



Examining the impact of demonetization on banking efficiency: Evidence from bootstrapped estimates after consideration of undesirable outputs

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Abstract

The recent demonetization announced in India led to a massive flow of deposits in banks, which called for efficient disbursement of available funds. Realizing its implication for the financial sector, researchers explored the possible impact of demonetization on the performance, profitability, and efficiency of Indian banks. However, these studies overlooked the non-performing assets, which are a serious concern for banks and have emerged as an undesirable output of the credit creation process. To fill this research gap, the present study investigates the impact of demonetization on the efficiency of domestic banks with due consideration of such undesirable assets. To get bias-free efficiency estimates, bootstrapped data envelopment analysis has been done. The study period has been divided into two sub-periods viz., pre-demonetization period and post-demonetization period. The results indicate that the efficiency of the majority of banks remains unaffected by demonetization. Only 13 banks have got a significant impact, out of which eight banks exhibited better efficiency while five banks were found to be less efficient during the post-demonetization period. However, these changes have been contributed to bank-specific factors, and demonetization cannot be accounted for the same. The findings are useful to banks, regulators, and policymakers.

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1. Introduction

The concept of demonetization of a specific currency is not new. Many countries, including Australia, Brazil, Ghana, Iraq, Myanmar, Nigeria, North Korea, Russia, the USA, and Zimbabwe have demonetized their currencies with different objectives. A few countries like European Union member states opted for demonetization in 2002 to switch over to 'Euro' as their official currency. However, most of the countries opted for demonetization with the objective to curb black money and reduce inflationary pressure in the economy (Nagdev, Rajesh, & Misra, 2021). Bose (2019) remarked that the government initiative of demonetization is very crucial, and a few similar instances of swift demonetization have already occurred in hyperinflationary economies. For instance, the Zimbabwean national bank removed the 100 trillion-dollar note from circulation in 2015 to combat inflation, which was estimated to be 231,000,000% and accepted the US dollar as the official currency. The demonetization resulted in bringing up the Zimbabwe economy from a state of hyperinflation to a slight deflation (Brookings, 2022). The initiative of demonetizing the currency left hybrid impressions in different economies. For example, the decision to switch to polymer notes for all paper currency by the Australian government in 1996 positively affected the economy. The new currency has been proven to be resistant to counterfeiting and more durable for banknotes (Groww, 2021). However, the demonetizations in Ghana and Myanmar led to severe economic downturns, riots, and fatalities.

With reference to India, till date, the country experienced demonetization three times. Initially, demonetization was announced in 1946 and the currency notes of 5000 and 10,000 were banned. Thereafter, in 1978, demonetization has taken place and currency notes of 1000, 5000, and 10,000 were taken out of

circulation. The third and most recent time the Indian economy experienced demonetization was in 2016. During that year, the government banned the acceptance of currency notes of rupees 500 and 1000 as legal tender money to discourage illicit revenue. The first two demonetizations affected only a small portion of the population, as the selected currency notes were so expensive at the time. However, the third and recent demonetization brought huge oscillations, as the banned currency notes of 500 and 1000 were in wide circulation. Individuals had no other option but to deposit these currency notes in banks, leading to a massive flow of deposits in banks and calling for the utmost efficiency to ensure rational disbursement of available funds (Bahl, Kiran, & Sharma, 2022). With reference to the impact of demonetization on Indian banks, a few studies have been carried out, such as those by Akhtar, Alam, Khan, & Shamshad (2022), Almaqtari, Hashid, Farhan, Tabash, & Al-ahdal (2022), and Antony, Maheshwari, & Preety (2017). Some of these studies, including those by Akhtar et al. (2022), and Almaqtari et al. (2022), investigated the impact of demonetization on the efficiency of banks because inefficiency in such a scenario may cause a situation like a sub-prime crisis. An efficient banking system ensures financial inclusion, availability of loanable funds at a reasonable price, and economic prosperity, whereas poor banking efficacy poses a serious threat and may collapse the entire system (Yang, 2014). However, the research in this area suffers with two limitations. The first limitation is the contradiction in the reported results. For example, Akhtar et al. (2022) observed an improvement in banking efficiency after demonetization, while Almaqtari et al. (2022) and Maity and Ganguly (2019) reported an adverse impact of demonetization on the profitability and efficiency of banks. The second limitation pertains to the non-consideration of undesirable outputs produced in the form of non-performing assets (NPA). The efficiency of a bank lies in the optimum utilization of input variables to generate output in the form of loans and advances. However, most of the times, a proportion of these loans remains overdue and turns into NPA for banks. According to the Reserve Bank of India (RBI), when the interest and/or principal instalment of a loan remains overdue for more than 90 days, it is termed as NPA (Puri & Yadav, 2014). These NPAs deteriorate the asset quality and are considered as undesirable outputs for the banks (Goyal, Singh, Singh, & Aggarwal, 2019). The NPA negatively influences the interest margin and operational costs of banks (Das & Uppal, 2021). If there is a significant amount of NPA and the same is somehow ignored while estimating efficiency, the computed scores will not be able to reflect unbiased results. Particularly in the context of India, where the level of NPA is comparatively higher than in other countries, it should be cautiously considered (Hafsal, Suvvari, & Durai, 2020). The NPA ratio to gross advances in India reached to 11.5% during March 2018, which was later reduced to 7.3% and 5.9% during 2021 and 2022, respectively (Panda, 2022). However, even now, it is higher than other countries like the USA (1.1%), the UK (1.2%), China (1.8%), Indonesia (2.6%), and South Africa (5.2%) (Times of India, 2022). Being a toxic asset, it affects the overall efficiency of banks as well (Rao, 2022). That is the reason why NPAs should be considered while assessing the performance of any financial system (Fujii, Managi, & Matousek, 2014). The incorporation of undesirable output makes the efficiency result more accurate and authentic (Zhou & Zhu, 2017). But in spite of huge importance, the NPAs are usually ignored in most of the efficiency analysis (Hamid, Ramli, & Hussin, 2017).

