Cloud Computing on the Digital Solution to the Future of Banking

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Abstract - **This study looks at how banks' strategic use of cloud computing affected their performance and risk-taking. We find that banks' adoption of cloud computing is associated with worse cost efficiency, higher profit efficiency, and increased operational risk using data on Chinese banks from 2008-2019 and a new measure of banks' exposure to cloud computing. Cloud computing enhances operational risk control and cost efficiency through synergy, while blockchain diminishes profit efficiency owing to substitutive effects. This is only one example of how cloud computing interacts with other new technologies. These results have real-world implications for policymakers, regulators, and bank managers at this critical juncture.**

Keywords: banks, Cloud computing, security.

I. INTRODUCTION

Cloud computing performs a maximum vital function withinside the regions of e-commerce, e-learning, healthcare. It has such a lot of advantages along with excessive quality, excessive monetary cost with low value Internet services. So with none doubt we are able to say that it will become the satisfactory revolution withinside the discipline of Internet and enterprise development [1]. But it additionally has a trouble of protection risks. ie, it's miles essential to gave right making plans and attention of taking risks, threats, protection troubles in the conversion of a hit cloud computing adoption.

Banks are the principle phase of enterprise sector wherein cloud computing is earmarking withinside the destiny following few years [2]. The principal troubles confronted via way of means of the banking zone are, implementation of superior technology in excessive fee and use of hardware efficiency. According to the function of cloud computing, via virtual digital banking carrier, it's far important to enhance the safety, carrier fine and to reduce the fee for banks [3]. The truth is that , for cost savings, using cloud services are better than personal services. Because we are able to store money. On the alternative hand cloud computing offerings has a few negatives that forestalls banks to undertake the cloud, together with protection confidentiality of the data, and additionally fine of offerings.

We are all literally encircled by the 'cloud,' what with more than 90% of major companies already embracing a multi-cloud architecture. A whopping 44% of more conventional SMEs and startups have also integrated hosting and cloud computing into their operations [4]. But the banking industry appears to be falling behind while the rest of the market is embracing cloud services to meet their data needs. This hesitancy to embrace digital change can have a significant effect on the customer experience in this area, which is frustrating.

But why should the financial and banking industries be worried about it?

Well, a Forrester study found that retail banks who prioritized optimizing the customer experience had three times the growth of those who did not. Relying on antiquated methods of operation and ignoring cloud computing in banking can have a negative effect on customers' experiences in this age of instant gratification [5]. One thing is now crystal clear: Integrating cloud computing in the financial sector is of unparalleled relevance. Where do I even begin? This blog can give us some ideas.

Utilizing Cloud Computing in the Banking Industry: Revamping the Way Things Were Big Blue, an IBM chess-playing computer, beat Garry Kasparov, the current world champion, in case you forget. The strange occurrence occurred 26 years ago. In a game as complicated as chess, many would find it hard to think that a computer could ever beat a person. The use of artificial intelligence, huge data, and computation allowed the computer to seemingly outsmart humans [6]. Computing in the cloud is nothing new. But now it's more than just a technology; it's a one-stop shop for industries, providing them with cutting-edge data storage and access amenities. In order to handle large volumes of data and have access to sophisticated analytical tools, most companies are turning to cloud-based solutions.

Cloud computing has great promise, but the financial industry has been slow to reap its benefits. It is quite difficult for most financial organizations to abandon their on-premise applications. Some companies have yet to make the transition to the cloud; one such is Capital One, which has eliminated its on-premise data centers in favor of the cloud. With the current

state of security, cloud use in banking is quickly becoming the norm [7].

How Does Cloud Computing in Financial Services Work?

The term "cloud computing" refers to a broad category of on-demand services that enable users to share and access data and programs via the Internet. This innovation allows financial organizations, such as banks, to move their data storage and management operations to remote servers.

The majority of financial institutions that use cloud computing nowadays use outsourcing or third-party cloud service providers. But this tendency is starting to change, as many major banks are moving toward or have already made the switch to multi-cloud [8].

Benefits of Cloud Computing in Banking: Why the Financial Sector Needs to Make a Shift?

Prominent financial institutions are now seriously considering storing and analyzing their data in the cloud after realizing the benefits of cloud computing.

