
The Impact of Technological Innovation on The Performance of Joint Stock Commercial Banks

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ABSTRACT: This paper focus review the literature of topic the impact of technological innovation on the performance of joint stock commercial banks. With bibliometrics method, this research study 273 articles, and were categorized into three main types: qualitative research, quantitative research, and mixed methods. Notably, qualitative research significantly outnumbered quantitative research and mixed methods. The research trends in this area focus on technological innovation in the financial and banking industry, the influence of technological innovation on the banking sector, and the adaptability and technology transformation of banks in the digital age.

KEYWORDS: technological innovation, commercial banks, bibliometrics.

1. INTRODUCTION

In the era of the Fourth Industrial Revolution, the banking industry faces fierce competition from both domestic and international rivals. The efficiency of banking operations is crucial for the success of any bank. The fundamental goal for bank administrators is always profitability. In the macroeconomic environment, a robust banking system contributes to effective business operations, resilience against adverse fluctuations, and positive stability within the national financial system. Over the past two decades, the global banking sector has been significantly impacted by rapid technological advancements (Ratten, 2008; Rishi & Saxena, 2004). Technological innovation has accelerated information processing and transmission within financial institutions, allowing for more efficient banking products and easier marketing due to expanded regional and global networks. Enhanced customer access and awareness have substantially increased banking operational efficiency (Campanella & colleagues, 2017).

Internationally, there have been numerous theoretical and applied studies on factors influencing banking performance. For instance, Berger and colleagues (1987), Berger (1995), Naceur (2003), and Athanasoglou and colleagues (2005) have researched bank profitability in specific countries. Meanwhile, Demiguc-Kunt and Huizinga (1999, 2001), Abreu and Mendes (2002), and Dietrich and Wanzenried (2014) have explored profit determinants across various nations.

A study by Foss (1996) demonstrated the relationship between transaction costs and technology investment in the Danish fruit and vegetable industry. The findings revealed that technology investment reduces production costs, thereby contributing to increased profitability. Additionally, reduced transaction costs benefit customers by allowing them to purchase products at lower prices without compromising on quality.

The study by Chen (2004) revealed a relationship between business performance and technology investment. Using the DEA method, the results indicated that incorporating technology into production processes increases productivity, leading to higher efficiency.

Benfratello, Schiantarelli, and Sembenelli (2008) observed that the probability of adopting technological innovations is significantly higher for banks headquartered in provinces with a greater ratio of bank branches to the total population. The positive impact of branch density on population serves as strong evidence for innovation processes within the banking industry. Furthermore, this statistical significance persists when endogeneity issues are addressed using instrumental variable estimates.

Ngugi & Karina (2013) investigated the influence of technological innovation strategies on the efficiency of commercial banks in Kenya. They found that strategies such as product repositioning, product substitution, and process innovation (including compliance with regulations and cost reduction) positively affect bank efficiency. Their conclusion emphasizes the bidirectional impact of technology innovation on bank effectiveness.

Francesco Campanella and colleagues (2015) conducted an empirical study analyzing 3,190 banks across 17 countries during the period from 2008 to 2011. The experimental research results revealed that first, there is a negative relationship between financial leverage and technological innovation related to resource allocation, software systems, and credit risk management, which means increasing debt for technology investment leads to reduced business efficiency. This suggests that banks may not be allocating

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technology resources optimally relative to the costs incurred. The second, strategic resource planning and the use of credit risk management software positively impact the business efficiency of banks, which means banks that strategically allocate human resources for technology and utilize credit risk management software experience increased operational efficiency.

Hobe & Alas (2016) further emphasize that technological innovation is a primary profit driver for banks. In the 21st century, it increasingly determines both efficiency and competitive capabilities within the banking sector.

2. LITERATURE REVIEW

- Implementation process

When implementing a systematic evaluation method, researchers may encounter challenges in synthesizing and analyzing large datasets due to the substantial volume of documents that need review and consolidation. Therefore, this study adheres to the integrated system evaluation method developed by Hauser and colleagues (2006). It establishes criteria for the evaluation process based on three primary steps:

- (1) Setting criteria for selected studies.
- (2) Identifying and selecting potential studies.
- (3) Classifying selected articles.

