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Article

Research on the application of big data technology in China's tax administration

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Abstract: With the advent of the big data era, the amount of various types of data is growing exponentially. Technologies such as big data, cloud computing, and artificial intelligence have achieved unprecedented development speed, and countries, regions, and multiple fields have included big data technology in their key development strategies. Big data technology has been widely applied in various aspects of society and has achieved significant results. Using data to speak, analyze, manage, make decisions, and innovate has become the development direction of various fields in society. Taxation is the main form of China's fiscal revenue, playing an important role in improving the national economic structure and regulating income distribution, and is the fundamental guarantee for promoting social development. Re examining the tax administration of tax authorities in the context of big data can achieve efficient and reasonable application of big data technology in tax administration, and better serve tax administration. Big data technology has the characteristics of scale, diversity, and speed. The effect of tax big data on tax collection and management is becoming increasingly prominent, gradually forming a new tax collection and management system driven by tax big data. The key research content of this article is how to organically combine big data technology with tax management, how to fully leverage the advantages of big data, and how to solve the problems of insufficient application of big data technology, lack of data security guarantee, and shortage of big data application talents in tax authorities when applying big data to tax management.

Keywords: big data technology; taxation; tax administration; application research

1. Introduction

1.1. Research background

In the context of rapid economic development, Internet cloud computing, big data and other advanced technologies are known by more and more people, and are constantly being applied to production and life. The traditional value realization model is broken, and a new era based on data collection and feedback is announced. In today's Internet era, enterprises use big data technology to analyze users' preferences to push relevant content to make marketing activities more accurate and promote their services to be more optimized (Federico and Thompson, 2019). But this also poses challenges to China's tax collection and management model. The boundaries of tax subjects are becoming increasingly blurred, and the time and place of taxation are gradually becoming difficult to determine. The original tax collection and management model is no longer applicable to the current economic development situation, making the problem of information asymmetry between tax authorities and taxpayers more and more obvious, which in turn exacerbates tax revenue loss (Wang, 2021). How to adapt to the new era of economic development, utilize technologies

such as big data to enhance the tax collection and management capabilities of tax authorities, transform tax collection and management models, and improve tax risk response capabilities are all practical problems faced by tax authorities (Lipniewicz, 2017). Therefore, it is urgent to improve the quality and efficiency of tax collection and management, and the use of big data technology to promote the high-quality development of tax authorities' collection and management models is of utmost importance.

For government agencies, they have unique advantages in data sharing and utilization compared to enterprises, and the government governance and service system based on big data technology is more complete. Applying big data to tax administration can improve the efficiency of tax administration and make the tax administration model more intelligent and efficient (Jiang, 2022). This article analyzes the current situation and problems of tax collection and management by tax authorities, explores the optimization path of tax collection and management by tax authorities under the background of deepening the reform of the tax collection and management system, effectively leverages the technological advantages of big data, and realizes a risk management model of "no risk, no disturbance, risk to deal with, and strong intelligent control throughout the process", providing useful reference for scientifically allocating tax management resources and improving tax governance capabilities.

1.2. Research significance

At present, there is a considerable amount of research on the application of big data technology in tax administration, but most of it is limited to general concepts and the feasibility of big data technology itself. The exploration of the practical obstacles in the application process of big data technology is not deep enough. This article not only elaborates on the promising application prospects of big data technology in the field of tax collection and management, but also explores the practical obstacles to the application of big data technology in the field of tax collection and management, attempting to improve the research system of big data technology to enhance the level of tax collection and management, and provide a weak foundation for subsequent academic research.

Big data technology has good application prospects in the field of tax collection and management. This article explores the practice of using big data technology to improve the level of tax collection and management, providing practical basis and experience reference for improving the level of tax collection and management nationwide. However, the current application level of big data technology is not deep enough, and there are still constraints in the system, organizational structure, and talent team of tax collection and management that are not suitable for the application of big data technology. Therefore, Gerard (2017) believes that studying the obstacles and countermeasures of big data technology in the process of tax collection and management is crucial, and it has practical significance in effectively utilizing big data technology to prevent and control tax risks, safeguard national tax revenue, and other aspects.

1.3. Research content

In the era of big data, the explosive growth of big data poses a great challenge to the data management ability of government departments, but also provides unprecedented space and possibilities for them to gain deeper, comprehensive, and forward-looking insights (Federico and Thompson, 2019). The enormous energy brought by big data is also being discovered by tax authorities. How to fully leverage the technological advantages of big data, provide suggestions for the problems existing in the application of big data in tax management, truly integrate tax big data into risk management, fully leverage the dynamic effects of big data, and truly achieve "tax governance with data" is the research content of this paper.

1.4. Research objectives

The purpose of this study is to propose suggestions for promoting the improvement of tax collection and management level, enhancing China's tax big data management level, and improving tax collection and management level.