They have come to understand that by utilizing cloud computing in banking, they can achieve both their business objectives and the expectations of their clients all at once. The following are a few ways in which financial institutions can benefit from cloud computing and how it might enhance their performance:
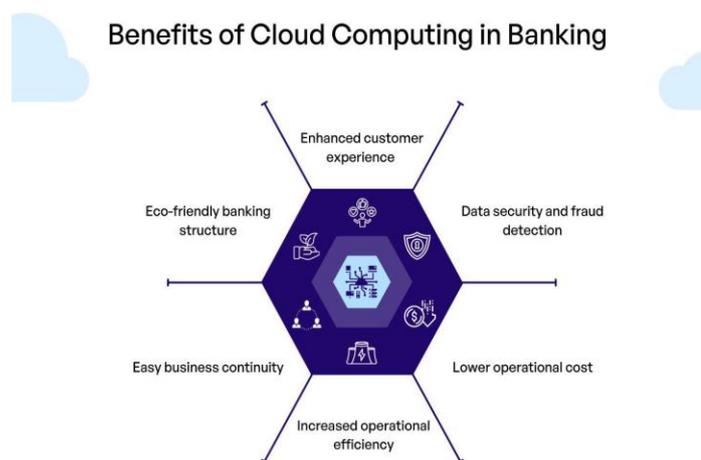

Figure 1: Benefits of Cloud Computing In Banking

Enhanced Customer Experience through Data Analytics

To gain insights into trends connected to client behavior, the banking business, like any other industry, needs modern analytics methodologies. Banks may learn a lot about their clients' typical interactions with financial services and products from these data. Financial institutions can also improve their operations and meet the expectations of their

clients by using cloud computing in banking. In addition, customers can enjoy the best possible banking experience at all times and from any location thanks to cloud solutions [9].

Data Security and Fraud Detection Like Never Before

The safety of customer information has long been a top priority for financial institutions. This is a major factor in the financial sector's reluctance to utilize cloud computing, which persists to this day. The cloud, however, is now a security-first strategy thanks to technology improvements that have optimized cloud computing services. The increased usage of cloud computing in the banking industry has many safeguards in place to prevent hacking and data breaches. Even more impressive is the fact that modern cloud computing technology can scan massive amounts of data from multiple sources in order to identify fraudulent or otherwise questionable actions prior to their occurrence [10]. Nonetheless, choose a cloud computing provider that provides the following to guarantee the goal is met:

- Consistency and efficiency.
- The incorporation of state-of-the-art technologies.
- Adherence to policies and procedures for safe data storage.
- Our customer support services are available at all times.

Increased Operational Efficiency

Cloud computing helps financial institutions with more than just data storage and processing; it also boosts operational efficiency and performance. Here are some cloud computing perks for banks that you may enjoy after you combine the correct solutions:

- Quality assurance and improvement.
- Strong loss prevention and disaster recovery capabilities.
- Decreased running costs.
- Managing risks in an optimal manner

Lower Operational Cost Through Usage-based Billing

Cloud computing in the banking industry is based on the pay-as-you-go model, which implies that financial and banking institutions only pay for the services they really use. The operational expenses become more controllable as a result. Additionally, banks can afford the low cost of cloud computing since they do not have to deploy significant software or hardware equipment. Hosting banking portals on the cloud also allows financial firms to reduce fixed and variable investments while increasing uptime.

Business Continuity Becomes Easy with Cloud

According to a study by Unitrends, nearly 84% of companies back up and keep their data in the cloud. You may be wondering, though, why.

Well, banks and other financial organizations get

- Data protection and recovery made easy
- Optimal fault tolerance
- The best options regarding disaster recovery

Cloud computing's incorporation into banking also aids the financial sector in comprehending and overcoming the sector's most pressing problems. But that's not all. It also helps financial institutions and businesses recover and back up data with little outlay of resources. Put simply, cloud computing plays a crucial role in preparing the financial sector for the future.
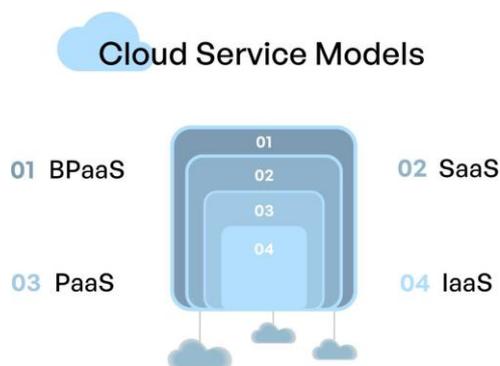
Cloud Service Models

Figure 2: Cloud service Models

Business Process-as-a-Service (BPaaS)

Payroll, billing, and human resource management are some of the commonplace business processes that make good use of BPaaS. You can easily integrate other cloud services into this paradigm with the right process knowledge.

Software-as-a-Service (SaaS)

One popular idea in cloud computing, software as a service (SaaS) has increased productivity in many different types of businesses.

