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The Impact of ICT on the Profitability of Indian Banks: The Moderating Role of NPA

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Abstract: The role of Information and Communications Technology (ICT) cannot be ignored in today's era of working. Its effects are studied in several sectors by various researchers. This study covers the impact of ICT on the profitability of banks. Thirty-three banks are operating in India. A sample period of 10 years (2010 to 2019) was studied. The study also provides insight into how ICT helps the banks' profitability during and post-COVID-19. A panel data analysis is performed to estimate the results. This study found that ICT adversely impacts banks' profitability (NIM) in India in a linear association. However, the quadratic association indicates a positive U-curved relationship between ICT and profitability. In addition, the Net of Non-Performing Assets significantly but negatively impacts the connectivity of ICT and profitability. The findings imply that banks should invest in ICT to maximize the long run. The findings have no significant implication on all stakeholders, including policymakers, shareholders, and managers, to consider implementing ICT tools as an essential factor in enhancing a bank's profitability in the long run. In addition, the level of otherwise lowered investments in ICT cannot be a fruitful step. The current study augments the existing literature on banking by providing novel evidence on the association of ICT with profitability under the influence of NPA. This study argues for the application of ICT in banks in order to increase their profitability. ICT helps the bank maintain transparency, accountability, and even the reach of financial services increases. This situation again leads to the enhancement of the country's economy.

Keywords: information and communication technology; Indian banks; bank profits; panel data analysis; net profit margin; non-performing assets

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1. Introduction (1200)

The term IT—Information and Technology—was coined in the year 1958. More recently, the term ICT—Information and Communication technology—has evolved. It implies the integration of communication media into the IT infrastructure. The role of ICT in academia to impart education is an extensively researched topic. With technological advancements and widespread adoption by various industry sectors, such as banking and manufacturing, exploration of ICT's impact on these sectors has become necessary, mainly the profits. Investing in ICT may not be an investment in the core business of these sectors, but a mechanism to bring efficiency to day-to-day operations. This situation may lead to the decision-makers and managers avoiding or keeping these investments to the minimum if the returns cannot be directly attributed to ICT. Throughout national economic systems, there has been a consistent upward trend in the digitalization of critical business operations in finance. Incorporating managerial innovations based on digital technology as a tool for attaining the strategic objectives of the financial organization is growing (Shinkevich et al. 2023).

India's banking sector is the backbone of the nation's economy. Like others, it is an integral part of financial systems (Kanoujiya et al. 2021; Balasubramaniam 2012). It affects the country's economy by providing financial services such as investment, credit, deposits, and other financial services (Gaur and Mohapatra 2021). With the enhancements in IT infrastructure, modern banking in India delivers financial services. In modern banking, banks are also helping farmers by providing easy credit. Hence, banks are notably contributing to rural development. Thus, the banking sector plays a role in the country's economic development (Kanoujiya et al. 2021; Balasubramaniam 2012). By now, India's banking structure has grown leaps and bounds. That is why it becomes essential to understand the different factors that may affect banks.

During COVID-19, ICT helped banks to sustain employment, reach remote areas, and maintain transparency and accountability. It increased the banks' businesses and made it easier for the customers to avail of the services from the comfort of their homes. The diffusion of ICT in the banking system has increased the stock returns of the banks and the Credit Default Swaps (CDS) (Cicchiello et al. 2021).

Net Interest Margin, simply put, is the interest earned on the loans and mortgages offered to the customers post the deduction of the cost of deposits accepted from the depositors. The higher the positive difference, the more profitable it is to the FI—financial institutions. The negative value of the Net Interest Margin represents an inefficient proposition for the FIs. The asset classes that generate income for the banks and the other FIs should have a higher share in the entire asset allocation mix in the bank's portfolio. A large percentage of these assets often turn non-performing, classified as NPA. It does not generate any income for the banks. That is where careful allocation in the portfolio mix and proper scrutiny of customers and their businesses play a crucial role.

Banks do adopt technological tools to perform this evaluation. However, it only serves as the guiding factor and may have inherent errors due to incomplete, inaccurate data fed to the systems. Ultimately, human judgment plays a significant role in this entire process of disbursals of loans and mortgages to reduce the NPAs and increase interest income. Due to sales pressure on the sales team, incorrect products are often offered to the customers. They may also resort to unethical means such as making wrong commitments or inflating the benefits that do not exist on the products. They may attract financial penalties and reputational damage to the educating staff on avoiding malpractices, and their consequences through ICT can be a boon.

The empirical study by Bansal et al. (2022) shows that, with technical advancements in Indian banks, their productivity grows. Multiple productivity, visualization, and analysis tools become available to the banks, which helps make better decisions. The considerable skill set level of the employees required to use these tools also increases. Banks have to upskill existing employees or hire new ones possessing these skills.

Investment in Information and Communication Technology (ICT) by financial institutions is a must to improve their profits. The study on banks in Oman shows that learning about customers plays a vital role in a bank's profitability as it helps make better judgments by bank officers about preventing money laundering (Al-Busaidi and Al-Muharrami 2021). Offering products to the customer calls for critical evaluation by the bank to minimize the risk of defaults and non-compliance. Bank staff at various levels should be competent enough. This competence and awareness about changing regulations can be imparted to staff through continuous grooming by making learning opportunities available within the organization. ICT can help in imparting this training.