1.5. Big data tax concept

Big data is a collection of data that cannot be captured, managed, and processed by conventional software tools within a certain period of time. It is a massive, high growth, and diverse information asset that requires the use of new processing modes to have stronger decision-making, insight discovery, and process optimization capabilities (Bourquart and Kirsch, 2014).

Tax big data refers to a collection of various types of data related to taxpayers' tax related behaviors in the field of taxation, including taxpayers' declaration data, financial data, invoice data, business data, as well as all other relevant data of taxpayers throughout their entire existence period, such as natural person information, corporate social credit, real estate information, vehicle information, etc. At the same time, it also includes relevant data of tax authorities in the process of tax collection and management, such as internal management data, law enforcement behavior data, business process data, internal supervision data, etc. (as shown in the **Figure 1**).

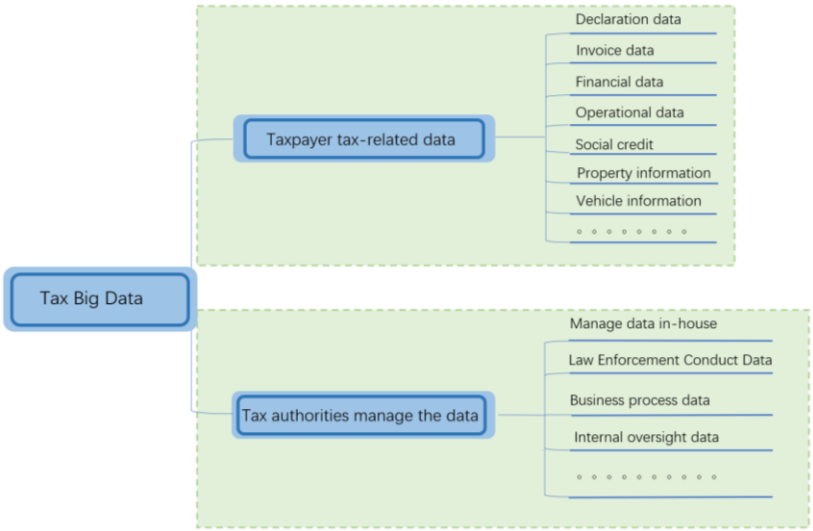

Figure 1. Tax big data.

2. Literature review

In the evolution of tax collection and management using big data technology, Lavalle and Lesser (2011) proposed that informatization will make tax collection and management more efficient. Tax authorities can optimize the collection and management process by using information technology, which simplifies the tax process for taxpayers and improves the work efficiency of tax personnel; Tang et al. (2016) believe that big data can help narrow the tax gap, strengthen data collection and sharing, and improve tax collection and management efficiency; By analyzing the current application status of tax big data, the connotation and types of tax big data were summarized. It is believed that with the increasing improvement of big data, a large amount of data and information are changing the way and methods of tax governance. Big data is gradually becoming the infrastructure for tax risk management, and a modern tax collection and management system supported by tax big data is taking shape (Chen et al., 2018); Manuel et al. (2021) argue that tax authorities are increasingly recognizing the potential efficiency and operation of big data in tax risk management at the cross-border level. Indirect taxes require global coordination for further benefits, and strengthening data management can enhance the level of tax risk management. The above research indicates that big data technology is moving towards mature applications in the field of tax collection and management.

In terms of the specific application of big data technology in tax administration, Bart Bessen (2016) pointed out in his book "Big Data Analysis: Application Scenarios and Practical Essence of Data Science" that we must deeply mine data, turn big data into real productivity, thereby obtaining greater value and maintaining market competitiveness. The author's research findings and perspectives have brought new ideas to the analysis and application of tax big data. Wu et al. (2012) studied the effectiveness of data mining techniques in reducing tax evasion. He believes that in the face of tax evasion, traditional tax audits are time-consuming and labor-intensive, while big data technology can help data agencies detect the risk of tax evasion, effectively reducing national financial losses. Castellon et al. (2013) applied big data thinking to invoice management, summarizing the characteristics of taxpayers based on the historical information collected on false invoices, and identifying and detecting potential users of false invoices. Silva et al. (2015) believe that big data mining technology can help tax authorities understand taxpayers' tax refund situations and improve management efficiency. Abrantes' (2016) research shows that the application of pattern recognition, natural language processing, and data analysis in big data technology can significantly improve the level of investigation of tax fraud. The above research indicates that big data technology has a wide range of applications and is highly effective in improving tax collection and management levels, with good prospects for application.

3. Analysis of the current situation of big data application in tax administration in China

With the continuous development of the economy and the continuous increase of various production factors, the tax collection and management methods are constantly

changing. The evolution of China's tax collection and management system can be roughly divided into three stages: before the 1990s, from the 1990s to the present, and now, the evolution process of China's tax collection and management model is shown in **Table 1** (Dong and Wang, 2017).

Since the 21st century, there have been fundamental changes in tax collection and management methods, procedures, and approaches. The tax department has applied information technology such as the Internet and big data to tax collection and management, developed tax collection and management software, established tax big data platform, etc., and tax collection and management has reached a new level. At this stage, the tax department utilizes the collected data information to extract, analyze, and apply it. The modern tax management model not only adopts advanced information technology means, but also pays more attention to risk management, and conducts specialized analysis by constructing risk models (Dong and Wang, 2017).

