Research Article

Constructing Risk Analysis for Changes in China's Local Government Bond System Based on SSP

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The local government bond system of China has experienced a series of changes from its initial creation to its abolition and then to a recovery again. During the period, the central government always dominated the changing direction of the local government bond system. However, as fiscal decentralization reform has progressed, the institutional needs of local governments and investors have gradually gained attention. As a result, the size and variety of local government bonds are expanding. Through the introduction of analysis of system change based on situation structure performance (SSP), this paper uses Machine Learning (ML) approaches to predict the risk of government debt of China in the context of changing the local government bond system. Besides, this research work includes the comprehensive weight assignment for government debt hazard, fiscal revenue forecasting, default risk calculation, and finally an analysis of the validity of government debt hazard. The system may provide financial signal advice and strategy reference for dealing with hazards in early payment, organizing debt repayment significance order, optimizing fiscal revenue and cost structure, and so on.

1. Introduction

For a long time, local government debt has been a huge issue in China's financial operations, and it has also become a crucial issue that substantially influences government investment risk. The key elements influencing the amount of debt risk are China's highest position of debt, the rate of development, and the strategy framework. Government borrowing hazards are classified into two categories: exchange devaluation hazard and government borrowing default hazard [1], and each of these hazards is associated with an increase in the government borrowing scale. At the same time, the danger of a government debt default will result in credit losses for the country. Some researchers [2, 3] believe, on the other hand, that financial unviability can be linked to debt hazard to some extent. As a result, the presence of debt hazard can be assessed by examining financial sustainability. Local government debt is critical for supporting local economic development as well as increasing public service standards [4]. To some extent, native

government debt will play an essential role in social and economic growth. Furthermore, rapid expansion, a poor management level, and structural issues continue to afflict local government borrowing control in China. With the danger of government debt increasing year after year, it is critical to tighten oversight of local government debt. How to properly and efficiently measure the size of native government debt hazard has long been a hot topic in educational circles. Nevertheless, there is no agreement on the risk valuation methodologies and evaluation index scheme aforementioned.

Driven by fiscal decentralization reforms around the world, the importance of local governments in providing local public goods and maintaining macroeconomic stability is increasing. However, the increase in "duties and responsibilities" has also forced local governments to seek more "financial resources." Theoretically, local government bonds can solve the problem of intergenerational fiscal balance while effectively raising funds [5]. As a result, it has become one of the main ways of financing local governments

in many countries. China's fiscal decentralization reform has always been plagued by the matching of local government's "fiscal power" and "duties and responsibilities." Budget Law of the People's Republic of China promulgated in 1994 prohibited local governments from issuing bond financing. This had led local governments to gradually accumulate huge amounts of hidden debt through various financing platforms. In response to the financial crisis in 2008 and the regulation of local government financing, China resumed the issuance of local government bonds in 2009. The initial scale of issuance was 200 billion yuan. In the following decade, the issuance of Chinese local government bonds gradually expanded. In 2015, China launched the local debt replacement plan and the scale of local government bond issuance exceeded one trillion. In the following three years, the scale of the issuance was more than 4000 billion yuan. At the end of 2017, the stock of local government bonds exceeded national debt for the first time, reaching 14.74 trillion yuan. The central government has been hoping that local government bonds can effectively replace other non-standard local government financing platforms, meet the capital needs of public facilities construction at a lower interest rate, and truly play a role in stabilizing investment, expanding domestic demand, and filling gaps. However, between 2017 and 2018, the scale of issuance of local government bonds fell.

Many experts have given close attention in recent times on the management of government credit risk and analysis. According to the authors of [6], the unique hazards of local government debt fall into two groups. The first is the hazard involved which is broken down into four components: overall payment, rate of interest, loan arrangement, and currency percentage. Another hazard is an outside hazard, which is classified into two categories: tax burden rise and macroeconomic change. The scholars [7] believe that China's rapid expansion of local government will have serious consequences. Notably, the increase in total debt contingent obligations will be significant, and the exact amount cannot be predicted. If the government debt hazard in a specific instance of handover to the government at a higher level affected the essential economic hardships and tremendous damage to the growth of the national economic system and consistency. The authors of [8] believe that the native government debt is unclear, which will pose hazards under the impact of certain conditions and will have negative consequences, generating issues for sustainable growth and social security. Similarly, the authors of [9] argue that when financial income is insufficient to cover fiscal spending in a given time period, the danger of local public debt arises. Furthermore, the experts in [10] believe that one case can be utilized to determine if local government debt is problematic; that is, when the growth in debt causes the local government and economy being unable to sustain it, this is regarded as the appearance of debt hazard. The authors of [11] thought that the quantity of native government debt in China was fast-rising and that when the debt payback time was condensed altogether, the demand for government borrowing payment would increase significantly. When employing debt funding, some local governments may not follow essential legislation. In the secondary market, the problems of single investor structure, chaotic securities, and low trading volume have not improved. The academia began to discuss whether the existing management system can guarantee the further expansion of the scale of China's local government bond market and the diversification of its structure. This paper adopted the analysis of system change based on SSP to analyze the evolution of China's local government bond system and sought the path of future changes in China's local government bond system, as well as the possible direction of future changes.

For the first time, this paper utilizes ML approaches for the risk analysis of government debt. This paper largely relies on the situation structure performance paradigm, which enables a comprehensive examination of the interconnectedness of various interest groups in the local government bond market. The SSP system enabled the investigation of both effect and transformation. In addition, this paper uses Machine Learning approaches to predict the risk of China's government debt in the context of changing the local government bond system. Furthermore, this study includes the government debt hazard widespread weight task, fiscal revenue forecasting, and default risk calculation, and finally this paper analysis the validity of government debt hazard.

The rest of our work is organized as follows. Section 2 is based on materials and methodology of China's local government bond system based on situation structure performance (SSP), Section 3 explains the development procedure of the proposed risk analysis framework for China's local government bond system, Section 4 consists of our experimental work for the proposed system and their simulations, and Section 5 summarizes our work.