The correlation between Non-Performing Assets and the profitability of banks is studied by Gaur and Mohapatra (2021) in the Indian context, by Kiran and Jones (2016) in the State Bank of India, and by Balasubramaniam (2012) on commercial banks in India.

Every year, banks pay millions of dollars in fines due to non-compliance, which can result from staff incompetence in mitigating these risks. To increase profitability, banks collaborate with financial technology firms. These collaborations of banks with external Fintech pose the risk of cybersecurity (Najaf et al. 2021). Investing in Cybertech becomes

essential for banks to not only deal with the threat but also bring operational efficiency and provide quality service (Uddin et al. 2020).

A Dutch bank was fined EUR 675 m for financial crimes between 2010 and 2016 (Yeoh 2020) for non-compliance with anti-money laundering laws. Jaeger (2018) finds that insufficient investments in a Dutch bank's personnel handling Customer Due Diligence (CDD) and investigation are the reason behind the breach and the damage to the bank. According to Edwards et al. (2018), operational risks (that majorly arise out of people), such as failure to catch money laundering activities, are essential to European banks. Hence, more robust tools need to be set to prevent banks from such crimes. A transparent IT system can solve such problems (Edwards et al. 2018).

The profitability in banks is a function of several variables. A general rule for maximizing profits is to reduce costs. The penalties that are levied for non-compliance are also costs. As expected, the non-performance or low performance of the investment is a cost. Investing in employee training to boost their performance is a cost, but it can yield returns on investment in the long run.

Yüksel et al. (2018), in a study on soviet countries, find that the non-interest income of banks and the nation's economic growth positively affect banks' profitability. However, they also argue that the loan amount in banks adversely impacts profitability. Horobet et al. (2021) estimate that macroeconomic factors such as inflation and unemployment harm banks' profitability. They also find that factors specific to banks, such as non-government loans and Non-performing assets (NPA), adversely affect a bank's profitability by reducing bank performance in Central and European countries. Potapova et al. (2022) indicate that the digitalization of Russian banks improves banks' performance leading to better profitability.

The use of Information Communication Technology plays a vital role. ICT can keep the costs minimum and still significantly affect the productivity and efficiency of the employees. Efficient employees can drive higher sales for the banks, with fewer incidents of mis-selling. Mis-selling attracts more considerable judicial fines along with reputational damage. Investing in asset classes is also a judgmental decision. Though various tools are available to investors to make intelligent choices, often, skills and knowledge to make the best use of the tools pose limitations on exploiting the tools' full potential. Investment in the wrong asset classes affects the banks' revenue and, thus, profits.

Managers have to lay down proper internal controls with the help of information technology tools and operational procedures. They will help staff access the latest learning through ICT, which can help banks save on fines and reputational damages.

The above discussion portrays the importance of ICT in the banking system. However, ICT's impact on a bank's profitability is less explored, particularly in the Indian context. Indian banking has seen several reforms to date. Hence, novel evidence on ICT and profitability needs to be investigated. This paper attempts to determine the impact of Information and Communication Technology on the bank's profitability. The proxy for ICT is the investment in ICT infrastructure by the bank. The study takes the Net Interest Margin as the banks' profitability. The net of Non-Performing Assets (NPA) is the moderator in the model.

Considering the financial impact of employees' skills on preventing operational slippages in the bank, empirically evaluating the relationship between ICT and profits is critical. A few studies have considered a handful of studies focusing on ICT and profitability. A more robust measure of profitability (Net Interest Margin) for ICT's impact on profitability in the current models makes this study unique. In addition, the moderating role of NPA in the association of ICT and profitability is not yet investigated in the existing literature. Hence, the study uniquely contributes to the existing literature.

The scope of this study is restricted to Indian banks and considers data until 2019. The subsequent section of this paper covers the literature review and hypothesis development. It then captures the data and methodology employed in the study and the models

developed. Finally, the results section is followed by a brief discussion of the results, which paves the way for the conclusion of the study paper.

2. Review of Literature and Hypotheses Development

The most significant bank-specific factors influencing the profitability of Indian commercial banks as assessed by ROA include bank size, branch count, assets management ratio, operational efficiency, and leverage ratio. Liquidity ratio, assets management ratio, and assets quality ratio are all found to increase ROE significantly (Almaqtari et al. 2019). There are numerous studies on banks' profitability and technological advancements. This section elaborates on a few critical studies available in the literature. Table A1 in the Appendix A presents a summary of some critical literature. The study on four subsidiaries of a Dutch bank by JH Coun et al. (2022) shows that access to knowledge via ICT plays a role in motivating employees and helps them be proactive. A motivated and proactive workforce contributes to streamlining processes, bringing in efficiencies, and identifying flaws in the system. These are reflected in higher revenues. Higher revenues do not always mean higher profits due to varying tax structures and rebates on different types of assets. Educating employees via ICT or otherwise about the implications of holding different asset classes on profits becomes critical.

