



**Analyzing the Technical Efficiency of Foreign Banks: A study across CRS, VRS, and Scale Efficiencies using DEA approach from 1991-2022**

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**Abstract**

The study Using Data Envelopment Analysis (DEA), to examines the average technical efficiency of foreign banks in varied working contexts under constant returns to scale, variable returns to scale and scale efficiency between 1991 and 2022. The findings indicate that average efficiency varied significantly over different periods: The post-liberalization reform stage from 1991 to 1999, the consolidation and growth stage from 2000 to 2010, the post-global financial crisis stage from 2011 to 2019 and the following COVID-19 pandemic recovery period from 2020 to 2022. Efficiency was highest throughout the post liberalization period, with a CRS efficiency average of 0.709, but it showed considerable fluctuation post-2010 due to global economic disruptions. Coefficient variation reflects high variability, especially in recent years, indicating inconsistent performance mid banks. The study similarly examines the proportion of banks fall under a standard deviation of the mean efficiency., highlighting a marked shift from higher stability pre-2010 to increased variability thereafter. The bank's distribution by CRS, DRS and IRS also underscores dynamic shifts in scale efficiencies across these periods. These trends underscore economics' impact cycles on foreign bank effectiveness in the studied context.

**Keywords:** *Foreign banks, Technical Efficiency, Constant Returns to Scale, Foreign Banks, Bank Efficiency Measurement*

**1. Introduction**

The Bank's technical efficiency, is a critical determinant of their performance and sustainability, particularly for Foreign banks functioning in highly competitive and dynamic financial environments. Studying The Foreign Banks technical efficiency offers valuable understandings into how these institutions utilize their resources to generate maximum outputs, ensuring their competitiveness and resilience against market fluctuations. Efficiency matters in banking as it directly influences profitability, customer satisfaction, and the



ability to withstand economic shocks, making it essential for foreign banks striving to establish and maintain their presence in diverse markets.

Despite extensive research on bank efficiency, there remains a limited understanding of how the technical efficiency of foreign banks has evolved over an extended period, specifically from 1991 to 2022. Existing literature often focuses on specific time frames or regions, neglecting the comprehensive analysis across different economic eras. This research bridges the gap by utilizing Data Envelopment Analysis (DEA) to assess the Average Overall Technical Efficiency of foreign banks under the Constant Returns to Scale (CRS) framework across a span of thirty years.

## **2. Literature Review**

Studies have extensively employed DEA to assess banking efficiency, especially under constant return to scale (CRS) and variable return to scale (VRS) assumptions. Grigorian and Manole (2002) and Berger and Mester (1997) underscore DEA's strength in estimating efficiency without requiring specific production functions, making it ideal for banks operating under varying regulatory and economic conditions. These studies revealed that efficiency often fluctuates due to external economic conditions, internal bank policies, and operational sizes. This approach provides a baseline for identifying optimal benchmarks in banking efficiency and understanding the productivity variations over time. A body of research suggests that regulatory and policy reforms can have significant effects on banking efficiency. Bonin, Hasan, and Wachtel (2005) examined banking sectors in transition economies, finding efficiency improvements post-liberalization reforms, similar to your study's "Post-Liberalization Reforms Period." They suggest that deregulation, foreign investment, and privatization play key roles in boosting technical efficiency, as banks adapt to competitive environments and improve resource allocation. The influence of reforms aligns with increased efficiency in your data, especially during periods following economic policy shifts.

Research analyzing the global financial crisis's impact on banking efficiency highlights notable declines in performances and resource allocation effectiveness during crisis periods. Studies like those by Kumbhakar and Lovell (2003) and Fiordelisi, Marques-Ibanez, and Molyneux (2011) emphasize that the crisis led to increased inefficiencies due to tightened credit and liquidity constraints. In the data, the "Post-Global Financial Crisis Period" reflects moderate efficiency levels, suggesting resilience but highlighting the sector's vulnerability to global market disturbances.

