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Design a management information system for financial risk control

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Abstract
This paper presents an evaluation of the financial system risk quantitatively and a management information system designed to improve financial risk management. Based on the recognition of risk sources for all kinds of financial institutions and financial markets, we use a matrix covering financial risk probability and related damage to assess local risks and carry out risk classification, and use self-organizing mapping neural network model to evaluate the overall risks. Also, by means of radio frequency identification technology and big data analytics platform—Hadoop platform, a management information system is built which could perform three core functions: real-time monitor, analysis and evaluation, and automatic control, which would help regulators to realize the whole process and comprehensive intelligent management for financial risk sources.

Keywords Financial system · Risk source · Management information system

1 Introduction

With the rapid development of China's financial industry, some financial institutions borrow short and lend long endlessly, which result in a rapid rise of the leverage in the financial markets, and could make the financial system highly unstable. The imperfect financial supervision mechanism are not sensible and do not reduce operational risks efficiently that could severely damage a company or investors. For example, bank note risk events took place continuously in 2017, agricultural bank of China lose 3.9 billion Yuan for bill payment fraud and deception in late January; 1 billion bills cannot be redeemed for Lanzhou branch of the bank of China in early April; A bill broker defrauded 786 million Yuan from Shanghai branch of Tianjin Bank by trading bank acceptance bill illegally in Jun. Moreover, with the financial institutions' innovation on business, the many products is to be issued by two or more institutions corporately (e.g. bank and bank, bank and trust company, bank and securities company, bank and fund company, securities company and fund company, etc.), cross risk events would take place increasingly. In June 2016, one subsidiaries of Wanjia fund found that its $800 million were misappropriated to repay its partner's wealth management products. Such incidents usually involve large amounts of capital, cause serious economic and reputational damage to the related institutions. Nowadays, how to perfect the risk management of the financial system has been an urgent task facing the scholars and government regulators.

Risk assessment is the basis of risk management. In recent years, researchers have done a lot of work on the financial risk assessment, some are committed to reduce the effect of subjective factors of evaluation, such as the analytic hierarchy process was used to determine the index weight [1]. Some are committed to applying emerging technologies to improve existing models, such as cloud computing is used for fuzzy comprehensive evaluation methods [2, 3]. And also some are making an earnest endeavor to look for new methods to evaluate risk more accurately, such as to measure the sensitivity of the relationship between volatility of market factors (e.g. interest rates, exchange rates, stock prices and commodity prices, etc.) and the asset price (income) [4–6]. But up to now few studies have put up a method to measure and monitor financial risk systematically.

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This paper will detect risk sources of the financial system, categorize them in terms of their characteristics, and design a risk management information system using new technology, in order to realize the real-time monitoring and dynamic evaluation of risk sources, and improve the risk management efficiency of the financial system.

The remainder of this paper is structured as follows. Section 2 gives an briefly description about risk source identification. Section 3 discusses the method of risk assessment and presents rules of risk classification. Section 4 develops the management information system. The last section concludes.

2 Risk source identification

As the important parts of the financial system, banks, securities and trusts are three important sources of systemic risk in finance industry.

2.1 Risks in banking

Banking risks can be divided into three risk categories: interbank, shadow banking and foreign exchange market according to their business characteristics.

2.1.1 Interbank risk

With the development of interbank business, many kinds of off-balance sheet financing taking the form of the non-standardized creditor assets grow quickly, the barbaric growth of the interbank business induce increasingly contingent risk. Moreover, the diversified and integrated business of commercial banks change gradually product properties and trading structure, such financial products are nested layer by layer, the trading products will be in a stretched market, which will increase the cross-financing risk, even threaten the foundation of the bank credit.

2.1.2 Shadow banking risk

Shadow banking risk mainly originated from wealth management products (WMP), local government debt and real estate loans. The biggest risk of wealth management products is liquidity risk caused by maturity mismatch. Repayments' periods of wealth management products trend to shorter and shorter, but its underlying asset, mainly paper assets are long-term loans, usually more than 1 year. Because it's always possible that the bank could lose money on its long-term investments if interest rates rise or worsening economic conditions lead some of its borrowers to default. In such a situation, if the customers owing wealth management products all decide they want their money back, there wouldn't be enough to pay them all.

