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DIGITAL PAYMENT ADOPTION AND ITS IMPACT ON PROFITABILITY IN INDIAN PUBLIC SECTOR BANKS A MACHINE LEARNING APPROACH

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ABSTRACT

The digital revolution has fundamentally transformed profitability paradigms in India's public sector banking sector, redefining payment platforms as strategic assets rather than operational necessities. This study investigates the differential impacts of digital payment adoption across transaction platforms using advanced machine learning techniques. Analysis reveals that while retail payment systems demonstrate strong profitability correlations, traditional institutional channels maintain unexpected significance in the digital era. The findings illuminate how digital infrastructures create value through distinct mechanisms – retail platforms driving volume-based efficiencies and institutional systems preserving high-margin operations. These insights challenge conventional banking frameworks by demonstrating payment systems' evolution into core profitability drivers. For financial institutions navigating India's digital transformation, the research provides critical strategic guidance on infrastructure investments and ecosystem development. The study contributes to emerging market banking literature by establishing a nuanced understanding of digital payment monetization and its implications for competitive positioning in increasingly platform-driven financial markets.

INTRODUCTION

The impact of digital banking and electronic payment systems on the financial performance of banks has been a subject of extensive research. The adoption of digital transactions, particularly UPI, RTGS, NEFT, IMPS, and mobile banking, has revolutionized banking operations, profitability, and financial stability. Several researchers have explored the relationship between digital transactions and key financial indicators such as Net Profit, Operating Profit, and Return on Assets (ROA).

Digital Transactions and Bank Profitability

The shift towards digital banking has significantly altered banks' revenue streams and cost structures. Sharma and Gupta (2020) found a strong positive correlation between digital transaction volumes and net profit margins in Indian public sector banks, citing operational efficiency and reduced transaction costs as key contributors. Similarly, Patel et al. (2021) analyzed real-time settlement systems such as RTGS and NEFT and concluded that improved liquidity management has directly contributed to enhanced ROA and Return on Equity (ROE). Mishra et al. (2019) further highlighted that digital transactions reduce dependency on physical branches, leading to lower overhead costs and higher profitability.

Ramesh and Iyer (2021) investigated the impact of UPI and IMPS transactions on financial stability and reported that banks with a high share of digital transactions demonstrated improved earnings consistency. This was supported by Bansal and Mehta (2022), who analyzed consumer behaviour trends and found that UPI transactions have grown exponentially, contributing significantly to banks' fee-based income and transaction revenues. Das et al. (2020) further emphasized that the adoption of digital transactions has allowed banks to expand their customer base, improving overall profitability.

Digital Banking and Operational Efficiency

The operational efficiency of banks has been greatly enhanced by digital banking innovations. Kumar and Rajan (2021) examined the cost reduction effects of mobile banking, IMPS, and UPI transactions, finding that banks with high digital penetration witnessed a 10-15% reduction in operational costs. Similarly, Mukherjee et al. (2022) analysed automation in digital payment processing and concluded that AI-driven payment validation has improved transaction accuracy, reducing reconciliation errors and fraud cases. Narayan et al. (2022) supported this by demonstrating that banks leveraging digital banking services experienced better resource allocation and enhanced cost efficiency.

Bank profitability is also linked to customer adoption of digital services. Srinivasan and Rao (2021) found that financial institutions with strong digital transaction infrastructure reported higher customer retention rates, leading to sustained revenue growth. This is consistent with the findings of Desai (2023), who examined the role of artificial intelligence in digital banking and concluded that AI-driven customer service solutions have enhanced user satisfaction and transaction frequency.

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Financial Inclusion and Digital Transactions
Digital banking has played a crucial role in promoting financial inclusion. Mishra and Sinha (2021) observed that digital transactions have expanded banking services to previously underserved rural areas, increasing account penetration and financial participation. Singh and Verma (2020) further noted that public sector banks have been able to maintain profitability while reaching a wider customer base due to digital banking adoption. Das and Mukhopadhyay (2023) emphasized that the availability of mobile banking and IMPS transactions has made banking more accessible, reducing dependency on traditional cash-based transactions.

Cybersecurity Risks and Regulatory Challenges
Despite its numerous benefits, digital banking also presents significant risks and regulatory challenges. Agarwal et al. (2021) highlighted that the growing reliance on digital transactions has led to an increase in cyber threats, necessitating investment in fraud detection and cybersecurity measures. Choudhury and Das (2022) discussed the complexities of real-time payment processing and customer data security, emphasizing the need for stricter regulatory frameworks. Singh et al. (2023) further examined the risks associated with AI-driven digital banking systems, highlighting concerns related to data privacy and transaction security.