2. Materials and Methodology of China's Local Government Bond System Based on Situation Structure Performance (SSP)

2.1. The Creation and Abolition of the Early Local Government Bond System. The foundation of China's local government bonds is derived from government bonds of production building and local government bonds of economic development issued in the northeast of China during the early days of the People's Republic of China [12]. The whole Northeast area was liberated by the end of 1948. To support the restoration of the Northeast and considering the limited local fiscal revenue, the central government has specifically approved the issuance of government bonds for production construction in the northeast to raise funds. In the late 1950s, the central government began to implement local economic construction bonds across the country. The issuance of local economic construction bonds can be considered a signal of the initial establishment of the early Chinese local government bond system. With the increase in the issuers of local government bonds and the expansion of the issuance scale, in the process of local economic construction bond issuance management, some regions are exposed to problems such as excessive circulation, over the long term, and forced apportionment. In the use of local

TABLE 1: Analysis of the changes of the early local government bond system.

Initial system	Market status	Upper system structure	System change performance
Focusing on financing effectiveness; lack of information systems and control systems	The ability to raise funds is strong; there is a lack of information on the direction of capital investment; it has an increased negative impact on the macroeconomy	The highly centralized, unified financial management system	The local government bond system was terminated by mandatory and abrupt system changes; the negative economic effects of local government bonds were eliminated bringing the vacancy of local government financing systems and the stagnation of local economic construction

government bonds, local governments invested funds in a large number of redundant construction projects, making the use of funds inefficient. To strengthen the control of the macroeconomy, the central government completely stopped the issuance of native government bonds in the early 1960s, and the local government bond system was abolished.

Local governments had certain powers of autonomous distribution under the early Chinese local government bond system, and the issuance regulations were amended at the time of the foundation of the RMB system. Relying on a flexible issuance system, the issuance of local government bonds has achieved good financing results. However, the loosening of the regulatory system and the lack of information systems have made it impossible for the central government to supervise and control the investment direction of local government bond funds. The use of local government bonds objectively brought a negative impact on China's macroeconomic construction. To eliminate the negative external effects of local government bonds, the central government decided to stop issuing local government bonds in a short time without fully coordinating with local governments in the process of strengthening the highly centralized financial system and unified accounting. The local government bond system was abolished through mandatory and sudden system changes. Although this measure reversed the difficulties caused by the failure of fiscal decentralization reform in the planned economic system, it also caused local governments to lose important financing channels. In the absence of enough financial support, local governments had difficulty in building local infrastructure, which seriously hindered the development of the local economy. An analysis of the changes in the early local government bond system is shown in Table 1.

2.2. Key Features of China's Local Government Bond. The local government financial markets of China have changed dramatically in recent years, becoming the largest global government bond industry [13]. It has also become China's largest bond market. Local governments in China, which typically account for a large proportion of overall government spending and carry out the majority of public infrastructure construction, rely heavily on the funding market. In 2017, bonds accounted for about 90% of local government debt, rising over 7% in 2014, when the debt was mostly made up of off-balance-sheet borrowing from banks. The figure
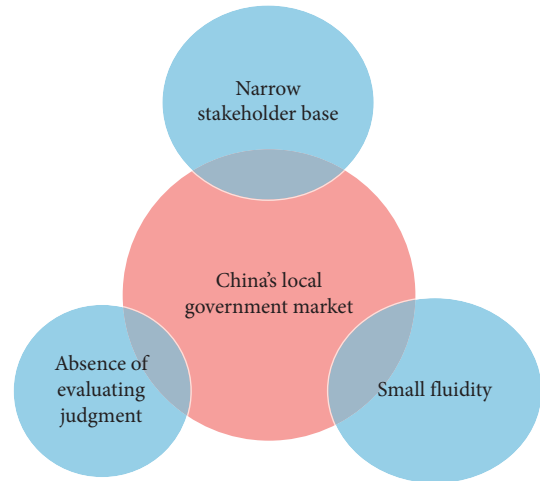

FIGURE 1: Key features of China's local government market.

explains the key features of China's local government market. Key features of China's local government market are shown in Figure 1.

2.2.1. Narrow Stakeholder Base. The Chinese municipal bond market has a small shareholder base, with Chinese financial institutions holding approximately 82% of outstanding bonds. These investments account for approximately 7.1% of total financial services assets in China. The major buyers of native government bonds are China's national financial institutions, which account for more than half of the country's banking sector. Municipal bonds, on the other hand, are held by a broad variety of institutional and noninstitutional customers in Japan and the US, and municipal bonds account for roughly 2.5% of overall assets of banking in the U.S. The limited stakeholder base of Chinese native government bonds mirrors the regulators' local government debt-swap policy in major part. Banks were the principal buyers of bonds are issued in exchange for LGFV debt and were a major source of financing for LGFVs.

2.2.2. Small Fluidity. Local government bonds are similarly prone to volatility. In 2018, the amount of private market financial trades on local government bonds amounted to just 30% of outstanding local government bonds. This associated with around 75.2% for United States public bonds and 51% for Japanese muni bonds. Speeds of Bid-ask spreads, another

sign of market fluidity, are also substantially wider for Chinese municipal bonds than for municipal bond markets in the US and Japan. Even said that activity in China's local government securities market has lately increased, possibly indicating legislative initiatives aimed at improving market liquidity. The experienced of the secondary market may be explained by the limited investment opportunities of local government bonds. Financial institutions in China typically purchase native government bonds to hold them till maturity. This is due, in part, to local governments' perceived low default risk and the low-hazard weights granted to native government bonds under China's assets restrictions.

2.2.3. Absence of Evaluating Judgment. Market rates of credit risk have proved to be consistent, across both bond classes such as special and regular bonds, and among borrowers. Despite considerable differences in risk profiles and debt burdens, spreads on local government bonds versus Chinese government bonds have been consistent throughout local governments of Chinese. In addition, there has been minimal variation in market pricing between ordinary and project-based special bonds. Here, it reflects the fact that, unlike income bonds in the U.S and other kingdoms, repayments of project-based bonds are directly connected to project income.