The majority of it is business software tailored to a particular company's needs, together with data associated with that program that can be accessed readily using web browsers. Products and services that are based on software as a service include the following:

- The Human Resources Management System (HRMS).

- Enterprise Resource Planning, or ERP.
- Client Relationship Management (CRM).
- Manage payroll, invoices, and accounts.
- Software for managing material.
- Administration of the service desk.

Platform-as-a-Service (PaaS)

Users can build apps, interfaces, databases, storage spaces, and test units using this cloud service model. The major goal of this strategy is to minimize resource utilization and expenses while providing comprehensive maintenance and support services and streamlining the development process.

Infrastructure-as-a-Service (IaaS)

Business owners can combine a fully featured outsourcing service structure with this cloud computing model for financial services to avoid buying software, data centers, servers, network tools, etc.
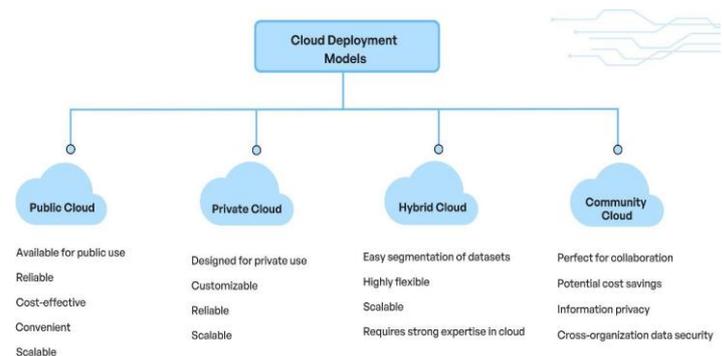
Cloud Deployment Models

Figure 3: Cloud Deployment Models

Public Cloud

The public and all financial institutions have access to this type of cloud infrastructure, which is held by cloud service providers. Because of the potential for economies of scale, this may be the best choice for certain banks. The following graphic shows the anticipated five-year (2019–2024) spending on information technology (IT) and public cloud share by worldwide banks.

A few of the most popular and well-known public cloud providers are Amazon Web Services (AWS), Microsoft Azure, Google Cloud, and IBM Cloud.

Private Cloud

Developed and mainly overseen by the bank or an on-site third party, this cloud deployment strategy is tailor-made for a single financial institution, as the name implies. This cloud

architecture is most often suggested for financial institutions like banks since it allows them greater control and flexibility.
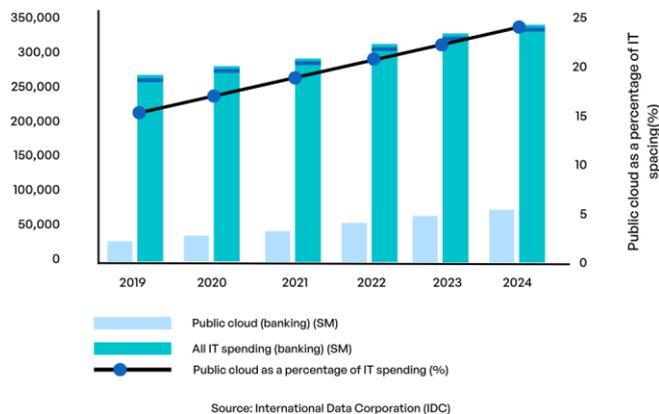

Figure 4: Global Overall Banking IT spending and Public Cloud Share During 2019-2024

This financial services cloud computing strategy reduces the likelihood of data breaches and fraud by deploying it inside the organization's firewall. Two other subcategories exist within this cloud deployment model:

1. Managed Private Cloud
2. Dedicated Private Cloud

Hybrid Cloud

A hybrid cloud, which mixes public and private clouds, is usually used by a single enterprise. An integrated IT ecosystem is a collection of interconnected systems that share resources and data via APIs, LANs, and virtual private networks (VPNs). Companies can have different ideas on what a hybrid cloud should be like. Conventionally, hybrid clouds can include:

- Having both public and private clouds is essential.
- Two or more external clouds, such as public or private ones.
- A cloud-connected virtual environment, either public or private.

II. LITERATURE REVIEW

Cloud computing in the banking industry

In the 1960s, a new paradigm for managing distributed, digital data resources called "the cloud" began to take shape. Several companies helped propel the idea to the forefront in the early 2000s, including Amazon Web Services in 2006, IBM's business cloud solutions in 2007, Google App Engine in 2008, Alibaba Cloud in 2009, and Microsoft Azure in 2010.

With yearly growth of approximately 20% from 2014 to 2019, the cloud computing market is projected to reach $266 billion in 2020 from $100 billion in 2019.

