore, no adverse impact of the COVID-19 pandemic overall bank performance was observed.

**Originality:** To the best of our knowledge, few studies have yet evaluated the impact of the GFC and COVID-19 pandemic on the efficiency, effectiveness and performance of Indian commercial banks.

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**KEYWORDS:** DDF-NDEA | Performance | Efficiency | Effectiveness | Crisis | Global Financial Crisis | Covid-19 pandemic

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## Introduction

The banking system of a nation directly influences the country's economic affairs (Xiazi and Shabir, 2022) and, therefore, long-term economic growth of any nation demands a sound banking system. The importance of a resilient banking system began to attract attention after the Asian financial crisis of 1997 and became a matter of strategic importance for regulators and policymakers after the Global Financial Crisis (GFC) of 2007-09. The existing literature has predominantly argued that economies with robust banks exhibited better macroeconomic stability and resilience to shocks (Tran & Nguyen, 2024; Biswas & Kumar, 2022; Elnahass et al., 2023; Nguyen et al., 2022). A thorough evaluation of bank performance during the events of crises is therefore important from the point of view of both bank managers and regulators.

Numerous studies have attempted to examine the impact of the GFC on bank performance (Alzubaidi and Bougheas, 2012; Fujii et al., 2014; Johnes et al., 2014; Wolters et al., 2014; Tzeremes, 2015; Gulati and Kumar, 2016 among many). However, these studies have mainly evaluated the impact through the lens of efficiency and stability of the banking system. Similar is the case with the studies on the COVID-19 pandemic (Gulati, 2022; Le et al., 2023; Mateev et al., 2024). Assessing the impact of crises solely through the lens of bank efficiency provides a narrow picture, as their broader effects on the banking sector are not evaluated. Existing studies have largely overlooked the broader impact of the GFC and pandemic on bank performance, especially in terms of efficiency in resource utilisation and effectiveness in achieving the pre-determined goals. This study addresses that gap by evaluating how these crises influenced bank performance through a dual lens of efficiency and effectiveness, offering a more comprehensive understanding of their systemic implications.

The studies use financial ratios like Return on Asset (ROA), Return on Equity (ROE), Net Interest Margin (NIM) and others as proxies for bank performance. These single-dimensional ratios fail to provide a comprehensive picture of bank performance. The Data Envelopment Analysis (DEA) based efficiency evaluation enables inclusion of multiple variables as inputs and outputs to compute the efficiency and effectiveness scores. The efficiency component reflects how well a bank utilises its critical inputs to produce outputs, while the effectiveness component measures the ability of the bank to achieve pre-determined goals. This aspect of bank performance has gained limited attention in the bank efficiency literature (Kumar and Gulati, 2009; Roghanian et al., 2012; Abbas et al., 2016). For the context of India, only Kumar and Gulati (2009) have evaluated bank performance as a product of efficiency and effectiveness. However, their study employs black-box DEA model and overlooks the internal structure of the banks. This study employs a two-stage directional distance function-based network data envelopment analysis (DDF-NDEA) model. The study

computes the technical efficiency of banks in the first stage and the effectiveness of banks in the second stage. The overall performance scores of an individual bank are computed as a weighted average of efficiency and effectiveness scores.

The paper makes significant contributions to the existing literature in several key ways. First, the DDF-NDEA model provides a holistic framework for assessing bank performance by integrating both efficiency and effectiveness dimensions while including the internal structure of the banks. Second, this study is the first attempt to investigate the impact of exogenous shocks on the efficiency, effectiveness, and overall performance of Indian banks in a single analysis. Additionally, it explores whether these shocks exhibit symmetric effects across different ownership structures. To the best of our knowledge, no similar study has been conducted within the Indian context. Finally, using truncated bootstrap regression by Simar and Wilson (1997), this study econometrically validates the potential impacts of the exogenous crises on bank performance and its components.

Empirical investigation shows that the adverse effects of both the GFC and the COVID-19 pandemic were not persistent and subsided quickly. The timely and effective regulatory interventions by the central bank and the government played a pivotal role in enabling banks to navigate through the period of crisis. Findings show notable asymmetries in the behavioural responses of different bank groups to these crises. In particular, Private Sector Banks (PBs) demonstrated more consistent and resilient growth in the post-pandemic years compared to their Public Sector counterparts (PSBs).

The rest of the paper is organised as follows. Section 2 presents a review of relevant empirical literature. Section 3 explains the DDF-NDEA model used to compute the efficiency, effectiveness, and performance scores and the truncated regression methodology used in the second stage. Section 4 discusses the empirical results, while the final section concludes the study and provides policy implications.

## Review of Literature

Crises like the GFC and the COVID-19 pandemic had profound impacts on both the economy and the banking sector, which have been extensively studied by researchers and academicians. Several prominent studies, including Alzubaidi and Bougheas (2012) for European countries, Dzenopoljac et al. (2017) for Arab countries, Ferrara and Kounetas (2024) for US, Johnes et al. (2014) for Islamic nations, Maredza and Ikhide (2013) for South Africa, Nitoi (2009) for Romania, Sufian and Habibullah (2010) for Thailand, Fujii et al. (2014), Tzeremes (2015) and Gulati and Kumar (2016) for India, Wolters et al. (2014) for Brazil, Zeitun and Benjelloun (2013) for Jordan and Liao (2023) for China and Taiwan have studied the impact of GFC on bank efficiency. It can be noted that, while there is a plethora of literature on the impact of the GFC on bank



efficiency, researchers have made limited efforts to explore the effect in developing and underdeveloped nations. Only Fujii et al. (2014), Gulati and Kumar (2016), and Tzeremes (2015) among many have explored the impact of GFC on efficiency of Indian banks. Furthermore, we also observe

that researchers often use “bank efficiency” and “bank performance” interchangeably, even though performance is a broader term encompassing both efficiency and effectiveness. Table 1 presents a detailed review of the literature on the impact of GFC and COVID-19 crises on bank performance.