The panel data analysis by Entele (2021) on the 25 years of data from the World Bank from 1996 to 2019 shows that adopting ICT services and building human capital and institutions has the potential to help organizations and economies grow. The data is likely unbalanced when taken over 25 years for study. Furthermore, Saedun and Mohamed (2017) argue that staff are often neglected in the overall ICT implementation. Instead, the focus is more on the IT infrastructure, i.e., without creating learning opportunities for the employees in the same proportion as IT growth. Barpanda and Athira (2022) have suggested that learning opportunities and an enjoyable work environment can decrease attrition. Higher attrition means wiping out knowledge, the degree of which depends on whether the organization is process-dependent or people-dependent.

Wang et al. (2021) studied the impact of Fintech on commercial banks' profitability in China. With proper communication technology implementation, respective areas showed heightened improvements in productivity and profitability. Zhu et al. (2021) studied the impact of research and development (R&D) and ICT on firms' productivity in China. Their results show that, with investments in R&D and ICT, innovation in products and processes takes place, which indirectly helps boost profits. A quality R&D team means good quality outcomes. Better products help sales teams keep pace with the organization's predicted sales. An organization working on R&D via ICT as a tool implies that sales and ICT can also be correlated.

Remittance is a source of income for banks. Opening accounts for non-residents or frequent travelers and offering competitive products such as multi-currency and forex cards can be good asset classes for banks. The capability to process cross-border transactions comes with its own cost and complications. The period involved in processing these transactions is crucial, and faster settlement is a selling point for banks to attract new customers. For quicker and more efficient processing of remittances, banks equip themselves with robust IT infrastructure and upskill employees through ICT or otherwise. Do ICT investments and sales lines run parallelly and in direct proportion? Adeabah et al. (2021) empirically demonstrated with a study of data from 96 countries that ICT impacts pension payments through banks to a certain point, and beyond it, the impact reduces. More the pension payments through banks, banks would have the details of pensioners along with their financial health to recommend investment products depending on their risk appetite. In countries such as India, even pension accounts can be opened with a spouse as joint accounts. Having customer data opens up a revenue stream for the banks.

Scott et al. (2017) used an in-depth field study on European and American banks. The study on 6858 banks from 29 countries of these 2 regions states that using SWIFT Network (Society For Worldwide Interbank Financial Telecommunication) significantly

impacts the profitability of the smaller banks compared to the larger banks. Transactions over SWIFT involve cost. How many branches are connected and at what volume the traffic flows determines the cost. Smaller banks tie up with prominent national or foreign banks (nostro-vostro account arrangements) to facilitate such transactions. The cost of SWIFT transfer goes down with higher volume. Offering forex products when the bank is not a direct member of SWIFT can be costly. In that case, the decision to have this product mix under assets classes (i.e., to become a SWIFT member or operate as an indirect participant) may need careful evaluation backed by proper data analytics and human judgment.

Del Gaudio et al. (2021) studied 28 EU banks. The study measured ICT's impact on the bank's profits with data from 1995 until 2015. The results are in sync with the other studies mentioned above, i.e., the bank's profitability increases with ICT. Their study also confirms that ICT coupled with IT and FinTech increases the financial stability of the banks. However, does a stable bank mean more revenues? Banks always have assets of varying risks in their portfolio. Doing customer profile evaluation backed by factual data, and continuing to invest in risky products, as guided by the regulation, can significantly increase the profits for the banks with negligible impact on the stability of the banks. This evaluation process has an inherent risk of assets turning non-performing.

Moreover, how does one grade the risk? A study by Wen et al. (2021) states that using IoT—Internet of Things—in banks enhances profitability. They have used the Mutually Exclusive Collectively Exhaustive (MECE) method to identify the correlation between indicators from IoT and risk grading in banks.

Ben Naceur and Goaied (2008) and Chhaidar et al. (2022) proposed that bank size plays a role in digital investments and their profitability. The impact is more significant as the size of the bank grows. The cost goes down with the adoption of digital means in operations. For a larger bank size, having ICT can optimize investments by reducing the per-employee cost. Initial ICT cost can be higher, and the reflection of its benefits may not start immediately. The investment in previous years continues to affect the subsequent years, which needs to be accounted for while using panel data analysis. The GMM—Generalized Method of the Moments—model can solve this problem by removing the endogeneity in the data. In GMM, the variable's past value is subtracted from the value for the next period. Chhaidar et al. (2022) paper used the Least Square Dummy Variable (LSDV) model, which few economists believe is not consistent for finite panel data, and they propose GMM instead.

A study using panel data from 13 Ethiopian banks from 2012 to 2016 employing a random effect model by Adane et al. (2021) suggests that ATM deployments significantly positively impact the Ethiopian commercial bank's profitability. This result shows that technological adoption without any interaction of ICT can also significantly impact the bank's profitability. Eliminating this noise while studying the relationship between technology and a bank's profitability is essential for accurate results. It is very little to no role of ICT that is playing in this study. Sanga and Aziakpono (2022) have concluded from their study in Africa that ICT significantly impacts bank deposits and credit to private sectors, bringing higher revenue links to the banks in Africa. Moreover, we assume that profits would rise in proportion to the revenue, though an actual study is required to predict it accurately. Saksonova (2014) states that NIM—Net Interest Margin—outweighs ROA—Return on Assets—in the context of the bank's effectiveness and stability basis in the study in the US, Baltic Countries, and Europe. Does this hold if the quality of assets improves with the intervention of ICT? This question still needs to be answered with fresh evidence on the association of ICT and NIM.

