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The Impact of Investment in AI on Bank Performance: Empirical Evidence from Pakistan's Banking Sector

Muhammad Naeem[i] , Muhammad Siraj[ii], Ahmad Shah Abdali[iii], Asim Mehboob[iv]

i) Department of Commerce, Islamia University of Bahawalpur, Pakistan
ii) Department of Business Administration, Shaheed Benazir Bhutto Dewan University Karachi, Pakistan
iii) Department of Business Administration, Ghazi University of Dera Ghazi Khan, Pakistan
iv) Department of Accounting and Law, Faculty of Business Administration and Social Sciences, Muhammad Ali Jinnah University Karachi, Pakistan.

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ABSTRACT

Artificial Intelligence has gained the attention of researchers, owners, and investors because it plays a vital role in the success of any type of business (Small and medium enterprises to large levels). This study is used to identify the impact of artificial intelligence on bank performance. Data are collected from the bank's annual reports on the Pakistan Stock Exchange. The study period is from 2011-2022 and the total observation of this study is 216. In this study, we used event study methodology for AI and quantitative measures for bank performance. Bank Performance is measured through these proxies i.e. Net profit margin, Return on Equity, and Return on Assets. The control variables used in this study are Bank Size and Bank Age. Results show that artificial intelligence investment positively contributes to bank performance. This study has implications for stakeholders especially for owners of banks to focus on artificial intelligence to increase bank performance. This study presents pioneering empirical evidence regarding artificial intelligence's impact on bank performance. It also serves as a valuable reference for businesses considering artificial intelligence investments.

1. Introduction

The rapid advancements in Artificial Intelligence (AI) present substantial business prospects across diverse industries, notably within finance, as underscored by Enholm and Valfridsson (2022) and Shareef et al. (2021). AI encompasses an array of technologies, effectively mimicking human intelligence (Łapińska et al., 2021, Vogan et al., 2020, Mamela et al., 2020). Leveraging AI

Corresponding Author: Muhammad Naeem
Email: rainaeem63@yahoo.com
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capabilities enhance operational efficiency, trims costs, and amplifies revenues, thereby catalyzing improvements in business processes (Bag et al., 2021). While a significant form of research has researched into the influence of AI on enterprises, as examined by scholars including (Rasheed et al., 2021, Wamba-Taguimdje et al., 2020, Ho et al., 2022, Islam et al., 2022, Liu et al., 2022b, Chen et al., 2022a) in developed economies, the Pakistani financial sector has remained relatively underexplored. It is crucial to recognize that transposing the implications from developed economies to emerging ones like Pakistan may not be straightforward, given the differing economic conditions in both contexts. Pakistan's financial sector grapples with an array of challenges attributable to the nation's economic conditions, including economic volatility, fraud, cybersecurity concerns, and issues related to credit ratings, all of which ultimately impact its overall performance. Despite the various methodologies employed to investigate the association between Investment in AI and firm value in SMEs, the application of the event study methodology has been limited. This study endeavors to link this gap by employing the event study technique to evaluate the impact of AI on the presentation of the Pakistani financial sector.

For identifying business opportunities, enterprise capabilities are critical. While AI has great potential to advance a business performance, there are substantial barriers to this business implementing AI (Yu et al., 2023). Businesses can use AI to improve performance through cost reduction and revenue growth (Manser Payne et al., 2021). When a business uses AI that is difficult to replicate by competitors, it gains a competitive advantage (Ali et al., 2020) and improves bank performance (BP) (Xu et al., 2022, Li et al., 2022). Exploring the mechanisms and critical factors of the impact of AI on performance (Li et al., 2022, Mikalef and Gupta, 2021) has therefore an important value (Theoretical and Practical) (Wang et al., 2021). According to Bughin et al. (2018), revenue from AI applications will increase in the coming years. Even though new technologies are triggering a lot of enthusiasm, some organizations are still anxious about executing them. Businesses have worried because they are concerned that machines might not be in line with management purposes, which could lead to poor decisions or functioning errors. There are two basic reasons for the reluctance to accept AI. Initially, businesses view the acceptance of AI as a substantial problem that, in the event of a machine failure, might result in lost revenue. Additionally, the associated expenses are a major warning for businesses looking to adopt AI technology. Therefore, it is probable that the aid of AI for organizations won't at all times clear as planned (Bughin et al., 2018).

AI delivers a technical solution to economic complications handled by emerging market enterprises at the bottommost of the economic pyramid. Through the incorporation of data from numerous sources, including websites, social media platforms, and traditional channels, firms can advance robust plans for revenue growth and pioneering business models. AI mobile apps, software, and technology may be used by developing-country businesses to increase efficiency (Strusani and Houngbonon, 2019). AI technologies have the potential to create new opportunities and expand markets by improving productivity and financial solutions (Briganti and Le Moine, 2020).

