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Research on big data technology application capability in Guangdong banking industry

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Abstract

This study examines the impact of digital dynamic capabilities on bank performance in Guangdong Province, focusing on big data technologies, data application modules, dynamic data modeling efficiency, and technology talent. The study uses big data visualization and regression analysis, collecting data from Guangdong banks between 2015 and 2023, to explore the relationship between digital dynamic capabilities and bank performance. The analysis finds that big data technology investment has the largest positive impact on performance, followed by data application modules, dynamic data modeling efficiency, and the proportion of big data technology personnel. The study highlights the importance of investment in big data, effective data application, and skilled personnel in enhancing bank performance, with large state-owned banks leading the digital transformation. Banks should focus on increasing big data investment, expanding data application modules, and developing a strong data talent pool to drive their digital transformation and improve performance.

Keywords: Big Data, Bank Performance, Data Application Modules, Digital Dynamic Capabilities, Dynamic Data Modeling, Technology Talent.

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1. Introduction

Against the backdrop of profound changes in the global economic landscape, China's banking industry is standing at a critical point of digital transformation. As an important pillar of the national economy, the quality of the banking industry's development is not only related to the stability of the financial system but also directly affects the high-quality development of the national economy [1]. Especially under the strategic guidance of building a new development pattern of 'double cycle,' how to realize the innovative development of the banking industry through digital transformation has become an important issue concerning national financial security and economic transformation and upgrading [2]. At present, the rapid development of a new generation of information technology, represented by big data and artificial intelligence, has brought unprecedented opportunities for the banking industry but has also exposed the shortcomings of traditional banks in

technological innovation, organizational change, and value creation. Therefore, building a digital dynamic capability system that adapts to the requirements of the digital era has become the key to realizing high-quality development in the banking industry [3].

As the frontier of China's reform and opening up, Guangdong Province has a remarkable demonstration significance in the development of its banking industry. in 2022, the total assets of the banking industry in Guangdong Province exceeded 30 trillion-yuan, accounting for more than one-tenth of the total assets of the national banking industry, and playing a pivotal role in the construction of the Guangdong-Hong Kong-Macao Greater Bay Area. However, with the increasing downward pressure on the economy and the task of financial risk prevention and control, the banking industry in Guangdong Province is facing an urgent need for transformation and upgrading. Especially under the wave of digitization, how to realize the transformation from scale expansion to quality enhancement by building a digital dynamic capability system has become a core issue to be solved by the banking industry in Guangdong Province [4]. The solution to this problem is not only related to regional financial stability but also of great significance as a model for the digital transformation of the national banking industry.

From the perspective of the current state of theoretical research, there are two obvious shortcomings in the existing research: first, it is too concerned about the application of the technical level, ignoring the systematic changes brought about by digital transformation to the organizational structure, business processes, and management mode of the banking industry [5, 6]; second, it is the lack of in-depth exploration of the mechanism of the role between the digital dynamic capabilities and the performance of the bank, especially in the context of the institutional environment of Chinese characteristics of the relative scarcity of empirical research [7, 8]. These theoretical gaps not only restrict academics' in-depth understanding of the laws of digital transformation in the banking industry but also affect the practical effects of digital transformation in the banking industry to a certain extent. Therefore, it is of significant theoretical innovation value to construct a theoretical framework of digital dynamic capabilities that meets the characteristics of China's banking industry and to explore its relationship with bank performance in depth.

Based on the real needs of China's banking industry development, this study focuses on the mechanism of the impact of digital dynamic capabilities on bank performance, taking the banking industry in Guangdong Province as the object of study. The study addresses three key questions: first, what are the connotations and components of digital dynamic capabilities in the banking industry under the institutional environment with Chinese characteristics? Second, how does digital dynamic capability affect bank performance through innovative means such as big data analytics? Third, how can the banking industry in Guangdong Province build a digital dynamic capability system with regional characteristics in the context of the construction of the Guangdong-Hong Kong-Macao Greater Bay Area? By answering these questions, this study aims to provide theoretical guidance and practical reference for the digital transformation of the banking industry.

This study adopts big data visualization and analysis techniques to reveal the impact mechanism of digital dynamic capabilities on bank performance through a data-driven perspective. Specifically, the study will collect multi-source data from the banking industry in Guangdong Province during the process of digital transformation, including financial data, business data, customer data, etc., and use advanced visualization tools and techniques to build a dynamic and interactive data analysis platform. Through data visualization, the study will intuitively present the components of digital dynamic capabilities and their impact paths on bank performance, providing banking managers with intuitive and easy-to-understand decision support tools.