**Table 1: Review of literature on crisis and performance**

Studies on GFC and Bank Performance				
Author(s)	Sample region (Year)	Dependent Variables	Methodology	Major Inference (s)
Olson and Zoubi, (2017)	MENASA region (1996-2014)	ROA, ROE, ROD, NIM, NNIM	Dynamic Panel model	Differential impact of GFC on bank performance across the regions
Bhimjee et al., (2016)	Emerging economies (2002-2010)	Bank performance index	Panel-regime switching model	Heterogeneous global banking industry performance is observed
Atahau and Cronje, (2021)	Indonesia (2003-2019)	ROA	Fixed effect model	Difference in performance in pre-GFC and post-GFC periods
Bannany, (2012)	UAE (2004-2010)	Intellectual capital performance	Multiple regression methods	Significant impact of GFC on intellectual capital performance
Rezvani and Mehdian, (2024)	US small banks (2001-2021)	ROA, ROE, Profit margin	Regression	Significant negative impact of GFC on the profitability of small U.S. banks
Batten et al., (2023)	Europe (2002-2021)	Volatility index, bank returns	GARCH and Quantile regression	Negative impact of the crisis on the volatility index. Significant impact of the pandemic.
Matousek et al., (2015)	Old European union (2005-2012)	Efficiency	Panzar-Rosse model, DEA, log t-test	Overall decline in efficiency and no evidence of post-crisis group convergence
Boamah et al., (2022)	Emerging economies (2005-2018)	ROA, ROE	Spatial Panel model	Banks in Emerging Economies responded to the GFC
Moradi-Motlagh and Babacan, (2015)	Australia (2006-2012)	Efficiency	Bootstrap DEA	The global financial crisis hurt the pure technical efficiency of Australian banks
Goswami, (2021)	India (1999-2017)	Technical efficiency	DEA, FEM	Banks failed to achieve financial intermediation objective in the post-crisis years, as compared to the crisis and pre-crisis years
Studies on COVID-19 and Bank Performance				
Obeidat et al., (2021)	Jordan (2010-2020)	NIM, ROA	Seemingly unrelated regression	Profits of banks fall during COVID period
Mirzaei et al., (2024)	Islamic banks (December 31, 2019, to March 31, 2020)	Bank stock price, Tobin Q, ROA	DEA, Multivariate regression	Islamic banks show superior crisis stock performance
Boubaker et al., (2023)	Islamic banks (2019-2020)	Efficiency, ROA	Inverse DEA	Banks need to reduce their inputs for efficiency to remain unchanged during crisis
Twum et al., (2022)	China (1990-2020)	ROA	GMM, Pooled Mean group method	Statistically significant and negative relationship between NPL and equity
Gazi et al., (2022)	Bangladesh (2010-2021)	Performance index using CAMEL, ROA, ROE, NIM, CAR	Panel model	high NPLs, holding more liquid assets, high hedging capital, and inappropriate bank size reduced banks' profitability during the pandemic.
Elnahass et al., (2021)	116 countries (2019-2020)	ROA, ROE, ROAA, ROAE	Panel model	Covid-19 outbreak has had detrimental impacts on financial performance
Gulati et al., (2023)	India (2015-2021)	Efficiency	DDF-NDEA model, Bootstrap truncated regression	Indian banking system was resilient and withstood the immediate impact of the COVID-19 pandemic.
Goswami and Malik, (2024)	India (2018-2022)	ROA	FEM, Pooled OLS	COVID-19 crisis enhanced the financial performance of Indian banks
Amrani and Najab, (2023)	17 countries (2006-2020)	ROA, ROE	REM, FEM	Board of directors has no association with bank performance, especially during GFC

Source: Authors' compilation

A large number of literature have analysed the impact of COVID-19 pandemic on the banking sector (Aneja and Ahuja, 2021; Banna et al., 2021; Demirgüç-Kunt et al., 2021; Dursun-de Neef and Schandlbauer, 2022; Elnahass et al., 2021; Goswami, 2023; Le et al., 2023; Mateev et al., 2024). The impact has been extensively studied across various fields, including bank stock performance, risk assessment, bank structural changes in response to policy announcements, and changes in the stock market during the pandemic (Gulati et al., 2023; Hassan et al., 2022). However, the immediate impact of the pandemic on bank performance in the case of emerging nations like India is still under-researched. Moreover, the studies have mostly employed the single dimension ratio indicators or stability index to assess the impact. To the best of our knowledge, only Gulati et al. (2023) have attempted to analyse the immediate effects of the COVID-19 pandemic on bank efficiency in India. Nonetheless, a few studies have explored the effect of the pandemic on overall bank performance encompassing efficiency and effectiveness components. This study is going to measure the impact of the GFC and COVID-19 pandemic on overall bank performance in India, through the lens of efficiency and effectiveness by employing the DDF-NDEA which is less studied in India.

## Methodological Framework

This section outlines the methodological framework for calculating efficiency, effectiveness, and performance scores of Indian banks. To measure the efficiency and effectiveness scores for individual banks, we utilise a two-stage DDF-NDEA model. The performance is computed as a product of efficiency and effectiveness.

Figure 1 illustrates a two-stage NDEA model, where Stage 1 is the efficiency stage, and Stage II is the effectiveness stage. In Stage 1, the bank utilises three inputs: fixed assets, loanable funds (deposits plus borrowings), and employees to produce three outputs: performing loans and investments as desirable outputs, and non-performing loans (NPLs) as an undesirable output. The desirable outputs are the intermediate links that serve as inputs of Stage 2. The efficiency stage assesses how efficiently a bank utilises its critical inputs to generate loans and investments.

Since NPLs are detrimental to bank efficiency, they are treated as an undesirable output, which is in line with the bank efficiency literature (Avkiran, 2015; Bangarwa and Roy, 2022; Bansal et al., 2022; Fukuyama and Matousek, 2017). The Stage 2 i.e., effectiveness stage produces net interest income and non-interest income using performing loans and investments generated in Stage 1.

