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IMPACT OF DIGITAL BANKING TRANSFORMATION ON BANK PROFITABILITY AND EFFICIENCY AN EMPIRICAL PANEL ANALYSIS OF SELECTED INDIAN BANKS

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ABSTRACT

This study examines the relationship between digital banking transformation and profitability and operating efficiency among ten selected Indian commercial banks over FY2020–21 to FY2024–25. The empirical framework uses a report-based Digital Banking Transformation Index (DBTI), together with Return on Assets (ROA), Return on Equity (ROE), Cost-to-Income Ratio (CIR), Net Interest Margin (NIM), Capital Adequacy Ratio (CRAR), Net NPA, bank size and loan growth. The panel contains 50 bank-year observations; the regression sample contains 40 observations because loan growth requires the preceding year's advances. Pearson correlation, VIF, fixed-effects (FE), random-effects (RE) and Hausman specification tests are applied. The bivariate results show positive associations between DBTI and ROA/ROE and a negative association with CIR. However, after controlling for bank and year effects, the FE estimates do not show statistically significant DBTI coefficients for ROA, ROE or CIR. The Hausman tests favour the FE specification for all three dependent variables. This suggests that observed cross-bank digitalisation differences should not be interpreted as causal evidence of improved profitability or efficiency. A key methodological contribution is the explicit separation of bank-reported financial indicators from the researcher-coded DBTI proxy.

KEYWORDS: Digital Banking; Digital Transformation; Bank Profitability; Bank Efficiency; ROA; ROE; Cost-to-Income Ratio; NIM; Indian Banks.

1. INTRODUCTION

Digital banking has become a central component of the Indian financial system. Mobile banking, internet banking, UPI, digital lending, APIs, artificial intelligence and automated customer journeys have changed the way banks acquire customers, process transactions and deliver financial services. RBI research covering 29 public and private sector banks during 2015–2023 found that digitalisation was positively associated with both cost and technical efficiency. The wider Indian payment ecosystem has also experienced rapid digitalisation. RBI reported that the share of digital transactions in the volume of non-cash retail payments reached 99.8% in 2023–24, while the RBI Digital Payments Index rose to 445.50 in March 2024. Against this background, this study investigates whether digital transformation is reflected in bank profitability and operating efficiency, while controlling for bank-specific characteristics.

2. Review of Literature

Vives (2019) argued that digital technologies are reshaping banking competition, business models and service delivery. Choudhury and Ghosh (2018) reported that technology expenditure does not necessarily translate immediately into higher profitability, highlighting the possibility of a technology-investment profitability paradox. He, Ho and Xu (2020) found that online-channel adoption could improve profit efficiency but could also create cost and risk implications. RBI's recent empirical analysis of 29 Indian banks provides evidence that digitalisation increases bank efficiency. The literature therefore supports a positive efficiency mechanism while also suggesting that the profitability effect may depend on scale, technology investment, and management capability and implementation quality.

3. Research Gap

Existing studies often use a single digitalisation measure, such as digital-payment volume or technology expenditure. Fewer studies simultaneously examine profitability and operating efficiency using ROA, ROE and CIR over a recent five-year period for a mixed public- and private-sector Indian bank sample. The present study addresses this gap by combining a report-based DBTI with conventional bank-performance indicators and panel-data methods.

4. Objectives

1. To measure the extent of digital banking transformation among selected Indian banks.
2. To examine the relationship between digital banking transformation and ROA and ROE.

3. To assess whether digital transformation is associated with operating efficiency measured by CIR.
4. To examine the role of bank size, loan growth, Net NPA and CRAR as control variables.
5. To compare pooled associations with bank- and year-controlled panel estimates.

5. Hypotheses

1. H1: Digital banking transformation is positively associated with ROA.
2. H2: Digital banking transformation is positively associated with ROE.
3. H3: Digital banking transformation is negatively associated with the Cost-to-Income Ratio.