2. Literature Review

2.1. Advances in Bank Performance Assessment Research

Bank performance assessment has always been a core topic in financial research, and with the continuous digital transformation of the banking industry, how to build an assessment system that adapts to the development of the new era has become an important part of academic discussions [9-11]. Early studies on bank performance relied on traditional financial indicators, such as return on assets (ROA) and capital adequacy ratio, which, although reflecting the basic operating conditions of banks, are difficult to comprehensively measure the comprehensive competitiveness of banks and their adaptability in complex market environments [12]. Therefore, many scholars have proposed more comprehensive performance assessment methods, such as Data Envelopment Analysis (DEA) and Balanced Scorecard (BSC)-based comprehensive assessment methods, which examine bank performance through multidimensional indicators, evaluating it in terms of finance, customers, internal processes, and learning and growth [13, 14].

However, even though these multidimensional assessment methods can reflect bank performance in a more comprehensive way, there are two significant limitations in the existing research: first, it lacks an in-depth exploration of how banks can redefine their performance assessment systems in the process of digital transformation; and second, it fails to adequately examine the mechanisms of how digital technology empowers banks to improve their performance. Especially in the context of the increasing penetration of technologies such as big data and artificial intelligence into the banking business, the traditional assessment system is gradually showing the limitations of not being able to adapt to the application of new technologies and market changes. Therefore, the issue of innovation and application of digital transformation to bank performance assessment systems still requires further research [15].

2.2. Application of Big Data in the Banking Industry

The rapid development of big data technology provides unprecedented innovation opportunities for the banking industry. Initially, big data applications were mainly focused on the fields of risk management and customer relationship management. For example, through big data analysis, banks were able to effectively identify potential credit risks and

optimize the loan approval process, thus improving their ability to control risk [16]. With the development of technology, the application scenarios in the banking industry have gradually expanded to core business aspects such as product innovation, process optimization, and personalized service. Studies have shown that by utilizing big data analytics, banks can not only improve operational efficiency but also enhance customer experience and market competitiveness through accurate customer data mining [17].

While the Chinese banking industry has made significant progress in the application of big data, with innovative practices such as the "Smart Bank" of the Construction Bank and the "Fintech Bank" of the China Merchants Bank, most of the existing research focuses on the application of the technology itself, with less attention paid to how big data can generate comprehensive benefits during the process of digital transformation of banks [18, 19]. However, most of the existing research focuses on the application of technology itself and pays less attention to how big data can generate comprehensive benefits in the process of bank digital transformation. Especially in the financial regulatory environment with Chinese characteristics, how to find a balance between the application of big data and compliance requirements has become an urgent issue in the digital transformation of the banking industry [20, 21]. Overall, existing research mostly focuses on the single dimension of technology and lacks systematic thinking about big data-enabled bank transformation, especially the trade-offs between efficiency and risk, innovation, and security, which remains an important gap in research.

2.3. Digital Dynamic Capabilities and Bank Performance

The theory of digital dynamic capabilities provides an important perspective for understanding digital transformation in banks. Digital dynamic capabilities are defined as an organization's ability to integrate, optimize, and reconfigure its resources and capabilities through digital technologies in a changing market environment [22]. In the banking industry, digital dynamic capabilities can be examined in three dimensions: technology application capabilities, organizational change capabilities, and value creation capabilities [23, 24]. Technology application capability refers to how banks effectively use digital technology to optimize existing business processes and improve operational efficiency; organizational change capability refers to how banks adjust their organizational structure and management model to adapt to external changes when facing digital transformation; and value creation capability emphasizes the innovation of bank products and services through digital technology, which in turn improves market competitiveness and customer satisfaction [25].

Notwithstanding the extensive theoretical attention paid to digital dynamic capabilities, existing research still focuses on theoretical construction and lacks empirical research on the application and formation mechanism of digital dynamic capabilities in Chinese banking practice [24]. Especially under China's unique market environment and financial regulatory policies, how to build a digital dynamic capabilities system adapted to China's banking industry is still an under-explored topic. Existing literature mainly focuses on digital dynamic capability models in the global banking industry, but how to apply these theoretical frameworks specifically to the banking industry in the Chinese market still requires in-depth research [23].

2.4. Big Data Visual Analytics and Banking Innovation

Big data visual analytics helps decision-makers quickly identify business trends and potential opportunities by transforming complex banking data into easy-to-understand graphs and charts. In the application of the banking industry, big data visualization has been widely used in many fields such as risk management, marketing, and customer service. For example, the Industrial and Commercial Bank of China (ICBC) and Ping An Bank (PBOC) have improved their risk management capability and marketing efficiency by using big data visualization technology through their "Smart Risk Control" system and "Smart Marketing" platform, respectively [26, 27]. The wide application of this technology can not only help banks identify potential problems in complicated data but also provide data support in the decision-making process, which provides strong technical support for bank innovation [28].

However, existing research has mainly focused on the study of big data visualization technology itself, and less on how it can be integrated with banks' strategic decision-making, especially its specific role in driving bank innovation [29]. While visual analytics can help improve data readability and decision-making efficiency, there is a lack of in-depth academic discussion on how it can work in tandem with a bank's digital dynamic capabilities to promote innovation and performance improvement. Therefore, how to combine big data visualization with digital dynamic capabilities to drive bank innovation and achieve performance improvement is an important direction for future research.