Let, an individual bank consists of two different sub-stages, i.e., the efficiency and effectiveness stages. Assuming that a typical bank  $n$  ( $n = 1, \dots, N$ ) employs  $M$  inputs  $\mathbf{x}_n = (x_{n1}, \dots, x_{nM}) \in \mathbb{R}_+^M$  to produce  $P$  desirable intermediate outputs  $\mathbf{Q}_n = (Q_{n1}, \dots, Q_{nP}) \in \mathbb{R}_+^P$  and  $Z$  undesirable outputs  $\mathbf{b}_n = (b_{n1}, \dots, b_{nZ}) \in \mathbb{R}_+^Z$ . The  $P$  desirable intermediate outputs of the efficiency stage are then used as inputs in the effectiveness stage to produce  $K$  desirable final outputs  $\mathbf{y}_n = (y_{n1}, \dots, y_{nK}) \in \mathbb{R}_+^K$ . An individual bank faces two production possibility sets:  $S^1$  and  $S^2$ , which indicates the production technology of the efficiency and effectiveness stages, respectively. These can be written as:

$$S^1 = \{(\mathbf{x}, \mathbf{Q}, \mathbf{b}) \mid (\mathbf{x} \in \mathbb{R}_+^M) \text{ can produce } (\mathbf{Q} \in \mathbb{R}_+^P \text{ and } \mathbf{b} \in \mathbb{R}_+^Z)\} \quad (1)$$

$$S^2 = \{(\mathbf{Q}, \mathbf{y}) \mid (\mathbf{Q} \in \mathbb{R}_+^P) \text{ can produce } (\mathbf{y} \in \mathbb{R}_+^K)\} \quad (2)$$

$(S^K)$  production possibility set can be obtained by combining the two previous production possibility set, which can be represented as:

$$S^K = \{(\mathbf{x}, \mathbf{Q}, \mathbf{b}, \mathbf{y}) \mid (\mathbf{x} \in \mathbb{R}_+^M) \text{ can produce } (\mathbf{y} \in \mathbb{R}_+^K) \text{ through production of } \mathbf{Q} \in \mathbb{R}_+^P \text{ and } \mathbf{b} \in \mathbb{R}_+^Z\} \quad (3)$$

The two-stage DDF-NDEA function that aims to increase the final desirable outputs and decrease the controllable inputs and undesirable outputs directionally can be defined on the technology set  $S^K$  as:

$$D(\mathbf{x}, \mathbf{Q}, \mathbf{b}, \mathbf{y}; \mathbf{g}_x, \mathbf{g}_b, \mathbf{g}_y) = \max_{\alpha^1, \alpha^2} \left\{ \alpha^1 + \alpha^2 : (\mathbf{x} - \alpha^1 \mathbf{g}_x, \mathbf{Q}, \mathbf{b} - \alpha^1 \mathbf{g}_b, \mathbf{y} + \alpha^2 \mathbf{g}_y) \in S \right\} \quad (4)$$

where the direction vector  $\mathbf{g} = (\mathbf{g}_x, \mathbf{g}_b, \mathbf{g}_y)$  determines the direction in which controllable inputs of the efficiency stage, undesirable outputs of the efficiency stage, and final desirable outputs of the effectiveness stage are scaled respectively,

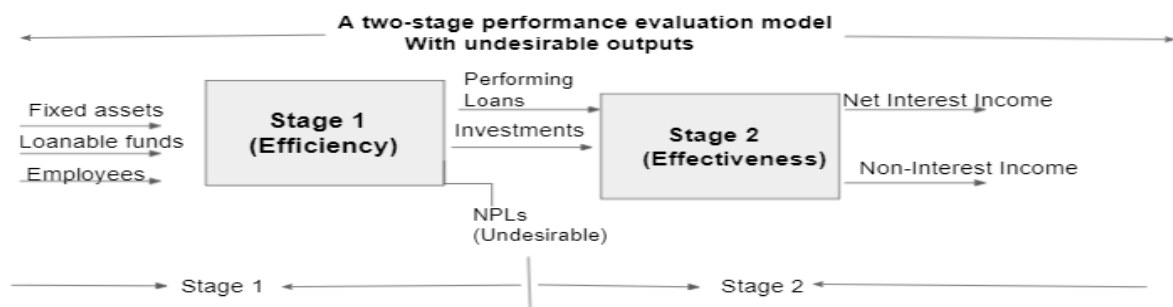


Figure 1: A two-stage performance evaluation model with undesirable outputs

Source: Authors' illustration



while the intermediate products are held constant. The technology reference set  $S^k$  assumes Variable Returns to Scale (VRS), strong disposability of desirable outputs and weak disposability of undesirable outputs with controllable inputs. On applying the DEA approach, the technologies  $S^1$ ,  $S^2$ , and  $S^k$  under VRS can be defined as follows:

$$S^1 = \left\{ (\mathbf{x}, \mathbf{Q}, \mathbf{b}) : \sum_{n \in N} \lambda_n^1 x_{mn} \leq x_m, \sum_{n \in N} \lambda_n^1 Q_{pn} \geq Q_p, \sum_{n \in N} \lambda_n^1 b_{zn} = b_z, \lambda_n^1 \geq 0, \right. \\ \left. m = 1, \dots, M, p = 1, \dots, P, z = 1, \dots, Z, n = 1, \dots, N \right\} \tag{5}$$

$$S^2 = \left\{ (\mathbf{Q}, \mathbf{y}) : \sum_{n \in N} \lambda_n^2 Q_{pn} \leq Q_p, \sum_{n \in N} \lambda_n^2 y_{kn} \geq y_k, \lambda_n^2 \geq 0 \right\} \tag{6}$$

$$T^N = \left\{ (\mathbf{x}, \mathbf{Q}, \mathbf{b}, \mathbf{y}) : \sum_{n \in N} \lambda_n^1 x_{mn} \leq x_m, \sum_{n \in N} \lambda_n^1 Q_{pn} \geq Q_p, \sum_{n \in N} \lambda_n^1 b_{zn} = b_z, \sum_{n \in N} \lambda_n^1 Q_{pn} \leq Q_p, \sum_{n \in N} \lambda_n^2 y_{kn} \geq y_k, \lambda_n^1, \lambda_n^2 \geq 0 \right\} \tag{7}$$

where  $\lambda_n^1$  and  $\lambda_n^2$  ( $n = 1, \dots, N$ ) are the intensity variables associated with the efficiency stage and effectiveness stage respectively under the network production technology. Let  $(\bar{x}_m, \bar{Q}_p, \bar{b}_z, \bar{y}_k)$  be the observed input-output direction vector for the bank  $O$ . The bank inefficiency estimates of the whole system can be obtained by solving the following linear programming model (LPP) under VRS assumption:

$$D(\mathbf{x}, \mathbf{b}, \mathbf{Q}, \mathbf{y}, \mathbf{g}) = \max \alpha_o = (w^1 \alpha_o^1 + w^2 \alpha_o^2)$$