Future of Digital Banking and Emerging Technologies
Emerging technologies are expected to further transform digital banking. Jain and Kapoor (2023) analysed the role of blockchain in banking transactions and found that decentralized ledger technologies have the potential to reduce settlement risks and enhance transparency. Desai (2023) examined AI-driven financial advisory systems, concluding that machine learning algorithms are improving risk assessment and fraud detection. Additionally, Rajan and Mehta (2023) explored the impact of robotic process automation (RPA) in banking and reported significant improvements in transaction speed and accuracy.

While prior research has extensively explored the benefits and risks of digital banking, there remains a gap in empirical analysis of its direct impact on key financial ratios such as Net Profit, Operating Profit, and ROA in Indian public sector banks. This study seeks to bridge this gap by investigating the correlation between digital transaction volumes and financial performance indicators in major public sector banks in India.

RESEARCH OBJECTIVES

1. To examine the correlation between digital transaction volumes (UPI and Mobile transactions) and banking profitability using multiple linear regression analysis.
2. To evaluate the predictive power of digital transactions in explaining Net Profit by analysing model fit metrics such as R-squared and Root Mean Squared Error (RMSE).
3. To assess variations in model accuracy across different profitability ranges and identify factors contributing to deviations in high-profit institutions.
4. To explore potential model limitations, including multicollinearity and heteroscedasticity, and suggest improvements for enhancing predictive accuracy.
5. To provide strategic insights for banking institutions on leveraging digital transaction platforms for sustainable profitability growth.

HYPOTHESES

H1: Correlation between Digital Transactions and Net Profit
- H_0: There is no significant correlation between digital transaction volumes (RTGS, NEFT, UPI, Mobile, IMPS) and Net Profit.
- H_1: There is a significant correlation between digital transaction volumes and Net Profit.

H2: Correlation between Digital Transactions and Operating Profit
- H_0: Digital transaction volumes (RTGS, NEFT, UPI, Mobile, IMPS) do not significantly correlate with Operating Profit.
- H_1: Digital transaction volumes significantly correlate with Operating Profit.

H3: Correlation between Digital Transactions and Return on Assets (ROA)
- H_0: Digital transactions do not have a significant correlation with Return on Assets (ROA).
- H_1: Digital transactions have a significant correlation with ROA.

RESEARCH METHODOLOGY

1. Research Design
This study employs a quantitative research approach to analyze the impact of digital transactions on bank profitability. The research is based on secondary data obtained from the National Payments Corporation of India (NPCI) and financial statements of banks.

2. Data Collection
- The data for this study has been sourced from:
- NPCI reports on digital transactions, including UPI and Mobile Banking usage.
- Annual reports and financial statements of selected banks.

3. Data Analysis Techniques
To assess the impact of digital transactions on bank profitability, the following statistical methods were employed:

a. Descriptive Statistics
- Summary measures such as mean, median, standard deviation, and variance were calculated for key financial and transaction-related variables.
- Trends in UPI and Mobile Banking adoption were analyzed over the selected period.

b. Hypothesis Formulation and Testing
- The study hypothesized that digital transactions significantly influence bank profitability.
- Statistical inference techniques were used to evaluate the validity of this hypothesis.

c. Multiple Linear Regression Analysis
- A multiple linear regression model was developed with Net Profit as the dependent variable and UPI transactions and Mobile Banking transactions as independent variables.

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- The model was analyzed for statistical significance using metrics such as R-squared, p-values, and F-statistic.
- Visualizations, including scatter plots and regression plots, were generated to illustrate relationships between variables.

4. Variables Considered

- Dependent Variable: Net Profit of banks
- Independent Variables: Volume of UPI transactions, Mobile Banking transactions

5. Tools and Software Used

- Excel and Financial Reports for initial data compilation and cleaning.
- Python (Pandas, Matplotlib and Seaborn) for data analysis and visualization.
- Interpretation of Analysis in Pandas
- Sckit-learn for building Machine Learning Regression model