The current work attempts to fill this research gap by looking into how the recent demonetization has affected the efficiency of Indian commercial banks while taking into account their undesirable output (i.e. NPA). The next section reviews the related literature, followed by the research methodology, findings, and conclusion of the study.

2. Literature Review

Demonetization is expected to have a far-reaching impact on the Indian economy, various studies have been undertaken to investigate the repercussions of demonetization in the Indian economy. For instance, Mali (2016) observed that demonetization had a negative impact on micro-businesses and online retail stores that offered cash on delivery, with some of these businesses temporarily ceased operations. On the flip side, e-wallet companies experienced an unprecedented boost in sales. Meher (2017) analysed the short- and long-term impact of demonetization on NPAs and found that it led to a rise in deposits and a reduction in the level of NPAs in banks. Nagdev et al. (2021) reported that demonetization mediated the adoption of cashless payment methods and IT-enabled banking services in India, but since the economy is characterized by around 95% cash-dependent transactions, the process of complete digitalization will take place gradually as it requires highly developed levels of infrastructure. Maity and Ganguly (2019) examined the trend in efficiency levels throughout the pre- and post-demonetization period from April 2014 to March 2018 and found that although efficiency declined during the post-demonetization period, the change was not statistically significant. However, Almaqtari et al. (2022) found a hybrid influence of demonetization on Indian banks, with a significant positive impact on Net Interest Margin but a negative impact on return on equity and return on assets. A recent study by Akhtar et al. (2022) observed that Indian banks performed better during the post-demonetization period, with the improvement in the efficiency of public sector banks being due to the major deposits during the post-demonetization period.

The studies mentioned have not considered NPA as a potential variable that could affect the efficiency scores. However, the available literature indicates the inclusion of NPA has the potential to impact efficiency scores. For example, Puri and Yadav (2014) found that the number of efficient banks decreased due to

increased NPAs ratios. Jayaraman and Srinivasan (2014) incorporated Gross Non-Performing Assets as undesirable output while investigating the profit efficiency of Indian domestic banks during 2005-2012. The study reported Gross NPA as one of the prominent factors affecting efficiency. The results indicate that a high volume of Gross NPA, operational cost, and low non-interest income lead to inefficiency. Zhou and Zhu (2017) also reported a change in the efficiency scores of Chinese commercial banks when Non-performing loans were considered as undesirable output. The efficiency analysis of 423 European banks by Rebai (2018) also revealed a significant impact of undesirable outputs over efficiency measures. The results indicate an increasing level of inefficiency for most of the selected European countries. The study was conducted over a period of two years from 2013 to 2015. Ngo, Le, and Ngo (2019) reported that the inclusion of undesirable output led to decreased efficiency of the benchmarked bank and upgraded the efficiency of the other banks. Hafsal et al. (2020) found that NPA caused a 16.2% of efficiency loss in the Indian banking system. Through parametric and non-parametric production frontier approaches, Dar, Mathur, and Mishra (2021) examined the impacts of NPA on the technical efficiency of Indian banks. The results discerned that public sector banks had a greater amount of NPAs as well as higher levels of NPA variation which results in lower technical efficiency.

Thus, NPA has a potential influence over the efficiency of banks, but the available studies aimed at analyzing the potential impact of demonetization on the efficiency of Indian domestic banks have not considered the same. To overcome this research gap, the present study measures the efficiency of domestic banks with the inclusion of NPA and compares the efficiency scores of the pre- and post-demonetization periods.

3. Research Methodology

The present study attempts to identify the possible impact of demonetization on the efficiency of public and private sector banks in India, measured with due consideration of undesirable output of banks in the form of NPAs. With reference to the measurement of efficiency, there are two approaches viz., the traditional approach and the frontier-based approach. The traditional approach applies ratio analysis to capture the financial soundness and profitability of a business unit (Ahmad, Naveed, Ahmad, & Butt, 2020). The Frontier based Approach measures the performance of a firm relative to the best practice firm located at the frontier. In the case of financial institutions where multiple inputs and outputs exist, ratio analysis is not suitable (Kiliç, 2011). Therefore, the current study applies a frontier-based technique to estimate bank efficiency.