The advancement in technology has notably affected banking efficiency over recent years, primarily through the concept of scale efficiency. Avkiran (2009) and Berger and Humphrey (1997) explored how technological integration and bank size influence efficiency. Larger banks tend to achieve greater efficiencies because of economies of scale and technology adoption, which aligns with your study's findings, where periods with



higher scale efficiency correlate with technological advancements in banking. This aspect is especially relevant for banks trying to optimize operations post-2000, a period of growth and consolidation noticeable by important tech adoption in financial services.

Recent literature examining the COVID-19 pandemic's impact on the banking sector, such as work by Ashraf (2020), shows that economic disruptions lead to short-term declines in efficiency as banks struggle with credit defaults and risk management. The "Post-COVID-19 Pandemic Recovery Period" in your study exhibits a downturn in average efficiency, consistent with findings by Le et al. (2021) that note an increased need for banks to adopt robust digital solutions to maintain efficiency. These studies underscore the challenges faced by banks globally during and after the pandemic and highlight the critical role of adaptability in crisis management.

### **3. Objectives**

1. To assess the changes in technical efficiency of Foreign banks all the years.
2. To understand the impact of significant economic periods.
3. To reveal trends or factors influencing the foreign banks' efficiency, thereby providing actionable insights for policymakers and banking institutions.

### **4. Methodology**

The research employs Data Envelopment Analysis (DEA) to measure the foreign banks' technical efficiency across three models: (CRS), (VRS) and Scale Efficiency. The CRS concept implies that banks may maintain the same balanced of efficiency regardless of scale, while the VRS model allows for efficiency variations due to changing scales. The Scale Efficiency model identifies how well a bank operates at its optimal size. The input orientation focuses on minimizing inputs to achieve a certain level of outputs, while output orientation emphasizes maximizing outputs from given inputs.

Efficiency metrics used include technical efficiency (the ratio of observed output to the best possible output), standard deviation ( $\sigma$ ), coefficient of variation (C.V.), and efficiency intervals defined as  $I=[M-\sigma, M+\sigma]$ , where  $M$  is the mean score. Banks percentage, falling within this interval is also calculated to analyze consistency.

Data was analyzed across specific periods: pre-liberalization (1991-1999), post-liberalization (2000-2010), post-global financial crisis (2011-2019), and post-COVID-19 (2020-2022) to highlight trends and significant changes in efficiency over time.



## **5. Findings and Examination of Mean Aggregate Technical Efficiency Derived from CRS, VRS, and Scale DEA for Foreign Banks**

This analysis evaluates the operational efficiency of foreign banks has evolved significantly between 1991 and 2022. using three different methodologies: (CRS), (VRS), and Scale DEA. The findings provide insights Analyzing the evolving patterns in performance and shifts in operational efficiency within the foreign banking industry.

**Table 1: Mean total Technical efficiency of CRS DEA Foreign bank**

| Years                                                 | Num.of banks | Num. of (CRS) | M     | $\sigma$ | C.V    | Interval    | %of banks- I |
|-------------------------------------------------------|--------------|---------------|-------|----------|--------|-------------|--------------|
| 1991–1999 Mean Post-Liberalization Reforms Period     | 27.778       | 8.333         | 0.709 | 0.270    | 38.522 | 0.438,0.98  | 63.747       |
| 2000–2010 Mean Consolidation and Growth Period        | 30.636       | 6.909         | 0.604 | 0.278    | 46.465 | 0.326,0.881 | 58.014       |
| 2011–2019 Mean Post Global Financial Crisis Period    | 42.667       | 10.000        | 0.609 | 0.296    | 49.810 | 0.313,0.905 | 59.431       |
| 2020-2022 Mean Post-COVID-19 Pandemic Recovery Period | 45.333       | 10.333        | 0.483 | 0.326    | 68.912 | 0.157,0.808 | 66.264       |
| 1991-2022 Mean.                                       | 34.594       | 8.500         | 0.624 | 0.285    | 47.276 | 0.338,0.909 | 60.798       |