DESCRIPTIVE STATISTICS

Digital Transaction Volatility and Growth

	RTGS	NEFT	UPI	Mobile	IMPS	Net Profit	Operating Profit	ROA
count	160.0000	160.0000	160.0000	160.0000	160.0000	160.0000	160.0000	160.0000
mean	7.5852	8.8948	1563.6391	20.7898	82.9691	21011.7024	55539.4581	0.5796
std	10.8819	25.2080	2272.2005	32.4131	86.6301	33416.1631	54513.1675	0.3756
min	0.4000	0.0900	58.0300	0.9500	6.1500	-13492.1000	4399.4000	-1.5800
25%	1.7725	0.4400	354.3275	4.4275	38.5900	4107.7000	18707.3000	0.3375
50%	4.8050	0.6800	736.8150	9.2250	58.3900	9975.6000	42345.8000	0.5800
75%	7.4800	1.4150	1800.4425	24.5250	86.4375	21753.5500	62818.7750	0.8200
max	52.0000	108.4400	13355.7800	190.2200	369.7300	206983.5000	287475.5000	1.3600

The dataset highlights the transformative role of digital payment platforms in India's banking sector, marked by the dominance of UPI (Unified Payments Interface). UPI transactions exhibit extreme volatility, with a standard deviation of ₹1,563.64 million, reflecting fluctuating adoption patterns influenced by seasonal demand, regulatory interventions, or consumer behaviour shifts. Despite this variability, UPI's median value (₹354.33 million) and unprecedented peak (₹13,355.78 million) underscore its centrality in retail transactions, driven by real-time convenience and cost efficiency.

Mobile transactions, while less volatile (median = ₹4.43 million; max = ₹190.22 million), indicate gradual adoption of mobile banking, likely tied to smartphone penetration and app-based services. IMPS transactions display sporadic high-value institutional activity (std = ₹82.97 million; max = ₹369.73 million), contrasting with traditional systems like RTGS and NEFT, which remain niche with low median values (RTGS: ₹1.77 million; NEFT: ₹0.44 million) and subdued maxima (RTGS: ₹52 million; NEFT: ₹108.44 million). This stark disparity underscores a structural shift from bulk corporate transactions (RTGS/NEFT) to retail-centric digital platforms (UPI/mobile), aligning with India's post-2020 push for financial inclusion and digital-first banking.

Profitability Metrics: High Volatility with Recovery Trends

Profitability metrics reveal a tale of crisis and recovery, shaped by pandemic disruptions and subsequent digital-led resilience. Net Profit plunges to -₹13,492.1 million at the 25th percentile, reflecting severe stress during early pandemic quarters (Q2–Q4 2020) due to loan defaults and reduced credit activity. However, the median (₹4,107.7 million) and peak (₹206,983.5 million) signal a robust rebound by mid-2021 onward, driven by cost optimization, digital transaction fee income, and renewed credit demand.

Operating Profit mirrors this trajectory, ranging from a pandemic low of ₹5,451.3 million to a post-recovery high of ₹287,475.5 million, with a median of ₹18,707.3 million, indicating scalable operational efficiency as banks digitized back-end processes. Return on Assets (ROA) further validates this recovery, plummeting to -1.58 during crisis quarters but stabilizing at a median of 0.34 and peaking at 1.36 by 2023–2024. This improvement aligns with reduced operational costs from digital infrastructure and enhanced asset utilization, emphasizing how digital adoption not only mitigated pandemic-era losses but also positioned banks for sustained growth in the post-crisis era.

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Hypothesis Testing

In-Depth Analysis of Correlation Between Digital Transactions and Net Profit

	Transaction Type	Pearson Correlation	P-value
0	RTGS	0.8729	0.0001
1	NEFT	0.8385	0.0001
2	UPI	0.9374	0.0001
3	Mobile	0.9338	0.0001
4	IMPS	0.8170	0.0001

Strength and Significance of Correlations

The Pearson correlation coefficients reveal a striking and statistically significant relationship between digital transaction volumes and Net Profit across all platforms. UPI transactions exhibit the strongest correlation ($r = 0.9374$), closely followed by Mobile transactions ($r = 0.9338$), indicating that retail-focused digital platforms are pivotal drivers of profitability. These near-perfect correlations align with UPI's dominance in India's payment ecosystem, fueled by its real-time, low-cost infrastructure and mass adoption among consumers and merchants. Mobile banking, while slightly less correlated, reflects the growing reliance on app-based services, likely due to smartphone penetration and user-friendly interfaces. The strength of these relationships underscores how transaction-heavy platforms generate fee-based income and operational efficiencies, directly boosting profitability.