AI has advanced significantly in the banking industry, allowing banks to optimize processes and improve client experiences (Sträßer and Stolicna, 2023). However, there is a huge knowledge vacuum about the direct impact of AI on key financial performance measures such as net profit margin, return on equity, and return on assets (Kacar, 2023). Despite AI's ability to streamline operations and boost efficiency, empirical research has yet to reveal the precise relationship between AI adoption and these financial consequences. Investigating this relationship is critical for banks to strategically harness AI for long-term financial success. While existing research (Crosman, 2018) recognizes AI's revolutionary potential in banking, the impact of AI adoption on specific financial

performance measures such as net profit margin, return on equity, and return on assets has not been thoroughly studied (Makhija et al., 2021). The relationship between AI adoption and financial performance is complicated and may be influenced by moderating factors such as bank size and age, which have not been properly investigated (Ernst, 2022, Rahman et al., 2023). This information gap provides a chance for researchers to shed light on the subtle implications of AI adoption on financial performance, as well as how these effects may differ based on the characteristics of individual institutions (Aprilia et al., 2023). By filling this vacuum, the study hopes to give banks evidence-based insights to steer Investment in AIs and improve financial results.

Our study objectives are; to inspect the impact of Investment in AI on BP in emerging markets. Therefore, the objective of this research is to fill this gap by responding to the following investigated questions: Does Investment in AI influence BP in Pakistan? In this study, we used a quantitative technique. AI is measured through event study methodology. Performance is measured through these proxies i.e. NPM, ROE, and ROA. Data was collected from 18 banks registered in PSX in the study period from 2011 to 2022. Our study found a positive substantial affiliation between these variables. This study answers the questions. Investment in AI gives competitive advantages to businesses through these competitive advantages businesses can earn more as compared with their competitors. The paper organized are as follows: section 2 discusses the literature review and section 3 presents the research methodology. Section 4 consists of analysis while sections 5 and 6 contain results and conclusion respectively.

2. Literature review

The terms "artificial" and "intelligence" must first be unstated individualistically to understand the idea of AI. "Intelligence" can be well-defined as concerning mental processes like comprehension, learning, and reasoning (Lichtenthaler, 2019). Contrariwise, "artificial" entitles something that is formed by humans as opposite to something that occurs naturally. Merging the two, Wamba-Taguimdje et al. (2020) state that "Artificial Intelligence can be understood as making machines capable of simulating intelligence." It is also defined as “a set of theories and techniques used to create machines capable of simulating intelligence. AI is a general term that involves the use of computers to model intelligent behavior with minimal human intervention”. According to Pallant (2020), AI is a field that uses big data and computer science to advance decision-making and problem-solving in enterprises. AI algorithms, for instance, can be used to shape proficient systems that can categorize data based on input or make forecasts. Therefore, AI in the business field can progress and create computer systems which is accomplished by human intellect (Davenport and Ronanki, 2018). Financial performance aids from the use of AI in a diversity of business value chains, such as personnel management, inventory tracking, financial record keeping, and consumer segmentation (Papagiannidis et al., 2021). For the reason, that AI practices and applications are the go-ahead and deficit standardized ideas, estimating AI adoption in enterprises is a problematic responsibility. The implementation of AI has been measured using a diversity of techniques in previous studies, including both qualitative and quantitative approaches. The request for AI-skilled human capital is being measured; business insights into AI are being unstated (Gill et al., 2019), the application of particular AI-based technologies, such as machine translation, is being inspected; and the incorporation of AI claims into central business functions is being carefully inspected (Drydakis, 2022, Deveci, 2023). These are examples of qualitative measures. Numerous metrics have been employed to measure the implementation of AI on a quantitative level. These include material derived from AI product statements (Zhou et al., 2021), funds or R&D expenses related to AI (Chen and Biswas, 2021, Liu, 2023), and the inspection of the application of AI patent (Damioli et al., 2021).