The absence of pricing differentiation for diverse degrees of credit hazard redirects the generally held anticipation that the national government would step in to avoid local authorities from violating interest payments. This view has been strengthened by China's fiscal system, where numerous local governments have restricted influence over income generation and, as a result, depend on heavily on central government payments to fund their operations. Furthermore, the central government authorizes the quantity and least estimating of local authority bond issuances through the Finance Ministry, which might enhance the idea of central government backing. These implied promises may cause local governments to borrow more than market-based pricing would. Because bond proceeds were utilized to support projects with poor marginal returns, this systemic risk may have worsened medium-term economic security concerns.

2.3. The Emergence and Development of the Management System of Local Financing Platform. After the long-term implementation of the planned economic system and the highly centralized financial management system, the Chinese economy experienced a series of problems such as distortions in industrial structure, slow economic growth, and decreasing fiscal revenue. Faced with the shortcomings caused by the aforementioned planned economic system, the central government decided to change the development strategy, and the fiscal decentralization reform entered the era of the fiscal responsibility system. The decentralization of the central government-aided local finances since it maintained relatively substantial fiscal receipts for a long time, and local governments had minimal need for financing. As a result, administrative decentralization of the fiscal

responsibility system increased local governments' administrative autonomy and stimulated local governments' zeal for economic development. It also led to practical problems such as "the over-strong local economy" and the "soft constraints" of state-owned enterprises. In 1994, the central government began the tax-sharing reform of economic decentralization for the purpose to strengthen the ability to regulate the macroeconomy. The "two proportions" had been continually improved during the tax-sharing reform process, as had the central government's macroeconomic regulation and control capacities. Furthermore, the management connection between central and local governments and businesses has been defined [14]. However, the tax-sharing reform objectively resulted in an increasing disparity between municipal fiscal revenue and spending.

To raise construction funds, local governments began to try a variety of financing channels and gradually formed local government financing platforms based on foreign loans, project financing, trust, and municipal construction company financing [15]. Local government financing platforms played an important role in mobilizing infrastructure funds for local governments, especially during the Asian financial crisis. However, due to different management regulations, several major financing channels had some defects [16]. Although foreign loans and project financing were relatively rigorous, they can provide limited funds but were difficult to become the main channel for local government financing. The financing of local government through the construction of investment companies and the issuance of corporate bonds and other "quasi-municipal bonds" had the advantages of various forms and enormous funds, but absence of operative management and easy to breed corruption. Analysis of the changes in the management system of local financing platforms is shown in Table 2.

The emergence of local government financing platforms has filled the vacancy of local government financing channels after the withdrawal of local government bonds, and its management system is also a financial system innovation. The development process of the local government financing platform management system shows the basic characteristics of induced and gradual system changes. Its designers are a significant number of local governments that are gradually induced system modifications led by the inherent institutional demands of the local government. This system mostly comes from the existing institutional arrangements in the Chinese financial market; the whole system is gradually improved during the game process of local governments, investors, and the central government. The gradual process of system change is stable, with less impact on existing political and fiscal systems but a higher success rate of institutional arrangements [17]. However, on the issue of reducing information costs and reducing negative externalities, this system established by local governments has always been flawed. Both the central government and investors lack effective access to local government information on capital use and repayment preparation. In the case of nontransparent debt management, the opportunistic behavior of local governments is difficult to control and leads to high local debt.

TABLE 2: Analysis of the changes in the management system of local financing platforms.

Initial system	Market status	Upper system structure	System change performance
The vacancy of local government financing system	The gap of local government's fiscal revenue and expenditure has been widened and there is a lack of economic construction funds	The tax-sharing reform began, and the budget law of the People's Republic of China and the guaranty law of the People's Republic of China prohibited local governments from borrowing money	The local financing platform management system was developed in the form of induced and gradual system changes, filling the gap in the local financing system. However, in terms of externalities and high information costs, there is a lack of effective management system arrangements, which could result in a large number of nontransparent local debts

2.4. The Restoration of the Local Government Bond System. Many experts began to aggressively support the reintroduction of local government bond issuance due to the low transparency and high risk of existing local financing platforms. Discussions on this topic persisted until the onset of the 2008 international financial crisis when local government bonds were able to reclaim the center stage as a result of this one-time event. The reconstruction of the Chinese local government bond system during the financial crisis was similar to the abolition of the early local government bond system because they adopted a form of compulsory system change. In the background of the worldwide fiscal crisis, the native government bond issuance system was able to complete the process from deliberation to announcement. After that, implementation in a relatively short period with a low system changes cost, fully encapsulating the benefits of the central government system change [18]. However, unlike the early elimination of local government bonds, the new local government bond system follows the slow route of China's fiscal decentralization reform, with several forms of study and preparation work completed before the issuance of local government bonds. To promote the implementation of the system, the central government adopted the strategy of "incremental reform" and did not ban local financing platforms while issuing local government bonds. Local governments had thus fully accepted this new expansion of financing channels. Local government bonds issued by the Ministry of Finance were supported by system investors with the help of the central government's credit guarantees and were sold easily during the financial crisis, thanks to the existing government bond sales channels. However, when designing the local government bond system, the central government first considers its institutional requirements for regulation and regulates the total amount and distribution of local government bonds through budget management. In the new local government bond system, efficient finance mechanisms and comprehensive information management systems have not been established. Restoration of the local government bond system is shown in Table 3.

From international experience, the local government bond system can be broadly divided into two basic models: the market-constrained model adopted by most federal states and the administrative control model adopted by most unitary states. The primary distinction between the two models is whether the central government has the authority to intervene directly in the issuing of local government bonds. China's local government bonds are issued and repaid by the Ministry of Finance, which is a typical administrative control model. The choice of an administrative control model is consistent with China's political and fiscal system characteristics. However, compared with the administrative control models of Japan, the United Kingdom, and other countries, China's administrative control over local government bonds is more stringent [19]. In the initial institutional arrangements for local government bonds in China, there are three basic institutional arrangements: one is the central approval system based on budget management; the second is the central credit guarantee system with the central fiscal revenue as the guarantee; and the third is the bidding system of government bond issuance channels.