2.5. Research Gaps and Innovations

The literature review shows that there are several obvious shortcomings in the existing research as follows. First, most of the studies fail to fully consider the specificities of the Chinese banking industry in digital transformation, especially under China's unique financial market and regulatory environment. There is still a lack of systematic research on how banks can use big data and digital dynamic capabilities to enhance their performance [30, 31]. Second, although the theory of digital dynamic capabilities has been widely used globally, the practical application and impact paths regarding its application in the Chinese banking industry are still in the preliminary stage. Finally, most of the existing research focuses on the technical application level of big data and digital dynamic capabilities and lacks in-depth research on their synergistic role in bank innovation and strategic decision-making. These research gaps provide room for innovation in this paper [32, 33]. Based on the existing theoretical framework, this paper will explore in-depth how digital technology can drive performance improvement in China's banking industry and reveal the specific role of digital dynamic capabilities in

banks' digital transformation through the big data visualization and analysis method and the perspective of digital dynamic capabilities.

3. Research Methodology

The main objective of this study is to explore the role of digital dynamic capabilities of banks in Guangdong Province in enhancing bank performance through big data visualization and analysis. The research design relies on existing bank financial data, secondary data related to digital transformation, and data on the application of big data technology to construct an analytical model that reveals the relationship between different dimensions of digital dynamic capabilities and bank performance.

To this end, this study adopts a quantitative analysis approach, focusing on regression analysis and factor analysis, to systematically assess how digital dynamic capabilities can ultimately enhance bank performance by optimizing the bank's technological application, organizational change, and value creation capabilities through multi-dimensional mining of data. Each step of data collection and model construction in the research design will strictly control the accuracy and representativeness of the data to ensure the reliability and validity of the analysis results.

The data sources of this study are all publicly available secondary data, which mainly cover the following aspects: firstly, bank financial data are derived from the financial statements of major banks in Guangdong Province, including balance sheets, profit and loss statements, and cash flow statements, etc., which help to assess the operational performance of banks, such as profitability, capital adequacy, and return on assets. Second, data on banks' digital transformation and technology application are mainly collected through publicly available annual reports, digital transformation project reports, and industry research reports, which reflect banks' investment in digital technology application, project implementation effects, and technology level enhancement. In addition, data on the application of big data technology, artificial intelligence, and other areas are also collected through banks' public digitalization project reports and technology development data, revealing the key role of digital dynamic capabilities in banks' digital transformation. The above data are highly representative and reliable, providing a solid foundation for subsequent analysis.

This study mainly adopts regression analysis combined with big data visualization analysis techniques to comprehensively investigate the impact of digital dynamic capabilities on bank performance. First of all, big data visualization analysis will be used as an important tool in this study to help find out the path of the impact of digital dynamics on bank performance by presenting the financial data and digital transformation data of the bank. Power BI, a data visualization tool, is used to show the comparison of bank performance under different levels of digital capability, the correlation between digital capability and financial indicators (e.g., return on assets, market share, etc.), and the trend of the impact of digital capability on bank performance over time. These visualized results provide an intuitive basis for regression analysis and valuable insights for researchers and policymakers. Regression analysis can quantify the specific impact of each dimension of digital capability on bank performance.

4. Research Results

This study systematically explores the development of banks in Guangdong Province in terms of investment in big data technology, data application modules, dynamic data modeling efficiency, and technology talent ratios using big data visualization technology. It further analyzes its impact on overall bank performance. The data collection period is June to September 2024, and the data sources are government statistics and publicly available data statements of major banks (2015-2023).

4.1. Investment Analysis of Big Data Technology in Guangdong Banks

The investment in big data technology by major banks in Guangdong Province varies widely. Figure 1-4 demonstrates the banks' investment in big data technologies. It shows that large state-owned banks, such as the Industrial and Commercial Bank of China, the Construction Bank of China, and the Bank of China, generally have higher investments in big data technologies, with an average investment of more than 600 million yuan, while joint-stock commercial banks, such as the Guangdong Development Bank and the Everbright Bank, have relatively lower investments of about 300-400 million yuan. Overall, there is a positive correlation between a bank's asset size and its big data investment, and banks with stronger financial strength usually have stronger technology research and development funds, which gives them a first-mover advantage in digital transformation. However, investment alone cannot fully explain banks' improved performance; it is the efficiency of the application of big data technology and the degree of data governance improvement that are the key variables affecting final performance.