It is well confirmed from the above discussion that ICT has a vital role to play in banking. Many recent studies such as JH Coun et al. (2022), Entele (2021), Adane et al. (2021), Chhaidar et al. (2022), Wen et al. (2021), Del Gaudio et al. (2021), Sanga and Aziakpono (2022) and Wang et al. (2021) have advocated that implementation of ICT is beneficial for a bank's profitability. This situation might be because it helps improve employees' work efficiency and reduces costs (Entele 2021). However, Adeabah et al. (2021) and Chhaidar et al. (2022)

point out that the significant positive impact of ICT on profitability is for a particular point in the variable range, beyond which the quantum of change decreases. Saedun and Mohamed (2017) and Barpanda and Athira (2022) argue that ICT cannot be helpful for any organization if it is only focused on infrastructure. Learning outcomes of employees and users are equally essential results of cost-cutting, and the conflicting role of ICT in profitability should be further explored. ICT adoption and NIM in banks are not extensively studied, particularly the banking. Found also found several studies on variables studied as a proxy for ICT and bank profitability in China, the US, and the EU. However, limited studies are available on the subject in the Indian context. Hence, the following null hypotheses are assumed.

This paper tests the below null hypotheses:

H_1: *ICT does not impact the Net Interest Margin.*

H_2: *Square of ICT (for quadratic relationship) does not impact the profitability of the banks.*

The asset classes that generate income for the banks and the other financial institutions should have a higher share in the entire asset allocation mix in the bank's portfolio. Many assets often turn non-performing, classified as NPA (Joseph and Prakash 2014; Kiran and Jones 2016). It does not generate any profit. Therefore, portfolio allocation and proper customer scrutiny play a crucial role. Das and Uppal (2021) argue that NPA reduces banks' profitability. Gaur and Mohapatra (2021) indicate a negative association of NPA with profitability. Manu and Maheshwari (2018) found mixed results on the association between NPA and profitability in banks in India. As it is observed in earlier studies that NPA negatively impacts profitability, it would be worthwhile to examine the ICT's impact on banks' profitability under the effect of NPA. Thus, the following null hypothesis is assumed for investigation.

H_3: *Interaction between ICT and Net Non-Performing Assets do not impact Net Interest Margin.*

Conceptual Model

This paper studies the ICT's impact on profitability (NIM). The expenditure on ICT by the banks has been taken as the proxy for Information and Communication Technology. This approach is taken as the primary explanatory variable. Net Interest Margin is a component of profit that we wish to study. ICT is the independent variable. The NPA is considered the moderator of the impact of ICT on profitability. Therefore, our conceptual model under study is shown in the Figure 1 below:

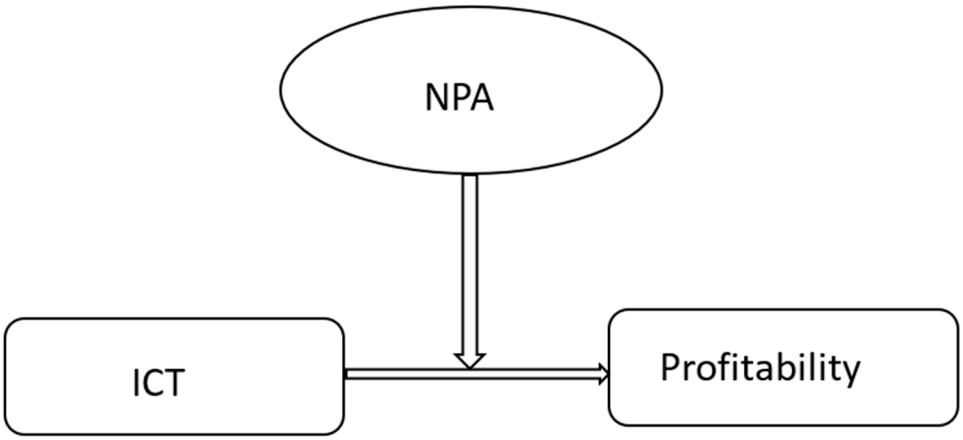

Figure 1. Conceptual Model. Note: ICT stands for Information and Communication Technology and is an independent variable. NPA stands for Non-Performing Assets and is a moderator. A firm's profitability is determined by its expenses and revenue. An effective business will generate higher revenue and keep expenses lower. ***Source*****:** *Author's compilation.*

3. Sample Data and Methodology

3.1. Sample Data

The sample used in the current study covers 33 commercial banks working in the Indian economy. We have considered only commercial banks in the sample due to their more extensive coverage of India's banking system. These include 21 private banks and 12 public sector banks. Moreover, only 33 banks were selected because adequate data in synchronization for balanced panel data was unavailable. However, these 33 banks capture the majority of the baking system in India. Hence, the sample is believed to provide enough insights into Indian banking (Kanoujiya and Rastogi 2022). These numbers have been extracted from the RBI's official website, where the Total number of banks is systematically classified into different categories. We have picked only the commercial banks (both private and public sector banks (RBI 2023)).