The central approval system is reflected in the formulation and approval of the annual local government bond issuance plan. The total amount and share allocation plan for the issuance of local government bonds in China each year are formulated by the Ministry of Finance and then submitted to the State Council for approval and reported to the National People's Congress for approval [20]. Through the examination and approval system, the central government controls the total amount of local government bonds, avoiding the problem of the out-of-control scale of debts in the early local government bonds of economic construction and local financing platforms [21]. To ensure the smooth issuance of local government bonds, the Ministry of Finance first compensates for the low level of local government credit through indirect credit guarantees. Secondly, the Ministry of Finance conducts local government bond bidding for national debt underwriters and regards participation in local government bond bidding as the coming year's assessment of underwriting of government bonds, thereby motivating underwriters by actively participating in the bidding of local government bonds. The method of bidding for central credit guarantees and bundled government bonds has become a double guarantee for promoting the full local government bonds issuance.

During the financial crisis, the experience of China's 200 billion local government bonds issued smoothly showed that under the circumstances of limited issuance of local

TABLE 3: Restoration of the local government bond system.

Initial system	Market status	Upper system structure	System change performance
Local financing platform management system	The gap of local fiscal revenue and expenditure has been widened and the world financial crisis broke out	The tax-sharing reform had made certain progress, and the central government implemented an expansionary fiscal policy	The local government bond system was restored in the form of mandatory and incremental system changes. Local government bonds coexist with local financing platforms

government bonds, the strict administrative control model had stable financing capabilities. Under strong administrative control, the Chinese local government bond system has recognized the institutional necessity for the central government to manage the external effects of local government bonds. However, it ignores the institutional needs of local governments to improve the efficiency of financing public debt and investors' desire to reduce the cost of market information. This makes it difficult for local government bonds in this period to replace local financing platforms, and local government bonds become the main financing channel for local governments and financial products favored by investors. During the financial crisis, local governments also expanded the scale of local financing platforms while financing through local government bonds. According to central bank figures, as of the end of June 2022, local governments at all levels of government developed 21,221 investment and finance platforms, 15,907 of which were founded by county governments. At the end of 2023, the central bank's statistics showed that the local investment and financing platform had a loan ceiling of 23 trillion yuan. The scale of local government bond issuance approved by the central government has been controlled at around 300 billion yuan until 2023, and it was not until 2023 that it was raised to 350 billion for the first time [22]. Local government bonds are difficult to meet the huge financing needs of local governments. In addition, effectiveness of the local government bond system, a supporting system for the tax-sharing system, stops at the provincial and municipal governments, and county governments, as well as township governments, do not qualify for the issuance of local government bonds.

The current local government bond system imposes strict restrictions on the size of the issue and the qualifications of the issuers, which makes it impossible for local governments to get rid of their dependence on local financing platforms after using the financing of local government bonds. For investors, Chinese local government bonds lack the necessary information publicity system. Before and after the issuance of local government bonds, the issuer is required to publish the circulation amount, bidding time, and bid result. Important information such as the financial revenue and expenditure of the issuer, the direction of the use of funds, the operation status of investment projects, and the preparation of repayments are all in doubt, and there is no corresponding mandatory information publicity system. Therefore, apart from state-owned commercial banks, most institutional investors and ordinary investors have no intention of entering the local government bond market, which directly caused the basic situation of the single investor structure in the local government bond market at that time.

3. Development of the Proposed Risk Analysis Framework for China's Local Government Bond System

3.1. Development of the Local Government Bond System. In terms of changes in Chinese local government bonds, the central government has always had a prominent role. Although the first administrative control model provides the central government's capacity to oversee local government bonds, it does not guarantee the ability of the central government to standardize and integrate local government finance platforms. As a result, the federal government must progressively encourage local governments to use local government bond financing. This means that the local government bond system must implement institutional mechanisms to meet the financial demands of the local government. Local government bonds became the only authorized funding channel for local governments once the new budget law went into effect in 2015. Local government bond issuance also increased to 3.8 trillion yuan. The issuance of local government bonds cannot always rely on the issuance of government bonds. Relying solely on government bond underwriters is unable to meet the needs of the expansion of the local government bond market. In this case, the central government introduced a series of new management systems to attract more investors into the local government bond market. As a result, the institutional needs of local governments and investors will enter the local government bond system through bottom-up induced system changes. Specifically, under the premise of not changing the administrative control model, the Chinese local government bond system gradually carried out the following four aspects of system reform:

(i) First, the central approval system is progressively being phased out. In 2011, the Central Ministry of Finance officially notified Shanghai, Zhejiang, Guangdong, and Shenzhen to launch pilot projects for local governments to issue bonds themselves. It declared in 2014 that it will grant 10 provinces and localities the authority to issue bonds under their own control. On January 1, 2015, the new budget legislation went into effect, granting local governments the authority to issue government bonds in order to borrow money. Local government bonds had therefore entered a new era of "self-

responsibility." From the issuing by the Ministry of Finance in 2009 to the local government's self-issuance of bonds in 2011 and the spontaneous self-responsibility in 2015, the central government is gradually loosening the strict control over the issuance of native government bonds. However, under the gradual loosening of the governmental control mode, the local government has conditional bond issuance rights, which is essentially different from the independent issuance rights under the market constraint mode.

(ii) Secondly, further the bond structure is enriched. Since 2015, local government bonds have been classified into general bonds and special bonds. General bonds are issued for nonprofit public welfare projects, repaying principal and interest on general public budget income, and included in general public budget management. The issue period can be classified into 1 year, 2 years, 3 years, 5 years, 7 years, 10 years, 15 years, and 20 years. The bonds are mainly used for public welfare projects that generate certain income and are repaid by local government funds or special income, which is included in the fund budget. Special bonds for land reserve, special bonds for toll highways, special bonds for Shenzhen rail transport projects, and special bonds for shantytown reconstruction are among the bond types. The issuance period includes 1 year, 2 years, 3 years, 5 years, 7 years, and 10 years. The above changes mean that the local government's capital needs and investors' investment needs are better matched.