Further, under the frontier approach, there can be a parametric frontier technique (that presumes all parameters are contained inside a finite-dimensional parameter space) or a non-parametric frontier technique (that presumes parameters to be in an infinite dimensional parameter space). The assumption of the parametric frontier approach is too limiting to estimate efficiency (Ajibefun, 2008). Further, in the context of banks, non-parametric techniques are more suitable (Svitalkova, 2014). The present study also applies one of the most extensively used non-parametric technique named as Data Envelopment Analysis (DEA). The DEA creates a piecewise non-parametric frontier and assesses the relative efficiencies of a decision-making unit (DMU) based on inputs and outputs. It computes efficiency scores based on linear programming. If the computed efficiency score of a unit is equal to one, the same is treated as an efficient unit and is located on the frontier. On the other hand, units with efficiency levels between zero and one are referred to as inefficient units and require performance improvement. The improvement can be done either through enhancing current output levels (output orientation) or reducing input levels (input orientation). In the present paper, input orientation has been considered as banks have stronger control over their inputs (Sanjeev, 2006; Yilmaz & Güneş, 2015).

Here, it is pertinent to note that the traditional DEA methodology works only for maximizing the outputs or minimizing the inputs. However, the present study considers NPA, which is an undesirable output for the banks and thus needs to be minimized. Therefore, the traditional DEA methodology cannot be applied. To resolve the problem, Guo and Wu (2013) proposed a unique resort whereby undesirable outputs like NPAs are considered as input variables. The rationale behind the approach is to proportionally reduce inputs and undesirable outputs of the DMU to the extent possible without reducing the level of desirable outputs. The present study also applies the approach of Guo and Wu (2013) and placed NPA in the list of input variables while estimating the efficiency scores. Furthermore, being a deterministic model, the DEA methodology fails to explicitly consider a random error. Thus, the overall deviation from the technology frontier may be affected by sampling variations (Munim, 2020). To overcome this restriction, Simar and Wilson (1998) proposed bootstrapping the DEA results. In order to improve the accuracy of the estimations, the present study also applies the same and obtains bootstrapped DEA efficiency estimates for each bank. The benchmarking package of R software has been used for estimation purposes, and the following null hypotheses have been tested:

- H_{0i} : There is no significant difference in bootstrapped efficiency scores of public sector banks estimated after the inclusion of an undesirable output during pre-demonetization period and the same score estimated during post-demonetization period.
- H_{0p} : There is no significant difference in bootstrapped efficiency scores of private sector banks estimated after the inclusion of an undesirable output during pre-demonetization period and the same score estimated during post-demonetization period.

To test the null hypotheses, statistical tests are supposed to be applied. To determine the appropriate test, firstly the normality of efficiency scores has been examined through Shapiro–Wilk test. Since the result confirms the normality of the scores, a t-test has been applied.

Study Period: For the purpose of the study, data of 12 years from 2010-2011 to 2021-2022 has been considered. Since, demonetization was announced on 8th November, 2016, the period till March 2016 i.e., the period during the financial year 2010-11 to financial year 2015-16 has been considered as pre-demonetization. The period the financial year 2016-17 to the financial year 2021-22 has been considered as post-demonetization period. The required data for input and output variables were collected from the published reports of the Reserve Bank of India and CMIE Prowess database. Input and Output Variables: With reference to the selection of input and output for computing banking efficiency, there is no consensus in the literature, and therefore researchers are allowed to make their own decisions (Jayaraman & Srinivasan, 2014). The selection is guided by the particular approach of the researcher amongst the available six approaches: asset approach, intermediation approach, operating approach, production approach, user cost approach, and value-added approach. Berger and Humphrey (1997) noted that the intermediation approach is more suitable for estimating the efficiency of financial institutions like banks. Additionally, as the intermediation approach has been used in the majority of prior studies (Sanjeev, 2006; Tamatam, Dutta, Dutta, & Lessmann, 2019; Yang, 2014), the present study also applies the intermediation approach and selected labour, loanable funds, and physical capital as inputs. Labour has been measured through the number of employees, physical capital has been proxied by fixed assets, and loanable funds have been computed by summing deposits and borrowings. Net interest income and non-interest income have been considered as desirable output. The net interest income represents the excess of interest earned over interest paid. The non-interest income refers to the other income earned by the bank. Further, gross NPAs of the banks have been considered as an undesirable output.

4. Results and Discussion

An efficient bank is a benchmark bank that portrays best practices to minimize inputs while producing a given level of output. To estimate the efficiency, the present study applies the DEA methodology that provides efficiency scores based on the inputs used by the producer and the corresponding outputs generated by the producing unit. The inputs considered in the study are labour, physical capital, and loanable funds. Net interest income and non-interest income have been considered as desirable output and gross NPA of the banks has been considered as undesirable output. Table 1 depicts the descriptive statistics of selected variables for the study period from 2010-11 to 2021-22, which spans 12 years.

Table 1. Descriptive statistics of variables (average 2010-22).