2.1 Theoretical Background

AI is being integrated into the financial sector. In the context of TAM, AI adoption would be driven by characteristics such as perceived usefulness and usability. These financial performance measures (Net Profit Margin, ROE, and ROA) will be altered by the use of AI in banking operations. TAM says that two major aspects drive technology adoption: perceived utility and perceived ease of use. Perceived usefulness can be quantified by surveying banking stakeholders on how they believe AI adoption would benefit various elements of banking operations, such as efficiency, decision-making, customer service, risk management, and so on. The higher perceived utility is likely to lead to increased AI adoption. Perceived ease of use refers to how easy it is for bank employees to use AI technology efficiently. Training availability, user-friendly interfaces, compatibility with existing systems, and so on can all have an impact on this. Increased perceived ease of use is likely to lead to wider adoption of AI. The model would seek to explore how the adoption of AI, impacted by perceived usefulness and ease of use, influences financial performance measures (net profit margin, ROE, ROA) in the banking sector while controlling for bank size and age. By examining the data, you may assess whether AI adoption, which is motivated by perceptions of usefulness and convenience of use, has a major impact on these financial performance measures.

2.2 Hypotheses Development

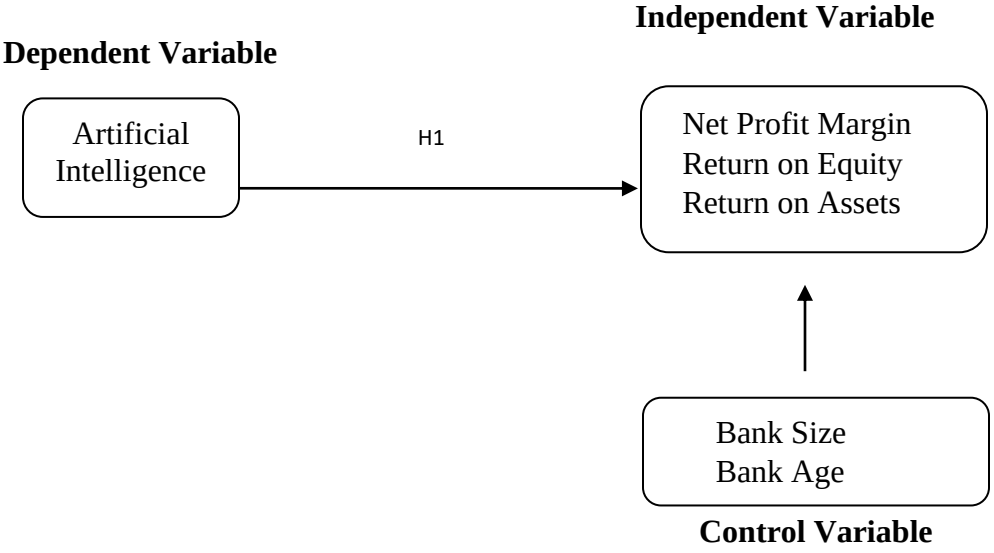
AI has emerged as a transformative force in the banking sector, redefining the landscape of BP. By leveraging advanced algorithms, machine learning, and data analytics, banks can now enhance customer experiences through personalized services, streamline operations by automating routine tasks, and mitigate risks by identifying anomalies in real-time. AI-driven chatbots and virtual assistants facilitate seamless interactions, while predictive analytics aids in making data-driven decisions for loan approvals and investment strategies. Moreover, AI's ability to analyze vast datasets enables banks to uncover valuable insights, optimize resource allocation, and detect fraudulent activities, ultimately leading to improved efficiency, profitability, and competitiveness in the dynamic world of finance.

ROA, ROE, EPS, and ROS are important performance indicators for businesses (Dubey et al., 2020). Investment in AI positively relates to BP measures (Yasmin et al., 2020). AI improves manpower and resource efficiency (Ashaari et al., 2021). AI through knowledge creation enhances BP (Chakraborty et al., 2020). This study concludes that AI significantly affects BP. Through the conceptual research model, some studies confirmed that AI has a positive impact on BP (Mikalef and Gupta, 2021). They have stated that AI improves BP. Firms can increase their business value and capability by implementing AI technology. When organizations adopt new technologies, it is possible to reconfigure their processes. Oke et al. (2008) and Miller et al. (2017) found that AI has a positive influence on FP. The digitalization of accounting measures in businesses was the main focus of the examination of AI concepts and their influence on accounting. The assumption reached was that while AI might not directly progress accounting, it does play a sympathetic role in the development of firm performance. Tan et al. (2022), examined how AI affects accounting fraud and the caliber of accounting data. Conferring to their conclusions, AI can equally reduce accounting fraud and progress the general caliber of accounting data. Turner (2018), examined the association between AI and finance and accounting. Conferring to the statement, AI has the revolutionary possibility to entirely change the system in that contract and auditing-related responsibilities are done.