This method is considered suitable for achieving the purpose of this research, which focuses on integration and convergence for assessing the situation, comparing, and formulating management policies related to labor mobility by economic sectors. The specific process described in Figure 1.1 includes the following steps: data collection, data filtering, analysis, synthesis, discussion, and ultimately identifying inheritable values applicable to this study and gaps for future research.

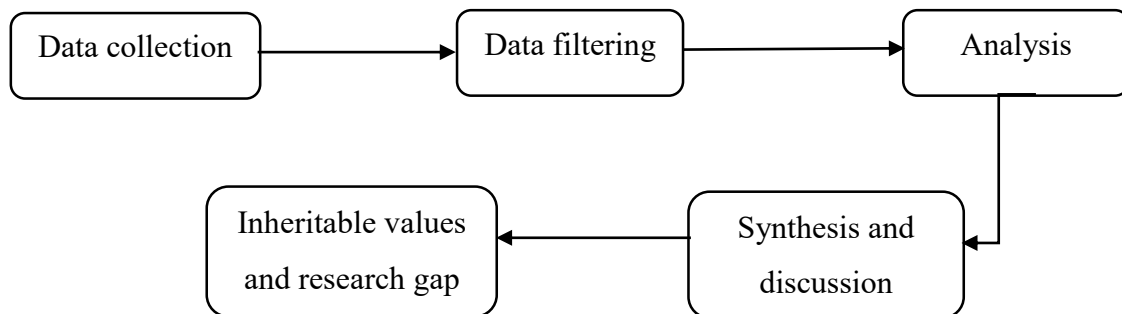


Figure Error! No text of specified style in document..1 Research process

Source: The process is developed by the author Hauser and colleagues (2006)

- Data collection

The systematic evaluation approach selected keywords for searching, including “Technological Innovation,” “Efficiency,” and “Commercial Banks,” using the Web of Science database. These keywords were applied to the Web of Science database, a reliable and meticulously curated repository of vast data established by Eugene Garfield in the 1960s under the name Institute for Scientific Information (ISI), now known as Web of Science (WoS). With this method, subjective biases in data collection by researchers were eliminated. The approach proposed by Becheikh and colleagues (2006) specifically considers experimentally published articles in academic journals; Therefore, non-experimental studies (such as internet sources) are excluded from the evaluation.

The initial search yielded 816 results corresponding to the specified keywords within the topic (titles, abstracts, and keywords). The subsequent step involved filtering articles in the English language, excluding book categories, resulting in 405 relevant articles. The third step entailed identifying articles most aligned with the research purpose based on titles, abstracts, and full texts, ultimately selecting 273 articles for the topic “Impact of Technological Innovation on the Efficiency of Commercial Joint Stock Banks” (Table 1.1).

The research evaluation system process will include the following stages:

- Conducting an analysis based on criteria (research implementation location, research methodology, classification of technological innovation forms in the banking industry, policies aimed at improving operational efficiency) in the study.
- Performing a literature review on selected articles will identify the authors and readers interested in specific keywords, and trends of technological innovation in the future to enhance the operational efficiency of the bank.

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Table Error! No text of specified style in document..1 The selected database search results

Database	Web of Science
Keyword	“ <i>Technological Innovation</i> ”; “ <i>Efficiency</i> ”; and “ <i>Commercial Banks</i> ”
Searching	Topic (Title, Abstract, Keywords)
Type of document	Articles
Publication years	1997 – 2023
Language	English
Research area	All
Web off Science Categories	All
Results	273 research

Source: Collected by author

ANALYZE DOCUMENT SYSTEMS

The directory analysis methods utilize quantitative information from the directory database (Web of Science) to identify previously influential articles. The co-citation analysis method relies on citation data within the topic to determine the theoretical foundations of current literature.

The data from the Web of Science directory for 273 reviewed articles that have been published underwent a co-citation analysis to reveal the theoretical foundation of research on the impact of technological innovation on the operational efficiency of joint-stock commercial banks. Co-citation is a measure of similarity between articles, authors, or journals (Zupic and Čater, 2014). In co-citation analysis, the number of times two specific articles are cited together in later publications is calculated. When two articles are co-cited by a more recent article, it indicates a certain quantitative relationship between the previously published articles and the ones cited together. The higher the co-citation frequency, the stronger the relationship between the two articles (Cao Minh Kiêm, 2009). Among the 273 articles, the research methods were categorized into three main types: qualitative research, quantitative research, and mixed methods. Notably, qualitative research significantly outnumbered quantitative research and mixed methods.