Source: Reserve Bank of India (Annual Report on Banking Statistics various years)

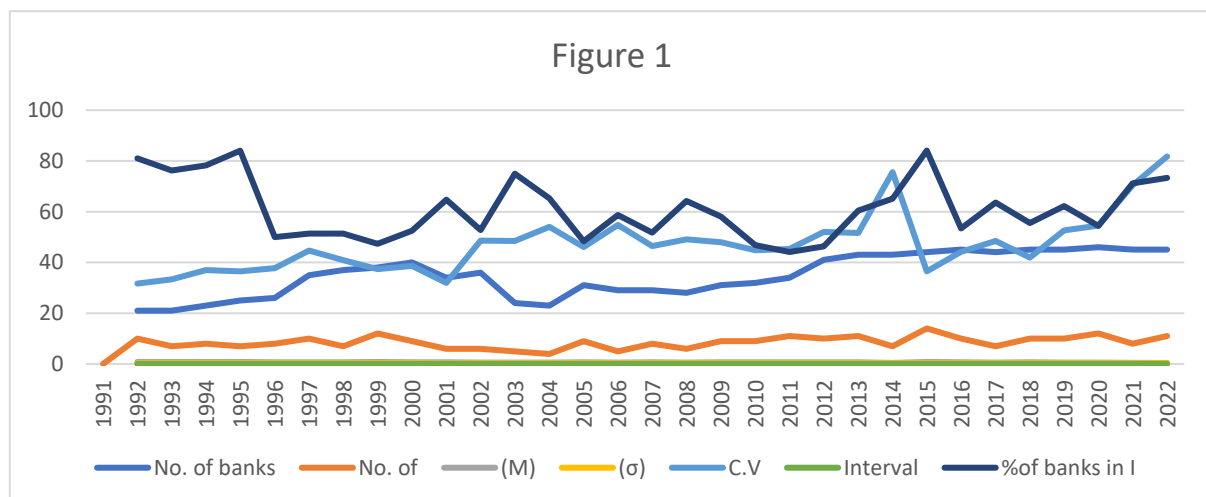
### **Constant -Returns to Scale- (CRS) Analysis**

1. Average Efficiency: The mean aggregate operational efficiency across the Whole duration (1991-2022) is 0.624. Efficiency levels show notable variation, reaching the peak of recorded efficiency at 0.780 in 1992 and the lowest at 0.433 in 2021.
2. Standard Deviation and Coefficient of Variation: The standard deviation, calculated as 0.285, and the coefficient of variation, measured at 47.276, represent key statistical metrics indicate considerable dispersion in efficiency values, suggesting a wide range of performance among banks.
3. Efficient Banks: The count of highly effective banks fluctuated significantly, peaking at 14 efficient banks in 2015 and showing a decline in subsequent years, particularly noted in 2021 and 2022 where only 8 and 11 banks were classified as efficient, respectively.

#### 4. Trend Observations:

- The Era of Reforms After Liberalization (1991-1999) had a mean The effectiveness is 0.709, indicating a strong performance relative to subsequent periods.
- The Consolidation - Growth Period (2000-2010) observed a drop in mean efficiency to 0.604, hinting at challenges during this time.
- Post-Global Financial Crisis Period (2011-2019) stabilized the mean efficiency at 0.609, although it did not recover to pre-crisis levels.
- The Post COVID 19 Rebound Phase(2020-2022) showed a further decline to 0.483, marking a concerning trend in efficiency.

**Figure 1** Technical efficiency of CRS DEA from 1991 to 2022.



#### Variable- Returns to Scale- (VRS) Analysis

1. Average Efficiency: The overall mean efficiency for the VRS model was higher, at 0.808, with the highest value of 0.894 in 1993 and a low of 0.586 in 2022.
2. Efficiency Variation: The efficiency scores, characterized by a standard deviation of 0.237 and a coefficient of variation of 30.107, indicate less variability than the CRS analysis.