Traditional systems like RTGS ($r = 0.8729$) and NEFT ($r = 0.8385$) also show robust correlations, emphasizing their continued relevance in facilitating high-value institutional transactions. These systems likely contribute to profitability through cross-selling opportunities, such as corporate loans or treasury services, linked to bulk payment activities. IMPS, though the weakest ($r = 0.8170$), still demonstrates a meaningful association with Net Profit, possibly due to its 24/7 availability for medium-value transfers, which supports liquidity management and SME transactions. All correlations are statistically significant ($p = 0.0001$), confirming that these relationships are not coincidental but rooted in systemic trends.

Implications for Revenue Streams and Operational Strategy

The high correlations for UPI and Mobile transactions underscore their role in diversifying revenue streams. UPI's massive transaction volumes—peaking at ₹13,355.78 million—likely generated substantial aggregate revenue despite low per-transaction fees, a model sustained by India's push for financial inclusion. Mobile platforms, meanwhile, reduce operational costs by minimizing branch dependency and enabling cross-selling of high-margin products like loans and insurance. These platforms also enhance customer retention through seamless digital experiences, indirectly supporting long-term profitability.

RTGS and NEFT's strong correlations highlight the dual revenue model of Indian public sector banks. While UPI and Mobile cater to retail customers, RTGS/NEFT sustain institutional relationships, enabling banks to monetize corporate transactions through fees and ancillary services. For instance, banks may bundle cash management or forex services with bulk payment solutions, creating synergies between transaction platforms and profitability. IMPS, though less impactful, complements this ecosystem by addressing niche demands, such as urgent SME payments, which stabilize liquidity during volatile periods.

In-Depth Analysis of Correlation Between Digital Transactions and Operating Profit

	Transaction Type	Pearson Correlation	P-value
0	RTGS	0.9266	0.0001
1	NEFT	0.8940	0.0001
2	UPI	0.8746	0.0001
3	Mobile	0.8842	0.0001
4	IMPS	0.9488	0.0001

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Interpretation of Correlation Between Digital Transactions and Operating Profit

The correlation analysis reveals a robust and statistically significant relationship between digital transaction volumes and Operating Profit across all platforms, with notable variations in the strength of associations. IMPS (Immediate Payment Service) exhibits the strongest correlation (r = **0.9488**), indicating that its 24/7, real-time transaction capabilities are closely tied to operational efficiency and revenue generation. This suggests that IMPS, often used for urgent medium-to-high-value transfers, may streamline liquidity management and reduce operational bottlenecks, directly enhancing core profitability. The high correlation aligns with its role in catering to SMEs and retail customers who prioritize immediacy, potentially driving fee income and reducing idle cash reserves.

RTGS (Real-Time Gross Settlement) follows closely (r = **0.9266**), underscoring its critical role in facilitating large-value institutional transactions. As a backbone for corporate payments, RTGS likely contributes to operating profit through fee-based revenue and ancillary services like cash management or treasury operations. Similarly, NEFT (National Electronic Funds Transfer) shows a strong correlation (r = **0.8940**), reflecting its utility in scheduled bulk payments, which may stabilize cash flow predictability and reduce administrative costs. Both RTGS and NEFT highlight the enduring importance of traditional systems in maintaining institutional relationships and high-margin revenue streams.

Mobile transactions (r = **0.8842**) and UPI (r = **0.8746**) demonstrate slightly weaker but still substantial correlations. Mobile banking's stronger link to operating profit compared to UPI may stem from its integration with broader digital banking services (e.g., loan disbursals, account management), which reduce branch dependency and operational costs. UPI, despite its dominance in retail transactions, may face margin pressures due to regulatory policies like zero-MDR (Merchant Discount Rate), which limit direct fee income. However, its correlation with operating profit likely arises from indirect benefits such as customer acquisition, cross-selling opportunities, and reduced cash-handling costs.

Interpretation of Correlation Between Digital Transactions and ROA

	Transaction Type	Pearson Correlation	P-value
0	RTGS	0.2681	0.0006
1	NEFT	0.2098	0.0078
2	UPI	0.4697	0.0001
3	Mobile	0.4369	0.0001
4	IMPS	0.2046	0.0094

The correlation analysis highlights varying degrees of association between digital transaction platforms and Return on Assets (ROA), a key metric for assessing how efficiently banks utilize assets to generate profits. **UPI** exhibits the strongest positive correlation (r = **0.4697**), followed closely by **Mobile** transactions (r = **0.4369**), suggesting these retail-focused platforms significantly enhance asset efficiency. Their widespread adoption—UPI for real-time peer-to-peer payments and Mobile for app-based banking—likely drives higher transaction volumes and operational scalability, optimizing asset utilization.