Variables	Particulars	Public sector banks			Private sector banks		
		Average	Max.	Min.	Average	Max.	Min.
Inputs	Labour (Total no. of employees)	39342	271556	401	19572	83058	1066
	Loanable funds	394747	2760810	685	159596	794454	5783
	Physical capital (Fixed assets)	3810	25307	20	1321	6774	29
Output-desirable	Net interest income	10730	75512	77	5494	29795	202
	Non-interest income	5272	41473	14	3461	18039	61
Output-undesirable	Gross NPA	20368	107963	28	4829	26568	139

Amongst the public sector banks, the average values of all input and output variables have been observed to be maximum for the State Bank of India (SBI) and minimum for the Bharatiya Mahila Bank (BMB). The reason for this variation may be attributed to the difference in the age of these two banks. The rich heritage and legacy of SBI for more than 200 years accredits it as the most trusted Bank through generations, which is acknowledged by its customers’ patronage and reflected in its maximum values of labour, capital, loanable funds, and income. On the other hand, BMB has the shortest existence as it was incorporated in 2013 and merged with SBI in 2017. Among private sector banks, the number of employees and loanable funds was observed to be the highest for Housing Development Finance Corporation Limited (HDFC) bank. Due to its maximum loanable funds, HDFC reported the highest net interest income among private sector banks. However, the physical capital and Gross NPAs found to be the maximum for the Industrial Credit and Investment Corporation of India (ICICI) bank. These two private sector banks (HDFC Bank and ICICI Bank) are the top private sector banks in India. In 2021, the HDFC bank reported a market capitalization of ₹ 8.23 lakh crores and witnessed a 30.4% rise in market capitalization over the period from 2019-20 to 2020-21. The ICICI bank also registered a remarkable growth by delivering a 34% compound annual growth rate in earnings during 2018-21. The Nainital Bank has been found to have the lowest values for all input and output variables, which may be attributed to its small number of branches compared to other banks. In 2021, there were only 160 branches of Nainital Bank, which was followed by 245 branches of Dhanalakshmi Bank.

The annual screening of yearly data reveals that although the public sector banks have higher average values for all studied variables, there is also a bigger standard deviation due to the large range between maximum and minimum values. All the inputs (labour, loanable funds, and physical capital) and outputs (Net

interest income, non-interest income, and Gross NPA) have been used to compute the bootstrapped efficiency of various banks during the study period. The annual average of bootstrapped efficiency scores of different banks is shown in [Table 2](#).

Table 2. Annual average bootstrapped efficiency scores of banks.

Year	Public sector banks	Private sector banks	Domestic banks
2010-11	0.833	0.780	0.807
2011-12	0.834	0.754	0.794
2012-13	0.857	0.726	0.792
2013-14	0.864	0.735	0.800
2014-15	0.835	0.731	0.783
2015-16	0.811	0.684	0.748
2016-17	0.857	0.730	0.794
2017-18	0.827	0.721	0.774
2018-19	0.859	0.670	0.765
2019-20	0.838	0.674	0.756
2020-21	0.895	0.768	0.832
2021-22	0.916	0.752	0.834
Average during total period 2010-22	0.852	0.727	0.790
Average during pre-demonetization period 2010-16	0.839	0.735	0.787
Average during post-demonetization period 2017-22	0.865	0.719	0.792

According to [Table 2](#), during the study period, public sector banks had an average efficiency score of 0.852, whereas private sector banks had an average efficiency score of 0.727. In other words, on average, public sector banks were 14.8% less efficient in converting inputs into output than their private sector counterparts, who were found to be 27.3% inefficient. The estimations are sufficient to support the claim that public sector banks perform more efficiently than private sector banks. This outcome is consistent with findings by [Akhtar et al. \(2022\)](#) and [Jagwani \(2012\)](#), who found public banks as the best performer. The year 2018–19 had the largest efficiency gap, which was followed by the year 2019–20. It is noteworthy to notice that public sector banks showed 3% growth in efficiency from 83.9% (2010–15) to 86.5% (2016–22) over the post-demonetization period. The public sector banks exhibited modest consecutive improvement in efficiency from 2011-12 (0.834) to 2012-13 (0.857) and 2013-14 (0.864). But during the year 2014-15, a fall in the efficiency scores of public sector banks has been observed. The scrutiny of financial performance disclosed that during the financial year 2014-15, the profitability of public sector banks reflected through returns on assets declined significantly from 0.50% to 0.46%. This may be linked to the fact that during that year, the volume and share of stressed assets of public sector banks increased, which contributed to the sustained decline in the asset quality of banks ([Reserve Bank of India, 2015](#)). The year 2015-16 was the worst year from the perspective of the efficiency of public sector banks. The average efficiency this year dropped to 81.1% (0.811). The individual efficiency scores of different banks estimated for 2015-16 divulge that eight public sector banks including SBI, Bank of Baroda, Bharatiya Mahila Bank, Canara Bank, Corporation Bank, Dena Bank, Indian Bank, and Syndicate Bank registered the lowest efficiency in this year. The reason for such a downfall may be attributed to the surmounting non-performing assets of banks and the ‘Asset Quality Review’ was conducted in the year 2015-16 by the Reserve Bank of India (RBI), which is the apex bank of India ([Dar et al. 2021](#)). The review was done to identify banks with inappropriate asset classification resorting to ever-greening accounts. It wreaked havoc on bank profit and loss accounts, and many banks suffered losses in both quarters. In some cases, the quarterly loss resulted in year-end deficits. The review resulted in an exponential increase in the reported figure of bad loans by 80% ([The Hindu, 2016](#)). Furthermore, it resulted in reduced interest and non-interest earnings of commercial banks ([Goyal et al., 2019](#)).