Concerns about reliability and regulatory constraints have slowed the adoption of new technology in the banking sector. Global regulators in the banking sector have warmly embraced cloud computing, as Amazon proved, allowing hundreds of millions of consumers to safely function online simultaneously [11].

Hosting servers, payment gateways, ERP, and client connections are just a few of the new frontiers that cloud computing offers to banks. One way in which cloud computing improves banking operations is by allowing financial institutions to maintain and enhance customer service through a multichannel engagement with their clients. Public, private, hybrid, and industry clouds are all available to banks as cloud computing alternatives that may be tailored to their specific needs in terms of cost, security, compliance, and performance. Major financial institutions frequently employ hybrid cloud solutions.

They take use of the public cloud's many cost and deployment advantages while keeping crucial company data under private cloud control. Around 90% of China's megabanks and joint-stock commercial banks have moved their noncore operations to the cloud in the last five years, while 88% of European banks, 100% of Japan's big banks, and over 80% of tier 1 regional banks have done the same [12].

Banks also face obstacles when trying to fully implement cloud computing. The management of data localization, the General Data Protection Regulation, and data backups all raise privacy and security concerns for customers. These problems are more severe for smaller and less established institutions since they do not use the services of industry-leading cloud providers. As a second point, there is always the chance of cybercrime, hacking, and data leaks. The third point is that following all of the rules and regulations may be a real pain. Finally, the extremely concentrated cloud computing industry poses significant systemic concerns if the international banking sector is overly dependent on a small number of providers, the majority of whom are situated in the United States [13].

In recent years, cloud computing has become increasingly popular in China's banking sector. In light of the government's "Internet Plus" policy and the financial services offered by internet giants like WeChat Pay and Alipay, cloud computing became the new development strategy for Chinese banks.

Infrastructure, platform, business, and communication channel services are just a few examples of the many that have

benefited from cloud computing. The largest banks that are under the control of the state are leading the pack when it comes to adopting new technologies.

Research on bank efficiency

The literature on bank efficiency is vast, with most studies explaining the differences in efficiency by looking at factors including the state of the economy, the nature of the market for industrial goods, and the specifics of individual banks. The macroeconomic environment can have an impact on the efficiency of banks. For example, you might discover that banking sector efficiency increases in an advantageous macroeconomic climate (i.e., high GDP growth). Compliance with regulations, specifically the Basel Core Principles for Effective Bank Supervision, has no effect on banks' efficiency, contrary to the claims made in [14], which imply that stricter regulation can have a negative effect on banks' cost and profit efficiency.

Market competitiveness and other industrial market conditions can have a significant impact on a bank's efficiency. Additionally, look at Latin American commercial banks; they claim to be more efficient when faced with more competition. Furthermore, the results show that the Schumpeter competition model significantly influences the efficiency-competition connection, and that increased innovation-based rivalry has a negative net effect on the banking industry. Additionally, discover proof that banks are more efficient after diversifying into insurance, which supports the idea of economies of scope.

There is a mountain of literature on the topic of how size, risk-taking, product diversity, ownership structure, culture, and other bank-specific traits affect efficiency. Smaller banks, those with a low risk tolerance, more product diversity, and chairmen and CEOs with comparable cultural traits are often more efficient than larger banks. Studies on the efficiency of banks often focus on the question of ownership structure, specifically on the relative merits of state-owned and foreign banks, with contradictory empirical findings [16]. The primary element propelling efficiency and productivity is technological progress. New emerging technologies are being used more and more, but how they affect the efficiency and productivity of banks has not been thoroughly studied. To address this knowledge vacuum, this paper analyzes how cloud computing affects the profitability and efficiency of banks.

Research on bank operational risk

Many operational risks "from inadequate or failed internal processes, people and systems or from external events" continually endanger the complex monetary operations of banks. As one of the three main risks,

operational risk necessitates that banks allocate a percentage of their equity capital to mitigate its potential impact, as mandated by the Basel capital treaty. Due to its complexity (many causes) and distinctive features (i.e., pure losses, no risk-return trade-off), operational risk has been mainly disregarded by academics in comparison to credit and market risk.

Primarily, early studies aimed to characterize and quantify operational risk. Two subgroups of operational risk, operating technology risk and agency cost risk, are derived from the framework found in corporate finance literature. In order to impartially analyze specific operational loss data, it is recommended to use statistical and probability methodologies [17]. A single nonmodel-based approach to assessing operational risk and determining capital requirements was suggested by the Basel Committee on Banking Supervision in December 2017. There has been no end in sight to this project.