Subject to:

Constraints of efficiency stage

$$\sum_{n=1}^N \lambda_n^1 x_{mn} \leq (1 - \alpha_o^1) x_{mo} \quad m = 1, \dots, M$$

$$\sum_{n=1}^N \lambda_n^1 b_{zn} = (1 - \alpha_o^1) b_{zo} \quad z = 1, \dots, Z$$

$$\sum_{n=1}^N \lambda_n^1 Q_{pn} \geq Q_{po} \quad p = 1, \dots, P$$

Constraints of effectiveness stage

$$\sum_{n=1}^N \lambda_n^2 Q_{pn} \leq Q_{po} \quad p = 1, \dots, P$$

$$\sum_{n=1}^N \lambda_n^2 y_{kn} \leq (1 + \alpha_o^2) y_{ko} \quad k = 1, \dots, K$$

Generic constraints

$$\sum_{n=1}^N \lambda_n^1 = 1, \sum_{n=1}^N \lambda_n^2 = 1$$

$$\lambda_n^1, \lambda_n^2 \geq 0, n = 1, \dots, N$$

where the subindex  $o$  is associated with reference banks.  $D(\mathbf{x}, \mathbf{b}, \mathbf{Q}, \mathbf{y}, \mathbf{g})$  provides a measure of overall underperformance of the individual bank.  $\alpha_o^1$  gives input-oriented inefficiency scores of Stage 1 and measures the reduction in inputs as well as undesirable output.  $\alpha_o^2$

gives non-oriented ineffectiveness scores of Stage 2 which measures the simultaneous reduction in inputs along with the expansion of desirable final outputs.

The objective function of the defined model maximizes the weighted inefficiency of stage 1 and ineffectiveness of stage 2 for bank  $o$ . Let  $\alpha_o^*$ ,  $\alpha_o^{1*}$  and  $\alpha_o^{2*}$  be the optimal values of  $\alpha_o$ ,  $\alpha_o^1$  and  $\alpha_o^2$ . The bank  $o$  is best-performing bank if  $\alpha_o^* = 0$ , which is only possible if the bank is efficient in stage 1 with  $\alpha_o^{1*} = 0$  and is also effective in stage 2 with  $\alpha_o^{2*} = 0$ . If  $\alpha_o^{1*}$  (or  $\alpha_o^{2*}$ )  $> 0$ , then bank  $o$  is inefficient (or ineffective) in stage 1 (or stage 2). Thus, a bank is not the best performing, if it is either inefficient in stage 1 or ineffective in stage 2. The subsequent definition provides the efficiency, effectiveness, and performance scores for a bank.

**Definition 1:** In the efficiency stage, the focus is on the simultaneous contraction of inputs and undesirable outputs. Thus, the efficiency score for the representative bank is calculated as:

$$\theta_o^1 = (1 - \alpha_o^{1*})$$

**Definition 2:** In the effectiveness stage, the focus is on the reduction of inputs along with the expansion of desirable final outputs. Therefore, the effectiveness score of the concerned bank is calculated as:

$$\theta_o^2 = \frac{1}{(1 + \alpha_o^{2*})}$$

**Definition 3:** The overall bank performance for each individual bank is taken as the product of both efficiency and effectiveness scores. Therefore, it can be represented as:

$$\theta_o = \frac{(1 - \alpha_o^{1*})}{(1 + \alpha_o^{2*})}$$

**Database and variable**

This study utilises data from 2003/04 to 2021/2022 for 12 PSBs, 21 PBs and 45 foreign banks (FBs) operating in India. The sample constitutes about 90% of the banks operating in India. The data is extracted from the ‘‘Statistical Tables Related to Banks in India’’ published by the Reserve bank of India (RBI) and performance highlights of Indian banks published

by Indian Bank of association (IBA). The dataset consists of an unbalanced panel of Indian banks spanning from the period 2003/04 to 2021/22.

All the variables in the dataset are converted into values per branch as it decreases volatility of the model. Secondly, the banks with missing value are removed from the dataset. After making the necessary adjustments, we have a total of 987 observations. The scores are calculated with the help of Max DEA software by applying DDF-NDEA model.

**Second stage analysis: Bootstrapped-truncated regression method**

The truncated bootstrapped regression given by Simar and Wilson (2007) is applied in the second-stage analysis for gauging the impact of crises on the efficiency, effectiveness, and performance scores of PBs and PSBs. The model is specifically designed for the DEA efficiency scores and hence, it can handle the dependent variable bounded between [0,1]. Moreover, bootstrapped procedure handles the serial-correlation making it suitable for inherently correlated DEA scores. Lastly, simulation of the process provides accurate confidence intervals for regression coefficients. Thus, the regression model provides robust and statistically reliable results and helps obtain better estimates over other panel regression methodologies.

The regression model applied under this approach can be written as:

$$Y_{it} = \alpha_0 + \alpha_1 Crisis_{it} + \alpha_2 D1_{it} + \alpha_3 D2_{it} + \alpha_4 Crisis_{it} \cdot D1_{it} + \alpha_5 Crisis_{it} \cdot D2_{it} + \sum_{i=1}^n \hat{a}_i + u_{it} \quad (8)$$

where  
 $Y_{it}$  represents efficiency/effectiveness/performance scores  
 Crisis represents crisis dummy for GFC/COVID-19 pandemic  
 D1 represents public bank dummy  
 D2 represents private banks dummy  
 $Crisis \cdot D1$  ( $Crisis \cdot D2$ ) represents interaction dummy between crisis and ownership  
 $Z$  are bank-specific control variables  
 $\hat{a}$  indicates error term

In equation (8), the dependent variable ( $Y_{it}$ ) represents the overall performance, efficiency and effectiveness scores. To capture the temporal effects of major crises, separate dummy variables are introduced. The GFC dummy is assigned a value of 1 for the crisis years and 0 otherwise; the COVID-19 dummy follows the same structure. The dummy for PSBs and PBs are represented by D1 and D2 respectively. FBs are taken as a base dummy.  $\hat{a}_i$  (and  $\hat{a}_i$ ) shows the coefficient of interaction dummy between crisis and ownership groups.  $z$  variable includes the different bank-specific control variables including ROA, ROE,

CAR, NIM, Size, Size\_sq, Leverage\_ratio, Liquidity\_risk, Net\_NPA to advances and Div (share of non-interest income in total assets as a proxy of income diversification). Among the control variables, NIM is the difference between interest received and interest paid over average assets. Liquidity risk is calculated using the bank’s deposits over average assets, and the Leverage ratio is quantified using equity over total assets. Incorporating these control variables along with our variable of interest in the model will provide unbiased and more interpretable findings.