However, during 2016-17, a remarkable improvement in the efficiency of domestic banks was observed, which may be accredited to massive deposits in banks following the announcement of a ban on the acceptance of ₹500 and ₹1000 notes as legal tender money. Although the efficiency level regressed in 2017-18, there was again improved efficiency in 2018-19, and the efficiency score reached its highest level in 2020-21. This was the year when coronavirus was in full swing, but in spite of the outbreak of the virus, public sector banks registered an improvement in efficiency. This can be attributed to the strategic decision to merge ten public sector banks into four banks, starting on April 1, 2020. For example, when Punjab National Bank merged with Oriental Bank of Commerce and United Bank of India, a loss of ₹8310.93 crore was converted into a profit of 2021.62 crore in 2020–21 ([The Hindu, 2021a](#)). The other three mergers (merger of Andhra bank and

Corporation bank with Union Bank of India; merger of Allahabad bank with Indian bank; and merger of Syndicate bank with Canara bank) resulted in a large capital base that allowed opportunities for technological innovations. Furthermore, the net interest income of public sector banks also escalated from 13% in March 2020 to 16.2% in September 2020. The earnings before provisions and taxes, return on assets, and return on equity of public sector banks also depicted growth during the six-months period from March-September 2020 (Times of India, 2021). The efficiency level of private banks exhibited a drastic fall from 78.0% in 2010-11 to 75.4% in 2011-12, which further reduced to 72.6% in 2012-13. Although there was a slight improvement during 2013-14, it was short-lived, the efficiency level again reduced during 2014-15 and 2015-16. In 2015-16, the efficiency level reached just 68.4%, indicating a 31.6% inefficiency in utilization of inputs. As previously discussed, the 'Asset Quality Review' conducted in 2015 wreaked havoc on banks' profitability, which was quite apparent from the reduced profitability of private sector banks with a decline in return on equity from 16.22% to 15.74% and deteriorating assets quality. This affected many private sector banks, including major players like ICICI and Axis bank, however, a few banks like HDFC escaped owing to their little commitment towards major infrastructure projects (The Hindu, 2021b).

Private sector banks witnessed a remarkable improvement in efficiency from 2018-19 to 2020-21. They reported a 159% increase in net profit at ₹ 18,814 crores in the second quarter of the year (July-September 2021), which was supported by a consistent increase in net interest income and a reduction in provisions as compared to the previous year in the same quarter (Business Standard, 2020a). It is quite interesting to note that, unlike public sector banks, the efficiency of private sector banks demonstrated reduced during the post-demonetization period by 1.6% from 73.5% (2010-15) to 71.9% (2016-22). The individual performance of banks in terms of bootstrapped efficiency scores can be observed through Table 3. The estimates show the averages of annual bootstrapped efficiency scores for the study period.

Amongst the public sector banks, the Bank of Baroda registered the highest efficiency score. The bank managed to keep its asset quality tight in 2013-2014 in comparison to its peers. Its delinquency ratio declined from 2.7% in the March 2013 quarter to 1.8% in the December quarter. The better asset quality of the bank may be attributed to the bank's strategy of diversification of loans across different sectors. Furthermore, troubled sectors such as metals and infrastructure formed a smaller part of the bank's portfolio as compared to its peers. During the third quarter of the financial year 2018-19 (October-December 2018), the bank had a stellar result. It reported three times higher net earnings, as well as stable gross NPAs and a strong loan book. The bank's excellent performance prompted Vijay Bank and Dena Bank to merge with it. The bank's gross NPAs to gross advances ratio decreased from 9.61% in March 2019 to 9.40% in March 2020.

State Bank of India scored the second position after Bank of Baroda with an efficiency score of 0.910. On the other hand, the efficiency score of the Central Bank of India (0.744) was found to be the lowest, followed by Punjab and Sind Bank (0.771). Scrutiny of financial variables pertaining to specific banks revealed that the Central Bank of India was exposed to the problem of high NPAs and low return on assets, owing to which the Reserve Bank of India put it under Prompt Corrective Action (PCA) in June 2017. However, later the bank was able to successfully improve its performance parameters, like low NPAs and better capital ratio, and during the recent financial year 2021-22, the RBI removed the bank from PCA. But the poor performance of the bank in the early years caused a reduction in the average efficiency level for the study period 2010-22. The low efficiency of Punjab and Sindh Bank may be attributed to the consistent occurrence of net losses i.e., ₹743.80 (2017-18), ₹543.48 (2018-19), ₹990.80 (2019-2020), ₹2732.90 (2020-21). The primary reasons for the poor efficiency and losses are deterioration in asset quality, large provisioning requirements, and increased credit costs (Credit Rating Information Services of India, 2021).

The comparison of efficiency scores of the pre-demonetization period (0.840) and efficiency scores of the post-demonetization period (0.861) reveals that public sector banks have seen an improvement in efficiency scores by 2.5%. The maximum increase of 17% (from 0.736 to 0.907) has been witnessed in the case of Indian Overseas Bank, followed by Vijay Bank (16.3%) and Central Bank of India (11%).