(iii) Thirdly, the Chinese local government bond information publicity system is being built. In 2014, the Ministry of Finance issued the "Pilot Project for Spontaneous Self-Responsibility of Local Government Bonds 2014," which required local government bonds to carry out credit ratings for the first time and publish the economic and financial status of bonds issuers and bonds data. At the end of December 2018, the Ministry of Finance issued the "Measures for the Publicity of Local Government Debt Information." The measures clarified the requirements for the publicity of local government debt budget and final accounts and the publicity of local government bond information and strengthened the supervision of information publicity. Its content regulated the publicity of local government bond information and identified and refined the publicity of local government bond issuance arrangements, issuance information, duration, and major issues. This enhancement satisfied institutional investors' expectations and offered an essential institutional guarantee for general investors to access the local government bond market.

(iv) Lastly, the way of issuing local government bonds is improved. The initial Chinese local government bonds were completely dependent on the Dutch bidding method of a single price, and the underwriters were also limited to the members of the government bond underwriting syndicate. This is very unfavorable for improving the efficiency of local government bond issuance and reducing the cost of issuance. With the advent of special bonds, the issuance of local government bonds has increased the number of targeted underwriting in addition to public issuance. The underwriter qualification also was loosened for legitimate financial institutions. As for the time of issuance, the central government has repeatedly guided and hopes not to concentrate on the second half of the year. In 2018, the Seventh Session of the Standing Committee of the 13th National People's Congress deliberated and authorized the proposal of some emerging new local government debt limit in advance. The issuance of new local government bonds in 2019 will be completed much earlier. The improvement of the issuance method, the loosing of underwriters' qualifications, and the optimization of the issuance time created a good market environment for further expanding the local government bond market. Development of the local government bond system is shown in Table 4.

3.2. Analysis of System Change Based on SSP. The SSP believes that various products and services have varying interdependencies in actual economic operations. As a result, the requirement for relevant systems to regulate and steer various interdependencies is established [23]. As a financial commodity, local government bonds have the characteristics of incompatibility of funds, external effects of investment, and high cost of information. The incompatibility of funds means that in the case of a limited supply of funds in the financial market, local government bonds need to compete with other bonds to obtain market funds. The external effect of investment projects refers to the impact on the macroeconomic operation after the local government bonds are invested in specific projects. The high information cost refers to the local government's "advantage of saving" in terms of accessing local government bond-related information, and the central government and investors need to spend more money and time. Around the above characteristics, various interests are formed among the participants in the local government bond market. This has created conflicts and cooperation between each other, as well as institutional requirements for establishing a local government bond system to deal with conflicts and promote cooperation.

For the incompatibility of funds, it is necessary to establish an efficient financing system to guarantee the full issuance of local government bonds, which is called system preference $\alpha 1$. It takes a certain amount of time and expense to obtain data about native government bonds to reduce the cost of information and establish a comprehensive information publicity system, which is called the system $\alpha 2$. The use and repayment of local government bonds will have an impact on macroeconomic operations; this external effect needs to be

TABLE 4: Development of local government bond system.

Initial system	Market status	Upper system structure	System change performance
Strict administrative control mode	Local government bonds coexist with other local financing methods	Fiscal decentralization has advanced to a deeper level	The local government bond system evolved in the form of induced and gradual system changes. The scale of local government bonds has gradually grown, the variety has increased, and the structure of investors has diversified

TABLE 5: SSP analysis framework for the system changes of China's local government bond.

Initial system	Market status	Upper system structure	System change performance
Initial system structure	Incompatibility; external effect; high information costs	Economic system; financial system	The form and result of system changes
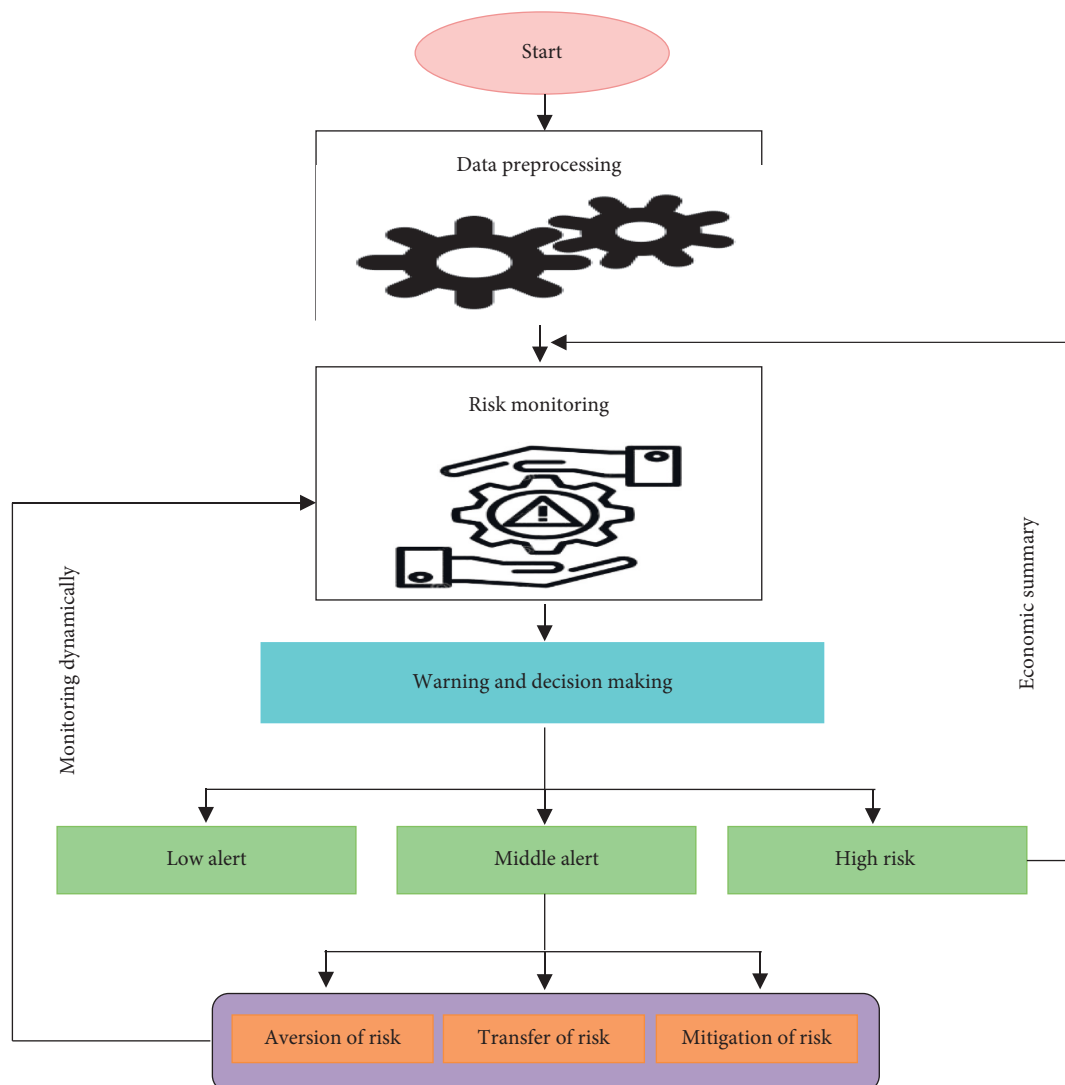
FIGURE 2: Flowchart of China's government debt evaluation system.