Babina et al. (2021) revealed that businesses that finance AI beat their competitors concerning employment, market valuations, and increases in sales, all of which are mainly attributable to product innovation. Larger businesses are more exaggerated than smaller ones, which makes sense a certain amount of data they gather. However, AI doesn't seem to have any influence on cost-cutting measures. The application and deployment of AI in organizations have been revealed to have decent aids on organizational performance and originality by Mikalef and Gupta (2021) current empirical investigation, representative of the valuable effects of AI capacity on FP. Alternatively, Liu et al. (2022a) observed how Investment in AIs affected business worth using an analysis of sixty-two publicly traded American firms' Investment in AI announcements. Their study showed that stock prices fell by 1.77% on the day of the announcement. Particularly, businesses in non-manufacturing industries and those with lesser credit ratings and information technology capabilities suffered further. Equally, Fotheringham and Wiles (2023) revealed that performance increased by 0.22% in response to Investment in AI announcements about customer support, such as chatbots. Chatbot marketing can influence the customer relationship (Siraj and Muhammad, 2023). Thus, we hypothesized it as follows.

H1: Artificial Intelligence Investment positively and significantly affects Bank Performance.

2.3 Theoretical Framework



3. Research Methodology

3.1 Data Used in the Study

Data is collected from annual reports available on the PSX study period from 2011 to 2022. We used a quantitative technique. Independent variable Investment in AI is measured through event study methodology. Dependent variables BP are measured through NPM, ROE, and ROA. Size and Age are used as control variables.

3.2 Measurement of Variables

3.2.1 Independent Variable

AI is measured through event study methodology in binary form. If banks use the word AI in their annual reports and newspapers to make announcements related to Investment in AI then allocate 1 otherwise 0. The event study methodology is widely used in accounting and finance to examine the association between AI announcements and financial and non-financial returns of the firms (Lui et al., 2022, Huang et al., 2019). We gathered data from the annual reports of banks.

3.2.2 Dependent Variables

BP is measured through quantitative techniques.
NPM is computed by dividing net income by total revenue.
ROE is computed by dividing net income by total equity.
ROA is determined as the ratio of net income to total assets.
3.2.3 Control Variables
Control variables used in this study are measured as follows:
Bank Size = Log of the total assets.
Bank Age= Number of years to the establishment of the bank
3.3 Econometric Model
The impact of AI on BP has been measured through the following equation:

Equation

$$BPit = \alpha 0 + \alpha 1AIit + \alpha 2Sizeit + \alpha 3Ageit$$

Whereas
BPit = Bank Performance for bank i for time t;
Sizeit = Size of the bank for bank i for time t
Ageit = Age of the bank for bank i for time t
α 0= Intercept for firm i for time t

4. Results

4.1 Descriptive Result

Table I: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
AI	216	.727	.447	0	1
NPM	216	.007	.016	-.072	.04
ROE	216	9.572	13.905	-54.18	30.149
ROA	216	10.071	6.365	1.575	53.943
SIZE	216	14.955	1.127	11.456	17.052
AGE	216	35.833	22.373	1	97

Table 1 shows the result of descriptive statistics. It shows that the average of AI is 72.7% which means that Pakistani banks approximately 73% focusing on Investment in AIs because banks have ideas now this time is for machine learning and AI. The mean value of NPM is 7 %. Investment in AIs 7% contribute to NPM. The mean value of ROE and ROA shows that AI also causes increases in these.

Bank size and age have mean values of 15% and 36% approximately means that these variables contribute more as compared with AI. Mostly those banks focus on Investment in AIs who has larger size and more age.

4.2 Correlation Statistics

Table II: Matrix of correlations

Variables	AI	NPM	ROE	ROA	SIZE	AGE
AI	1.000					
NPM	0.052	1.000				
ROE	0.198	0.658	1.000			
ROA	0.173	0.008	0.149	1.000		
SIZE	0.055	0.532	0.564	0.482	1.000	
AGE	0.184	0.444	0.406	0.053	0.612	1.000

We conducted a correlation analysis to assess the presence of multicollinearity among variables in the dataset. Regression analysis involves multicollinearity, which is the existence of a substantial correlation between two or more independent variables. The struggle in separating the different effects of each variable on the dependent variable stems from this high correlation. In this case, we followed a guideline from Anderson and Reeb (2003) that states a correlation coefficient value above 0.7 indicates the presence of multicollinearity. According to the results presented in Table 2, none of the correlation coefficients between variables exceeded the threshold of 0.7. This suggests that there is no significant multicollinearity issue among the variables you analyzed. This is a positive outcome as multicollinearity can lead to unstable coefficient estimates, reduced interpretability, and challenges in drawing meaningful conclusions from a regression analysis. By confirming that our variables have correlation coefficients below the threshold, we have more confidence in the reliability of our regression results.