The first stage was before the 1990s, when China's tax system adopted the "one member into the household, and each tax under unified management", that is, the household management system. Each taxpayer had its own corresponding tax staff responsible for all tax related affairs, including tax collection, inspection, and management, which were independently completed by tax administrators. This led to a high degree of concentration of power in the collection, management, and inspection of taxes in the hands of one person, and due to the lack of proper supervision, tax work was subjective and prone to corruption.

The second stage is from the 1990s to the present, where computers have been applied to tax collection and management work. At this stage, through job rotation and dedicated positions, the various functions of tax collection and management are reorganized, gradually achieving the separation of collection, management, and inspection from the separation of collection and inspection work. The application of computer technology in tax collection and management has replaced manual operations, improving the efficiency of tax collection and management work and the integrity and authenticity of tax data.

In the third stage, since the 21st century, there have been fundamental changes in tax collection and management methods, processes, and approaches. The tax department has applied information technology such as the Internet and big data to tax collection and management, developed tax collection and management software, established tax big data platform, etc., and tax collection and management has reached a new level. At this stage, the tax department utilizes the collected data information to extract, analyze, and apply it (Dong and Wang, 2017).

Table 1. The evolution process of China's tax collection and management model.

Phases divide	**Stage 1**	**Stage 2**	**Stage 3**
duration of existence	Before 1990	From 1990 to present	present time
Tax collection and management system	Household management system	Stewardship system	Management system + Number management system
Tax collection and management methods	Manual operation	Computer + database	Big data technology

3.1. Application process of big data in China's tax collection and management

The tax department's acquisition and application of big data in tax collection and management work mainly involves the following steps, the flowchart is shown in **Figure 2** below: first, collecting data, and deeply mining the sources of tax collection and management big data through big data technology. The tax department collaborates with data subjects such as the industry and commerce department, social security department, and financial department to establish a data sharing system, which enables them to grasp taxpayers' tax related situations through various channels; Next is data integration. The data collected by the tax department needs to be transmitted to a big data platform, and big data technology can be used to filter and clean the data by applying features that can analyze the data to the maximum extent possible. The tax department needs to establish good data filtering rules and indicators in this step, clean up and remove useless junk data, and integrate massive and complex tax related data into convenient and usable ready-made data; Next, the data analysis work is carried out. In this step, the tax department uses big data technology to analyze and study the data collected and integrated in the early stage, thereby transforming tax related information into quantifiable, comparative, and referenceable data information; In addition, tax authorities can automatically identify various tax related matters such as taxpayers' registration information and risk information based on existing indicator models, thereby realizing the value of tax related data after deep mining; The final step is the application of data. Tax departments use these valuable tax related data to achieve more refined management and services for different categories of taxpayers, such as tax reminders, tax inspections, tax assessments, etc., thereby improving the quality and efficiency of tax management (Chen et al., 2018).

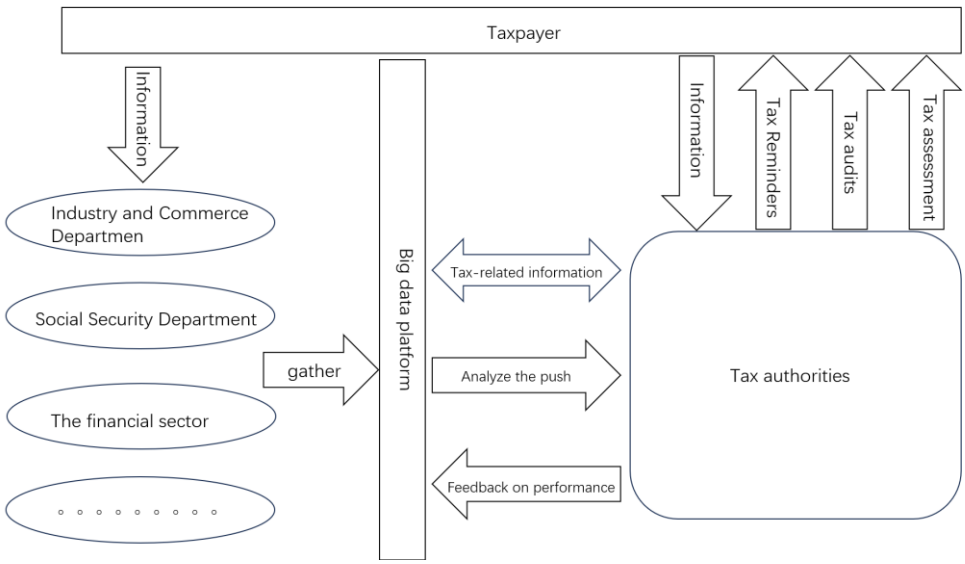

Figure 2. Application process of big data in tax collection and management.