The data will be examined for the 10-year study period (2010 to 2019). The reason behind using the secondary data of all these major banks is the need for data required for the analysis, which involves using a reasonably large sample size to obtain infallible outcomes. Data after 2019 is not included in the sample due to missing information or data due to the COVID-19 pandemic. The data has been retrieved from the CMIE Prowess database. For deeper detail of each aspect involved in the study, please refer to Table 1, in which we have briefly discussed the variables mainly used in the study's analysis.

Table 1. List of Variables.

SN	Variable	Type	Code	Definition	Citations
1	Net Interest Margin	DV	NIM	The percentage of net interest earned compared to interest outflow of a bank.	Nariswari and Nugraha (2020), Mahdi and Khaddafi (2020)
2	Information and Communication Technology	IV	ICT	The term for integrating telecommunication and computer medium mediates hardware and software. It is the expenditure on ICT by banks (in INR). The natural log value is taken.	Sarkar (2012), Adeabah et al. (2021)
3	Non-performing assets	IV	NPA	It is an advance bank given for which interest or principal payments are overdue for 90 days or more.	Joseph and Prakash (2014), Kiran and Jones (2016)
4	Sales	CV	Ln_salescr	An indicator of revenue brought in by banks (in INR).	Sanya and Wolfe (2011), Kosach et al. (2019)
5	Assets	CV	Ln_assetscr	The investments in various asset classes by investing team of banks (in INR).	Wagner (2007), Narula and Singla (2014)

***Note*:** DV is the proxy of banks' profitability in India, and IV is the proxy of Information & Communication Technology (ICT). INR is short for Indian. ***Source*:** *Author's compilation.*

3.2. Methodology

The panel data model (PDM) has been employed in this study to assess the variables and generate reliable results. As per Hsiao (2007) and Baltagi (2008), the PDM depicts not only cross-sectional but also time-series features, which means that, in comparison to the cross-section analysis or using only time-series in the study, PDM provides comparatively more information. Hence, PDM is less biased on estimates. PDM has fewer chance of endogeneity issues. However, if significant endogeneity issues exist in PDM, it has better alternatives to deal with them (Baltagi 2008; Wooldridge 2015). For instance, in the current study, there is a significant endogeneity issue; hence, instrumental regression (IVreg) is

used to test the hypothesis. Thus, this is the primary reason for using PDM in the current analysis. The model specifications are given as follows:

$$NIMit = \beta0 + \beta1\ ICT + \beta2\ ln\_Sales + \beta3\ ln\_Assets + uit \quad (1)$$

$$NIMit = \beta0 + \beta1\ DICT + \beta1\ DICT2 + \beta3\ ln\_Sales + \beta4\ ln\_Assets + uit \quad (2)$$

$$NIMit = \beta0 + \beta1\ DICT + \beta1\ DNETNPA + \beta1\ DICT\_DNETNPA + \beta4\ ln\_Sales + \beta5\ ln\_Assets + uit \quad (3)$$

NIM is the study's dependent variable and stands for net interest margin (proxy of profitability). Further, β0 stands for the constant term. ICT is the independent variable which is short for information and communication technology. Equation (1) specifies the base model (Model 1) for a linear relationship, and the quadratic model is specified in Equation (2) for the nonlinear association. Equation (3) is associated with the interaction model (Model 3). Prefix 'D' is the for the demean value of the variable. The moderating variable used in the analysis is net NPA, which is short for net non-performing assets. Further, two control variables, i.e., sales and assets, have been put in the models to have the perfect fit model (Baltagi 2008; Wooldridge 2015). Lastly, it is considered an error term in the equation.

The current study includes only one dependent (NIM), one independent variable (ICT), and one moderating variable (NET NPA) in this study. A total of three models have been developed to analyze the problem, each for testing the base association, quadratic relationship, and interaction effect between ICT and profitability.

4. Results

4.1. Descriptive Analysis and Correlation Matrix Table

Table 2 lists the descriptive statistics and correlation coefficients for the survey's variables. The overall value of ICT is calculated to be 4.54, with SD 1.66. It shows the moderate or regular amount of expenditure that has been performed on the ICT sources by the banks working in India for the efficient and smooth working of our economy. Lastly, the mean value of net NPA 3.015 is low, and the SD value of 2.71 shows the minute amount of deviation from the average value of the moderating variable.

Table 2. Descriptive Statistics and Correlation Matrix.

	Correlation Matrix					
	lnICT	**lnICT_lnNPA**	**Ln_sales**	**ln_asset**	**Mean**	**SD**
lnICT	1				4.540	1.66
lnICT_lnNPA	0.3524 *	1			-	-
Ln_sales	0.9963 *	0.2920 *	1		8.74	1.61
ln_asset	0.8393 *	0.2700 *	0.8420 *	1	11.75	1.40

Note: * shows a significant value at a 5% significance level. The table shows the computed correlation values. ***Source*:** *Author's compilation.*

The independent variable (ICT) correlates significantly with the correlation matrix's moderating and control variables (dnetnpa, sales, assets). However, the significant correlation has a value of less than 0.80. Hence, the issue of multicollinearity is restrained among all the variables in the study (Baltagi 2008).

4.2. Regression Analysis

Results of Model

In Model 1, a static base relationship between the dependent variable (NIM) and independent variable (ICT) has been perceived. The result of the analysis is delineated in Table 3. For random effects, the BP test has been used. The study shows insignificant as the figure is more than 0.05, prompting the Hausman test. The Hausman test emerges to be significant. Therefore, the model shows congruity with E.