**Table 2: Mean total technical efficiency of VRS DEA of Foreign Banks**

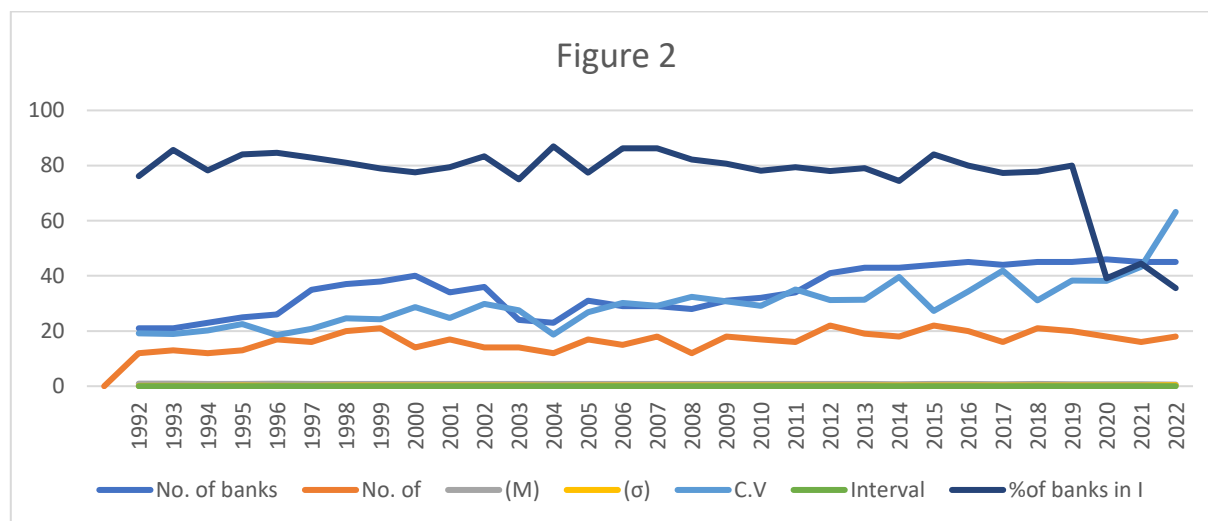
| Year                                                 | Num. of banks | Num. of (CRS) | (M)   | ( $\sigma$ ) | C.V    | Interval    | %of banks- I |
|------------------------------------------------------|---------------|---------------|-------|--------------|--------|-------------|--------------|
| 1991–1999 Mean PostLiberalization Reforms Period     | 27.778        | 15.111        | 0.864 | 0.191        | 22.268 | 0.673,1.056 | 81.204       |
| 2000–2010 Mean Consolidation or Growth Period        | 30.636        | 15.273        | 0.825 | 0.231        | 27.998 | 0.595,1.056 | 81.177       |
| 2011–2019 Mean Post-Global Financial Crisis Period   | 42.667        | 19.333        | 0.779 | 0.267        | 34.476 | 0.512,1.046 | 78.899       |
| 2020-2022 Mean Post COVID19 Pandemic Recovery Period | 45.333        | 17.333        | 0.658 | 0.312        | 48.244 | 0.347,0.971 | 39.710       |
| 1991-2022 Mean                                       | 34.594        | 16.563        | 0.808 | 0.237        | 30.107 | 0.57,1.045  | 76.656       |

Source: Reserve Bank of India (Annual Report on Banking Statistics various years)

3. Efficient Banks: The number of banks achieving efficiency also varied, with 22 efficient banks in 2012. However, recent years reflect a downward trend in efficiency levels, emphasizing the impact Cross-border economic shifts factors.
4. Trend Observations:
  - Similar to CRS, The Era of Reforms After Liberalization(1991-1999) demonstrated robust efficiency (mean 0.864), while The Unification and Growth Interval (2000-2010) reflected a minor decrease (mean 0.825).
  - The period following the Global Financial Crisis (2011-2019) had a mean of 0.779, but efficiency fell significantly in the Post-COVID-19 Recovery Period (2020-2022) to 0.658, indicating persisting challenges.