RESULTS OBTAINED FROM THE ANALYSIS

- Analysis of national research allocation

Throughout the 273 selected articles, research experiments related to the impact of technological innovation on the operational efficiency of joint-stock commercial banks were conducted in 72 countries. Table 1.2 lists the countries with the highest publication rates from 1997 to 2023. The country with the highest publication rate is China, with a total of 71 published works. The United States ranks second in terms of the number of published articles, with 32 publications. Additionally, the United States has the highest citation count, with 2018 citations, indicating the level of interest from these two major powers and the influence of the articles on the topic of technological innovation in the banking industry.

Table Error! No text of specified style in document..2 10 countries with the highest publication rates

Research location	Quantity	Citations	C/Art
China	71	605	8,52
United Kingdom	24	521	21,71
United States	32	2018	63,06
India	16	211	13,19
Turkey	10	84	8,40
Australia	8	80	10,00
Malaysia	14	62	4,43
Italy	10	149	14,90
Switzerland	9	148	16,44
Germany	8	63	7,88

Source: Author's analysis of WOS data

- Analysis of top research journals allocation

Analyzing leading journals in each field is crucial. In the context of the impact of technological innovation on the operational efficiency of joint-stock commercial banks, within the 213 journals that have at least one publication, we identified seven journals with more than four published articles. From Table 1.4, we observe that the INTERNATIONAL JOURNAL OF BANK MARKETING leads the way with a total of nine relevant articles and 202 citations. The second position belongs to the

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journal TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE, which has published seven articles and boasts the highest journal impact factor in the category, with a ranking of 10,884 in 2023.

Table Error! No text of specified style in document..4 Top 10 journals

Journal	Quantity	Citations	TC/Art	Impact Factors
INTERNATIONAL JOURNAL OF BANK MARKETING	9	202	22,44	5.083
TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	7	140	20,00	10.884
ENVIRONMENTAL SCIENCE AND POLLUTION RESEARCH	5	38	7,60	5.8
IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT	5	74	14,80	8.702
JOURNAL OF BANKING FINANCE	5	254	50,80	1.716
JOURNAL OF BUSINESS RESEARCH	4	91	22,75	2.895
SUSTAINABILITY	4	89	22,25	3.889

Source: Author's analysis of WOS data

- Allocation of top research

To fully understand the research on the impact of technological innovation on the efficiency of operations in joint-stock commercial banks, an analysis was conducted on the distribution of the most frequently cited articles. Among the 273 selected articles, only 10 were most cited (Table 1.5). *From the table, we can observe that most of these highly cited articles focus on (1) analyzing the role of technological innovation, which highlights technological innovation as a key factor in competing within the banking industry and demonstrates a positive relationship between the two variables; (2) studying the relationship between technological innovation and financial services. They examine adjustments aligned with user preferences and evaluate customer satisfaction; (3) analyzing different types of financial innovations: notably, mobile banking emerges as a significant trend among banks. Positive changes and substantial investments in research and development (R&D) are identified as enhancing user experience and bolstering the competitive advantage of banks.*

Table Error! No text of specified style in document..5 Top 10 most highly cited research studies

Author	Title	Citations	Method	Results
Nanda, Ramana; Nicholas, Tom	Did bank distress stifle innovation during the Great Depression?	96	To quantitatively study the impact, researchers employed a Difference-in-Differences (DID) regression model using data from all U.S. banks during the Great Depression period, spanning the years 1921, 1927, 1931, 1933, and 1938. The dataset included information related to Research and Development (R&D) and operational costs.	The research findings indicate that during the Great Depression, banks faced significant challenges related to a substantial decline in both the extent and quality of innovation. This was particularly pronounced for banks engaged in Research and Development (R&D) activities. Additionally, the Great Depression marked a period of profound technological transformation within the banking industry, signifying a remarkable leap forward in the history of the U.S. banking system.
Alessandrini, Pietro; Presbiteroy, Andrea F.; Zazzaroz, Alberto	Bank size or distance: what hampers innovation adoption by SMEs?	81	The quantitative study conducted three large surveys to collect information about banks across Italy, covering a diverse range of bank sizes. Alongside the surveys, accounting balance sheet data from all banks during the surveyed years (including the periods 1995–1997, 1998–2000, and 2001–2003) were also collected. Additionally, data related to population and actual provincial value-added were gathered from the National Institute of Statistics (ISTAT).	The research findings indicate that small and medium-sized banks in provinces with more distant local banking systems tend to apply less innovation in their processes and products. On the other hand, larger banks exhibit a more proactive approach to innovation, particularly in the areas of technological innovation and product development within the banking industry.
Consoli, D	The dynamics of technological change in UK retail banking services: An evolutionary perspective	53	The comprehensive study delved deep into analyzing the origins and impact of technological changes within the banking sector in the United Kingdom during the period	Research results have revealed that the development process in the banking sector of the United Kingdom consists of three stages, driven by intertemporal coordination across several