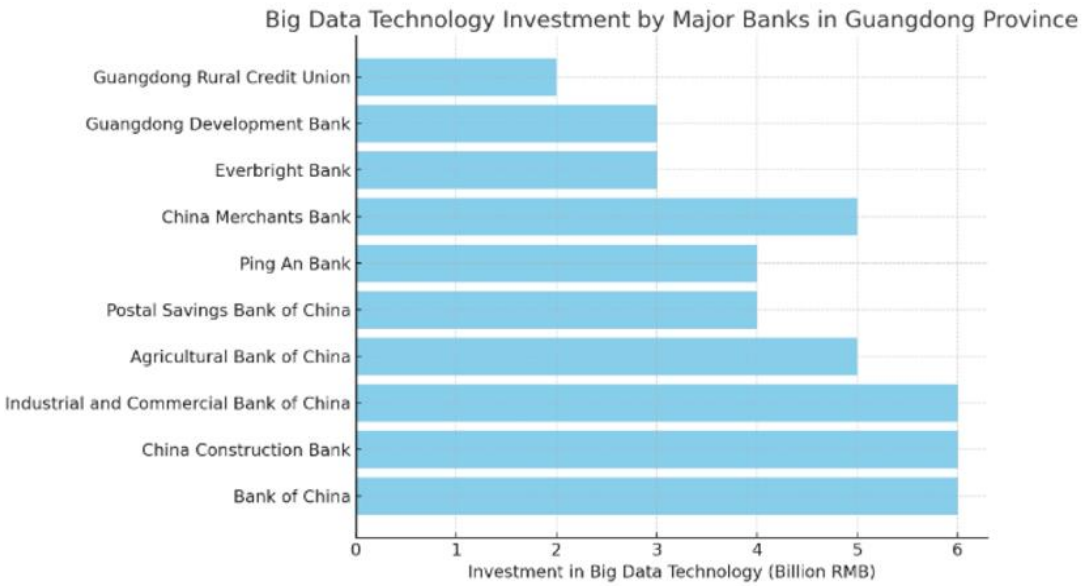

Figure 1.
Big data technology investments by major banks.

4.2. Utilization of the Data Application Modules

In Figure 2, the heat map demonstrates the adoption of different data application modules by major banks in Guangdong Province from 2015 to 2023. By means of color shades, the diagram visually reflects the extent of adoption of big data modules by banks in different years. Analytical results show that large state-owned banks, such as the Bank of China (BOC), China Construction Bank (CCB), Industrial and Commercial Bank of China (ICBC), and Agricultural Bank of China (ABAC), have been gradually adding data application modules since 2015 and significantly expanding them after 2020, especially in the areas of intelligent risk control and precision marketing. In contrast, joint-stock banks and some city banks were slower to adopt modules, focusing mainly on customer management and risk assessment, and their growth did not accelerate until after 2020; however, the overall level was still lower than that of large banks. As a whole, the number of data application modules in a bank is closely related to its size and financial strength, with large banks undergoing more rapid digital transformation, while small and medium-sized banks are lagging behind, with module growth mainly concentrated in traditional business areas.

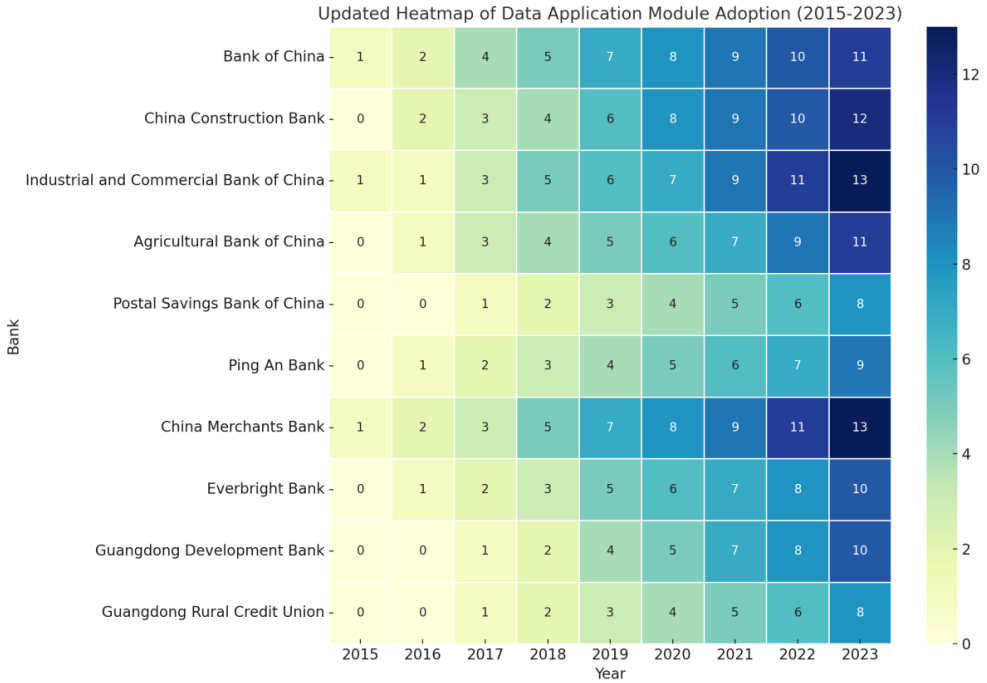

Figure 2.
Growth of data application modules by banks.