In recent years, researchers have focused primarily on the factors and causes of operational risk incidents. Results show that operational losses are greater after credit booms and excessively accommodating monetary policies, but they go down when supervision is better, when macroeconomic variables and regulatory characteristics are included. Large operational losses for financial institutions are caused by poor macroeconomic conditions, which are mostly caused by tail events that occur frequently and with a high degree of severity [18]. Operational risk is higher for large, leveraged banks, making them more susceptible to macroeconomic changes. As for firm-specific characteristics, operational risk is strongly correlated with them. The operational risk of a company is increased when its age, complexity, exposure to credit risk, and financial distress risk are all higher, and when the CEO's stock option holdings and bonuses are more than their pay, according to data from US financial institutions. According to [19], size is an important factor; among major U.S. bank holding companies, the biggest banks face a greater degree of operational risk. For example, there is a body of work that discusses how operational risk can affect things like financial stability. According to [20], large US bank-holding companies see a favorable relationship between operational risk and systemic risk.

This correlation is both statistically and economically significant. When it comes to bank returns, operational losses eat up about 18% of those returns. Take a look at how financial penalties stemming from bank misconduct affect the market; how the market reacts negatively and faster to operational loss announcements caused by fraud; how pretax profitability and buy-and-hold returns are correlated; and how there is a negative association between the two.

III. METHODOLOGY

Cloud computing index

One of the biggest problems with assessing the effects of new technology is that there isn't enough data to determine how often they're used. Researchers have utilized text-based filtering approaches to extract rich textual data and study its impact on banking and financial markets. Some of the topics that have recently been studied include the role of language in successful crowdfunding campaigns, the impact of different types of COVID-19 data on stock market price dynamics, the changes brought about by the advent of online banking on traditional banking procedures, and the effects of bank FinTech on credit risk. Most previous studies have used crawler technologies and text analysis methodologies to try to put a number on the rate of new technical development. Through the use of text analysis, web crawlers are able to transform vast quantities of unstructured data found on the internet into more conventional structured data. Inspiring by this line of inquiry, we construct a novel index to measure, at the bank-year level, the resilience of banks' strategic shift toward cloud computing. We built a related word frequency generator using fuzzy search results and based it on the bank's cloud computing approach.

After that, we do a more targeted search by logically combining cloud computing terms with bank names and years; this produces a textual database with all relevant search results. Lastly, a standardized index database is produced by applying panel factor analysis and frequency statistics to the textual data database. A higher index number indicates that there has been an increase in the volume of network news mentioning cloud computing, which in turn indicates that the bank is more committed to making the switch.

With two new enhancements, our text mining method is better than before. In order to make our keyword setting approach more sophisticated, we start by obtaining cloud computing- related keywords from the word clouds that come from the fuzzy search results. The loss of important data and the index's rationale could result from the widely utilized direct keyword setting method. We can get a better feel for the subjects and the locations of pertinent disclosures using fuzzy search and related word frequency, which could lead to more effective keyword setup. Second, we don't depend on news articles from specific news websites; instead, we quickly peruse the results of Baidu, the most popular search engine in China (www.baidu.com). This way, we can avoid processing discrepancies in streaming media data, work around reporting source limits, and reduce the chances of crawlers having trouble reaching certain websites.

Estimation of bank efficiency

Bank efficiency is defined as the degree to which a given bank approaches the optimal bank or banks in terms of providing the same output given the same inputs and circumstances. As a result of its capacity to prevent efficiency estimates from being skewed by insufficient coverage of assets and liabilities, the stochastic frontier approach (SFA) is our preferred method. To be more precise, we use the multilevel fixed effects and time-varying efficiency genuine fixed- effect SFA model. Efficiency research in transition economies can benefit from SFA since it is better able to account for measurement mistakes and unpredictable economic contexts. Using the literature as a guide, we establish three outputs: non-interest income (y3), net loans (y1), and other earning assets (y2). We also set up three input prices: the fund price (w1), which is interest expense divided by total fund; the labor price (w2), which is personnel expense divided by total assets; and the capital price (w3), which is non-interest expense divided by fixed assets. Our method involves tracking a trend t over time and using its second-order term to show how far we've come in terms of best practices. The cost frontier is empirically specified in Equation (1), and a commonly used translog function form is employed.