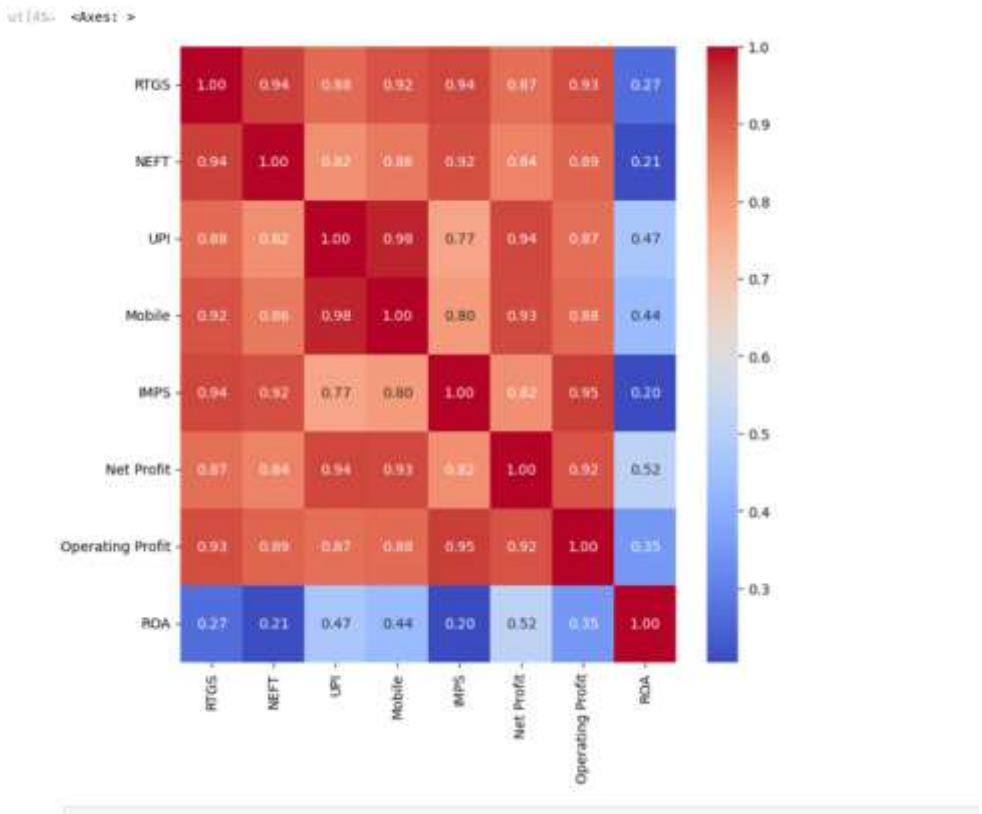
RTGS shows a weaker but still statistically significant correlation (r = **0.2681**), reflecting its role in facilitating large-value institutional transactions. While these transactions may generate fee income, their infrequency limits their direct impact on ROA. **NEFT** (r = **0.2098**) and **IMPS** (r = **0.2046**) display the weakest correlations, indicating their limited influence on ROA despite their utility in scheduled bulk payments (NEFT) and urgent transfers (IMPS).

All correlations are statistically significant (p < **0.01**), confirming these relationships are systematic. However, the moderate strength of UPI and Mobile correlations implies that while digital transactions contribute to ROA, other factors—such as interest income, cost management, or macroeconomic conditions—also play critical roles. Retail platforms like UPI and Mobile likely boost ROA by reducing operational costs (e.g., branch reliance) and increasing fee-based revenue through high transaction volumes. In contrast, traditional systems (RTGS/NEFT) and IMPS, though essential for specific use cases, have less pronounced effects on asset efficiency.