4.3. Cost-benefit Analysis of Banks' Big Data Technology Investments

Figure 3 illustrates the trend in the cost-benefit ratio of big data technology investments by major banks in Guangdong Province over the period from 2015 to 2023. From 2015 to 2018, the return on big data investments was low for most banks, especially in 2015-2017, when the return was close to between 0.1 and 0.4, reflecting the fact that banks faced greater initial technological upgrades, capital consumption, and operational adjustment pressure. The application of big data technology has focused on infrastructure development, technology introduction, and staff training, and thus failed to generate significant economic returns in the short term. However, starting from 2019, the return on investment of all banks gradually increased, especially in 2020-2021, when the return rate showed significant growth, with the return rate of several banks exceeding 1.0, indicating that the application of big data technology gradually brought actual economic benefits.

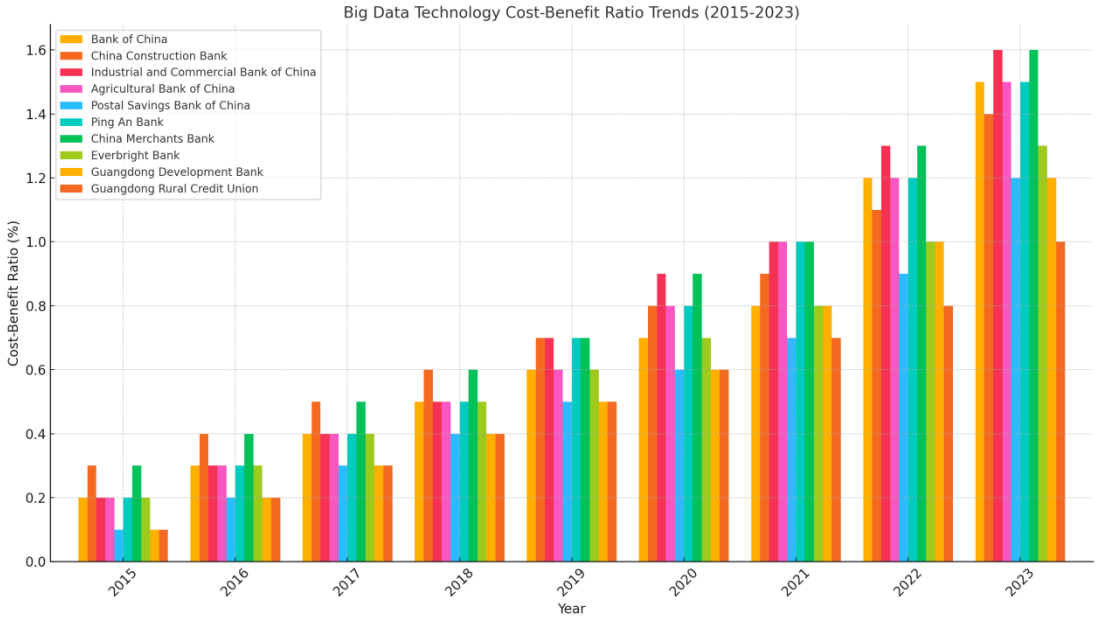

Figure 3.
Trends in the cost-benefit ratio of big data technologies.

In 2022-2023, banks' returns on big data investments continue to grow steadily, with returns stabilizing at between 1.2 and 1.6 for some banks. This growth trend suggests that as big data technology matures, banks will be able to achieve more efficient operations in areas such as intelligent risk control, precision marketing, and personalized services, thereby improving profitability. In particular, the surge in demand for online financial services during the 2020 epidemic further boosted banks' technology adoption on digital channels, driving returns on investments in big data technology. With the continuous optimization of data systems and intelligent algorithms, the operational efficiency of banks was improved, further enhancing their competitiveness in the market.

4.4. Relationship between Dynamic Data Modeling Capabilities and Bank Performance

In Figure 4, the horizontal axis represents the bank's dynamic data modeling efficiency and the vertical axis shows the bank's overall operational effectiveness score. The size of the bubble reflects the bank's investment or technical complexity in data modeling. Overall, the overall operational effectiveness of most banks is also more prominent when they have higher dynamic data modeling efficiency, especially ICBC and ABC, which have more than 40% modeling efficiency and higher operational effectiveness scores. This suggests that higher modeling efficiency usually helps banks improve decision accuracy and risk control, which in turn improves overall operational effectiveness.