Taking the big data tax collection and management of City A as an example, the tax bureau, in accordance with the requirements of the State Administration and the provincial bureau, has deepened the concept of "managing tax by numbers", made full

use of Internet thinking and big data technology, and explored and formed the concept of tax risk governance based on big data. According to **Table 2**-Risk Response Effectiveness Table of a City Taxation Bureau from 2019 to 2022, In 2022, it will achieve a tax revenue of 78.596-billion-yuan, accounting for 53.35% of the province's tax revenue, bringing great contributions to the province's tax revenue, of which, 331 million yuan will be achieved through risk response, accounting for 0.42% of the city's tax revenue.

To solve the problem of weak targeting and low response quality in tax risk identification, the Municipal Bureau has established a risk analysis and identification team consisting mainly of business personnel from tax officials and technical personnel from third-party companies. This team fully leverages the business advantages of tax backbone and the technical advantages of third-party companies, based on big data, to jointly establish a risk indicator identification and scanning system and closed-loop management mechanism, forming a "establishment identification analysis confirmation optimization" management loop, improving the targeting of risk identification and the accuracy of indicator scanning, helping taxpayers avoid possible tax related risks, and continuously improving law enforcement problems in tax management through data reflection. Big data technology is beneficial in helping tax authorities identify risky tax payments and further improve work efficiency.

Table 2. Risk response effectiveness of a city taxation bureau from 2019 to 2022.

Year	Annual tax revenue	Risk response tax	Risk response contribution rate
2019	94,132 million	481 million	0.51%
2020	94,387 million	194 million	0.21%
2021	106,189 million	203 million	0.19%
2022	78,596 million	331 million	0.42%

3.2. Specific application analysis of big data in tax collection and management

3.2.1. Application of big data in tax risk prevention and control

Tax authorities make full use of big data platforms, tax collection and management software, and sharing mechanisms with other departments to extensively collect tax related data, screen, integrate, and process it. Through the use of established risk identification indicator models and systems, risk model analysis tools, the obtained data information is scanned, analyzed, and identified comprehensively. Combined with the current tax model, high-risk links and areas are identified, and high-risk tax groups are identified. Based on the analysis results, risk taxpayers are ranked from low to high levels, and a risk taxpayer database is established. Real time updates are made according to changes in the taxpayer risk level ranking. The tax department needs to adopt measures including low-risk reminders, organizing tax assessments, conducting tax audits, and tax inspections to address the risks posed by taxpayers of different levels (Schwanke, 2017).

3.2.2. Application of big data in tax inspection

Tax inspection, as an important component of tax collection and management, and its integration with the effectiveness of big data are important parts of intelligent inspection. One is to establish big data analysis models, such as false invoice models, export tax fraud models, etc., to make the research ideas of tax inspection personnel clearer and faster; The second is to apply big data technology to electronic auditing, which makes it faster and more accurate to read accounts, and makes it easier to identify tax related doubts. Based on these doubts, intelligent inspection and handling suggestions are pushed, greatly improving the work efficiency of staff; The third is to use big data for intelligent matching with enterprises. Big data technology can automatically match and analyze the "three flows" of goods logistics, invoice flow, and fund flow with the business transactions of enterprises through third-party information, which greatly improves the quality of inspection. The fourth is to use big data to accurately "profile" enterprises, which can assist tax inspection personnel in searching for enterprises with tax risks more effectively and accurately, enhancing the pertinence of tax inspections (Dong and Wang, 2017).

3.2.3. Application of big data in tax services

One is that the list of tax related matters handled online is constantly increasing. In recent years, the tax department has followed the idea of "handling as much as possible online", continuously optimized the functions of the electronic tax bureau through the full utilization of information technology and tax big data, and added and improved online tax payment items. By sharing the data collected by our department's information system with other departments' data information, we can reduce the burden of taxpayer payer information submission; Secondly, the tax department utilizes big data technology to analyze and explore new methods of tax services, improve business processes, and enable enterprises to automatically identify taxpayers' registered addresses through WeChat real name authentication, independently import financial statements and review their logic, use issued invoices and registered tax source information to independently calculate tax declaration forms, etc. These functions enable taxpayers to truly feel the convenience brought by tax management services, implement effective tax consulting services, and promote tax authorities to "do a good job in benefiting civil affairs and modernizing services".