controlled by a strict regulatory system, which is called the system $\alpha 3$. As the main body of local government bonds, local governments are eager to establish an efficient financing system. Under the pressure of competition in the bond market, to attract investors, local governments also need to publish information on local government bond issuance and partial management information. For controls from the central government, evasive attitudes are often adopted. The system preferences of local governments can be summarized as $\alpha 1 > \alpha 2 > \alpha 3$. As a macroeconomic manager, the central
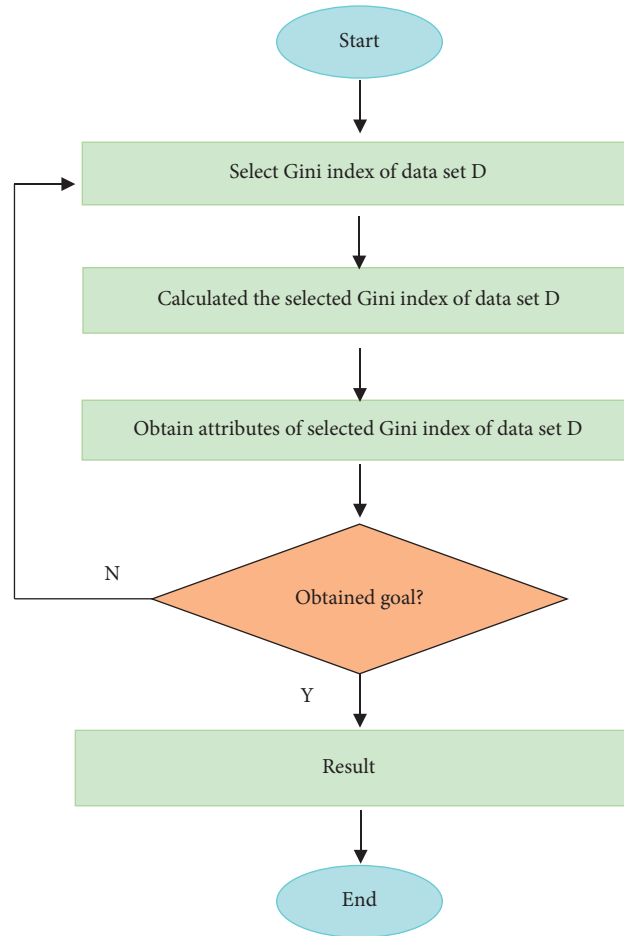
FIGURE 3: Flowchart of CART algorithm for the prediction of our proposed scheme.

government first expects to establish a strict control system to control the external effects of local government bonds. Secondly, it is hoped that the smooth issuance of local government bonds can effectively promote the steady growth of the local economy. Finally, there is a willingness to support the system of information publicity to reduce the difficulty of supervision. The system preferences of the central government can be summarized as $\alpha1 > \alpha2 > \alpha3$. Investors hope to establish a comprehensive information publicity system to make accurate investment judgments; at the same time, they also value the market competitiveness of local government bonds; investors do not need the control system of local government bonds. Accordingly, the system preferences of investors can be summarized as $\alpha1 > \alpha2 > \alpha3$. The three major stakeholders in the local government bond market have obvious differences in the demand for local government bond financing systems. As a result, reaching a "unanimously approved" solution for reforming local government bond finance management systems is challenging.

Therefore, the change in the local government bond system of China would keep the balance of the central government. Local governments and investors in the framework of China's specific political system and different stages of economic development focus on the incompatibility of external government bonds, external effects, and high information costs [24]. For the sake of simplicity, this paper introduced an analysis of system change based on SSP, as shown in Table 5. At each stage of the system change, the local government bonds are summarized using a tabular analysis framework. The first column was the institutional structure of the local government bond system at the beginning of the transition. The second column was the basic situation of the various characteristics of the local government bond market at this stage. The third column was the main upper institutional structure to promote and restrict the chances of the local government bond system; the fourth column was the form and result of system changes.