6. Sample and Data

The sample comprises State Bank of India, HDFC Bank, ICICI Bank, Axis Bank, Kotak Mahindra Bank, IndusInd Bank, Bank of Baroda, Punjab National Bank, Canara Bank and Union Bank of India. The study period is FY2020–21 to FY2024–25. Financial ratios and balance-sheet variables are compiled from annual-report and official-result disclosures. For example, Axis Bank's FY2024–25 report provides five-year total assets and advances, while HDFC Bank's annual reporting provides five-year financial highlights and digital-transaction indicators. SBI's FY2024–25 presentation reports more than 98% of transactions through alternate channels and FY2025 ROA of 1.10%, ROE of 19.87% and NIM of 3.09%. The DBTI is a researcher-coded proxy based on annual-report disclosures of digital channels, digital transactions, digital acquisition/service journeys, mobile/internet banking, APIs/AI and other technology-enabled banking capabilities. It is not a bank-reported accounting statistic. This distinction must be retained in the final journal manuscript.

7. Variable Measurement

Variable	Measurement
DBTI	Researcher-coded 0–100 report-based digital transformation index
ROA	Return on Average Assets (%)
ROE	Return on Equity (%)
CIR	Operating/Cost-to-Income Ratio (%)
NIM	Net Interest Margin (%)
CRAR	Capital to Risk-Weighted Assets Ratio (%)
Net NPA	Net Non-Performing Assets Ratio (%)
Bank Size	Natural logarithm of total assets
Loan Growth	Year-on-year growth in advances (%)

8. Empirical Dataset

Bank	Year	DBTI	ROA	ROE	CIR	NIM	CRAR	Net NPA	Log Assets	Loan Growth
State Bank of India	2020-21	72	0.38	7.74	52.46	2.75	13.74	1.50	15.190	
State Bank of India	2021-22	76	0.48	9.94	53.60	2.86	13.83	1.02	15.327	5.34
State Bank of India	2022-23	82	0.67	13.92	53.31	3.05	13.70	0.67	15.422	11.61
State Bank of India	2023-24	88	0.96	19.43	53.87	3.28	13.54	0.57	15.523	17.02
State Bank of India	2024-25	92	1.10	19.87	54.20	3.09	14.25	0.47	15.637	15.78
HDFC Bank	2020-21	84	1.84	16.60	42.00	4.20	19.10	0.40	14.373	
HDFC Bank	2021-22	88	1.88	16.90	36.90	4.40	19.00	0.32	14.542	20.83
HDFC Bank	2022-23	91	2.03	17.39	40.40	4.30	19.30	0.27	14.718	16.93
HDFC Bank	2023-24	95	1.98	16.10	40.20	3.40	18.80	0.33	15.101	55.25
HDFC Bank	2024-25	97	1.91	14.56	40.50	3.48	19.40	0.43	15.179	7.51
ICICI Bank	2020-21	78	1.40	12.30	45.80	3.96	18.35	1.14	14.271	
ICICI Bank	2021-22	83	1.80	14.70	43.90	4.00	19.16	0.76	14.379	24.50
ICICI Bank	2022-23	88	2.16	17.28	42.00	4.48	18.34	0.48	14.490	18.70
ICICI Bank	2023-24	92	2.37	18.71	40.23	4.53	16.33	0.42	14.678	16.16
ICICI Bank	2024-25	95	2.40	18.71	39.10	4.45	16.55	0.39	14.789	13.29
Axis Bank	2020-21	70	0.70	7.55	52.60	3.44	19.12	1.05	13.802	
Axis Bank	2021-22	76	1.21	12.91	50.20	3.56	18.54	0.73	13.977	15.23
Axis Bank	2022-23	82	1.82	18.38	47.80	3.97	17.64	0.39	14.091	19.40
Axis Bank	2023-24	88	1.83	18.86	47.70	4.04	16.63	0.31	14.206	14.17
Axis Bank	2024-25	94	1.74	16.52	48.00	3.97	17.07	0.33	14.292	7.85
Kotak Mahindra Bank	2020-21	68	2.20	12.80	45.00	4.50	23.40	1.20	13.079	
Kotak Mahindra Bank	2021-22	73	2.40	13.40	42.00	4.70	23.70	0.70	13.211	20.74
Kotak Mahindra Bank	2022-23	79	2.60	14.40	41.00	5.40	23.30	0.40	13.338	17.94
Kotak Mahindra Bank	2023-24	86	2.70	15.10	46.00	5.30	21.80	0.40	13.551	19.84
Kotak Mahindra Bank	2024-25	92	2.70	15.20	43.00	5.00	23.30	0.31	13.687	12.97
IndusInd Bank	2020-21	62	1.10	9.80	48.00	4.20	18.46	2.67	12.860	
IndusInd Bank	2021-22	68	1.20	10.60	45.00	4.00	18.01	2.35	12.927	8.37
IndusInd Bank	2022-23	75	1.28	10.20	43.00	4.11	17.86	1.98	13.070	22.73
IndusInd Bank	2023-24	82	1.90	15.32	42.00	4.28	17.23	1.38	13.152	12.59
IndusInd Bank	2024-25	87	0.50	4.17	48.00	4.10	16.24	0.95	13.190	8.55
Bank of Baroda	2020-21	60	0.07	1.07	55.00	2.49	14.99	3.09	13.844	
Bank of Baroda	2021-22	67	0.56	8.46	52.00	2.55	15.84	1.72	13.937	9.15
Bank of Baroda	2022-23	74	0.96	14.36	49.00	2.83	16.24	0.89	14.023	16.13
Bank of Baroda	2023-24	83	1.17	18.95	47.71	3.18	16.31	0.68	14.173	19.44
Bank of Baroda	2024-25	90	1.16	16.96	47.94	3.02	17.19	0.58	14.273	12.79
Punjab National Bank	2020-21	55	-1.14	-12.80	63.00	2.78	14.91	4.75	14.047	
Punjab National Bank	2021-22	63	0.14	1.80	61.00	2.87	14.76	4.80	14.089	6.18
Punjab National Bank	2022-23	71	0.51	7.00	57.00	3.15	15.15	2.72	14.195	12.68
Punjab National Bank	2023-24	82	0.78	12.50	54.00	3.18	15.09	2.96	14.261	11.15
Punjab National Bank	2024-25	89	1.02	16.10	51.00	3.00	17.01	0.40	14.398	9.83
Canara Bank	2020-21	58	0.23	5.01	59.00	2.52	13.18	3.82	13.981	
Canara Bank	2021-22	65	0.48	8.96	56.00	2.60	14.90	2.65	14.046	9.22
Canara Bank	2022-23	73	0.81	17.14	52.00	2.75	16.68	1.73	14.138	16.88
Canara Bank	2023-24	81	1.01	20.22	49.00	2.90	16.28	1.27	14.244	16.67
Canara Bank	2024-25	89	1.09	18.22	48.00	2.80	16.33	0.70	14.364	15.48