**Empirical results**

**GFC crisis and bank performance: asymmetries across ownership groups**

This section provides a detailed investigation of the impact Indian banks faced due to the GFC crisis. Table 2 provides estimates of the performance, efficiency, and effectiveness of Indian banks for three different sub-periods: i) the pre-GFC period (2003/04 to 2006/07), ii) the GFC period (2007/08 to 2008/09), and iii) the post-GFC period (2009/10 to 2012/13). We draw some noteworthy conclusions by comparing the bank performance estimates from these sub-periods. First, the GFC has had a significant negative impact on the performance levels of PSBs compared to their peers. This is apparent from the sharp decline in the average performance score of PSBs by around 20% during the years of GFC. The reduction in PBs was far less, amounting to approximately 8% and FBs showed an improvement of around 7% during the period. Our findings are statistically validated by the Li-test results (Table 3). The results from the Li-test shows that: i) domestic banks experienced a rebound in their performance, but this effect was only significant for PSBs, ii) Foreign banks showed a sudden improvement in their performance during the GFC period, but this improvement slowed down in the post-GFC period. However, their performance remained higher than what was observed in the pre-GFC period. Interestingly, the results yield identical narratives for the effectiveness component of overall bank performance. These findings show that Indian banks were largely protected from the GFC crisis. Our findings align with Gulati (2022), who claims that foreign banks were the least affected by the GFC crisis because they prioritise profit maximisation above other objectives like increasing financial intermediation and expanding their social and financial outreach.

**Table 2: Impact of GFC crisis across ownership groups**

	Performance				Efficiency				Effectiveness			
	All banks	PSBs	PBs	FBs	All banks	PSBs	PBs	FBs	All banks	PSBs	PBs	FBs
GFC Period	0.6327	0.5825	0.6212	0.772	0.9372	0.9385	0.9267	0.9597	0.6725	0.619	0.6647	0.8087
During GFC	0.531	0.385	0.542	0.832	0.923	0.909	0.919	0.958	0.57	0.4225	0.5825	0.8725
Post-GFC Period	0.5757	0.4557	0.5725	0.797	0.90	0.8955	0.881	0.937	0.6357	0.5067	0.6437	0.8577

Note: These are the average values over the studied period  
 Source: Authors’ calculation



Table 3: Li-test results for GFC crisis

Null Hypothesis	All Banks		Public Banks		Private Banks		Foreign Banks	
	Li-test Statistic	Decision	Li-test Statistic	Decision	Li-test Statistic	Decision	Li-test Statistic	Decision
<b>Performance</b>								
pdf (2003/04-2006/07) = pdf (2007/08-2008/09)	10.072 (0.000) <sup>a</sup>	Reject	21.773 (0.000) <sup>a</sup>	Reject	1.264 (0.018) <sup>b</sup>	Reject	-2.586 (0.806)	Accept
pdf (2007/08-2008/09) = pdf (2009/10-2012/13)	3.738 (0.022) <sup>b</sup>	Reject	2.398 (0.006) <sup>a</sup>	Reject	2.038 (0.258)	Accept	2.008 (0.791)	Accept
pdf (2003/04-2006/07) = pdf (2009/10-2012/13)	3.769 (0.001) <sup>a</sup>	Reject	13.348 (0.000) <sup>a</sup>	Reject	1.070 (0.075) <sup>c</sup>	Reject	0.484 (0.694)	Accept
<b>Effectiveness</b>								
pdf (2003/04-2006/07) = pdf (2007/08-2008/09)	8.404 (0.000) <sup>a</sup>	Reject	22.884 (0.000) <sup>a</sup>	Reject	0.695 (0.036) <sup>b</sup>	Reject	-6.460 (0.911)	Accept
pdf (2007/08-2008/09) = pdf (2009/10-2012/13)	9.357 (0.142)	Accept	4.052 (0.001) <sup>a</sup>	Reject	2.429 (0.184)	Accept	8.400 (0.707)	Accept
pdf (2003/04-2006/07) = pdf (2009/10-2012/13)	6.794 (0.062) <sup>c</sup>	Reject	11.828 (0.000) <sup>a</sup>	Reject	-0.974 (0.639)	Accept	-0.254 (0.296)	Accept
<b>Efficiency</b>								
pdf (2003/04-2006/07) = pdf (2007/08-2008/09)	-14.942 (0.038) <sup>b</sup>	Reject	-0.519 (0.035) <sup>b</sup>	Reject	-1.990 (0.053) <sup>c</sup>	Reject	0.926 (0.86)	Accept
pdf (2007/08-2008/09) = pdf (2009/10-2012/13)	14.005 (0.698)	Accept	-1.335 (0.295)	Accept	7.209 (0.555)	Accept	13.288 (0.777)	Accept
pdf (2003/04-2006/07) = pdf (2009/10-2012/13)	-7.130 (0.004) <sup>a</sup>	Reject	-2.549 (0.022) <sup>b</sup>	Reject	6.142 (0.325)	Accept	17.421 (0.796)	Accept
<b>Notes:</b> 1) "a" refers to 1 percent significance level, "b" refers to 5 percent significance level, and "c" refers to 10 percent significance level. 2) Values in brackets are p-value.								

Source: Authors' calculation

On the aggregate level of the banking industry, we note a persistent decline in average efficiency level by 1% in the GFC period and 2.3% afterward. A consistent drop in average efficiency levels has been noted at the disaggregated levels defined by ownership types. However, this drop was more profound for PSBs and was minimal for the case of FBs. The results from the Li test indicate that the robustness in efficiency differences in terms of statistical significance is not uniform across ownership groups. In short, the lack of noticeable improvement in efficiency during the post-crisis period indicates that there was no meaningful rebound in the efficiency component of bank performance post GFC, particularly among public sector banks.