Among the private sector banks, Kotak Mahindra Bank (0.869) has the highest average efficiency score, followed by the Industrial Development Bank of India (IDBI) with an efficiency score of 0.867. On the flip side, the efficiency score of Lakshmi Vilas Bank (0.500) was found to be the lowest. The main reason for the poor performance of Lakshmi Vilas Bank is assumed to be the change in the strategy of the bank during 2016-17 when the bank shifted its focus to large businesses rather than small and medium enterprises. In 2018, Religare Finvest filed a case against the bank for the diversion of funds, leading to the Reserve Bank of India imposing prompt corrective action in September 2019. As a result, Lakshmi Vilas Bank was prohibited from issuing fresh loans and opening new branches. Eventually, the bank was merged with Singapore's largest lender, DBS Bank, due to shareholders' dissatisfaction with the bank's bad loans and value erosion (Business Standard, 2020b). In the comparison of efficiency scores of pre-demonetization and post-demonetization periods, a slight decline in the average efficiency score for private sector banks is observed. The highest decline of 27.9 % has been observed in the case of Nainital Bank, followed by Jammu & Kashmir Bank.

Table 3. Bank-wise bootstrapped efficiency scores.

Public sector banks	Bootstrapped efficiency scores			Private sector banks	Bootstrapped efficiency scores		
	Total period	Pre-demonetization	Post-demonetization		Total period	Pre-demonetization	Post-demonetization
Allahabad Bank	0.856	0.901	0.789	Axis Bank	0.796	0.834	0.759
Andhra Bank	0.903	0.901	0.906	Bandhan bank	0.819	0.793	0.823
Bank of Baroda	0.922	0.916	0.927	City Union bank	0.724	0.694	0.754
Bank of India	0.818	0.844	0.791	Catholic Syrian Bank (CSB) Bank	0.576	0.507	0.646
Bank of Maharashtra	0.885	0.883	0.886	Development Credit Bank (DCB) Bank	0.632	0.655	0.608
Bharatiya Mahila Bank	0.898	0.894	0.909	Dhanalakshmi Bank	0.513	0.469	0.557
Canara Bank	0.824	0.804	0.843	Federal Bank	0.722	0.748	0.696
Central Bank of India	0.744	0.689	0.799	Housing Development Finance Corporation (HDFC) Bank	0.837	0.847	0.828
Corporation Bank	0.896	0.887	0.910	Industrial Credit and Investment Corporation of India (ICICI) Bank	0.821	0.837	0.806
Dena Bank	0.776	0.770	0.786	Industrial Development Bank of India (IDBI) Bank	0.867	0.896	0.838
Indian Bank	0.903	0.873	0.933	Infrastructure Development Finance Company (IDFC) First Bank	0.683	0.265	0.753
Indian Overseas Bank	0.821	0.736	0.907	Indusind Bank	0.850	0.849	0.851
Oriental Bank of Commerce	0.878	0.910	0.828	Jammu & Kashmir bank	0.765	0.837	0.693
Punjab And Sind Bank	0.771	0.749	0.792	Karnataka Bank	0.602	0.591	0.614
Punjab National Bank	0.896	0.921	0.872	Karur Vysya Bank	0.701	0.646	0.756
State Bank of India	0.910	0.902	0.918	Kotak Mahindra Bank	0.869	0.892	0.847
Syndicate Bank	0.814	0.820	0.806	Lakshmi Vilas Bank	0.500	0.538	0.444
UCO Bank	0.781	0.785	0.776	Nainital Bank	0.727	0.867	0.588
Union Bank of India	0.879	0.880	0.878	RBL Bank	0.794	0.753	0.835
United Bank of India	0.864	0.835	0.908	South Indian Bank	0.576	0.635	0.518
Vijaya Bank	0.800	0.745	0.909	Tamilnad Mercantile Bank	0.794	0.835	0.753
Average	0.849	0.840	0.861	Yes Bank	0.787	0.826	0.748
				Average	0.725	0.719	0.714

Table 4. Results of statistical tests performed on bootstrapped efficiency differences.

Bank	T statistics	P-value	Null hypothesis	Bank	T stat.	P-value	Null hypothesis
Allahabad Bank	3.63	0.01	Rejected	Axis Bank	1.92	0.08	Accepted
Andhra Bank	-0.45	0.66	Accepted	Bandhan Bank	-1.45	0.21	Accepted
Bank of Baroda	-0.61	0.56	Accepted	City Union Bank	-2.55	0.03	Rejected
Bank of India	1.82	0.10	Accepted	CSB Bank	-1.77	0.11	Accepted
Bank of Maharashtra	-0.10	0.92	Accepted	DCB Bank	1.01	0.34	Accepted
Bharatiya Mahila Bank	-0.96	0.44	Accepted	Dhanalakshmi	-3.23	0.01	Rejected
Canara Bank	-0.85	0.42	Accepted	Federal Bank	0.77	0.46	Accepted
Central Bank of India	-2.73	0.02	Rejected	HDFC Bank	1.39	0.20	Accepted
Corporation Bank	-1.39	0.20	Accepted	ICICI Bank	0.80	0.44	Accepted
Dena Bank	-0.26	0.80	Accepted	IDBI Bank	1.54	0.16	Accepted
Indian Bank	-2.70	0.02	Rejected	IDFC First Bank	-2.67	0.04	Rejected
Indian Overseas Bank	-6.16	0.00	Rejected	Indusind Bank	-0.08	0.94	Accepted
Oriental Bank of Commerce	4.53	0.00	Rejected	Jammu & Kashmir Bank	5.02	0.00	Rejected
Punjab And Sind Bank	-0.94	0.37	Accepted	Karnataka Bank	-0.68	0.51	Accepted
Punjab National Bank	2.02	0.07	Accepted	Karur Vysya Bank	-3.86	0.00	Rejected
State Bank of India	-1.68	0.12	Accepted	Kotak Mahindra	1.76	0.11	Accepted
Syndicate Bank	0.28	0.79	Accepted	Lakshmi Vilas Bank	1.88	0.10	Accepted
UCO Bank	0.11	0.91	Accepted	Nainital Bank	23.53	0.00	Rejected
Union Bank of India	0.05	0.96	Accepted	RBL Bank	-1.83	0.10	Accepted
United Bank of India	-1.52	0.17	Accepted	South Indian Bank	3.12	0.01	Rejected
Vijaya Bank	-3.73	0.01	Rejected	Tamilnad Mercantile	1.82	0.10	Accepted
Public Sector Banks	-1.04	0.31	Accepted	Yes Bank	1.50	0.16	Accepted
				Private Sector Banks	0.10	0.92	Accepted