3.3. Basic Design China's Local Government Bond System. A modern and scientific risk evaluation system should collect data, identify risks, make risk judgments, provide feedback on evaluation results, monitor risks, and make additional connections based on sensitivities, workability, and relevancy. As a result, our proposed risk evaluation approach is based on a study of the government debt condition, and the hazard analytical outcomes indicate the risk level of local government debt, allowing the local government to identify and address concerns on time [25]. The level of risk is split into moderate risk, moderate risk, and serious risk by establishing the warning line, which may directly depict the risk level [26]. The modest risk, for
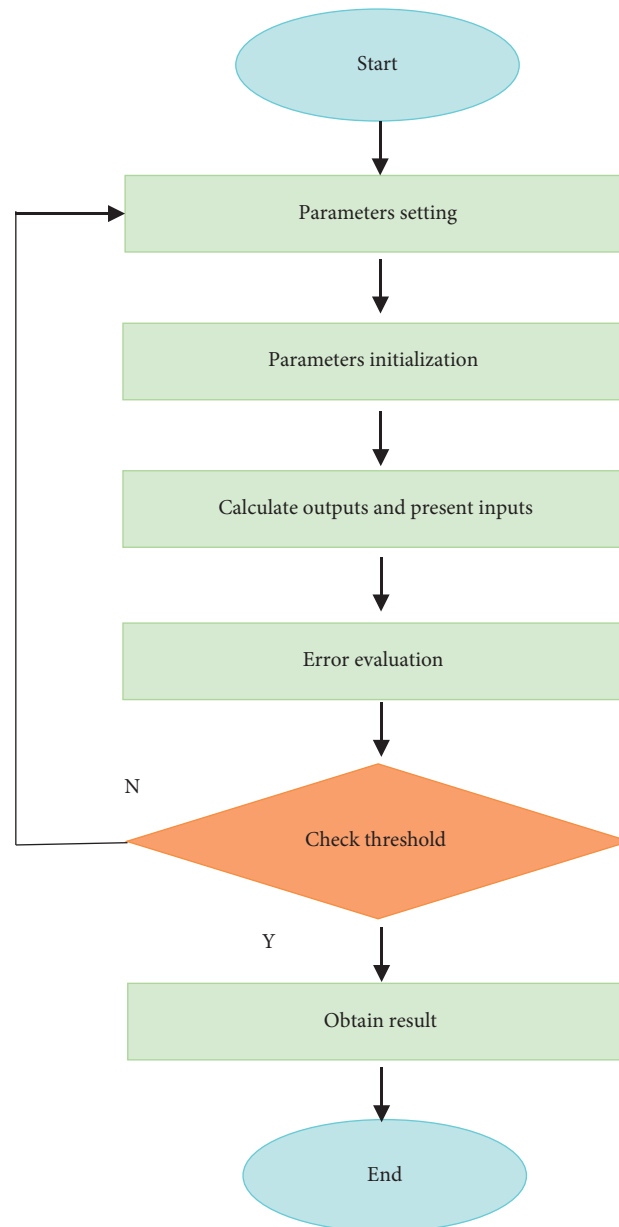
Figure 4: Flowchart of CART algorithm for the prediction of our proposed scheme.

example, indicates that the local economic activity is secure and simply requires regular monitoring of the debt problem. Moderate hazards suggest that some dangers in economic activities must be avoided and handled on time. Severe risk means that the risk level has crossed the alert mark and the fiscal position is in jeopardy. As a result, an emergency alert should be issued, bond production should be halted, and a series of steps should be implemented to decrease the risk to a safe level. Various risk intervals correlate to different levels of risk by establishing a threshold level for the complete threat assessment index.

The risk assessment system for China's government debt is designed to calculate debt hazards using the assessment layout developed. In addition, judge's risk degrees based on the proper evaluation value provide timely feedback on risk decision data to pertinent government agencies and takes

consistent measures based on dissimilar risk grades. The particular linkages comprise debt data collecting, debt risk evaluation based on the established assessment layout, and threat valuation value decision to take necessary steps based on the judgment outcomes. Figure 2 depicts China's government debt evaluation system.

3.4. Machine Learning Algorithms for the Evaluation Proposed System. In this paper, we have adopted CART [27] and BP [28] ML algorithms to carry out early risk warnings on the debt risk of China's local government system.

3.4.1. Classification and Regression Trees (CART) Algorithm for the Proposed Approach. The CART is created through iterative segmentation using a greedy approach, which
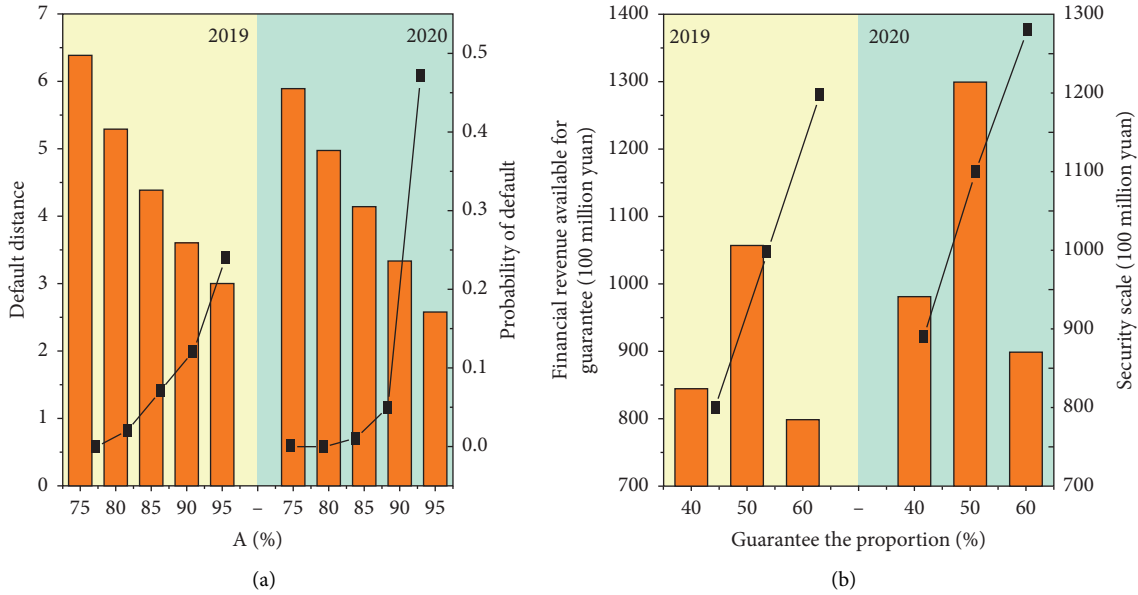
Figure 5: Comparison of subjective weight, factual weight and the total weight of indicators.

includes two rounds of tree creation and pruning [29, 30]. The segmentation method, or the instance selection metric, is critical in the generating process. As per the various classification forms, the decision tree may be separated into two techniques: firstly, the C5.0 approaches are the information theory technique and the representational technique. Secondly, there is the minimal Gini index technique, namely, the CART technique. C5.0 and CART are powerful organization algorithms with great efficiency, simplicity of use, and resilience. It may be separated into three approaches based on the differences in decision tree creation. The first is Information Gain's ID3 technique. The C4.5 method is the second approach. The third approach in the Gini index is the CART. These techniques are known as the ID3 proposed method, the C4.5 decision tree technique, and the CART technique. The Gini index may be utilized to identify and categorize characteristics in the CART method. Figure 3 depicts the main idea as a flowchart of our CART method.