Union Bank of India	2020-21	56	-0.12	2.40	62.70	2.64	13.42	3.68	13.835	
Union Bank of India	2021-22	63	0.58	10.20	60.70	2.82	13.64	2.70	13.911	10.77
Union Bank of India	2022-23	71	0.84	14.60	58.70	3.09	14.45	1.62	13.998	13.89
Union Bank of India	2023-24	80	0.69	13.26	57.00	3.24	15.03	1.03	14.078	12.20
Union Bank of India	2024-25	88	1.26	17.20	54.50	3.05	16.33	0.63	14.152	14.13

9. Descriptive Statistics

Variable	N	Mean	Std. Dev.	Minimum	Maximum
DBTI	40	81.950	9.484	63.000	97.000
ROA	40	1.367	0.713	0.140	2.700
ROE	40	14.463	4.285	1.800	20.220
CIR	40	48.437	6.398	36.900	61.000
NIM	40	3.619	0.775	2.550	5.400
CRAR	40	17.119	2.582	13.540	23.700
Net_NPA	40	1.086	0.986	0.270	4.800
Log_Assets	40	14.219	0.665	12.927	15.637
Loan_Growth	40	15.247	7.963	5.342	55.247

10. Correlation Analysis

Variable vs DBTI	Pearson r	p-value
ROA	0.570	0.0001
ROE	0.656	0.0000
CIR	-0.568	0.0001
NIM	0.368	0.0196
CRAR	0.254	0.1133
Net_NPA	-0.772	0.0000

The bivariate results show positive and statistically significant associations between DBTI and ROA, ROE and NIM, and a negative association with CIR and Net NPA. Because the DBTI scores and several bank outcomes trend over time and differ systematically across bank types, these bivariate relationships should not be interpreted as causal effects.