**Figure 2** The mean overall technical efficiency based on VRS DEA for foreign banks between 1991 and 2022.



### Scale DEA Analysis

1. Average Efficiency: The overall mean efficiency using the Scale DEA was 0.769, reaching a maximum of 0.871 in 1992 and a low of 0.590 in 2014.
2. Standard Deviation and Coefficient of Variation: The variability (0.238) and The variability coefficient (31.703) are comparable to the VRS analysis, suggesting stable performance across years.

**Table 3:** Mean Total Technical Efficiency of Scale DEA of foreign Banks

| Year                                                    | No. of banks | No. of (CRS) | (M)   | (σ)   | C.V    | Interval    | %of banks in I |
|---------------------------------------------------------|--------------|--------------|-------|-------|--------|-------------|----------------|
| 1991–1999 Mean PostLiberalization Reforms Period        | 27.778       | 8.556        | 0.814 | 0.223 | 27.622 | 0.591,1.037 | 83.088         |
| 2000–2010 Mean Consolidation or Growth Period           | 30.636       | 7.000        | 0.737 | 0.246 | 34.120 | 0.491,0.983 | 65.632         |
| 2011–2019 Mean Post-Global Financial-Crisis Period      | 42.667       | 10.333       | 0.775 | 0.234 | 31.121 | 0.541,1.01  | 74.049         |
| 2020-2022 Mean Post-COVID-19 - Pandemic Recovery Period | 45.333       | 10.333       | 0.730 | 0.266 | 36.829 | 0.465,0.996 | 70.515         |
| 1991-2022 Mean                                          | 34.594       | 8.688        | 0.769 | 0.238 | 31.703 | 0.531,1.007 | 73.366         |

Source: Reserve Bank of India (Annual Report on Banking Statistics

various years)



3. Efficient Banks: The distribution of banks classified as efficient fluctuated, in height of 17 efficient banks in 2015. Notably, The quantity of banks in the context of increasing returns to scale (IRS) is rising category grew, reflecting structural shifts In the financial services industry.

4. Trend Observations:

- Consistent with CRS or VRS findings, The Era of Reforms Post. Liberalization (1991-1999) had a strong performance (mean 0.814).
- The period of consolidation and expansion (2000-2010) witnessed a decrease in mean efficiency to 0.737.
- The Post-COVID-19 Period further highlighted challenges, with mean efficiency at 0.730, showcasing the vulnerabilities within the foreign banks sector throughout recovery.