The risk of local government financing platform will appear when the local government financing in the form of PPP, industrial investment fund and debt-equity combination financing, etc., aims to alleviate its increasing distress from the gap between local financial revenue and expenditure. A large part of real estate financing is obtained from the shadow banking system in China, it is a highly crossover between real estate and financial ecological system, the risk of real estate might deteriorate asset quality of financial institutions, lead to local finance risk, even systemic financial risk.

2.1.3 Foreign exchange market risk

If "black swan" events take place, and induce the capital outflows, and the RMB exchange rate will depreciate accelerated, which could trigger a growing explicit risk of domestic asset price volatility, especially when the price of junk assets abroad is at a historic high level.

2.1.4 Cross infection risk

Banks, non-banking financial institutions and private financial institutions all develop the business of shadow banking, with the extension of the credit chain, cross infection risk may occur in each intersection, and extends outward through the cross flows of capitals, then a chain reaction will lead to the outbreak of the whole financial system.

2.2 Risks in securities industry

The first risk to the securities market is policy risk, e.g. a change in central bank's interest rate policy. In addition to providing confidence in markets and a feeling of "risk on", gradually increasing interest rates have allowed securities to be valued at even lower levels. Market liquidity will decline synchronously with the price of securities, the low liquidity will produce the spillover effects on the external economy, which will induce a systemic financial risk. The second risk to the securities market is operational risks. Company's profits are impacted by the economic cycle or commercial operating cycle, the change of competitors, company's own management and decision level. The decrease of company profits would cause investors yield reduction or loss of the principal. The third risk to the securities market is infection risk. The point is that there is a very significant risk that US securities will lose value very quickly even if only temporarily. Should that happen, it will have a very negative effect on Chinese securities as

investors sell their winners (Chinese securities) to pay for their losers (securities stocks).

2.3 Risks in trust industry

Typical trust business is mainly trust loans. For the majority trust loan programs, their financing side and the demand side are one-to-one correspondence, the main risk are trust default risk, such as real estate loan default risk, commercial enterprise loan default risk, basic industries default risk.

2.4 Atypical financial institutions

Atypical financial institutions such as public funds, private equity funds, small-loan companies and P2P lending platform have the following potential risks: one is run risk. When long-term borrowing standard is broken down into short-term borrowing standard, large sums of money is broken into small shares, the financial institutions are likely to take a risk of capital chain fracture in the case of external shock, if there is a crisis of confidence, a run is inevitable. The other is moral hazard. Many atypical financial institutions have no perfect internal control rules and lack strict supervision over the middle account funds, fraud and runaway with money are now the most common type of crime. Moreover, opaque information often leads to "ponzi schemes".

3 Risk assessment

Risk matrix method (RMM) and self-organizing maps (SOM) neural network model are used here to assess financial risk sources to build a scientific, sophisticated and comprehensive evaluation system, risk assessment flowchart is shown in Fig. 1. The local evaluation targets real-time control for risk sources, and the overall evaluation aims to provide a reference for the management of financial system.

3.1 Local risk assessment

The local assessment means using a risk matrix to quantitatively calculate the risk level of various risk sources in the financial system, according to occurrence probability of the risk event and the loss.

3.1.1 Loss estimation of risk events

Financial risk loss refers to the loss caused by investors' actual earnings less than their expected earnings due to the impact of various unanticipated uncertainties. Operational risk, for example, in 2016, the specific operational risk loss can be classified into six types: internal fraud, external fraud, contract risk, customer abnormal behavior, unstandardized operation procedure, science and technology progress, as shown in Fig. 2.

3.1.2 Risk occurrence probability evaluation

Risk occurrence probability can be gotten through the survey of the financial system risk source, consulting with experts and risk manager. The evaluation index system of risk probability of events is established in terms of the risk category (Table 1). According to the likelihood of risk events, risks are divided into five levels: smaller, small, medium, large and larger, as shown in Table 2.