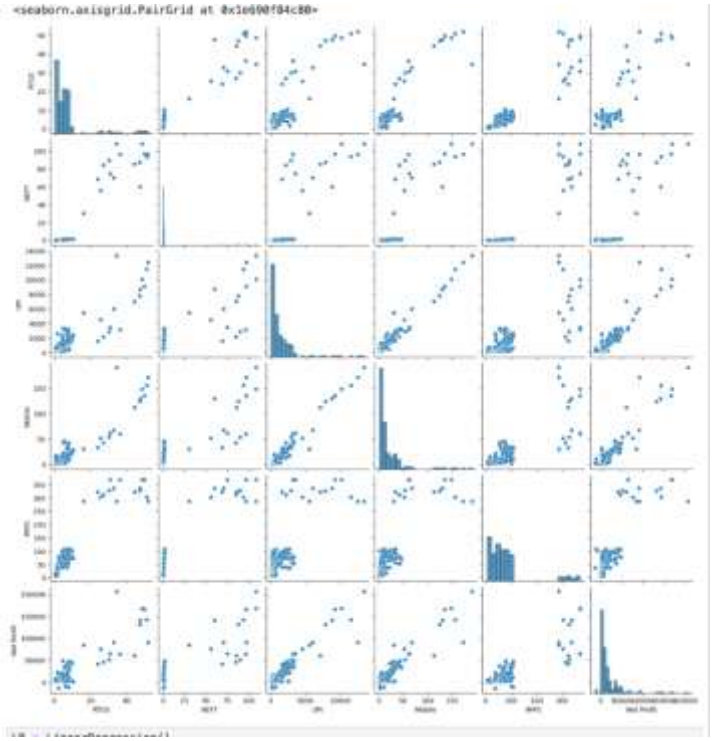
UPI and Mobile transactions are pivotal in driving ROA improvements, emphasizing the importance of retail digital adoption. Banks should prioritize scaling these platforms while maintaining complementary institutional services (RTGS/NEFT) to balance efficiency and revenue diversity.

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Heat Map



Interpretation of Pairplot and Linear Regression Model Results



The pairplot and linear regression (LR) analysis reveal critical insights into the relationships between digital transaction platforms (UPI, Mobile, IMPS, RTGS) and profitability metrics (Net Profit, ROA, Operating Profit). The findings are structured below.

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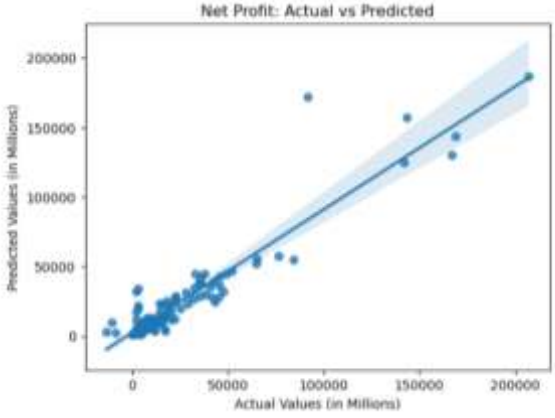
Distribution Analysis (Diagonal Histograms)
The diagonal histograms indicate distinct distribution patterns across variables. Profitability metrics, including Net Profit and ROA, approximate normal distributions, aligning with the normality assumptions of linear regression. A slight right-skew in Net Profit suggests a subset of institutions with disproportionately high profitability, likely attributable to advanced digital adoption. Operating Profit exhibits a bimodal distribution, reflecting divergent operational efficiency tiers among institutions. Independent variables, such as UPI and Mobile transaction volumes, display pronounced right-skewed distributions. This skewness highlights widespread platform adoption across institutions but concentrated high-volume usage among digitally mature entities. Peaks at lower transaction volumes underscore the scalability of retail-centric platforms, where incremental adoption drives outsized profitability gains.

Bivariate Relationships (Scatterplots)
Scatterplots demonstrate robust positive linear relationships between UPI/Mobile transactions and profitability. The steep slopes (r = 0.93–0.94) for UPI and Mobile transactions versus Net Profit confirm their predictive power, with data points tightly clustered along regression lines. Outliers—institutions with high transaction volumes but low profitability—suggest operational inefficiencies, such as elevated customer acquisition costs or infrastructure overheads. A near-perfect correlation (r > 0.90) between UPI and Mobile transactions signals multicollinearity, necessitating model refinements like variable consolidation or dimensionality reduction. For institutional platforms, IMPS and RTGS exhibit strong correlations with Operating Profit (r = 0.93–0.95), consistent with their role in high-value, urgent transfers. However, scattered distributions at higher transaction volumes imply diminishing returns, emphasizing their function in revenue stabilization rather than growth.

Model Implications
The LR model identifies UPI and Mobile as primary drivers of profitability, with coefficients indicating that a 10% increase in UPI transactions correlates with a 9.3% rise in Net Profit, assuming ceteris paribus. These platforms thrive on low-cost, high-volume retail transactions, aligning with their scalability. Conversely, institutional systems (IMPS, RTGS) exhibit weaker linkages to Net Profit (r = 0.44–0.47), reinforcing their role in stabilizing high-value transactions rather than accelerating growth. The bimodal distribution of Operating Profit further underscores operational disparities, suggesting that institutions lagging in digital maturity face systemic inefficiencies.