Table 3. Results of Regression Analysis (Model 1) (Fixed Effect Model).

DV: NIM						
	Model 1		**Model 2**		**Model 3**	
Variable Name	**Coefficient**	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**
Constant	−234.60 *	129.24	6.236 **	3.287	2.417 ***	0.3492
lnICT	−56.58 *	30.705	-	-	-	-
DICT2	-	-	5.39×10^{-7}	6.31×10^{-7}	-	-
lnNPA	-	-	-	-	-	-
lnICT_lnNPA	-	-	-	-	−0.126 ***	0.022
ln_sales	56.96 *	30.744	0.0477 *	0.2510	0.2954 ***	0.0409
Ln_assets	−0.341 ***	0.083	−0.3627	0.176	−0.1669 ***	0.0517
Part B (Model Estimates)						
R-Square	0.0008 *		0.0428 *		0.1231	
BP-Test	0.00 (1.00)		8.53 (0.0017) *		5.58 (0.0091) *	
Hausman Test	10.78 (0.0130) *		1.91 (0.3852)		13.26 (0.0210) *	
No observations (n)	300		300		300	

Note: * significant at 1%, ** significant at 5%, *** significant at 10%. The table shows the computed regression values. ***Source*****:** *Author's compilation.*

Furthermore, the Durbin chi-square and Wu-Hausman tests check endogeneity due to all models' main explanatory variables and the dependent variable. The lag three values are used in Instrumental variable regression to test endogeneity. The endogeneity in the model comes out to be significant (Table 4). Hence, there exists an endogeneity issue. Therefore, the IVreg regression models are used to test the hypotheses.

In Table 3, lnICT shows the negative coefficient value of −56.58 with *p*-values less than 0.065 (marginally significant) in Model 1. Hence, the result shows that ICT significantly and adversely affects banks' profitability in India.

A quadratic relationship has been investigated in Model 2. (see Table 3). The study shows that the BP test was conducted, and the results are noteworthy. Consequently, the Hausman test had a non-significant *p*-value. As a result, the model exhibits RE compatibility. In addition, the model's endogeneity comes out to be significant. In Table 3, DICT2 shows positive coefficient values with *p*-values over 0.100. Hence, the output clearly shows that the square term of ICT insignificantly impacts the profitability of banks working in India.

In Model 3, the moderating effect of NPA is analyzed on the association between ICT and NIM (proxy of profitability). The result of the analysis is displayed in Table 3. The BP test has been used for random effects, which turns out to be significant. However, the Hausman test valuation produced a significant *p*-value. The model, therefore, demonstrates FE compatibility.

Additionally, endogeneity has proven to be significant. The coefficient of lnICT_lnNPA is −0.126, with a significant *p*-value of 0.00, depicting that the moderating variable significantly and negatively affects the relationship between the dependent and independent variables. It further means that ICT adversely impacts profitability (NIM) in the case of higher NPA.

Table 4. Endogeneity.

DV: NIM			
	Model 1	**Model 2**	**Model 3**
Durbin Chi-square	13.657 (0.0002) *	5.409 (0.0200) *	4.697 (0.0302) *
Wu Hausman Test	14.069 (0.0002) *	5.416 (0.0206) *	4.692 (0.0311) *

***Note*:** The value in () is the *p*-value. * shows a significant value at a 5% significance level. The table represents the calculated endogeneity values. ***Source*:** *Author's compilation.*

4.3. Robustness Check

The robustness or reliability of the results obtained has been checked with the help of the multi-model approach (Kanoujiya and Rastogi 2022; Gautam et al. 2022). Most models show similar results, indicating that ICT significantly impacts banks' profitability in India. Hence, the similarity of the results ensures robustness.

5. Discussion

This study demonstrates that the H1 and H3-related null hypotheses are untrue. H2 has a piece of evidence that cannot be disregarded. The mean square of ICT has little effect on the bank's profitability. ICT significantly influences Net Interest Margin, and ICT and Net Non-Performing Assets impact the Net Interest Margin significantly. The current findings are on the expected lines that ICT cuts the bank's profitability. Inferred from the moderating effect of NPA is that ICT reduces bank profitability. This situation could result from ICT offering simple credit services, leading to future NPA.

This study does not concur with the ICT and profitability studies by Wang et al. (2021) in China, Del Gaudio et al. (2021) in the EU, Scott et al. (2017) in the EU and US, and Wen et al. (2021) and Sanga and Aziakpono (2022) in the banking sector. They advocate that ICT enhances profitability. However, Adeabah et al. (2021) and Chhaidar et al. (2022) point out that the significant positive impact of ICT on profitability is for a particular point in the variable range, beyond which the quantum of change decreases. Moreover, Saedun and Mohamed (2017) and Barpanda and Athira (2022) argue that ICT only in terms of infrastructure cannot be fruitful for any organization to earn profit. Its learning for users and employees is also essential.

Before the introduction of ICT in banks, the profitability movement in banks requires a study and a comparison to effectively measure the role of ICT on profitability. None of the previous studies that we assessed make this comparison. At a broader level, it can be interpreted that investments in employee skills building via ICT help banks increase their profits by avoiding penalties or boosting efficiency, and improving the quality of income streams to the banks.