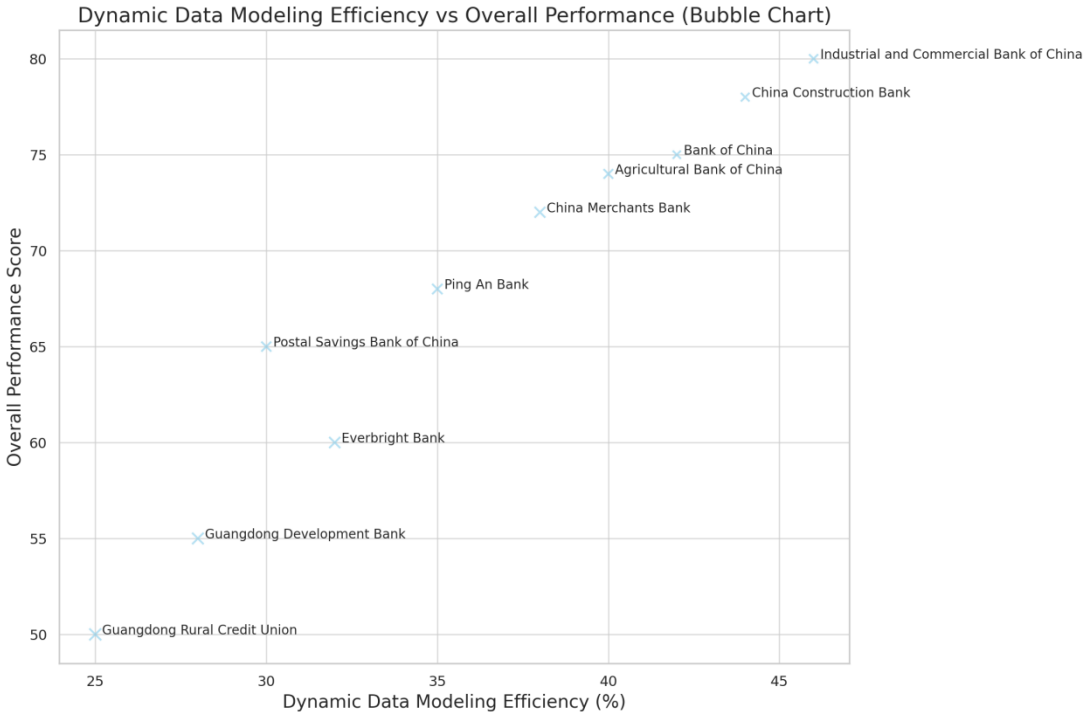

Figure 4.
Dynamic data modeling efficiency vs. overall effectiveness.

However, although some banks have invested more in data modeling, their modeling systems are overly complex due to insufficient data governance capabilities, which increases the computational burden and maintenance costs, and in turn, reduces overall operational effectiveness. The bubbles of these banks are located in the lower left of the chart, indicating their low modeling efficiency and unsatisfactory operational effectiveness. Generally, there is a positive correlation between a bank's modeling efficiency and operational effectiveness, but overly complex models and poor data governance may have a negative impact.

4.5. Trends in Big Data Technician Sizing

Figure 5 shows the growth trend of the number of big data technicians in the banking industry in Guangdong Province from 2015 to 2023. It can be seen that the number of big data technicians in banks has been growing steadily, especially after 2019, when the number of personnel has grown significantly faster. This reflects the increasing demand for big data technology in banks and the fact that the pool of big data talent has become a key factor for banks in digital transformation and fintech innovation. The data in the chart shows that banks have increased their investment in big data technology teams in recent years to cope with the rapidly changing financial environment.

In addition, the rapid growth in the chart, especially with 2020 as a notable node, may be closely related to the accelerated digital transformation of banks and the surge in demand for online financial services during the epidemic. This change suggests that banks are gradually strengthening their pool of data science and technology talent to enhance their capabilities in big data applications. Altogether, the growth in banks' demand for big data technicians suggests that data-driven business innovation and accurate decision-making are becoming one of the core competencies for banks' development.