**Figure 3** Mean total technical efficiency of Scale DEA of Foreign Banks- from 1991 to 2022.

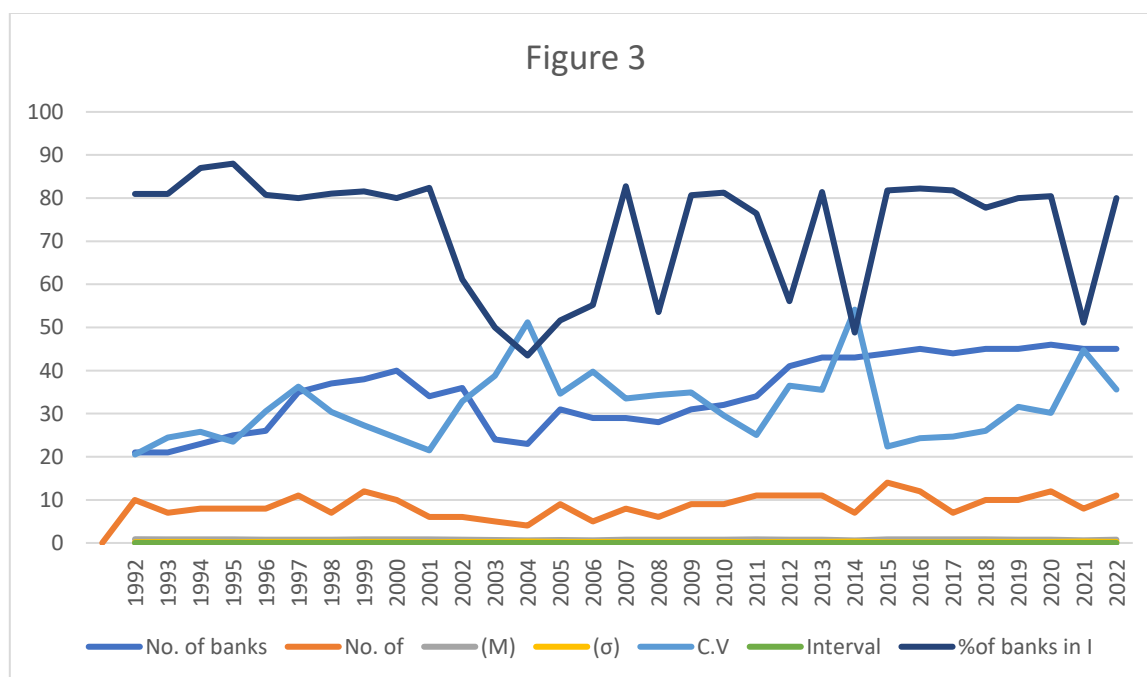
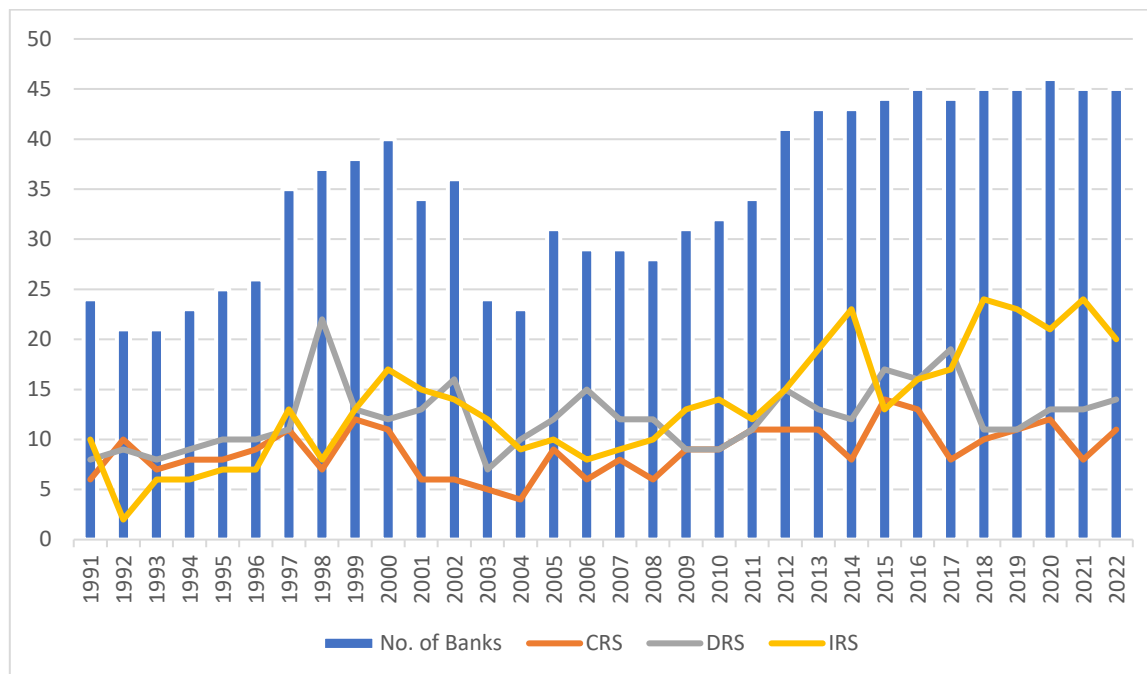