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			from 1840 to 1990. The research aimed to highlight the significance of opportunities and constraints that shaped the growth and development of the banking industry.	supplementary areas, including production activities, business organization, consumption, and fundamental management mechanisms. The study also indicates that the development of banking in the UK exhibits characteristics of a decentralized innovation process, wherein technology developers, service providers, and customers significantly contribute to the industry's structural changes.
Moser, Florian	Mobile Banking A fashionable concept or an institutionalized channel in future retail banking? Analyzing patterns in the practical and academic mobile banking literature	35	Qualitative research has critically analyzed practical theory to examine models in the field of Mobile Banking.	Research indicates a positive trend toward wider adoption of Mobile Banking in the near future. This trend may be linked to developments such as convenience, utility, and readiness.
Yatsukh, Olena; Demchenko, Ivan; Ilnytskyi, Denys; Tsap, Volodymyr; Shmatkovska, Tetiana	MANAGEMENT OF BANKING INNOVATIONS IN THE CONDITIONS OF DIGITALIZATION	33	The qualitative synthesis research and analysis examine the substantial transformation of the entire banking system towards digital banking, along with the benefits, challenges, and predictions of future trends.	The research has revealed that in the context of widespread digitization of economic relations in general, and considering the specific processes of transitioning from traditional to digital banking, bank innovation management should be seen as a process supporting the development and implementation of new digital platforms for the bank's technology operations. Simultaneously, the use of automated management systems for banking innovation based on cognitive technology and artificial intelligence is objectively necessary to enhance the efficiency of innovation management and ensure appropriate effectiveness in a dynamic market environment. This can only be achieved through the use of digital technology. Furthermore, the overall improvement of the banking innovation management system should focus on ensuring the deployment of integrated digital solutions to improve both the organizational and economic aspects of banking products. It should also address customer needs for innovative digital products. Only on this basis can the innovation policies of banking organizations be successfully implemented.
Gopalakrishnan, S; Wischnevsky, JD; Damanpour, F	A multilevel analysis of factors influencing the adoption of Internet banking	27	Qualitative research has examined the factors influencing the adoption of the Internet at three levels of analysis: external industry context, the industry itself, and individual companies.	Research has revealed that Internet technology will enable banks to either build advantages or, conversely, determine the extent to which Internet technology allows banks to create an edge. Additionally, existing banks can leverage their competitive strength to turn new technology to their advantage.
Wang, Chenguang; Qiao, Cuixia; Ahmed, Rahil Irfan; Kirikkaleli, Dervis	Institutional Quality, Bank Finance and Technological Innovation: A way forward for Fourth Industrial Revolution in BRICS Economies	25	Quantitative research employs the Cross-Sectional Autoregressive Distributed Lag (CS-ARDL) method to estimate coefficients of various variables related to institutional quality, bank finance, technology innovation, and Gross Domestic Product (GDP).	The research results indicate that bank finance, institutional quality, high-tech exports, and GDP are positively correlated with technological innovation. From a policy perspective, this study recommends that for sectors to adopt advanced technology, large-scale capital investment and improved liquidity are prerequisite conditions. Therefore, easing financial access is

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				necessary, creating an enabling environment for companies to deploy advanced technologies and implement innovation projects.
Hsu, Po-Hsuan; Wang, Chong; Wu, Chaopeng	Banking systems, innovations, intellectual property protections, and financial markets: Evidence from China	25	Quantitative research employs the Ordinary Least Squares (OLS) regression model to estimate the actual impact of financial market development in the region and the role of intellectual property protection within the region. This approach aims to address the imbalance issues within banks and provide insights into effective solutions.	Research has revealed the uneven development of financial systems and technological sectors across different geographical regions. This provides a robust potential environment for studying the dynamics between banking systems, innovation, intellectual property (IP) protection, and stock market reactions. This research is particularly valuable for understanding the policy-finance-innovation relationship in emerging economies. The study emphasizes the nurturing role of the financial system in fostering innovation, enhancing the value of firms' innovation activities, and predicting the leading lag effect of innovation on stock profits in the context of emerging economies. Importantly, the research suggests that stronger provincial-level IP protection will reduce copyright infringement and consequently enhance the market value of local businesses.