The specific cases of applying big data technology to tax collection and management are as follows:

Since the reform of tax collection and management, the provincial and municipal tax bureaus have actively carried out the construction of "smart taxation", formulated plans, and successively launched "smart taxation" related platforms, enabling tax management to operate in a more intelligent way. Smart taxation is supported by big data, complies with the trend of the "Internet plus" era, constantly innovates technical skills, effectively integrates collection and management resources, and integrates to form an organic system conducive to tax activities. Open up the management channel of "big data + tax risk", use modern technological means to collect, filter, and screen effective information from the "resource sea" of tax data, explore the connotation of information, analyze data logic, digest tax data into reliable tools to help governance, and achieve the goal of accurately focusing on risks. In the process of promoting smart

taxation, City A effectively utilizes big data technology to obtain relevant tax data and identify related risks. If a certain enterprise gives customers a gift of 230,339.82 yuan during its 2021 promotional activities, of which 224,969.82 yuan has already paid personal income tax of 44,993.96 yuan, and the remaining 5370 yuan has not yet paid personal income tax, an additional 1074 yuan of personal income tax should be paid. In the 2022 promotional activities, customers were given gifts worth 7,644,522.55 yuan, and personal income tax of 152,901.51 yuan was not paid on behalf of them. An additional personal income tax of 152,904.51 yuan should be paid. The total amount for two years is 153,978.51 yuan. This case reflects the problem of enterprises providing prizes or benefits to individuals, taking advantage of policy loopholes, failing to withhold personal income tax, and concealing personal income and underreporting personal income tax.

In the above case, under the background of smart taxation, the tax agency of City A established a big data risk indicator model, extracted data from enterprise declaration forms for comparison, and found that there was a significant difference between personal income tax wage and salary declaration and enterprise income tax wage and salary declaration. The tax authorities not only eliminated the tax evasion behavior of the enterprise in advance through pre-enforcement, avoided risks beforehand, but also did not affect the tax credit rating of the enterprise. The application of big data technology in tax management is beneficial for increasing tax revenue, reducing fraudulent behavior, and improving management efficiency.

4. The Application of big data technology in China's tax administration and management

China's tax collection and management started relatively late. Although it has a huge foundation of tax big data, it has not fully utilized the advantages and functions of big data. According to the interview outline (As shown in the Appendix), 10 employees from the big data technology application department of A city's tax bureau were interviewed about relevant questions. The answer results are as follows: there are 20 employees in the big data technology application department, including 2 leaders and the rest ordinary employees. Each employee has specific responsibilities, such as tax risk prevention and control, tax audit, tax services, etc. Some employees believe that their department responsibilities are relatively clear and that a comprehensive performance evaluation system has been established; However, some employees believe that their specific responsibilities and assessment system are not clear. At the same time, most employees believe that the tax authorities in City A have shortcomings in recruiting data mining talents and are relatively weak in cultivating data technology reserve talents. The number of personnel who can proficiently use relevant technologies to integrate and analyze data is always at a low level, resulting in the ineffective use of big data in grassroots work. In the future, it is recommended to improve the integration and analysis capabilities of big data technology and strengthen management. In the actual application process, there are still several issues with the application of big data in tax collection and management, including:

4.1. Insufficient application of big data technology

The value of data has not been fully developed and utilized at present, and tax risk management analysis and data indicators led by big data are still in the theoretical stage in most regions. Therefore, effective tax analysis has not yet been realized. The characteristics of big data are massive, redundant, and scattered data. Washington (2014) believes that to effectively utilize it, one needs to have a keen ability to observe, discover, and analyze data. Currently, most tax authorities' development and utilization of data information is still limited to simple data queries and rule summaries, resulting in the value of some tax related information being buried. In addition, a large part of grassroots tax risk management departments only complete the risk push tasks conveyed by superiors, and their initiative in conducting risk assessments is not high, their awareness is not strong, and their technical means and personnel are relatively lacking. At the same time, due to the fact that most existing data analysis relies on taxpayers' self declared data, the established tax risk indicators cannot fully consider all the risks that may arise in tax collection and management. Therefore, there may be some missing indicators in the corresponding risk indicators. Combining tax declaration data from different periods for comparison, with varying degrees of data, the long-term risk model remains unchanged, and risk identification will lose its binding force after taxpayers become familiar with various risk indicators (Jiang, 2022).

4.2. Lack of guarantee for data security

Data security is an important cornerstone for the development and application of big data. Only when data security is effectively guaranteed can the application of big data be meaningful. If data security cannot be guaranteed, once the problem of data leakage occurs, it will cause serious consequences. Tax big data includes extensive information about taxpayers and tax authorities. Once leaked, it will have immeasurable impacts on taxpayers, payers, tax authorities, and even the national level (Misran et al., 2022)

Due to insufficient emphasis on data security and inadequate technical capabilities, only the daily work needs of the tax system can be guaranteed, and there is a lack of awareness of dealing with data leakage risks, data encryption transmission, and security. For example, the tax system in City A has repeatedly experienced situations such as unauthorized external connections of internal and external computers due to human operation, cross interconnection of internal and external computers, and data leakage caused by non-standard data exchange between internal and external networks, resulting in serious adverse consequences. Software protection also has shortcomings, with security risks in data storage, processing, transmission, and application, making it difficult to ensure data security and limiting the effectiveness of big data applications (Feng et al., 2022).