4.3 Regression Result

Table III: Regression Results

Variables	NPM	ROE	ROA
AI	0.040**	0.113*	0.119*
	(0.012)	(0.021)	(0.029)
Size	0.0289*	0.454**	0.317*
	(0.019)	(0.152)	(0.610)
Age	0.0220	0.089**	0.092*
	(0.018)	(0.039)	(0.043)
Constant	0.303***	0.222	0.019**
	(0.096)	(0.240)	(0.224)
Observations	216	216	216
R-squared	0.218	0.191	0.201
Number of Firms	18	18	18

Note: Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

The impact of Investment in AI on BP is shown in Table III. Results demonstrate that AI has a positive substantial influence on NPM, ROE, and ROA which means that now these days' banks are focusing on AI installment in their banks and reducing their cost. Those banks that are more focused on AI and technology ultimately, they are reducing their manpower as well as their expenses in the form of salary. So due to this their performance increases. AI has also a positive substantial consequence on Bank size and bank age because those banks that have more assets and are old in the form of age are more investing in AI. Our results are aligning with (Chen et al., 2022b, Ma et al., 2021). R square of NPM is approximately 22% which means that AI brings 22% change in NPM. The same as NPM ROE and ROA R square is 19% and 20% respectively. Investment in AI in the form of credit rating, banking apps, and other types of capabilities and tools enhances BP.

5. Discussion

The study's findings shed light on the possibilities of AI integration in Pakistan's banking industry. They emphasize that investments in AI may significantly improve innovation and overall performance, with bank age and size also having a big impact. To succeed in today's globalized world, Pakistani banks must adopt technology-driven channels for transactions and client engagement. It emphasizes the importance of crucial investments in AI to promote industrial change. Results demonstrate that AI has a positive substantial influence on NPM, ROE, and ROA which means that now these days' banks are focusing on AI installment in their banks and reducing their cost. Those banks that are more focused on AI and technology ultimately, they are reducing their manpower as well as their expenses in the form of salary. So due to this their performance increases. AI has also a positive substantial consequence on Bank size and bank age because those banks that have more assets and are old in the form of age are more investing in AI. Investment in AI in the form of credit rating, banking apps, and other types of capabilities and tools enhances BP. The advent of AI as a global scientific achievement has progressed beyond theoretical principles to actual applications in a variety of disciplines. Its tremendous influence, notably in the financial sectors of leading nations, is obvious. AI has grown into a vital tool for improving BPs, generating innovation, and obtaining a competitive advantage. Nonetheless, despite significant time and resource expenditures, several AI programs confront obstacles, in part owing to a lack of a clear understanding of AI's potential to provide commercial value and the expected forms of such value. The study's findings shed light on the possibilities of AI integration in Pakistan's banking industry. They emphasize that investments in AI may significantly improve innovation and overall performance, with bank age and size also having a big impact.

6. Conclusion

To succeed in today's globalized world, Pakistani banks must adopt technology-driven channels for transactions and client engagement. It emphasizes the importance of crucial investments in AI to promote industrial change. This research has theoretical as well as practical ramifications. It emphasizes AI's critical role as a resilient driver of performance, especially under difficult situations. The findings give significant information for firms considering AI integration, including insights into avoiding investment risks. Proactive investors and managers may find possibilities to diversify portfolios and optimize returns by studying and investing in stocks of banks that have effectively incorporated AI. Furthermore, the study demonstrates that tracking the performance of AI-adopting companies provides a fresh route for both technical and fundamental assessments, potentially improving decision-making processes. While this study adds greatly to our understanding of AI's influence on the banking industry, it is not without limits. Notably, it does not

assess how AI influences the performance of SMEs or non-financial organizations, leaving the potential for further study in these areas. The study's sample size was small, indicating that larger-scale studies are needed for greater generalizability. Furthermore, the report focuses exclusively on performance gains and does not go thoroughly into the risk management elements of AI adoption. Future research should look at a variety of routes to build on this topic. To begin, researching how AI affects SMEs and non-financial enterprises can give a more thorough knowledge of AI's applicability across many industries. Increasing the sample size and covering a larger range of banks can improve the robustness of the findings. Furthermore, future studies might dive into the complexities of risk management in the context of AI integration, looking at possible issues like ethical and cybersecurity threats. Finally, emphasizing AI implementation methodologies and identifying important success factors might give significant insights for firms contemplating AI adoption. To summarize, this study lays the groundwork for further investigation of AI's diverse consequences and its capability to drive sustainable growth and novelty across businesses.

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