(Source: Collected by author)

- Analyze the trend of keywords.

Co-word analysis, applied to keywords appearing in scholarly articles, allows authors to identify research trends or prominent topics within each field. The keywords used by research authors provide information about the most important research topics (N. J. Van Eck & Waltman, 2014). In the current study, a simultaneous occurrence analysis of keywords, which may originate from titles, abstracts, or authors, was conducted using VOSviewer. A total of 1425 keywords appeared at least once, with 68 keywords appearing most frequently (≥ 5 times) as shown in Figure 1.1. The four main keywords in the study include: "Innovation": Appears most frequently (58 times); "Performance": Appears 42 times; "Impact": Appears 23 times; "Fintech" (associated with financial technology): Appears 27 times. These keywords align with the requirements of the topic related to the impact of technological innovation on the operational efficiency of joint-stock commercial banks. The research trends in this area focus on technological innovation in the financial and banking industry, the influence of technological innovation on the banking sector, and the adaptability and technology transformation of banks in the digital age.

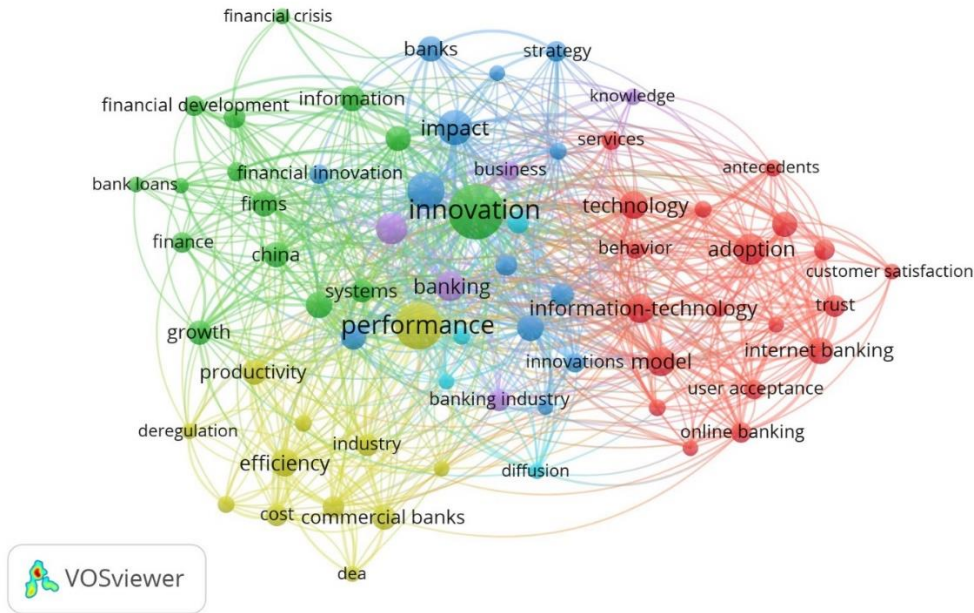
Table Error! No text of specified style in document..6 Keywords with the highest frequency

No.	Keyword	Times	TLS	No.	Keyword	Times	TLS
1	Innovation	58	199	11	Technological Innovation	19	56
2	Performance	42	150	12	Model	16	53
3	Impact	23	86	13	Internet Banking	14	52
4	Fintech	27	84	19	Efficiency	15	49
5	Determinants	14	77	15	Risk	13	47
6	Adoption	19	76	16	Productivity	12	44
7	Banking	18	67	17	Mobile Banking	13	41
8	Information-technology	16	66	18	Management	12	38
9	Competition	14	64	19	Commercial Banks	11	22
10	Technology	15	62	20	Financial service	9	37

Source: Author's analysis of WOS data

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Figure Error! No text of specified style in document..1 Cluster distribution of keyword cluster trends



Source: Author's analysis of WOS data

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