4.3. Lack of big data application talents in tax authorities

To achieve deep level development and application of tax data, multidisciplinary support is required. Staff not only need to be familiar with tax policies and regulations, tax collection and management business, and professional financial knowledge, but

also need to be proficient in computer knowledge such as data mining and analysis. The application of big data in the modernization of tax administration requires a large number of versatile talents who are proficient in big data skills and familiar with tax business (Lipniewicz, 2017). The application time of big data technology in the field of taxation in China is relatively short, which has led to the most practical problem faced by tax authorities being personnel issues. Firstly, for grassroots tax workers, their professional skills are single and they lack awareness of big data technology. For example, the A city tax bureau requires its staff to understand both tax business and computer technology, but the tax bureau's employees who understand the business do not understand the technology, and the technical personnel who understand the technology do not understand the business, resulting in a disconnect between business and technology, which cannot achieve deep utilization of data and restricts its application effect. Secondly, almost no grassroots staff of tax authorities have the corresponding technical means to collect, integrate, mine, and research data in their respective regions to establish tax data models that are in line with local practices. It is difficult to link regional characteristics with local tax risks, and therefore, a general risk indicator system cannot efficiently and accurately analyze and monitor this system (Jiang, 2022).

4.4. The application of big data technology in tax collection and management capabilities needs to be improved

The key to achieving tax informatization and improving the application of big data technology lies in the in-depth analysis and precise utilization of tax information data. According to a survey conducted by a third-party organization in the United States, for every 10% increase in data accuracy analysis, the quality of products and services will improve by 14.6%. From this perspective, deep mining of data value is an important path for modernizing tax governance. This also poses a great challenge to the big data analysis technology of tax personnel. At present, Chinese tax personnel are mainly composed of finance and taxation professionals, lacking the ability to analyze and apply big data technology. They are still in the stage of simple queries, statistics, and screening, without conducting in-depth data analysis, let alone using big data technology to strengthen tax risk control. Faced with a vast amount of tax data information, tax authorities are faced with the challenge of how to efficiently extract information and conduct in-depth analysis of data. Based on the above situation, the data analysis of the tax information system is currently mainly based on statistical queries, lacking the ability to analyze and apply data.

5. Foreign experience reference of big data application in tax administration and management

In 2011, the US Federal Tax Service established the Office of Compliance Analytics (OCA) with the aim of using big data and predictive algorithms to build analysis programs that identify potential tax refund fraud and reduce tax fraud. The US Federal Tax Service (IRS) attaches great importance to the management of information technology, building a management framework that can accommodate numerous management systems, and using standardized management methods to

deeply integrate these systems, so that they can cover the vast majority of tax management work (Li, 2016). In 2014, the Senior Deputy Minister for Policy Innovation of Canada prepared the 2014 Big Data Report, which introduced a series of big data initiatives within the government, including the Canadian Revenue Agency's attempt to use big data as a more effective means of identifying fraud claims. The Australian Taxation Office (OTA) has built a risk assessment system based on a big data platform. For the personal income tax refund module, a set of audit indicators has been developed to scan suspicious data for focused review, achieving significant results (OECD, 2020). The French Ministry of Finance fully utilizes information technology for data mining, laying a solid data foundation for constructing risk analysis models. By forming an expert team and applying mathematical thinking to establish a tax professional analysis model, the goal of improving the quality and efficiency of tax inspections is achieved (Lipniewicz, 2017). By issuing legal regulations, the UK requires that all relevant information of local taxpayers must be made public to government departments, and information sharing must be achieved between government, finance, taxation, banking, and courts, thereby expanding the channels for obtaining tax related data and ensuring its authenticity. At the same time, the UK Inland Revenue has also established a risk assessment system, which classifies and organizes data through the development of mathematical statistical models, and conducts risk analysis and response (Schwanke, 2017).

China leverages advanced technologies such as 5G, big data, and artificial intelligence to provide personalized preferential policies, credit fund circulation, and risk compliance reminders as value-added services. At the same time, integrating these services into the government service integration network effectively promotes and popularizes the new regulatory mechanism based on "credit + risk". Connect 12366 call service and O2O (Online to Offline) through the lobby, realize the combination of offline service scenarios and the Internet, and make the Internet a platform for offline services. China focuses on the demand for digitalization as the driving force for transformation, and strives for reform and innovation. By expanding the application scope of technologies such as AI artificial intelligence and RPA robot process automation, and combining online channels such as electronic tax bureaus, cross platform self-service terminals, and V-Tax remote visualization tax handling systems, we continuously explore the innovative integration of advanced technologies and tax scenarios. They apply artificial intelligence to tax inspection, risk prevention and control, invoice management, export tax refund and other businesses, providing intelligent support for tax collection and management.