The results from the regression analysis are presented in Table 4. The following are observed from the truncated regression table. First, efficiency, effectiveness, and performance measures vary significantly across ownership groups, both PSBs and PBs have a significant negative impact on performance measures. Second, GFC doesn't significantly affect the efficiency, effectiveness, and performance scores. However, across ownership groups, the crisis has a significant negative effect on the effectiveness and performance scores of PSBs by 9% and 8% respectively. The PBs and FBs did not depict any significant impact on performance measures. Previous findings stand in line with the regression results.

**Table 4: Effect of Global Financial Crisis (Simar Wilson approach)**

Variables	Efficiency			Effectiveness			Performance		
	Coefficient	Bootstrap SE	p-value	Coefficient	Bootstrap SE	p-value	Coefficient	Bootstrap SE	p-value
D1	-0.041	0.013***	0.002	-0.208	0.028***	0.000	-0.215	0.028***	0.000
D2	-0.045	0.012***	0.001	-0.127	0.027***	0.000	-0.144	0.026***	0.000
GFC	0.005	0.016	0.773	-0.030	0.036	0.407	-0.025	0.032	0.428
GFC×D1	-0.002	0.018	0.908	-0.094	0.038**	0.014	-0.086	0.033***	0.010
GFC×D2	0.014	0.019	0.465	-0.046	0.045	0.307	-0.028	0.041	0.492
Size	-0.122	0.013***	0.000	-0.339	0.030***	0.000	-0.413	0.031***	0.000
Size sq	0.010	0.001***	0.000	0.026	0.003***	0.000	0.032	0.003***	0.000
Leverage ratio	0.036	0.055	0.511	0.884	0.172***	0.000	0.897	0.162***	0.000
Liquidity risk	-0.046	0.025*	0.073	-0.034	0.036	0.337	-0.072	0.043*	0.091
NPA to Advances	0.003	0.001***	0.000	-0.008	0.002***	0.000	-0.006	0.002***	0.001
ROA	0.002	0.002	0.312	0.013	0.005**	0.014	0.013	0.005**	0.012
CAR	0.001	0.000	0.154	-0.003	0.001**	0.031	-0.003	0.001*	0.071
Div	0.003	0.003	0.299	0.042	0.005***	0.000	0.041	0.006***	0.000
Constant	1.299	0.043***	0.000	1.705	0.092***	0.000	1.878	0.100***	0.000
Sigma	0.076	0.002***	0.000	0.154	0.003***	0.000	0.152	0.003***	0.000
Wald chi2(14)	250.82***			1630.36***			1786.56***		
Prob > chi2	0.000			0.000			0.000		

Notes: a) \*\*\* refers to 1 percent significance level, \*\* refers to 5 percent significance level, and \* refers to 10 percent significance level.  
 b) D1 dummy is for public banks and D2 dummy is for private banks and foreign banks are the base dummy group. Div is the diversification index. The definition of the control variables are provided in the methodology section.

Source: Authors' calculation

Among the bank-specific control variables, we observe the following noteworthy observations. First, efficiency scores are only affected by either liquidity risk, size or the share of NPA in total advances. Second, Size variables show the inverted-U-shaped relationship with efficiency, effectiveness, and performance variables. Third, effectiveness and performance scores are positively and significantly affected by the diversification variable (proxied by the share of non-interest income in total assets) and the leverage ratio. Fourth, the capital adequacy ratio has a significant negative impact on performance and effectiveness scores of less than 1%.

Overall, we observe that the GFC adversely impacted the effectiveness and performance of Indian banks with no rebound effect, especially in the case of public banks. Its impact was largely symmetric across all ownership groups. However, in the presence of a rebound effect in the case of the efficiency component, we can safely infer that Indian bank, irrespective of their group affiliation, managed successfully to mitigate the initial ill effects of GFC and weathered the impact of worldwide financial turmoil, which major economies face after the Great Depression of the 1930s.

### **COVID-19 pandemic and bank performance**

In this sub-section, we investigate the performance of Indian banks during the period of COVID-19 pandemic in detail. Some noteworthy conclusions by comparing bank performance, efficiency, and effectiveness estimates from the pre-pandemic period (2014/15-2019/20), just 1 year before pandemic (2019/20) and just 1 year after pandemic (2021/22) to during pandemic (2020/21). Different ownership groups showed improvement in their performance, efficiency, and effectiveness scores of banks during the pandemic compared to before the pandemic and just 1 year before. The results are reported in Table 5. The improvement in performance score is around 12% from the pre-pandemic period to during pandemic period. The improvement in overall bank efficiency is only around 4%, while the improvement in overall bank effectiveness is around 11%. The results from Li-test shown in Table 6 confirm that bank performance does not differ significantly between pre-pandemic period and during pandemic period for PSBs and FBs and PBs rather showed a significant improvement in their performance. Thus, the banking system remained resilient. However, after the pandemic, because of the withdrawal of RBI's accommodative measures, bank performance and component scores declined within the range of 5 to 10 percent.



Table 5: Impact of Covid-19 pandemic across ownership groups

	Performance				Efficiency				Effectiveness			
	All Banks	PSBs	PBs	FBs	All Banks	PSBs	PBs	FBs	All Banks	PSBs	PBs	FBs
Pre-Pandemic period	0.6147	0.4754	0.64	0.7607	0.9265	0.9215	0.9047	0.9582	0.6603	0.5138	0.7058	0.7925
Just 1 year prior to the pandemic	0.667	0.491	0.725	0.771	0.944	0.932	0.95	0.948	0.704	0.527	0.763	0.811
During the pandemic	0.732	0.514	0.783	0.812	0.948	0.902	0.966	0.956	0.77	0.572	0.81	0.851
Just 1 year after the Pandemic	0.611	0.405	0.627	0.719	0.862	0.814	0.86	0.892	0.707	0.5	0.726	0.812

Source: Authors' calculation

As far as bank efficiency is concerned, the increase in efficiency is insignificant during the pandemic compared to a pre-pandemic period for all ownership groups, as supported by the Li results. Another significant finding observed in this table is that PSBs and PBs faced a significant decline in their efficiency after the pandemic compared to the pre-pandemic and during the pandemic scores. FBs did not show any

movement in efficiency scores. Regarding effectiveness, the difference in scores is insignificant for all ownership groups in the pandemic period compared to the pre-pandemic period, which is supported by the non-parametric kernel density Li-test results. We further observed in the table that PSBs and PBs faced a significant decline of around 7 percent in their effectiveness scores after the pandemic in comparison to during the crisis.