Estimating the alternative profit frontier entails substituting total profit for total costs and making the appropriate changes to the error terms.

$$ln(TC_{it}\ or\quad TP_{it}) = \alpha + \sum_{j=1}^{3}\beta_i ln\left(y_{j,it}\right) + \sum_{m=1}^{3}\psi_m ln\left(w_{m,it}\right) -$$
$$+\frac{1}{2}\sum_{j=1}^{3}\sum_{k=1}^{3}\beta_{jk}\times ln(y_{it})ln(y_{kt}) + \frac{1}{2}\sum_{m=1}^{3}\sum_{n=1}^{3}\psi_{mn}\times ln(w_{m,it})ln(w_{n,it}) -$$
$$+ \sum_{j=1}^{3}\sum_{m=1}^{3}\varpi_{jm}ln\left(y_{j,it}\right)ln(w_{m,it}) + \tau_1 t + \tau_2 t^2 + v_{it} + u_{it}\ (1)$$

Operation risk indicator

Starting on January 1, 2022, the final Basel regulations governing operational risk capital needs will be enforced. These regulations were published in December 2017. All three previous methods for assessing operational risk capital have been superseded by the Standardized Approach (SA), a single non-model-based method, under Basel III. There are three primary components to this method. Firstly, there is the Business Indicator (BI), which is used to depict operational risk in financial statements. Secondly, there is the Business Indicator Component (BIC), which modifies the BI with a set of marginal coefficients (αi) decided by regulators. Lastly, there is the Internal Loss Multiplier (ILM), which modifies the BIC to account for the average historical losses of the bank. Since there is a dearth of comprehensive data on operational risk losses within an organization that spans a decade, we utilize the BI to gauge the operational risk exposure of banks.

Data sources and sample statistics

From 2016 to 2023, our sample comprises data from 118 different commercial banks in China. These financial institutions, which comprise 74 metropolitan banks, 27 rural banks, 5 state- owned banks, and 12 joint-stock banks, account for more than 95% of the market's total assets. Since the use of cloud computing was progressively expanded after 2023, the sample begins in 2016. Every single bank has records going back at least three years. To reduce the impact of data errors and outliers, all continuous variables were winorized at the 2.5% level. Using FitchSolution, we compile financial data for banks. Table 1 displays various sample statistics, including the most recent Basel Committee recommendations, our novel computing index, forecasted cost and profit efficiency, and computed operating risk indicator.

Table 1: Descriptive statistics

High-Tech Indices:

Variables	Observations	Mean	Std. Dev.	Min	Max
Cloud Adoption (Cloudit)	1053	0.100	0.191	0	0.9
Big Data Technology (Bigdatait)	1053	0.129	0.225	0	0.9
Blockchain Innovation (Blockchainit)	1053	0.081	0.173	0	0.9
Internet Technology (Internetit)	1053	0.205	0.291	0	0.9
Artificial Intelligence (AIit)	1053	0.033	0.091	0	0.9
High-Tech Presence (HighTechit)	1053	0.115	0.188	0	0.9

Bank Efficiency Indicators:

Variables	Observations	Mean	Std. Dev.	Min	Max
Total Costs (TCit)	1054	32.469	78.850	0.103	496.240
Total Profit (TPit)	1054	16.969	49.404	0.008	355.272
Net Loan (y1it)	1054	599.725	1702.538	2.098	12,800
Other Earning Assets (y2it)	1054	432.474	1054.088	2.594	7,565.485
Non-interest Income (y3it)	1054	7.780	21.864	0	144.906
Price of Funds (w1it)	1054	0.023	0.006	0.003	0.049
Price of Labor (w2it)	1054	0.005	0.002	0.002	0.012
Price of Capital (w3it)	1054	0.740	0.765	0.124	11.465
Cost Efficiency (CEit)	1054	0.983	0.015	0.841	0.998
Profit Efficiency (PEit)	1054	0.781	0.184	0.181	1

Operational Risk Factors:

Variables	Observations	Mean	Std. Dev.	Min	Max
Dividend Yield (Dividendit)	1053	0.031	0.274	0	7.204
Net Fee Income (Net Feeit)	1053	6.168	18.145	- 0.595	125.612
Gain from Banking Book (Net Gain Banking bookit)	1053	0.188	1.345	- 8.739	15.506
Gain from Trading Book (Net Gain Trading bookit)	1053	0.779	2.190	- 7.365	22.490
Net Interest Income (Net Interest Incomeit)	1053	25.500	69.790	0.031	477.827
Other Operating Income (Other Operation Incomeit)	1053	1.248	3.641	- 1.186	55.654
Other Operating Expenses (Other Operation Expenseit)	1053	4.495	11.680	0.025	75.060
Operational Risk (ORit)	994	7.090	20.031	0.033	135.405

Control Variables:

Variables	Observations	Mean	Std. Dev.	Min	Max
Total Assets (Sizeit)	1054	1209.078	3249.111	9.071	23,700
Non-performing Loan Ratio (NPLit)	906	0.017	0.035	5.49E- 07	0.988
Tier 1 Capital Ratio (Tier1it)	941	10.760	2.884	3.25	58.56
Equity to Assets Ratio (EAit)	1054	7.001	1.808	2.19	30.81
Return on Equity (ROEit)	975	15.202	10.781	0.26	292.90

Ownership Structures:

Variables	Observations	Mean	Std. Dev.	Min	Max
State-owned Commercial Banks (SOCBi)	1053	0.057	0.231	0	1
Joint-stock Commercial Banks (JSCBi)	1053	0.120	0.326	0	1
City Commercial Banks (CCBi)	1053	0.610	0.487	0	1
Rural Commercial Banks (RCBi)	1053	0.210	0.407	0	1

This tables reports descriptive statistics of variables used in our analysis over the period 20016– 2023.

IV. EMPIRICAL RESULTS

The effect of cloud computing on bank cost efficiency

The results of the cost-effectiveness analysis are shown in Table 2. The large negative coefficient on Cloudit demonstrates that cloud computing applications hurt cost efficiency. The impact on the economy may be little, but it is substantial from a statistical standpoint. If the cloud computing index increases by one standard deviation, the cost efficiency decreases by less than one seventh of the standard deviation ($(0.010 \times 0.191)/0.015 = 1/7$).

The savings that were anticipated from using cloud computing apps have not yet come to fruition. Cloud computing applications are still in their early stages of change. The conventional infrastructure continues to function, even if there will be an upfront investment in research and development, infrastructure, and human resources due to the transition. The predicted benefits of moving to cloud computing are not worth the overall price. Column (2) shows the baseline model with bank ownership included; Column (1) shows that when SOCBs are omitted from the regression as the control group, the coefficient on Cloud is negative and significant.

It appears that there is little to no difference in the cost-effectiveness of the performance of the three Chinese banks (JCB, CCB, and RCB) because the coefficients on these variables are not statistically significant.

Table 2: Cloud computing's impact on efficiency and cost

Variables	Dependent variable:					
	Cost efficiency			Cost efficiency rank		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Cloudit	-0.010	-0.010	-0.013	-31.602	-31.602	-35.936
Empty Cell	(0.002)	(0.002)	(0.004)	(8.800)	(8.800)	(12.766)
JSCBi		-0.004	-0.009		-28.846	-46.489
Empty Cell		(0.010)	(0.012)		(30.591)	(33.913)
CCBi		-0.004	-0.010		-30.965	-54.838
Empty Cell		(0.014)	(0.016)		(38.880)	(43.175)

RCBi		-0.004	-0.013		-36.062	-68.591
Empty Cell		(0.019)	(0.022)		(62.919)	(67.893)
JSCBi× Cloudit			0.001			-1.854
Empty Cell			(0.004)			(14.303)
CCBi× Cloudit			0.010**			36.624*
Empty Cell			(0.005)			(19.311)
RCBi× Cloudit			0.008			-13.669
Empty Cell			(0.005)			(22.838)
Control variables						
Sizeit	0.002	0.002	-0.002	-2.198	-2.198	-7.093
Empty Cell	(0.003)	(0.003)	(0.003)	(7.848)	(7.848)	(8.577)
NPLit	0.012***	0.012***	0.012***	35.685**	35.685**	35.378**
Empty Cell	(0.004)	(0.004)	(0.004)	(15.737)	(15.737)	(15.929)
Tier1it	0.001**	0.001**	0.001**	2.170***	2.170***	2.252***
Empty Cell	(0.000)	(0.000)	(0.000)	(0.582)	(0.582)	(0.580)
Constant	0.980***	0.980***	0.999***	57.710	57.710	134.645
Empty Cell	(0.046)	(0.046)	(0.052)	(124.555)	(124.555)	(136.734)
Bank & Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	822	822	822	822	822	822
Sigma/Adj.R^2	0.006	0.006	0.006	0.098	0.098	0.102

Table 3: Cloud computing's impact on operational risk in banks

Variables	Dependent variable: Operational risk			
Empty Cell	**(1)**	**(2)**	**(3)**	**(4)**
Cloudit	0.185	0.185	-0.235	-0.214
Empty Cell	(0.064)	(0.064)	(0.069)	(0.069)
JSCBi		-1.214***	-1.873***	-1.912***
Empty Cell		(0.282)	(0.303)	(0.276)
CCBi		-2.149***	-2.936***	-2.905***
Empty Cell		(0.358)	(0.382)	(0.360)
RCBi		-2.039***	-3.067***	-3.029***
Empty Cell		(0.477)	(0.512)	(0.481)