3.1.3 Risk rating

It is generally believed that risk value R is equal to the risk occurrence probability p multiply risk loss q, that is, $R = f(p, q)$. Here we use a risk matrix to calculate the risk value, put the five level risk probabilities and five level risk losses into the matrix, 5×5 risk matrix will be built (Table 3), a

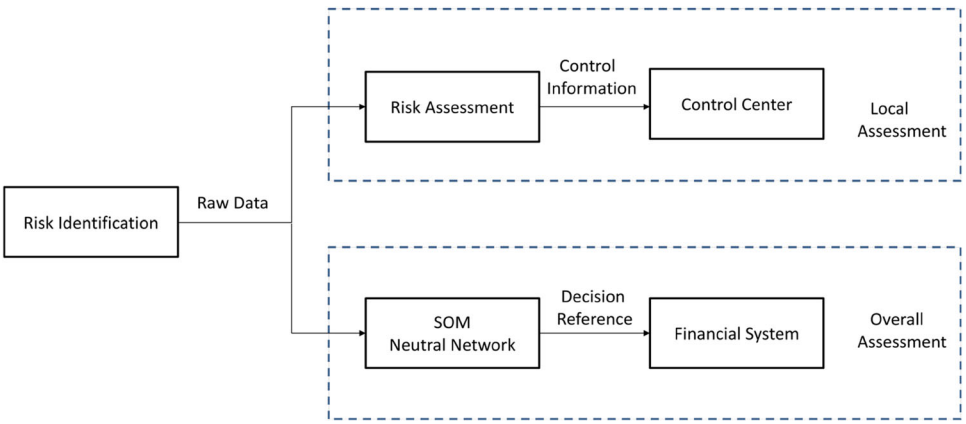

Fig. 1 Risk assessment flowchart

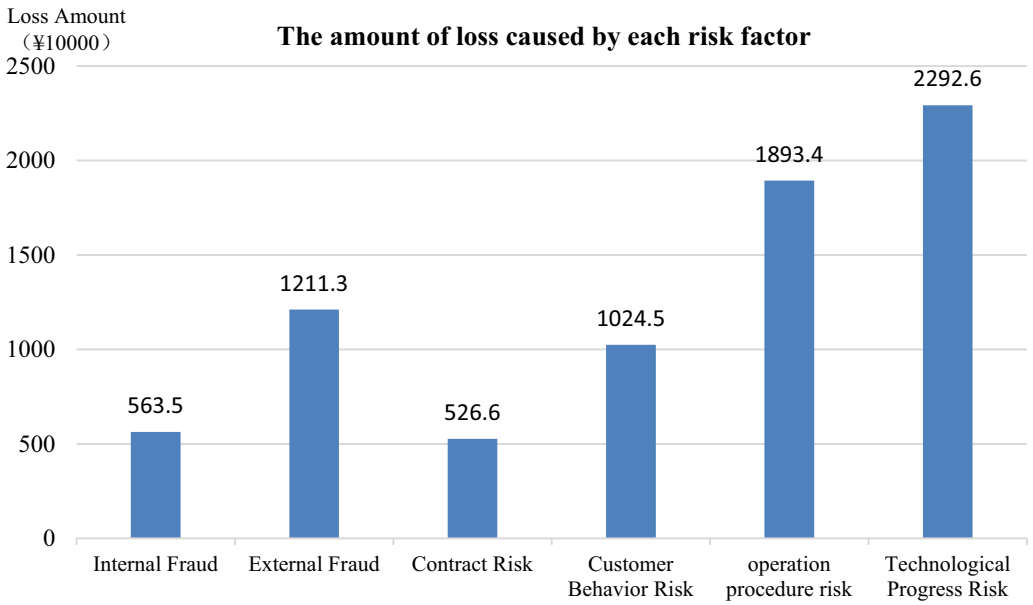

Fig. 2 The loss caused by various operational risk in commercial Banks (2016)

different q and p combinations will determine a different risk value. Dividing the risk values into five grades: I, II, III, IV, V, the result is shown in Table 4.