Table 6: Li-test results for Covid-19

Null Hypothesis	All Banks		Public banks		Private banks		Foreign banks	
	Li-test Statistic	Decision	Li-test Statistic	Decision	Li-test Statistic	Decision	Li-test Statistic	Decision
<b>Efficiency</b>								
pdf (2014/15-2019/20) = pdf (2020/21)	-11.252 (0.96)	Accept	-1.741 (0.416)	Accept	-1.802 (0.265)	Accept	-5.208 (0.119)	Accept
pdf (2019/20) = pdf (2020/21)	2.451 (0.045) <sup>b</sup>	Reject	-0.885 (0.344)	Accept	6.187 (0.064) <sup>c</sup>	Reject	1.311 (0.379)	Accept
pdf (2020/21) = pdf (2021/22)	0.000 (0.001) <sup>a</sup>	Reject	1.687 (0.033) <sup>b</sup>	Reject	5.121 (0.001) <sup>a</sup>	Reject	0.224 (0.33)	Accept
Pdf (2019/20) = pdf (2021/22)	4.899 (0.006) <sup>a</sup>	Reject	4.940 (0.001) <sup>a</sup>	Reject	1.590 (0.018) <sup>b</sup>	Reject	-1.126 (0.608)	Accept
<b>Effectiveness</b>								
pdf (2014/15-2019/20) = pdf (2020/21)	3.908 (0.022) <sup>b</sup>	Reject	-0.572 (0.165)	Accept	-2.421 (0.455)	Accept	3.478 (0.147)	Accept
pdf (2019/20) = pdf (2020/21)	-0.167 (0.682)	Accept	-0.654 (0.441)	Accept	-0.855 (0.492)	Accept	0.214 (0.797)	Accept
pdf (2020/21) = pdf (2021/22)	-0.109 (0.388)	Accept	0.278 (0.081) <sup>c</sup>	Reject	0.329 (0.084) <sup>c</sup>	Reject	2.783 (0.649)	Accept
Pdf (2019/20) = pdf (2021/22)	-0.325 (0.333)	Accept	0.243 (0.246)	Accept	-0.486 (0.442)	Accept	2.083 (0.668)	Accept
<b>Performance</b>								
pdf (2014/15-2019/20) = pdf (2020/21)	3.319 (0.005) <sup>a</sup>	Reject	-0.265 (0.173)	Accept	0.734 (0.08) <sup>c</sup>	Reject	1.458 (0.162)	Accept
pdf (2019/20) = pdf (2020/21)	1.012 (0.226)	Accept	-0.831 (0.524)	Accept	-0.539 (0.519)	Accept	1.325 (0.047) <sup>b</sup>	Reject
pdf (2020/21) = pdf (2021/22)	1.360 (0.158)	Accept	1.453 (0.011) <sup>b</sup>	Reject	1.990 (0.018) <sup>b</sup>	Reject	-0.674 (0.421)	Accept
Pdf (2019/20) = pdf (2021/22)	0.688 (0.187)	Accept	1.873 (0.004) <sup>a</sup>	Reject	0.701 (0.424)	Accept	0.878 (0.146)	Accept

Notes: 1) "a" refers to 1 percent significance level, "b" refers to 5 percent significance level, and "c" refers to 10 percent significance level.

2) Values in brackets are p-value.

Source: Authors' calculation

The impact of the COVID-19 pandemic on different performance measures, obtained through truncated bootstrapped regression, can be concluded in the following points. First, the efficiency, effectiveness, and performance of an individual bank suffered adversely across each ownership group. This effect comes out to be negative and significant. Second, the COVID pandemic left a significantly positive impact on each dependent variable of private ownership groups as inferred from Table 7. This effect is insignificant across public banks. the positive impact of the crisis on the bank's performance can be attributed to timely policy actions and measures taken by the central bank. Third, the size variable has an inverse U-shaped relation with each dependent variable depicting the non-linear relation. Fourth, all profitability ratios such as ROA and CAR among bank-specific control variables had a highly significantly positive impact on banks' efficiency, effectiveness, and profitability. In sum, the COVID pandemic left a positive impact on bank performance indicators, especially in the case of private banks. Our results validate that different crises asserted different impacts on Indian bank performance across ownership groups.

## Conclusion

This paper studies the evolution of bank performance, efficiency, and effectiveness in response to exogenous crises, with a particular focus on GFC (2007–2009) and the COVID-19 pandemic (2020–2021). It examines the long-term trajectory of bank efficiency, effectiveness, and performance in India from 2003/04 to 2021/22 by employing a two-stage network DEA-based directional distance function (DDF-NDEA). To evaluate how crises impacted these efficiency, effectiveness and performance scores, the paper utilises a truncated bootstrapped regression method proposed by Simar and Wilson (2007).

The analysis highlights that the efficiency, effectiveness and performance of Indian banks declined during the times of these crises. Although banks experienced a decline in efficiency and effectiveness in the immediate aftermath, they showed resilience and adaptability in the long run. Also, the impact of both the GFC and the pandemic was insignificant for both stages of bank performance evaluation. Secondly, the Li-test for equality of distribution shows performance