3.4.2. BP Algorithm for the Proposed System. At the moment, the most popular neural network layout is the BP neural network, which was created using an artificial neural network. It is theoretically based on the error back-propagation learning method, and the output value is close to the predicted value due to continual correction of the error between both the output value and the actual value. Figure 4 depicts our BP algorithm for our proposed system.

4. Experimental Work and Simulations

In our experimental work, the analytic hierarchy method and the probability approaches are employed to provide positivist and interpretive weight to each indicator of the warning index network of local government potential hidden debt hazard. Following that, the risk of local government debt is thoroughly assessed. According to the detailed calculation process based on subjective and goal weights, the weight of C1 local government borrowing proportion, C2 local government borrowing proportion, C3 local backing policy debt to GDP, C4 PPP scheme spending to common budget income ratio, and C9 fiscal self-sufficiency proportion are all greater than 8% among the initial threatening detection of possible contained debt hazard of local governments. Figure 5 depicts the specific weight of threatening pointers based on the AHP approach, the factual weight of different initial threatening signs based on the entropy value technique, and the total weight of pointers.

Figure 6 depicts the BP neural network error variation curve as 4 lines. Through BP training, the training line reflects the average square error performance. The test line describes the MSE performance of the BP test process. The ideal line shows that the optimum BP training outcomes are obtained after training the BP network for the tenth time. The objective line is the neural network learning stop target defined by the ANN toolbox during training BP, and the ideal line is parallel to it. Whenever the neural network learning iteration approaches the 10th iteration, the network output error meets the predetermined model performance, and the network accumulates to the ideal steady-state value. The fit between predicted and real production acquired after training is excellent, with an MSE value of only 0.00097. The training impact is strong, and the warning reliability is excellent.

According to Figure 6, the simulation and real values of the test samples are close, with a fitting degree of 97.8 percent and a mean square error of only 0.00749, showing that the modeling effect is excellent and the threatening effect is optimal.
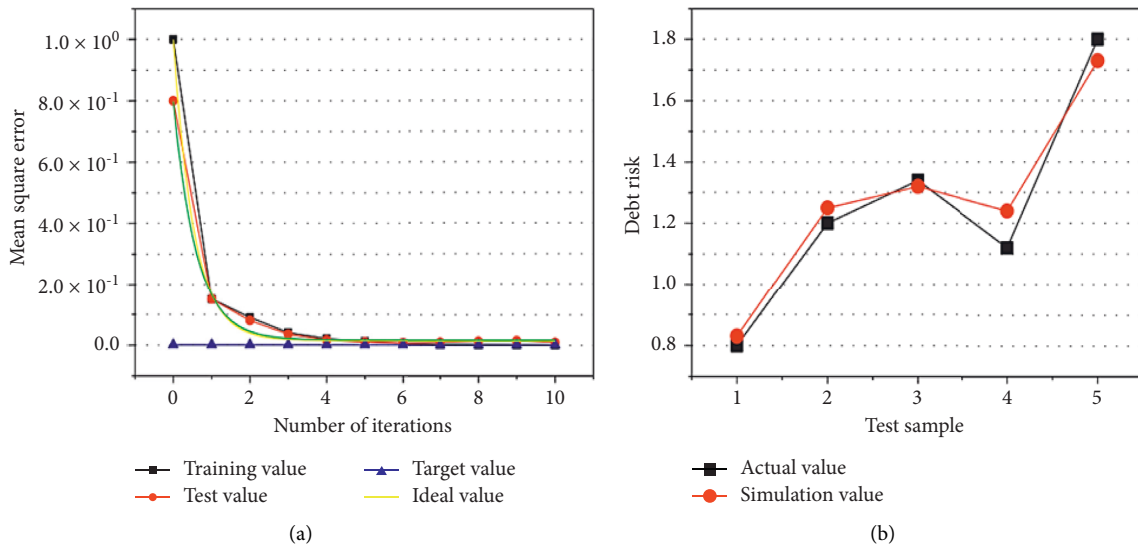
Figure 6: Comparison of BP neural network error variation curve as four lines.

5. Conclusions and Future Work

As the main participants in the local government bond market, the central government, local governments, and investors each have their own institutional needs for the local government bond system. Due to the limitations of China's political system, there are some gaps among these three in terms of influencing the changes in China's local government bond system. To address these shortcomings, the purpose of this paper aims to improve China's local government bond system by developing a risk analysis method based on SSP. This research employs machine learning techniques such as the CART and BP methodologies to anticipate the risk posed by China's government debt in the context of reforming the local government bond system. The following are other improvements to China's government bond system: the first is the intergovernmental credit guarantee system. When the local government cannot pay off all its debts by its tax revenue, government fund income, or special income, the central government should provide certain financial assistance. Such institutional arrangements can assist economically underdeveloped regions in issuing bonds at a lower cost, avoiding the widening of differences in economic development levels between regions due to the issuance of local government bonds. When providing guarantees, it will still focus on supporting underdeveloped areas in the central and western regions. The second is the local debt regulatory system, which divides the local government debt status into multiple levels including stable level, early warning level, and restructuring level. Local governments have a responsibility to regularly publish their financial status, especially debt information, to the public, and it is overseen by the central government, investors, and third parties. If there are local government's fiscal deterioration and insufficient debt repayment funds, the central government will adjust the local government's budget. Thus, local governments can choose to restructure their debts or receive financial assistance from the central government. According to the path dependence of the changes in China's local government bond system, the institutional needs, game process of various stakeholders in the local government bond market, and contents of the changes in China's local government bond system will be judged in the future.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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