JSCBi× Cloudit			0.535***	0.557***	
Empty Cell			(0.051)	(0.053)	
CCBi× Cloudit			0.750***	0.757***	
Empty Cell			(0.171)	(0.170)	
RCBi× Cloudit			0.435***	0.452***	
EmptyCell			(0.152)	(0.148)	
Control variables					
Sizeit	0.673***	0.673***	0.542***	0.545***	
Empty Cell	(0.075)	(0.075)	(0.080)	(0.072)	
NPLit	0.558***	0.558***	0.516***	0.496**	
Empty Cell	(0.212)	(0.212)	(0.197)	(0.202)	
EAit	0.015	0.015	0.010		
Empty Cell	(0.012)	(0.012)	(0.013)		
ROEit	-0.003	-0.003	-0.002		
Empty Cell	(0.003)	(0.003)	(0.003)		
constant	-0.326	-0.326	1.898	1.889	
Empty Cell	(1.213)	(1.213)	(1.296)	(1.151)	
Bank & Year FE	Yes	Yes	Yes	Yes	
Observations	826	826	826	870	
Adjusted-R^2	0.981	0.981	0.982	0.981	

Table 4 shows that banks' profitability (ROA and ROE) and an increased overhead-to-equity ratio are both correlated with the cloud computing index. All of the predicted coefficients on the ownership and control variables have been found. The findings corroborate our primary findings, which show that cloud computing raises expenses but yields significant profits mainly as a consequence of a more rapid growth in income.

Table 4: Cloud computing's impact on financial institutions' efficiency

Variables	Dependent variable:					
	Overhead to equity ratio		Return on assets		Return on equity	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Cloudit	0.130	0.151	0.172	0.183	3.304	5.356
Empty Cell	(0.004)	(0.028)	(0.060)	(0.073)	(0.915)	(1.079)
JSCBi	0.026	0.051	0.238	0.266	12.488***	15.492***
Empty Cell	(0.909)	(0.850)	(0.235)	(0.274)	(3.886)	(4.344)

CCBi	-0.260	-0.230	0.641*	0.679*	18.178***	21.860***
Empty Cell	(0.406)	(0.527)	(0.354)	(0.415)	(5.743)	(6.471)
RCBi	0.118	0.155	1.243**	1.295**	26.835***	31.573***
Empty Cell	(0.797)	(0.766)	(0.364)	(0.416)	(5.998)	(6.601)
JSCBi× Cloudit		-0.024		0.007		-2.763***
Empty Cell		(0.723)		(0.058)		(0.910)
CCBi× Cloudit		-0.034		-0.062		-3.442**
Empty Cell		(0.753)		(0.119)		(1.921)
RCBi× Cloudit		-0.056		-0.042		-1.143
Empty Cell		(0.631)		(0.157)		(2.221)
Control variables						
Sizeit	0.005	0.005	0.083	0.090	3.511	4.096
Empty Cell	(0.923)	(0.923)	(0.066)	(0.075)	(1.124)	(1.224)
NPLit	0.108*	0.108*	-0.055	-0.056	-1.738	-1.577
Empty Cell	(0.093)	(0.093)	(0.154)	(0.155)	(3.136)	(3.011)
Tier1it	-0.064***	-0.064***	0.029***	0.028***	-0.395***	-0.405***
Empty Cell	(0.000)	(0.000)	(0.008)	(0.008)	(0.138)	(0.141)
constant	-0.903	-0.903	-0.591	-0.707	-31.888*	-41.784**
Empty Cell	(0.385)	(0.385)	(1.070)	(1.206)	(18.550)	(20.081)
Bank & Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	822	822	777	777	776	776
Adjusted-R^2	0.831	0.831	0.732	0.731	0.745	0.746

V. CONCLUSION

Using text-based filtering methods and information crawling technology, we build a new cloud computing index and look at how cloud computing affects operational risk and bank efficiency. We also look at how this effect changes depending on who owns the bank and whether other new technologies are used. The following are our primary conclusions. The first finding is that banks who use cloud computing are less efficient with costs but more efficient with profits. Second, cloud computing typically raises operational risk for banks. But this impact changes drastically depending on who owns the bank: operational risk goes down at state-owned banks but up at every other kind of bank. Three, there is some preliminary evidence that cloud computing influences operational risk and bank efficiency through interactions with other new technologies. When it comes to managing operational risk, we discover evidence of widespread synergy gains. Policymakers, regulators, and bank managers can all benefit practically from the results, which are of urgent policy significance. The banking industry's use of cloud computing is in its early stages of transformation, and the full impact of this technology is yet unknown. Cloud computing and other new technology's effects on the financial industry warrant more study.

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