3.2 Overall risk assessment

Overall risk assessment is conducted by SOM neural network model. SOM neural network is made up of a fully connected neuron array competitive network, it could simulate the brain self-organizing mapping function of neural systems, and realize self-organizational learning by no teacher in the course of learning [7], which could avoid artificial factors in the process of evaluation, and improve the objectivity of the evaluation.

3.2.1 Evaluation model

Based on the basic principle of SOM neural network, the network of the evaluation model needs to be trained using the sample data. The sample data is classified into different categories by clustering function based on its intrinsic characteristics. When the classification number of the sample data is consistent with that of the preset risk level, it means that the clustering performance has reach the requirement of assessing risk level. After that, the characteristic similarity between the pending rating data and the sample data could be compared, and the risk level of the pending data which has the most similar characteristics is to be a risk rating of the sample data.

3.2.2 The training process

Due to the inherent characteristics of the training sample data is a potential and implicit criteria, it is reasonable to use the median of different risk level to build the training sample. To maintain the consistency of local assessment and overall assessment, in combination with local risk hierarchy of assessment, the same five hierarchies are used for overall assessment: I, II, III, IV, V. Converting them to value [0, 1] to facilitate calculation, the intermediate value of five grades are 0.9, 0.7, 0.5, 0.3, 0.1 respectively. An input sample of SOM neural network learning process established see Table 5.

3.2.3 The evaluation process

To put local evaluation results of each risk source as the input data of the SOM neural network model, according to the result of similarity measure to classify the pending data, the output is the risk level of data, that is, the financial system risk level as a whole, which can be used as a decision-making reference for risk manager of financial system.

4 Management information system design

4.1 System module design

This system mainly is made up of three basic modules: the acquisition center, the analysis center and the control center. The acquisition center is used to collect state

Table 1 Risk evaluation indexes

	Category	Subclass	Specific indicators
Commercial bank	Interbank	Credit risk	Non-performing loan (NPL) ratio
			Non-performing assets rate
			Default rate
			Overdue loan rate
			Credit loss rate
			Loss preparation adequacy rate
			Provision coverage
		Liquidity risk	Net stable funding ratio
			High liquidity asset adequacy ratio
			Liquidity matching rate
			Current ratio
			Excess reserve rate
			Core debt ratio
			Liquidity gap rate
		Operational risk	Internal fraud
			External fraud
			Contract risk
			Customer behavior risk
			Process design risk
			Technological risk
	Shadow bank	Financial product risk	Bank-trust financial product growth rate
			Entrusted loan proportion
			Bill financing proportion
			Loan-deposit ratio
		Cross risk	Accumulated foreign exchange exposure ratio
			Interest rate risk sensitivity
			Normal loan migration rate
			Non-performing loan migration rate
		Local Government debt risk	Social financing scale growth rate
			Fiscal deficit ratio
			Financial debt dependency
		Real estate loan risk	Long-term loan ratio
			Net non-interest income share
			Loan-deposit ratio
	Foreign exchange market	Liquidity risk	High liquidity assets reserve growth rate
			Foreign exchange volatility
			Crude oil price changes
			OECD leading indicators
			Import and export exchange rate
	Stock market	Liquidity risk	Average price-earnings ratio
			Shanghai composite index volatility
			Average turnover rate
Securities	Bond market	Credit risk	Collateral insufficiency value risk
			Leverage risk
			Settlement risk
	Future market	Liquidity risk	Volume rate of change
			Turnover rate of change
			Month-end rate of change in open positions

Table 1 (continued)

	Category	Subclass	Specific indicators
			Turnover market share rate of change
	Real estate market	Credit risk	Rental ratio
			Vacancy rate
			Investment purchase and home purchase ratio
			Real estate loans proportion
			Price income ratio, real estate climate index
Trust	Industrial enterprises	Credit risk	Aggregate fund trust loan ratio
			Bank-trust cooperation financial business ratio
			Trust asset NPL ratio
			Trust related party transactions NPL ratio
			Item litigation ratio
		Market risk	Trust assets single largest customer concentration
			Securities risk item amount proportion
			Risk Item Amount Proportion
	Basic industries	Credit risk	Aggregate fund trust loan ratio
			Bank-trust cooperation Financial Business ratio
			Trust asset NPL ratio
			Trust related party transactions NPL ratio
			Item litigation ratio
		Market risk	Trust assets single largest customer concentration
			Securities risk item amount proportion
			Risk item amount proportion
Atypical financial institutions	P2P internet loans	Operational risk	Demolition risk
			Moral hazard
			Information asymmetry risk