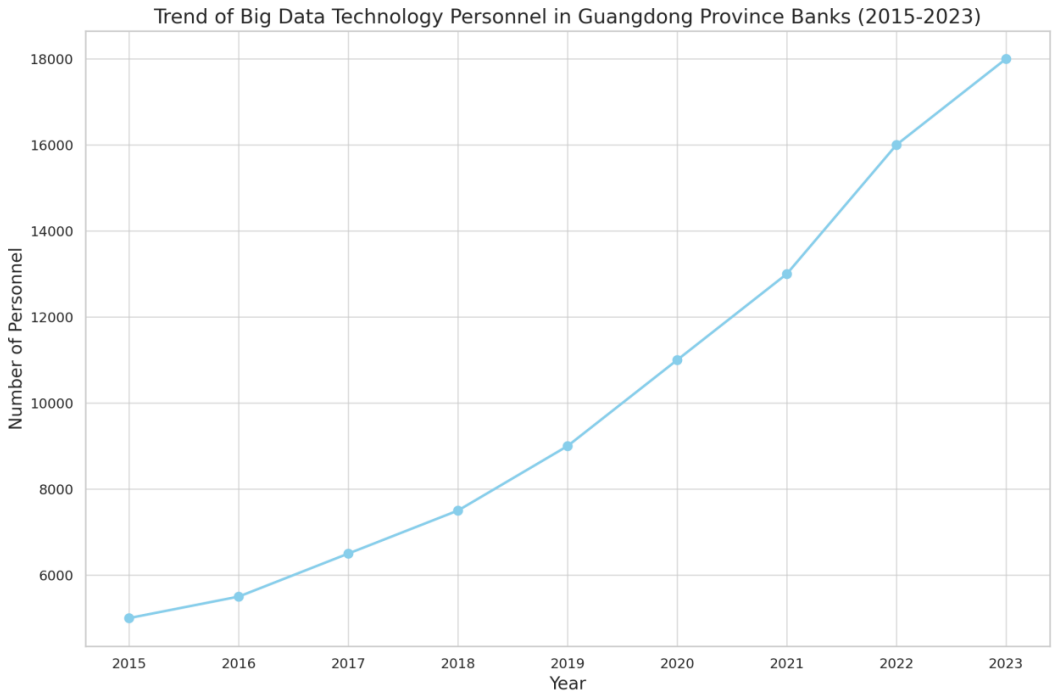

Figure 5.
Big Data Technician Trends at Guangdong Banks.

4.6. Regression Analysis of Factors Related to Banks' Big Data Capabilities

Big data technology investment has the greatest impact on bank performance, with a factor loading of 0.88, an eigenvalue of 3.6, and a variance explained of 36%. This indicates that banks with more significant financial investments tend to possess stronger data analysis and processing capabilities, which allow them to leverage big data technology more effectively to enhance performance. Secondly, data application modules and dynamic data modeling efficiency also play important roles in influencing bank performance. The factor loading for data application modules is 0.80, with an eigenvalue of 3.1 and a variance explained of 31%, while the factor loading for dynamic data modeling efficiency is 0.78, with an eigenvalue of 2.7 and a variance explained of 27%. This suggests that, while investment in hardware and infrastructure is important, the breadth and depth of data application, as well as the efficiency of dynamic data modeling, are also key drivers of a bank's competitiveness. Lastly, the proportion of big data technology personnel also positively impacts bank performance. With a factor loading of 0.74, an eigenvalue of 2.3, and a variance explained of 23%, this highlights that talent reserves play a crucial role in enhancing the bank's digital dynamic capabilities.

Table 1 shows the factor analysis results for the factors influencing bank performance, including factor loadings, eigenvalues, and variance explained, further clarifying the roles and impacts of each factor on bank performance.

Table 1.
Results of factor analysis affecting bank performance.

Factors	Factor Loadings	Eigenvalue	Variance Explained (%)
Big Data Technology Investment	0.880	3.600	36
Data Application Modules	0.800	3.100	31
Dynamic Data Modeling Efficiency	0.780	2.700	27
Big Data Technology Personnel Ratio	0.740	2.300	23

Multiple regression analysis explores the various factors that affect bank performance, specifically investment in big data technology, data application modules, dynamic data modeling efficiency, and the percentage of big data technicians. The impact of these factors on bank performance can be quantified more precisely through regression modeling. The results are shown in Table 2.

Table 2.
Results of multiple regression analysis

Factor	Coefficient (β)	Standard Error	*t*-Statistic	*p*-Value
Big Data Technology Investment	0.450	0.080	5.630	0.000
Data Application Modules	0.380	0.070	5.430	0.000
Dynamic Data Modeling Efficiency	0.310	0.060	5.170	0.000
Big Data Technology Personnel Ratio	0.290	0.050	5.800	0.000
Intercept (β_0)	1.150	0.230	5.000	0.000

The magnitude and sign of the regression coefficients reflect the extent and direction of the impact of each factor on bank performance. The large and positive regression coefficients for investment in big data technology indicate that banks' investment in big data has a significant positive effect on their performance. Data application modules and dynamic data modeling efficiency also positively affect bank performance, especially in terms of technical capabilities and application depth; the more a bank engages in these two areas, the more it can improve its market competitiveness and decision-making accuracy. The proportion of big data technicians, while having a smaller impact on performance, also indicates that the competence and staffing ratio of the technical team determines the effectiveness and execution of the implementation of big data technologies to a certain extent during the digital transformation process.

The table shows the detailed output of the regression analysis, including the regression coefficients, standard errors, t-statistics, and p-values for each factor. The p-values of all the factors are significantly less than 0.05, indicating that their impact on bank performance is statistically significant. The positive values of the regression coefficients further validate the positive effect of these factors on bank performance. Based on these results, banks should pay attention to the investment and application of big data technology, as well as strengthen their data modeling capabilities and talent team building, in order to fully utilize the potential of big data in business innovation and market competition.