**Table 7: Effect of COVID-19 pandemic (Simar Wilson approach)**

Variables	Efficiency			Effectiveness			Performance		
	Coefficient	Bootstrap std. err.	P>z	Coefficient	Bootstrap std. err.	P>Z	Coefficient	Bootstrap std. err.	P>Z
D1	-0.041	0.013***	0.002	-0.226	0.028***	0.000	-0.231	0.028***	0.000
D2	-0.046	0.013***	0.000	-0.144	0.026***	0.000	-0.159	0.026***	0.000
Covid	-0.002	0.019	0.903	0.024	0.041	0.566	0.021	0.043	0.628
Covid×D1	-0.009	0.029	0.757	0.048	0.052	0.354	0.036	0.050	0.467
Covid×D2	0.053	0.023**	0.026	0.155	0.054***	0.005	0.181	0.055***	0.001
Size	-0.122	0.013***	0.000	-0.344	0.029***	0.000	-0.416	0.030***	0.000
Size sq	0.010	0.001***	0.000	0.027	0.002***	0.000	0.032	0.003***	0.000
Leverage ratio	0.037	0.055	0.502	0.890	0.164***	0.000	0.904	0.157***	0.000
Liquidity risk	-0.043	0.028	0.126	-0.036	0.033	0.271	-0.070	0.039*	0.073
NPA to Advances	0.003	0.001***	0.000	-0.007	0.002***	0.000	-0.005	0.002***	0.007
ROA	0.002	0.002	0.292	0.013	0.005***	0.009	0.013	0.005**	0.012
CAR	0.001	0.000	0.181	-0.003	0.001**	0.018	-0.003	0.001**	0.043
Div	0.003	0.003	0.270	0.042	0.005***	0.000	0.041	0.005***	0.000
Constant	1.300	0.044***	0.000	1.728	0.094***	0.000	1.896	0.094***	0.000
Sigma	0.076	0.002***	0.000	0.154	0.003***	0.000	0.151	0.003***	0.000
Wald chi2(14)	279.54***			1472.88***					
Prob > chi2	0.000			0.000			0.000		
Notes: a) *** refers to 1 percent significance level, ** refers to 5 percent significance level, and * refers to 10 percent significance level.									
b) D1 dummy is for public banks and D2 dummy is for private banks and foreign banks are the base dummy group. Div is the diversification index. The definition of the control variables is already provided in the methodology section									
Source: Authors' calculation									



comparison across ownership groups and highlights that the FBs are the most resilient owing to their profit-maximisation objective, whereas the PSBs and especially their efficiency stage are the worst hit by the crises. This indicates that the PSBs prioritise social objectives over efficiency. However, both PSBs and PBs show strong signs of recovery in the post-crisis period. Lastly, all ownership groups have a distinct, asymmetric, and idiosyncratic impact on overall bank performance in achieving policy objectives during the crisis. These findings are in line with the regression results, which support the differentiated impact of ownership structures on bank performance and its components.

This research highlights several substantial policy implications. The Indian banks showed a reduction in the performance scores post-GFC and pandemic period. However, the dip in the scores did not last long and the banks showed quick recovery. This proves the effectiveness of the timely policy interventions by RBI and the government. Although it must be noted that the pandemic's impact on loan defaults was mostly masked by the short-term loan moratorium, which effectively curbed a surge in non-performing loans during and immediately after the pandemic. Thus, the banks must also focus on building good quality assets and manage strong capital buffers to prepare themselves for future shocks. Lastly, among all, FBs remained most resilient throughout the crisis periods. This indicates that the Indian domestic banks should learn from their foreign counterparts and adopt better risk management practices to ensure better stability and resilience from future shocks.

In all, the sound regulatory and financial support from the central bank and the government is of utmost importance, and it helped individual commercial banks navigate through the crisis of the pandemic and the GFC by dealing with the problems of deteriorating assets and impacts from economic slowdown.

Since our investigation has focused on a specific aspect of this expansive subject, opportunities for further exploration emerge in the following directions. First, while this paper studies the impact of two exogenous crises namely the GFC and COVID-19 pandemic on efficiency, effectiveness, and performance of banks, one needs to look at the other exogenous factors affecting the same. Second, our study has primarily included only the immediate impact of the COVID-19 pandemic due to data unavailability and the long-run impact of the pandemic has not yet been explored. Including the long-term impact will provide a more comprehensive understanding of the dynamics at play. Third, exploring the impact of the endogenous crisis on bank performance will provide more comprehensive details about the state of Indian banks.

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## Annexure 17.4.1

Submission Date	Submission Id	Word Count	Character Count
22-Oct-2025	4695744 (DrillBit)	7875	52628

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11	gjimt.ac.in	<1	Publication
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### Reviewers Memorandum

**Reviewer’s Comment 1:** This study examines a highly relevant and contemporary issue by analysing the impact of the Global Financial Crisis and COVID-19 on Indian banks. The research objectives are clearly defined, and the study successfully fills an important gap in existing literature. A logical and well-organised structure is to be found throughout the entire research work.

**Reviewer’s Comment 2:** The methodological approach adopted in the study is strong and appropriate for the research objectives. The use of a two-stage DDF-NDEA model combined with bootstrapped truncated regression enhances the robustness of the results. However, providing a simpler explanation of the methodology would help readers with limited technical background understand the analysis better.

**Reviewer’s Comment 3:** The empirical findings of this study provide strong and insightful evidence on how public, private, and foreign banks respond differently to economic crises. Due to the strong connection between the debate and the consequences of regulatory and policy frameworks, the findings are practically important. On the other hand, the interpretation may be improved by providing a more concise summary of the most significant results and by doing a comparison that has a limited scope across ownership groups.



Mehak Gupta, Preksha Jain and Diksha Uppal  
 “Impact of Crises on Efficiency, Effectiveness and Performance of Indian Banks: A Network Directional Distance Approach”  
 Volume-17, Issue 4, Oct-Dec 2025. (www.gjeis.com)

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**Conflict of Interest:** Author of a Paper had no conflict neither financially nor academically.

### Editorial Excerpt



The article has 5% plagiarism, which is within the accepted percentage as per the norms and standards of the journal for publication. As per the editorial board's observations and blind reviewers' remarks, the paper had some minor revisions, she was communicated promptly to the authors (Mehak, Preksha and Diksha), and all necessary corrections were incorporated as and when directed. The comments related to this manuscript are closely aligned with the theme "Impact of crises on efficiency, effectiveness and performance of Indian banks: A network directional distance approach" both subject-wise and research-wise. This study talks about how major crises like the Global Financial Crisis and COVID-19 affected the performance of Indian banks. Using efficiency and effectiveness measures, it shows how different types of banks responded and recovered over time. After thorough reviews and the editorial board's remarks, the manuscript has been categorized and approved for publication under the "Empirical Research Paper" category.

### Acknowledgement



The acknowledgement section is an essential part of all academic research papers. It provides appropriate recognition to all contributors for their hard work and effort taken while writing a paper. The data presented and analysed in this paper by the authors (Mehak, Preksha and Diksha) were collected first handily and wherever it has been taken the proper acknowledgment and endorsement depicts. The author is highly indebted to others who facilitated accomplishing the research. Last but not least, endorse all reviewers and editors of GJEIS in publishing in the present issue.

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