6. Suggestions on the application of big data technology in China's tax administration

6.1. Protecting the use of big data through legal systems

In terms of tax related data collection, many countries have already granted tax authorities sufficient powers at the legislative level to ensure the collection and retrieval of third-party institutions' tax related data, taxpayers' business data, bank accounting data, etc. One is to ensure the implementation and construction of big data

through the rule of law. The US government has explicitly stipulated in law the legal obligation for all parties to submit personal tax related information, and passed the Electronic Government Act as early as 2002. It is precisely with the mandatory protection of regulations that the United States Federal Tax Service could force Swiss banks to submit personal account information of national citizens (Washington, 2014). China can learn from relevant experience and clarify the obligation of all sectors of society to provide true and effective tax related data in accordance with the law from a legal perspective, in order to protect the legality and quality of data collection. Standardize the rules for data processing from an institutional perspective, improve the efficiency of tax authorities in screening and processing external data, and accelerate the integration and verification of internal and external data. Standardize the methods and rules of data application from an institutional perspective, so that data is not abused, leaked, or tampered with, and ensure the secure use of big data.

The second is to ensure the normal operation of big data in taxation through a scientific management system. The UK government launched the "Tax Digitalization Plan" in 2018, which uses artificial intelligence and big data analysis to obtain important evidence in tax research and gradually abandons traditional property search methods to determine collection criteria. China can learn from relevant experience and formulate strategic plans for the application of big data technology in tax collection and management. Firstly, conduct top-level design and overall planning to determine the strategic goals, development vision, implementation plan, stage evaluation, etc. of applying big data technology to tax collection and management. Reasonably allocate resources in the process of strategic implementation, form intensive management, and solve the problem of unclear application of big data technology.

6.2. Ensuring data security through legal system

Miloš et al. (2021) believe that big data methods are becoming an important tool for detecting tax fraud around the world, and propose a new hybrid unsupervised anomaly detection method for tax evasion risk management. The large amount of available tax data can help develop mathematical models to study and understand the dynamics of tax fraud. Tax authorities can use big data and predictive algorithms to build analysis programs to identify potential tax refund fraud and reduce tax fraud.

One is to improve the regulatory system for data security protection. The construction of the regulatory system can be based on the principle of hierarchical classification, that is, the central and local governments should classify supervision and be responsible at different levels. Secondly, you can try to establish a specialized organization responsible for data security protection. For example, setting up a cross-border data security risk review and assessment agency specifically responsible for cross-border data security. Thirdly, China needs to increase its enforcement, supervision, and punishment efforts for illegal activities that undermine tax data security, such as strengthening searches and increasing fines, in order to deter and force relevant parties to consciously protect data security (Feng et al., 2022).

The second is to strengthen the construction of data security capabilities for corporate taxpayers. The state encourages enterprises to use advanced technology to ensure data security and provides relevant policy support; Encourage enterprises to

establish a maturity assessment system for data security capabilities, clarify the maturity requirements for different types of data security capabilities, conduct data security capability maturity assessments, and promote the establishment of data security capabilities that match the type and scale of data by enterprises.

6.3. Building a talent team for big data application in tax authorities

Firstly, focus on cultivating existing talent resources to enable them to possess both big data technology and familiarity with relevant tax related businesses. Through continuous targeted training, we are moving towards strengthening the professional talent team for tax big data applications. Secondly, we will improve and optimize the talent training system for tax big data, selecting composite personnel with solid tax knowledge, company financial knowledge, and mastery of information system technology to join the big data management project. Develop relevant plans to effectively integrate tax management business with technical capabilities, regularly carry out learning of big data technology knowledge such as data analysis technology and data mining technology, and organize talent teams to apply big data technology to real tax work, in order to enhance data analysis and mining skills in practice. Finally, establish an external expert team. We can cooperate with high-end professional structures such as higher education institutions, software development institutions, and data research companies. And draw on the advanced practical experience of foreign countries in cultivating tax big data professionals, tailor measures to local conditions, and cultivate corresponding high-end talents in tax administration and management.

6.4. Enhance the application capability of big data technology in tax collection and management

Strengthening risk management through the use of big data technology is an inevitable requirement of the tax collection and management system. To enhance the level of data application, firstly, it is necessary to improve data collection, unify the standards and content of data collection, and ensure the accuracy and usability of data. The second is to improve analytical skills and comprehensively use various information technology methods to explore the value of data. The third is to strengthen the use of means to achieve informatization and intelligence in tax governance (Abrantes, 2016).

The internal performance evaluation of tax authorities mainly focuses on law enforcement risks, law enforcement effectiveness, etc., lacking assessment indicators for data quality maintenance. Therefore, tax personnel lack initiative and enthusiasm in managing the quality of tax related data. Tax authorities should include it in the scope of performance evaluation and hold accountable those who fail to maintain data in a timely manner. At the same time, utilizing data analysis techniques to clean up garbage data in a centralized manner, avoiding invalid data occupying too much storage space and misleading tax personnel to use it; Advanced data analysis generally refers to a series of processes that use statistical and machine learning methods to gain insights into data, optimize resource allocation, and achieve the best possible results. Advanced data analysis projects can be roughly divided into two types: (1) predictive analysis. It can be used for analyzing the accuracy of tax declaration and the timeliness

of tax payment. Through simple prediction functions, it helps tax authorities choose response strategies; (2) Descriptive analysis. It can be used for tax policy promotion, risk warning and analysis. Through descriptive analysis, tax authorities can analyze and predict taxpayer behavior, thereby providing personalized services and pushing tax policy information to taxpayers. At the same time, tax authorities should carry out normalized risk analysis, coordinate algorithm model design, establish and improve a risk warning indicator system that covers the entire cycle, chain, tax category, industry, classification, and special risk management needs of taxpayers, and enhance the accuracy of risk identification.