To test the null hypotheses at the outset, the normality of efficiency scores has been examined through Shapiro–Wilk test. Since the result confirms the normality of the scores, t-test has been applied to determine whether demonetization has affected the bootstrapped efficiency of Indian banks or not. To analyze the impact of demonetization on bank efficiency, the scores of all domestic banks for the pre-demonetization period (2010-11 to 2015-16) have been compared with the scores for the post-demonetization period (2016-17 to 2021-22). [Table 4](#) depicts the estimates of test statistics with the probability. If the probability of the test is more than 5%, the null hypothesis will be accepted and it will be concluded that there is no significant impact of demonetization on the efficiency of banks. However, if the probability is less than 5%, the null hypothesis cannot be accepted and it will be concluded that the demonetization that has taken place in India during 2016-17, has significantly influenced the efficiency of domestic banks.

As shown in [Table 4](#), most of the domestic banks did not have a significant impact from demonetization. Amongst public sector banks, a significant impact was found on six out of 21 banks, while the remaining 15 banks did not have any significant impact. Out of these six banks, four banks including the Central Bank of India, Indian Bank, Indian Overseas Bank, and Vijay Bank saw a significant increase in their efficiency levels. The other two banks Allahabad Bank and Oriental Bank of Commerce, reported a decline in efficiency during the post demonetisation period. Since the majority of the banks did not show any significant impact of demonetization, the financial performance of the affected banks has been scrutinized. It was found that the change in efficiency during the post-demonetization period may be attributed to some specific events/reasons rather than demonetization.

In the case of the Central Bank of India, the bank was able to successfully improve its performance parameters. The bank reported a decline in Gross NPA from 19.99% in December 2019 to 16.30% in December 2020, and its capital adequacy ratio increased from 0.95% in March 2017 to 3.33% in June 2022. The low NPAs and better capital ratio improved its efficiency and profitability. According to an assessment by the Board for Financial Supervision, the bank did not breach prompt corrective action (PCA) parameters, which led to the removal of the bank from PCA during the recent financial year 2021-22.

Regarding Indian Bank as noted by [Ramnarayan, Sindhwani, Shah, & Parihar \(2021\)](#), the successful amalgamation of Allahabad Bank with the bank on April 1, 2020, resulted in a better financial state and laid down its vision as a future-ready bank. The synergy benefits were reflected in the form of a decrease in the cost-to-income ratio of the Bank (40.86% for the first quarter of June 2021). The net profit of Indian Bank increased to ₹3004.68 crores as of March 2021, compared to ₹ 753.36 crores in March 2020 (an approximate increase of 298.83%).

In the context of Indian Overseas Bank, it was noted that the bank's management team embarked on a massive turnaround programme in the year 2017, under which the bank adopted a multi-pronged strategy that included using the Indian Rupees surplus swap option, rebalancing its portfolio by significantly reducing exposure to large corporates, increasing its focus on human resource, and perfecting its information technology systems ([The Hindu, 2021a](#)). This led to a drop in NPAs to 3.58% in the quarter ending March 2021, as compared to the 5.44% in the previous quarter, and the bank was able to sustain its profitability. After six years of losses, the bank swung into profit in the fourth quarter of 2019-20, reporting a net profit of ₹831 crores during 2020-21 in comparison to a net loss of ₹8,527 crores during 2019-20. By deliberately lowering exposure to the stressed sector in the business segment, the bank increased its focus on retail and agricultural segments and rebalanced its loan portfolio.

With reference to Vijaya Bank, the bank enjoyed a healthy growth in retail income, aided by a marginal fall in bad loan proportion. This resulted in an increased net profit of ₹751 crores (2016-17) as compared to ₹382 crores (2015-16), which further increased by 57.5% during the quarter ending June 2017 ([Business Standard, 2020b](#)).

The reduced efficiency level of Allahabad Bank may be attributed to mounting NPAs and reduced profits. The bank reported a consistent loss for four years: ₹313.52 crores, ₹4,674.37 crores, ₹8,333.96 crores, and ₹5396.09 crores during 2016-17, 2017-18, 2018-19, and 2019-20 respectively. On the asset front, the bank's gross NPA ratio stood at 17.55% at the end of March 2019 as compared to 15.96% in March 2018.