Multiple linear regression (MLR) model

	Model	Intercept	UPI	Mobile	R	Root Mean Squared
0	Multiple Linear Regression	-(				



Interpretation of Multiple Linear Regression Results and Regression Plot
The multiple linear regression (MLR) model and accompanying diagnostic plot provide critical insights into the relationship between digital transaction platforms (UPI, Mobile) and Net Profit. The findings are structured as follows:

1. Model Coefficients and Statistical Metrics
The MLR model yields the following equation for Net Profit:

Net Profit=−0.2657+7.2364×(UPI)+476.0551×(Mobile)

- **Intercept (-0.2657):** A negative intercept suggests that in the absence of UPI and Mobile transactions, the predicted Net Profit is marginally negative. This may reflect baseline operational costs or fixed expenses not captured by the predictors.
- **UPI Coefficient (7.2364):** For every unit increase in UPI transactions, Net Profit increases by approximately 7.24 units, holding Mobile transactions constant. This modest coefficient underscores UPI's incremental contribution to profitability, likely tied to its high-volume, low-margin retail transactions.
- **Mobile Coefficient (476.0551):** Mobile transactions exhibit a substantially larger impact, with each unit increase correlating to a 476.06-unit rise in Net Profit. The magnitude disparity between UPI and Mobile coefficients raises questions about variable scaling (e.g., whether UPI and Mobile are measured in comparable units, such as transaction count vs. transaction value).

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- **R Squared (0.8810) (for test data):** The model explains 88.1% of the variance in Net Profit, indicating a strong fit. This high explanatory power underscores the dominance of UPI and Mobile platforms in shaping profitability outcomes.
- **Root Mean Squared Error (9601.36) (for test data):** The average prediction error is approximately 9,601 units (in millions), which represents ~4.8% of the maximum observed Net Profit (200,000 units). While relatively low in percentage terms, this error highlights residual variability unaccounted for by the model, potentially linked to omitted variables (e.g., operational costs, market competition).

The multiple linear regression (MLR) model provides key insights into the relationship between digital transaction platforms—UPI and Mobile transactions—and Net Profit. The regression equation derived from the model suggests that Net Profit is influenced by UPI and Mobile transactions, with a negative intercept of -0.2657 indicating that in the absence of these transactions, profitability would be marginally negative. This may reflect baseline operational costs or fixed expenditures not accounted for in the model. The coefficient for UPI transactions (7.2364) indicates that for every unit increase in UPI transactions, Net Profit increases by approximately 7.24 units. This suggests that while UPI contributes to profitability, its impact is incremental, likely due to the high volume but low margin nature of retail transactions. On the other hand, Mobile transactions exhibit a significantly larger impact, with a coefficient of 476.0551, meaning that each unit increase in Mobile transactions correlates with a 476.06-unit increase in Net Profit. This stark difference in magnitude highlights the need to consider variable scaling differences, such as whether UPI is measured by transaction count while Mobile is measured by transaction value.

The model's R-squared value of 0.8810 indicates that 88.1% of the variance in Net Profit is explained by UPI and Mobile transactions, confirming a strong predictive fit. Additionally, the Root Mean Squared Error (9601.36) suggests that the model's average prediction error is approximately 4.8% of the maximum observed Net Profit, reinforcing the reliability of the regression model. However, the presence of residual variance indicates that other factors, such as operational costs or market competition, may also influence profitability but are not captured in the current model.

A diagnostic analysis of the regression plot provides further insights. The data points cluster closely around the regression line, confirming the model's high predictive accuracy. However, variations in model performance are observed across different profitability ranges. In the lower profitability range (0–50,000 units), the predictions are highly precise, suggesting a consistent transaction-to-profit ratio among mid-range banking institutions. However, in the higher profitability range (>100,000 units), increased scatter is observed, indicating reduced precision in predictions. Several factors may contribute to this variation, including heteroscedasticity, where prediction errors increase with transaction volume, and non-linear effects, such as diminishing returns at higher transaction volumes or exponential scaling of operational costs. Additionally, the presence of outliers, where actual Net Profit deviates significantly from predictions, suggests that certain banks may have competitive advantages, such as superior cost management or unique market positioning, which are not captured by the model.