6.5. Exploring cooperation models between government and enterprises

The responsibility of the tax department is to manage the country's taxation. Tax authorities can actively explore ways to cooperate with enterprises and fully leverage their professional advantages. Firstly, it is necessary to introduce advanced technology from enterprises, develop professional personalized security protection plans based on the actual work needs and information system situation of the tax department, and establish a data security protection system; Secondly, daily maintenance should be done well, and timely upgrades and transformations should be carried out according to changes in demand and technological upgrades to ensure the sustainability of data security protection; Finally, it is necessary to sign a confidentiality agreement with the technology company, clarify confidentiality responsibilities, strengthen personnel management, and standardize the construction and operation of data security protection systems.

6.6. Enhancing the application of blockchain technology in tax administration

Tax authorities at all levels have also begun exploring the integration of tax risk management and new technologies, exploring the use of advanced technologies such as big data, artificial intelligence, and blockchain to optimize tax risk management and enhance its effectiveness. The combination of blockchain technology and tax governance can be attempted from the following aspects: firstly, strengthening the sharing mechanism. The decentralized co governance feature of blockchain technology can effectively solve the problem of information asymmetry between tax collectors and taxpayers. By establishing consensus algorithms and rules with third-party institutions, it can provide comprehensive and accurate data sources for tax authorities; The second is to improve the efficiency of tax collection and management. In the process of using blockchain technology, information will become tamper proof, which will help tax authorities obtain real transaction information, and at the same time achieve automatic calculation and withholding of taxes through cooperation with third-party payment institutions; The third is to reduce tax disputes. The application of blockchain technology makes all transaction activities transparent, and tax authorities have the initiative in information collection and investigation of illegal activities, which is more advantageous and reduces tax disputes between tax collectors and taxpayers.

7. Summary

In summary, the rapid development of the social economy has brought many difficulties in tax governance. The tax department, as the core of tax collection and management, tax services, inspection and evaluation, and even tax policy formulation, has a significant impact on the economic behavior of taxpayers. In the era where big data is widely applied to social and economic activities, once the tracking of tax related economic behavior traces of natural persons is achieved, and the obtained data information is deeply analyzed and utilized, the tax department can effectively carry out tax management, which provides new ideas for the tax department's collection and service. By effectively utilizing big data, tax departments can more accurately identify and manage tax collection and management risks, providing scientific basis in the process of formulating tax policies. The application of big data will bring more efficient and intelligent tax management to tax departments, and also provide taxpayers with more convenient and personalized tax services. This article systematically introduces the concepts and research background of big data and tax administration, analyzes the current status and existing problems of big data technology in tax administration, and proposes relevant suggestions for the application of big data technology in tax administration.

As a data aggregator, tax authorities should establish the image of data information protectors and focus on taxpayers' demands for data security, privacy protection, and other aspects. To establish relevant regulations to standardize data application methods, China needs to increase the crackdown on illegal activities such as the abuse of tax related information, personal information leakage, and privacy infringement. It is necessary to continuously improve relevant laws and regulations, strengthen the application of technology in ensuring data security, and effectively do a good job in data security work.

In future research, it is necessary to strengthen the protection of data security, adjust tax and fee data query permissions, implement data query and export trace management, clarify standards for external data provision, standardize data supply approval processes, and strengthen data security management. Improve data utilization efficiency, guide the application of big data platforms, strengthen the complementary application of front-end and back-end data, fully leverage data efficiency, and serve tax work.

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Appendix

Table A1. Interview outline for research on the application of big data technology in China's tax administration.

Interview time	**2024.10**	**Interview location**	**Office of A Municipal Taxation Bureau**
Interview department	Technical Application Department of A City Taxation Bureau	Interviewee	Departmental staff
Interview content			
1. Does the Tax Bureau of City A have a professional department or team for big data technology application? How many people? How was it allocated? 2. Are the responsibilities of the big data technology department or team clear? Do you have a specific plan? 3. Has the tax bureau of City A established a performance evaluation mechanism for each stage of technology application? What exactly is it? 4. Is the human resource of the big data technology department or team sufficient? What is the professional and age distribution of personnel engaged in management? 5. Have you participated in tax big data technology application training organized by the municipal or district bureau? Is it helpful for work? 6. What do you think of the quality and quantity of tax data related to the application of tax big data technology? Are you proficient in using various data platforms to analyze data? 7. What are your main tasks in the application of big data technology? How about achieving quality and efficiency? 8. What do you think of the current level of big data technology application in the tax authorities of City A? Do you have any suggestions or opinions?			