The current study argues that the penalties on banks eat up a significant portion of the profits, and it can be avoided with proper employee education through ICT. However, a study by Köster and Pelster (2017) concludes by studying 671 incidents on 68 international banks from 2007 to 2014 that the penalties significantly increase profits. The rationale quoted is that penalties reduce tax liability and that the benefits generated by non-compliance outweigh the fines. However, we strongly disagree with this 'statistical' advocacy since statistical inferences are impractical. Not taking any action to mitigate, if not avoid, the penalty can put the bank at risk of losing the banking licenses. There are instances where regulators have given ultimatums to international banks to invest in employee education and avoid human errors, or they lose the license to a bank in the United States called Deferred Prosecution Agreement, a corrective action by regulators.

This paper adds a new body of knowledge about ICT and the interrelationship between the banks' Net Profit Margin and Non-Performing Assets. Zhou and Wong (2008) have studied the determinants of NPM. Our study further does the empirical analysis using NPP and ICT. The findings on banks can be generalized to any FI—financial institution—and NBFI—Non-Banking Financial Institution—about the role of ICT on the organization's profits. People are the biggest asset to any organization. They are the pillars that support

any organization. Therefore, investment in people and their development should be the key priority of people managers, ultimately benefiting the banks.

ICT and Its Relevance for Banks Post-COVID

Various studies (Del Gaudio et al. 2021; Phan et al. 2020; Jardak and Ben Hamad 2022) empirically explore the impact of ICT on the banks' profitability in the pre-COVID era. Few studies from the pre-COVID-19 period concluded that ICT impacts a bank's profitability, and the bank's size also plays a role. Studies like that of Doran et al. (2022) have an overlapping sample that does not compare the pre-COVID-19 and post-COVID-19 performance as a primary objective but as a periodic change.

The profit components, ROE—Return on Equity—and NIM—Net Interest Margin—are adversely impacted post-COVID-19 compared to the global financial crisis period. Technology played a pivotal role in the pandemic (Ramlall 2023). A similar study that included samples for a brief post-pandemic period 2020–2021 used ROE and ROA—Return on Assets—to evaluate the bank's performance. It also shows that digitalization helped banks to stay profitable (Doran et al. 2022).

Banks operate in an environment surrounded by various risks. Failure to address the risks, such as liquidity risks, can collapse an entire bank and give significant shocks to the other players in the sector. The recent collapse of a 40-year-old major bank, funding start-ups in the US, and the troubles of a 169-year-old Swiss giant highlight the importance of handling various operational risks in the banks effectively. According to Yan et al. 2023, systemic risk is an inherent risk contributing to the industry's failure in a particular market. During the pandemic, this risk increased significantly for the banking industry, and this study proposed policy changes to adopt digitalization (Yan et al. 2023). To avoid these risks, banks must forecast different parameters such as forex reserves, monitor different statutory ratios, and predict liquidity position requirements under different circumstances. With the growing complexities and globalization in the banking system, deploying smart tools to make accurate predictions becomes essential. In this direction, Von Solms et al. (2021) conducted a study post-COVID-19. Their findings suggest that banks invest heavily in digitalization to deal with risks inherent in treasury, risk, and finance departments. Banks rely on new-age technologies such as artificial intelligence, analytics, robotics, and machine learning to prepare themselves to stay unshaken by calamities such as COVID-19 or the financial crisis.

A 'pre- and post-COVID-19' effects study on European banking compares the impact of ICT on the banks' profitability. The comparison between pre-COVID-19 and post-COVID-19 profitability shows that the investments in ICT reduced the risk and generated more profit in the post-COVID-19 period (Cicchiello et al. 2021). Advertising is a means to educate a firm's customers about the firm's values and vision. Let us take advertising spending as a proxy for investment in ICT. A study by Albuquerque et al. (2020) shows that, during COVID-19, the firms which portrayed their social commitment via ICT continued to perform better in the stock markets, and it helped them stay profitable. A study by Saleh (2021) acknowledges that the study participants, who were running home-based businesses, benefitted from the bank's online facilities during COVID-19. This situation testifies to the importance of technology in the banks.

It is not only the banks that are after technology and digitalization. Big technology players are also keen on entering the financial space. They know that technology is their strength and that they can add value and be pivotal in either making or breaking the banks' legacy. Credit Kudos is a UK-based start-up. It has tie-ups with banks in the UK to leverage the Open Banking framework. Apple, a technology giant, acquired Credit Kudos in March 2022 (post-COVID-19 period). It will further boost the digitalization efforts in the banking and financial sector.