5. Discussions

The results of the analysis indicate that investment in big data technology is a key factor in improving bank performance. The regression analysis reveals that investment in big data technology has the strongest positive driving effect on bank performance. Higher investment implies that banks can allocate resources more efficiently in terms of data infrastructure, advanced technology introduction, and data processing capabilities. This finding emphasizes the importance of adequate capital for banks to build capacity in the big data space. However, capital investment alone is not sufficient to fully explain the performance improvement; banks must ensure that technology investments can be effectively applied and strengthen data governance mechanisms in order to fully utilize the benefits of big data technologies [17, 34].

Data application modules and dynamic data modeling efficiency also have a significant impact on bank performance. Large state-owned banks usually have more data application modules and higher dynamic data modeling efficiency, which enables them to apply big data technology more widely, thus improving operational efficiency and market competitiveness. Particularly in areas such as intelligent risk control and precision marketing, banks have not only improved their technological capabilities but also enhanced decision-making accuracy and risk management by expanding data application modules and improving data modeling efficiency [21]. In contrast, small and medium-sized banks are lagging behind in module expansion and modeling efficiency improvement, and are mainly concentrated in traditional business areas, thus facing more pressure for transformation [35].

In addition, the percentage of big data technicians plays an important role in supporting the improvement of bank performance. As the digital transformation of the banking industry accelerates, the demand for data science and technology talent in banks continues to grow. These technicians not only play a key role in data modeling and technology application but also provide banks with the ability to innovate and execute. The results of the regression analysis show that banks with a higher proportion of technical staff are able to apply big data technology more effectively to drive innovation and development of the banking business. Therefore, in promoting digital transformation, banks must focus on the cultivation and reserve of technical personnel to enhance their digitalization capabilities and market competitiveness [27, 31].

The digital transformation of the banking industry in Guangdong Province has shown a clear trend, especially in terms of investment in big data technology and data personnel reserves. As the frontier of China's reform and opening up, Guangdong Province has made significant progress in the application of big data technology. Investment in and application of big data technology, especially in areas such as risk control and customer management, have greatly improved banks' operational efficiency and market responsiveness [30]. However, despite the significant improvement in the digitization level of most banks, there are still some small and medium-sized banks that are lagging behind in terms of the depth of data application and technological innovation, which provides potential challenges and opportunities for subsequent transformation within the industry [33].

With the continuous development and application of big data technology, the banking industry is facing unprecedented opportunities and challenges. In the future, the application of big data will not only be limited to the traditional areas of risk control and customer management but will also be further expanded to product innovation, personalized services, and intelligent decision-making [26]. In order to fully utilize the advantages offered by big data, banks should pay close attention to the latest trends in big data technology, especially the rapid evolution of artificial intelligence, machine learning, and big data analytics platforms. For stakeholders, including bank management, technology teams, and regulators, the following measures are recommended: First, banks should invest more in emerging big data technologies and integrate them into business innovation and decision-making processes to achieve more efficient operations and more accurate market forecasts; second, banks should strengthen data governance and privacy protection measures to ensure big data application compliance and safeguard customer data; finally, regulators should provide a clearer policy framework to promote data sharing and technological innovation while preventing financial risks and ensuring the stability and sustainability of the financial system.

6. Conclusions

This study delves into the key role of digital dynamic capabilities in the performance improvement of banks in Guangdong Province and reveals the practical application of big data technology in the digital transformation of banks. By analyzing factors such as big data technology investment, data application modules, dynamic data modeling efficiency, and

technical staff ratios, the study shows that banks must comprehensively consider various factors such as technology investment, talent building, and data governance in promoting digital transformation. Especially in the context of accelerating fintech innovation, improving big data application capabilities can not only enhance banks' market competitiveness but also provide strong support for business innovation and risk management. This study provides a theoretical basis and practical guidance for the digital transformation of the banking industry, especially in Guangdong Province.

However, this study also has some limitations. First, the study is limited to the banking sector in Guangdong Province, and although the region has a demonstration role in China, whether the results can be fully generalized to other regions of the country or international markets still needs to be further verified. Second, this paper mainly relies on publicly available financial data and secondary data, which may be incomplete or not updated in a timely manner, potentially affecting the accuracy of the analysis results. Finally, although this paper adopts quantitative methods such as regression analysis, the actual application benefits of big data technology are still affected by a variety of external factors, such as the policy environment and market changes, which have not been fully considered in this study.

Future research can be further expanded in several directions. First, future research can expand the scope of the study to cover more regions of the banking industry, conduct cross-regional or cross-country comparisons, and explore the effects of the application of big data technologies under different economic environments and financial regulatory frameworks. Second, with the continuous development of big data technology, new data analysis methods and techniques will continue to emerge, and future research can pay more attention to how these emerging technologies can contribute to the enhancement of bank performance, especially in the areas of product innovation, personalized services, and intelligent decision-making. In addition, future research can further explore how big data technologies can be integrated with other digital technologies (e.g., artificial intelligence, blockchain, etc.) in the banking industry to form a more powerful digital dynamic capability system, which can provide more innovative ideas and strategies for banks' digital transformation.

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