**Figure 4** shows the spread of foreign banks based on traditional returns to scale over time highlights notable patterns in efficiency and operational shifts within the banking industry. The period spanning from 1991 to 2022, there has been a noticeable fluctuation in the quantity of financial institutions operating under different returns to scale, namely (CRS), (DRS) and (IRS). During the formative years, such as 1991 and 1992, there were more banks exhibiting IRS, indicating potential for growth and increasing efficiency. However, As the years passed, particularly during the late 1990s and early 2000s, the allocation of banks shifted, with CRS and DRS becoming more prevalent. This shift suggests a maturation of the market and a possible response to external economic pressures, regulatory changes, or competitive dynamics. For instance, 1998 indicated a

notable increase in the number of banks encountering DRS, which could indicate Obstacles in upkeeping efficiency in the sectors expanded. Notably, from 2012 onwards, the trends showed some stabilization in the

**Figure 4: Allocation of Foreign Banks by Conventional Returns to Scale**



Source: Reserve Bank of India (Annual Report on Banking Statistics various years)

Count of financial institutions under each category, indicating that foreign banks are finding a balance in their working capacity efficiencies. The information indicates that although the total count of banks may remain constant, Their experience can have a considerable impact on how they achieve economies of scale competitiveness and operational strategies in the ever-evolving banking landscape.

## 6. Discussion

The examination of the general technical efficiency through the Constant>Returns to Scale (CRS) Data-Envelopment Analysis (DEA) of international banks across the years uncovers notable trends and patterns. Throughout the observation the time span from 1991 to 2022 witnessed an average level of efficiency fluctuated, indicating varying performance levels across the bank's sector. Notably, the mean efficiency peaked at 0.884 in 1992, coinciding by a height percentage of efficient financial institutions (80.952%), signifying that the liberalization reforms throughout this epoch may have positively impacted operational efficiencies. Conversely, A significant reduction in overall productivity was observed In the aftermath of the Global Financial Crisis (2011-2019), with a mean efficiency of 0.609, which became even more intense during the post-COVID-19 pandemic recovery phase (2020-2022), where the average dropped to 0.483.



The standard-deviation and coefficient-variation values indicate a significant discrepancy in performance levels among banks, particularly in years such as 2014 and 2022, where the coefficient-variation stretched 75.610 and 81.766, respectively, reflecting a heightened disparity in performance. The analysis also reveals a consistent trend of banks Functioning with diminishing returns to scale (DRS), especially evident in years like 1998 and 2004, where a large proportion of banks operated inefficiently. This trend points to potential issues in management practices and resource allocation within these institutions, While certain financial institutions exhibit high efficiency, many are still struggling to optimize their operations. Overall, these findings highlight the complexities of the bank sector's performance and the effect of exterior economic factors on efficiency, emphasizing the necessity for continuous improvements and strategic interventions to enhance operational effectiveness.

## **7. Conclusion**

The analysis of foreign banks' means total technical efficiency between 1991 to 2022, as evaluated by Constant>Returns to Scale (CRS), Variable>Returns to Scale (VRS) and Scale Data Envelopment Analysis- (DEA), indicates significant trends and variances over time. The mean efficiency scores indicate fluctuating performance, with notable improvements during specific periods, Examples include post-liberalization changes, as well as consolidation and expansion stages. However, A decrease in mean efficiency is observed in the years After the global financial-crisis or the recovery epoch following the COVID-19 pandemic. The variability in efficiency, indicated by the variability or dispersion measured by the standard deviation and coefficient of variation, suggests However, certain financial institutions have maintained or improved their efficiency, others have struggled, leading to considerable differences within the sector. This underscores necessity for ongoing assessments help improve efficiency in operations in foreign banks adapt to changing economic conditions and improve overall performance. The distribution of banks operating at varying scales, whether increasing or decreasing returns, further emphasizes the complex landscape of The sector of banking or the importance of strategic management to enhance competitiveness and efficiency.

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