In the Indian context, Jayaraman and Makun (2022) studied the impact of ICT on the inflow of bank remittances, analyzing the post-COVID-19 period sample. Remittances bring in revenue through fees to the banks. They have implications for the profitability of the banks. Banks are indeed using ICT in the post-COVID-19 era, as evident from the transformation programs such as ISO20022 mandated by the various central bank regulators and global bodies such as SWIFT and ISO. All banks globally involved in cross-border payments must comply with these regulations by November 2022. As part of these mandates, several online learning modules are created by banks and regulators to train employees involved in the payments, clearing, and settlement of domestic and cross-border remittances. This situation is a significant investment in ICT which banks continue to make post-COVID-19. Though this investment will not immediately contribute to the banks' profitability, it is a revolutionary step in global banking. It will reduce the manual processing efforts in the banks. Faster settlement contributes to increased volume, and straight-through processing implies lower processing costs to the banks and customers. In addition, cost reduction is a crucial contributor to banks' profitability. A study by Cazachevici et al. (2020) proves that remittances stimulate economic growth in Asia. The efficiency, speed, and last-mile connectivity via domestic transactions, and not just remittances, are also critical in the bank's digitalization journey. UPI adoption by advanced foreign countries such as Singapore and UAE highlights the importance of this technology to banks, governments, and the people globally.

In India, post-COVID-19, in September 2022, the Reserve Bank of India and NPCI—National Payments Corporation of India—launched "UPI Lite." Rich literature is available on UPI as a concept, but very scanty literature is available on 'UPI lite' as a feature since it is a recent disruption in digitalization. With this feature, customers will be able to make low-value transactions even when they are offline. This step is a revolutionary step. Eight public and private banks in India have invested and adopted this change quickly. Though the feature will be provided via BHIM App (non-bank app), banks must also make significant infrastructure changes to adhere to the regulators' statement and balance reporting guidelines. In the first six months, the adoption rate is 16% in the public and private banks (i.e., 8 out of the 27 public and 21 private banks) as of March 2023. UPI is an indirect source of revenue for banks and contributes to banks' profits, not just that of payment wallets.

A systematic literature review of 143 relevant papers, filtered down to 40 highly relevant papers (Indriasari et al. 2022), concludes that banks must invest in digitalization post-COVID to serve customers better and, thus, improve their profitability. It also recommends introducing new technologies in the bank. To keep bank staff at par with the changing technology, banks must also invest in their employee learning via ICT to avoid manual errors due to an unskilled workforce.

Ed-techs-institutions providing education using technology are mushrooming across the globe. Financial institutions and banks are at the forefront of collaborating with these ed-techs to upskill their employees and ultimately empower themselves and the employees. Post-COVID-19, banks continue to collaborate with platforms such as Coursera and LinkedIn learning to educate employees via ICT. This investment is in addition to their in-house learning platforms, which are also continuously evolving. The ed-tech platforms also collaborate with globally reputed educational institutions to provide online education and degrees to bank employees worldwide.

Banks adopting FinTech either by partnering with existing technology players or setting up their technology centers indicate that banks do not want to stay behind the competition. It also shows that, by using technology, banks are taking measures to address the threats in their path to profitability and, eventually, to their existence. Furthermore, it can be concluded that digitalization and its by-product ICT, in banking, is spreading worldwide like wildfire in their battle to sustain and flourish, especially post-COVID-19.

6. Conclusions

Technological advancement plays a vital role in the modern banking system. This study examines the ICT's impact on banks' profitability in India. Through the empirical investigation, it can thus be concluded that ICT significantly impacts the profitability of banks in India and that the Net of Non-Performing Assets significantly impacts the ICT and profitability of the banks. It implies that the importance of ICT cannot be ignored in organizations, even if it is not a technological firm. The current study significantly contributes to related literature in banking through its novel evidence on the association between ICT and profitability.

The findings also give important implications to all stakeholders, including managers, investors, and policymakers, that ICT should be treated critically for a bank's profitability in India. Thus, findings have considerable policy implications for concerned stakeholders. The influential stakeholders in the decision-making should give due importance to ICT in boosting the quality of assets and sales by continuing to invest in employee education related to sales processes, developing products, building strong asset classes, and minimizing the NPAs. The findings signal to policymakers that ICT helps the bank maintain transparency, accountability, and even the reach of financial services increases. This situation, again, leads to the enhancement of the country's economy. Hence, ICT should be given an important place in policy designs.

This study has the limitation of its scope in Indian banking. However, we believe the current findings provide insights into the banking system in other economies. This study is performed on the sample period until 2019 due to missing data during COVID-19 and later. Future studies may consider the data from 2019 onwards (per the data availability) in a similar model. The undesirable event of the COVID-19 pandemic also requires an event-based study comparing ICT's pre- and post-pandemic effects on profitability. Other variants of profitability should be investigated in future studies. From a methodological perspective, GMM (generalized method of moments) can be applied in future studies. Banks in other economies should be investigated for such associations.

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Appendix A

Table A1. Literature Review summary of important studies.

S. No.	Reference	Country	Findings
1	JH Coun et al. (2022).	Dutch	ICT improves profitability
2	Entele (2021)	World	ICT improves profitability
3	Adane et al. (2021)	Ethiopian	ICT improves profitability
4	Wang et al. (2021)	China	ICT improves profitability
5	Zhu et al. (2021)	China	ICT improves profitability
6	Del Gaudio et al. (2021)	European Union	ICT improves profitability
7	Scott et al. (2017)	European and American banks	ICT improves profitability
8	Barpanda and Athira (2022)	India	ICT does not affect profitability
9	Adeabah et al. (2021)	Worldwide	ICT impacts profitability
10	Sanga and Aziakpono (2022)	Africa	ICT improves profitability

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