Table 2 Occurrence probability of risk events

Risk rating	Occurrence probability of risk	Probability value	Possibility description
1	Smaller	0.0–0.2	Almost impossible
2	Small	0.2–0.4	Unlikely
3	Middle	0.4–0.6	Could happen
4	Large	0.6–0.8	Likely happen
5	Larger	0.8–1.0	Almost certain

Table 3 Risk matrix

q (loss)	p (probability)				
	Smaller	Small	Middle	Large	Larger
Little	I	I	II	II	III
Small	I	II	II	III	IV
Big	II	II	III	IV	IV
Bigger	II	III	IV	IV	V
Significant	III	IV	IV	V	V

information of risk sources. The analysis center is used to determine the risk level for risk sources and the control center is used to control the risk. The big data platform management system uses Cloud to connect the data platforms of various financial institutions and financial markets, in order to share information of risk source and jointly improve the risk management level of the financial system. The module design flowchart of this system is shown in Fig. 3.

Table 4 Risk management guidelines

Grades	Description	Color	Countermeasures
I	Negligible	Green	Inaction
II	Slight	Blue	To strengthen daily management
III	Moderate	Yellow	To take precautions to reduce risks
IV	Major	Orange	To take early warning, preplan and emergency measures
V	Do not allow	Red	To take effective measures to reduce and avoid risk immediately

Table 5 A overall risk assessment training samples for the financial system

Grades	Credit risk	Operation risk	…	Liquidity risk	Regulatory risk
I	0.9	0.9		0.9	0.9
II	0.7	0.7		0.7	0.7
III	0.5	0.5		0.5	0.5
IV	0.3	0.3		0.3	0.3
V	0.1	0.1		0.1	0.1

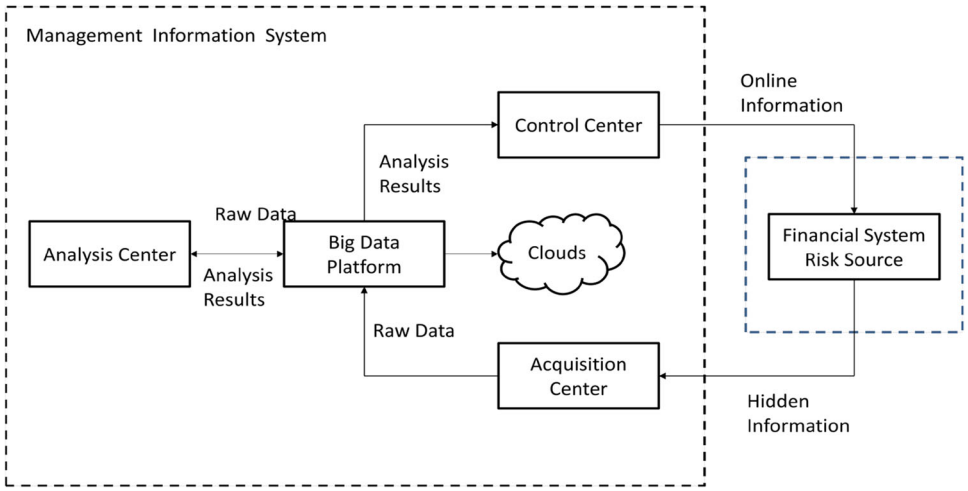

Fig. 3 The module design flowchart

4.2 System function design

4.2.1 Information acquisition function

Information acquisition is completed by the acquisition center, which obtains the original data of the risk source. Data collection is completed by radio frequency identification (RFID). It consists of the rf signal to realize the non-contact information transfer and identify the transmitted information. It is mainly composed of transponder (e.g. tags) and the reader. Transponder is attached to the target object to collect data, reader is used to read the tag information and transfer the data. We set tags on the key indexes of the financial system to complete real-time monitoring, and transfer data from the tags to the reader by radio frequency, and then transfer the data from reader to acquisition centre, see Fig. 4.