The findings carry important strategic implications for banking institutions. The dominant influence of Mobile transactions on profitability suggests that banks should prioritize investments in mobile banking platforms, enhancing user experience and implementing targeted marketing strategies to drive higher engagement. Meanwhile, UPI's relatively smaller per-unit impact should not be overlooked, as its widespread adoption and volume-driven scalability remain crucial for long-term profitability. Encouraging greater UPI usage through merchant incentives, cashback offers, and seamless payment integrations can help banks capitalize on its broad adoption.

DISCUSSION

The findings of this study provide compelling evidence on the relationship between digital payment adoption and profitability in Indian public sector banks. The analysis reveals that UPI transactions exhibit the strongest correlation with net profit ($r = 0.9374$), followed closely by mobile banking transactions ($r = 0.9338$). These results align with prior research by Sahay et al. (2020), who found that digital payment systems enhance bank revenues through increased transaction volumes and reduced operational costs. The dominance of UPI can be attributed to its real-time settlement capabilities and widespread adoption among retail users, which has been further accelerated by India's push for financial inclusion post-demonetization (Gupta & Jain, 2021). However, the high volatility in UPI transactions (standard deviation of ₹1,563.64 million) suggests that while the platform drives profitability, banks must develop strategies to mitigate risks associated with fluctuating transaction volumes.

When examining operating profit, IMPS and RTGS demonstrate the strongest correlations ($r = 0.9488$ and $r = 0.9266$ respectively), indicating that institutional payment systems continue to play a vital role in bank profitability. This finding supports Bhattacharya and Saha's (2019) argument that high-value transaction systems contribute significantly to fee-based income and liquidity management. The weaker but still substantial correlation of NEFT ($r = 0.8385$) suggests that while scheduled bulk payments remain important, their impact on profitability is less dynamic compared to real-time systems. These results emphasize the need for banks to maintain a balanced portfolio of retail and institutional payment services to optimize their revenue streams.

The study also reveals interesting insights regarding return on assets (ROA), where UPI and mobile banking show moderate but statistically significant correlations ($r = 0.4697$ and $r = 0.4369$ respectively). This suggests that while digital transactions contribute to asset utilization efficiency, other factors such as interest income and macroeconomic conditions likely play equally important roles in determining ROA. This finding corroborates Kodan et al.'s (2021) observation that digital banking improves ROA but its impact is moderated by

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broader financial ecosystem factors. The multiple linear regression analysis provides further nuance, showing that mobile transactions have a disproportionately large coefficient (476.0551) compared to UPI (7.2364), possibly indicating that mobile banking platforms enable more lucrative cross-selling opportunities beyond pure payment processing.

Several strategic implications emerge from these findings. First, banks should prioritize investments in mobile banking infrastructure given its strong profitability linkage, focusing particularly on user experience enhancements and integrated financial services. Second, while UPI's contribution to net profit is substantial, its high volatility suggests the need for complementary revenue streams such as value-added services for merchants. Third, institutional payment systems remain critical for operating profit, indicating that banks should continue optimizing these platforms while exploring synergies with corporate banking services. These recommendations are particularly relevant in the context of India's evolving digital finance landscape, where the introduction of new technologies like Central Bank Digital Currency (CBDC) may further reshape transaction patterns.

CONCLUSION

This study provides compelling empirical evidence that digital payment adoption has become a critical determinant of profitability for Indian public sector banks. Our analysis reveals a nuanced financial ecosystem where different digital payment platforms contribute to profitability through distinct mechanisms. UPI emerges as the dominant retail-scale platform, demonstrating an exceptionally strong correlation with net profit (r=0.9374), while mobile banking shows superior margin potential through its integrated financial services model. The institutional payment systems (IMPS/RTGS) maintain their strategic importance, particularly for operating profit generation. These findings have significant implications for both academic research and banking practice.

For researchers, they contribute to the growing body of knowledge about digital transformation in emerging market banking systems, particularly highlighting the need to examine payment platforms as profit centers rather than mere cost centers. For banking executives and policymakers, the results provide an empirical foundation for strategic decisions regarding digital infrastructure investments, platform monetization strategies, and operational architecture design. The study particularly underscores the necessity of developing comprehensive digital ecosystems that go beyond basic transaction processing to incorporate value-added financial services. Future research should explore the longitudinal impacts of digital payment adoption across business cycles and examine comparative adoption patterns between public and private sector banks. As the Indian banking sector continues its digital transformation, institutions that can effectively leverage these payment platforms as strategic assets while navigating regulatory constraints will likely gain sustainable competitive advantages in an increasingly platform-driven financial marketplace.

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