In the case of Oriental Bank of Commerce, the bank sustained massive losses due to a sudden increase in bad loans from 8.9% gross NPA to 9.5% in the quarter ending June 2017, as a result of which the Reserve Bank of India had to take prompt corrective action on October 5, 2017. The results of the increased NPA are quite apparent from the profitability of the bank also. The bank reported an annual loss of ₹1094 crore for the financial year 2016-17. It further reported an increase in Net NPA from 10.48% as on 31st March 2018, as against 8.96% a year ago. The worsening of asset quality led to a net loss of ₹ 5,872 crores in the financial year 2017-18.

In the context of private sector banks, seven out of the 22 private sector banks experienced a significant impact of demonetization. During the post-demonetization period, four banks including City Union Bank, IDFC First Bank, Karur Vysya Bank, and Dhanalakshmi Bank, demonstrated an increment in their efficiency scores, while the other three including Jammu & Kashmir Bank, Nainital Bank, and South Indian Bank exhibited a decline in their efficiency levels. Similar to public sector banks, further investigation of the

financial variables of banks indicated certain events/factors (other than demonetization) which may be responsible to bring changes in efficiency level.

City Union Bank experienced an increase in its other income and a reduction in expenses during the post-demonetization period, which resulted in a rise in profitability and bank efficiency. The bank reported an 18% increase in the net profit during 2018, from ₹503 crore in the previous year to ₹592 crore. IDFC First Bank came into existence after the merger of IDFC Bank Ltd and Capital First in 2018, with the purpose of the growth of both banks. The merger resulted in the expansion of loan disbursement and an increased customer base, which led to an increase in the net interest margin from 1.9% to 3.0%. The increment in net interest margin of the bank is reflected in the better scores of bank efficiency. With reference to Karur Vysya Bank, it was observed that the bank's diversification strategy towards agricultural gold loan book, housing loans, and high rated assets led to reduced risk. The sizable volume of retail deposits and improved capital adequacy ratio resulted in an increased net profit from ₹50.56 crore in the fourth quarter of 2017-18 to ₹60.02 crore in 2018-19. All these factors may be credited to the improved efficiency of the bank. The improved efficiency of Dhanalakshmi Bank may be attributed to its positive performance indicators in 2021. During the third quarter ending December 2021, the bank reported an increase in deposits by 5.63%, net interest income by 2.91%, and gross advance by 10.45%, as compared to the previous year. The bank's digital transactions also reached greater heights of 62% during that period.

With reference to Jammu and Kashmir Bank Limited, the bank experienced a very tough phase during the post-demonetization period from 2016-17 to 2021-22, which included one natural disaster, one significant sociopolitical unrest, the abrogation of Article 370, and a COVID-19 lockdown. Due to its special and strategic location in the socially and politically sensitive union territories of Jammu and Kashmir and Ladakh, the efficiency level of the bank oscillated. In the context of Nainital Bank, it was found that during the post-demonetization period, the bank suffered with the increase in gross NPA ratio to 13.39% in the first half of the financial year 2021, as compared to 10.65% in the financial year ending 2019. This was followed by increased credit costs and affected the bank's profitability. On the other hand, due to the increased level of bad loans, South Indian Bank reported a net loss of ₹187 crore in the second quarter of 2021-22, as compared to a net profit of ₹65.10 crore in the previous period.

Therefore, it may be inferred that the majority of the banks remained unaffected by the demonetization. Around 30% of domestic banks (13 out of 43 banks) exhibited certain significant changes (8 banks reported a rise in efficiency level, and 5 banks reported a fall in the level of efficiency). Yet, it may be discerned that demonetization cannot be held responsible for the same. The changes in the efficiency level may be attributed to bank-specific factors as discussed in the previous paragraphs.

5. Conclusion

The present paper aimed at investigating any possible impact of demonetization on the efficiency of Indian domestic banks. Although a few studies have already been conducted in this direction, but they suffer from the problem of non-consideration of NPAs, which are crucial and prominent undesirable outputs for the banks. To fill the research gap, the present study considers NPA and estimates bootstrapped efficiency scores for the period of 12 years from 2010-22. The entire period has been divided into two sub-periods: from 2010-16 as the pre-demonetization period and 2016-22 as the post-demonetization period. The results indicate that in terms of efficiency, public sector banks outperformed private sector banks. The comparison of efficiency during the two sub-periods reveals that the majority of banks experienced no significant changes during the two periods. Only 13 banks had a significant impact, out of which eight banks exhibited better efficiency, while five banks were found to be less efficient during the post-demonetization period. Further investigation of individual banks revealed that these changes were contributed by bank-specific factors, and demonetization cannot be accounted for the same. In other words, demonetization had no significant impact on the efficiency of domestic banks.

The findings of the study are useful for policymakers as well as stakeholders. The inefficient banks can enhance their efficiency by replicating the standards set by benchmark banks. It is expected to provide useful insights by highlighting the importance of considering undesirable variables in computing efficiency. The study can be further extended by increasing the sample size, such as the inclusion of foreign banks operating in India. In addition, in the context of demonetisation, the impact of other market shocks can also be examined for studying the impact on banking efficiency.

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