11. Multicollinearity – VIF

Regressor	VIF
DBTI	2.960
Log_Assets	2.193
Loan_Growth	1.243
Net_NPA	2.899
CRAR	2.229

All reported VIF values are below 5, indicating that severe multicollinearity is not evident in the working specification.

12. Fixed-Effects, Random-Effects and Hausman Tests

ROA model: Hausman $\chi^2(5) = 59.665$, $p = 0.0000$. The test favours the Fixed-Effects specification at the 5% level.

ROE model: Hausman $\chi^2(5) = 14.329$, $p = 0.0137$. The test favours the Fixed-Effects specification at the 5% level.

CIR model: Hausman $\chi^2(5) = 23.568$, $p = 0.0003$. The test favours the Fixed-Effects specification at the 5% level.

Dependent Variable	Hausman χ^2	df	p-value	Selected model
ROA	59.665	5	0.0000	Fixed Effects
ROE	14.329	5	0.0137	Fixed Effects
CIR	23.568	5	0.0003	Fixed Effects

13. Fixed-Effects Regression Results

Dependent	Regressor	Coefficient	Robust SE	p-value
ROA	DBTI	0.0150	0.0285	0.5989
ROA	Log_Assets	0.2259	1.2504	0.8567
ROA	Loan_Growth	-0.0027	0.0074	0.7200
ROA	Net_NPA	0.0000	0.1016	0.9998
ROA	CRAR	0.0898	0.1142	0.4319
ROE	DBTI	-0.0554	0.3083	0.8575
ROE	Log_Assets	-11.1572	12.5407	0.3736
ROE	Loan_Growth	0.0160	0.0759	0.8334
ROE	Net_NPA	-0.8026	1.1323	0.4784
ROE	CRAR	1.6556	1.0728	0.1228
CIR	DBTI	-0.1915	0.2913	0.5109
CIR	Log_Assets	1.3328	9.5903	0.8895
CIR	Loan_Growth	0.0214	0.0438	0.6248
CIR	Net_NPA	1.4250	0.6867	0.0380
CIR	CRAR	-0.5480	0.8025	0.4947

Model R^2 values are 0.929 for ROA, 0.803 for ROE and 0.949 for CIR. In the FE specification, DBTI is not statistically significant for ROA (β=0.0150, p=0.5989), ROE (β=-0.0554, p=0.8575) or CIR (β=-0.1915, p=0.5109).

14. Interpretation of Findings

The correlation analysis initially suggests that banks with higher digital-transformation scores also report stronger profitability and lower cost-to-income ratios. However, the fixed-effects estimates are more informative for this panel because they control for time-invariant bank characteristics and year effects. Once these effects are controlled, the DBTI coefficients become statistically insignificant. The result indicates that the strong raw associations may

partly reflect persistent differences between banks and common changes in the Indian banking environment rather than a direct within-bank causal effect of digital transformation.

The RBI's independent evidence that digitalisation increased efficiency among 29 Indian banks provides contextual support for a positive efficiency mechanism, but it does not establish that the DBTI coefficient in this study is causal.

15. Robustness and Data-Integrity Notes

The DBTI is a researcher-coded disclosure proxy and should not be described as an externally published bank-level digitalisation score.

The final submission should include the annual-report page number supporting each DBTI component for every bank-year.

Financial variables should be reconciled against the audited standalone banking entity figures before submission.

FY2020–21 loan growth is unavailable because FY2019–20 advances are outside the specified study window; therefore regression analysis uses FY2021–22 to FY2024–25.

The Hausman results are based on the working FE/RE implementation and should be independently reproduced in Stata/R/EViews before journal submission.

16. CONCLUSION

The study finds strong bivariate associations between digital banking transformation and selected measures of profitability and efficiency, but these associations are not sustained as statistically significant DBTI effects in the fixed-effects models. The evidence therefore supports a cautious conclusion: digital transformation is strongly associated with the changing performance profile of Indian banks, but the present five-year sample does not establish that digital transformation independently causes higher profitability or efficiency. A page-audited DBTI, bank-level digital transaction data and additional controls would strengthen the empirical contribution.

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