4.2.2 Analysis function

Data analysis is carried out by the analysis center. Local analysis uses the risk matrix method to evaluate the status of various risk sources. First the information about the risk events such as the frequency of the incident and its consequences is preset in the system, and the analysis center assess the state of risk source based on the preset information, and send a corresponding control instruction for the evaluation results.

The overall analysis is to evaluate the risk of the financial system through SOM neural network, to facilitate the risk managers to find the management defects in time and provide the management decision reference for them.

4.3 Control function

The control center could realize automatic control of risk sources based on the preset reaction mechanism and the

Fig. 4 Work interface of acquisition center

evaluation results, as shown in Fig. 5. The abnormal state of risk source and the corresponding reaction mechanism could be preset in the system, if the center receives an abnormal report for evaluation results, it would query in the abnormal state library, once the assessment result is detected matching with any state in the library, the system will automatically open the corresponding control mode; If no matching state is found, a abnormal status report is sent to the manual control room, which is controlled by the staff. Finally, the control results are fed back to the control database, the abnormal state library and the big data platform to update the data.

4.4 Big data management

The big data management function of the system is realized by big data platform, which is mainly used to store the whole data of the system, and is the transmission center of system data flow. Hadoop, as an open source distributed computing platform, is good at processing unstructured data (feedback sensor, text and multimedia data, etc.), semi-structured (equipment log and system log, etc.) data. Hadoop architecture is used to realize HDFS supported by distributed storage layer and map reduce (MR) supported by the distributed parallel task handler, which two together will complete the main tasks of the distributed cluster.

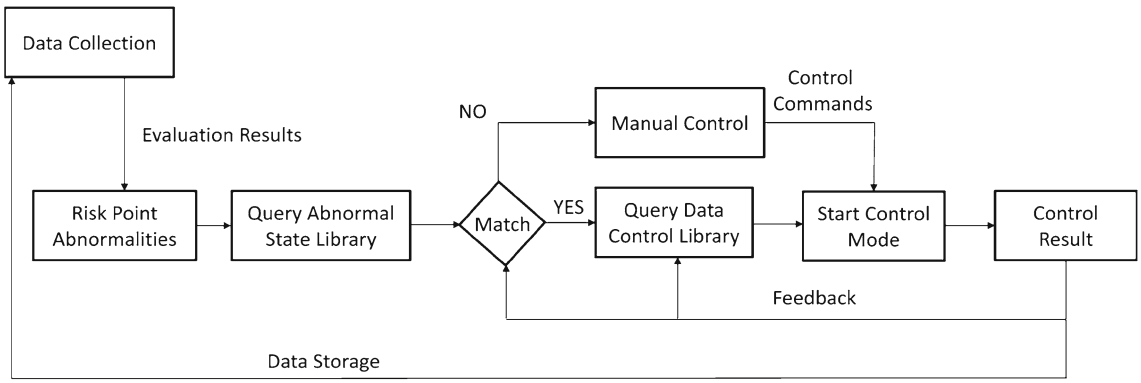

Fig. 5 The working mechanism of the control center

5 Conclusion

This paper introduced emerging technologies such as radio frequency identification (FRID) technology, large data management technology based on Hadoop platform, information system management technology into financial risk management system. We put forward a risk source identification and evaluation system for financial system. The risk matrix is used to evaluate various risk sources, SOM neural network is used to evaluates the financial risk system, provide a sophisticated and comprehensive risk management devises from the local and overall aspects. By means of radio frequency identification technology and big data analytics platform—Hadoop platform, a management information system is built which could perform three core functions: real-time monitor, analysis and evaluation, and automatic control, which would help regulators to realize the whole process and comprehensive intelligent management for financial risk sources.

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