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Perspective on Performance Balancing of Digital Payment Risk Control Models Under Multi-Objective Optimization

Zhaoning Zhang

School of Computer Science, College of Computing, Georgia Institute of Technology, Atlanta, GA 30332, USA.

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***Corresponding author:** Zhaoning Zhang, School of Computer Science, College of Computing, Georgia Institute of Technology, Atlanta, GA 30332, USA.

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Abstract

Digital payment scenarios are becoming more diversified, and transaction data indicate a rapid increase in the digital economy period, which causes the traditional risk control methods to encounter significant performance discrepancies during practical application. The contradictions among the prevention of risks, operational efficiency, control cost and service quality interfere with the stable growth of digital payment business. This research comprehensively analyzes the operating conditions of present digital payment risk control models and summarizes the specific manifestations of the performance imbalance from various aspects. Based on this, a multi-objective optimization performance equilibrium model is established by formulating scientific construction principles, selecting important optimization variables, and defining proper constraints. The model achieves the overall architecture design for the balance of multiple conflicting factors in risk control. Focusing on the key conflicting points in payment risk control, the study proposes specific optimization strategies, including efficiency-risk balance, cost-service balance, and dynamic iterative adaptation. The obtained results can effectively resolve the performance deviation issue of the traditional risk control methods, achieve the coordinated and balanced development of various performance indicators in digital payment risk control, and offer technical and theoretical assistance for the intelligent and high-quality development of digital payment risk control systems.

Keywords

Digital payment; risk control model; multi-objective optimization; performance equilibrium

The quick spread of mobile Internet and digital financial technology has made digital payment the main transaction method of the social economy, including personal consumption, corporate settlement, cross-border trade, and other various business areas. The scale of digital payment transactions is increasing continuously, and the types of payment risks show diversified, concealed, and repetitive new features, which make a higher demand on the accuracy and comprehensiveness of the payment risk control work. The traditional payment risk control models mainly base their assessment criteria on a single risk security, and set up strict risk control rules to prevent the loss of capital. Nevertheless, the single optimizing objective results in serious performance inconsistency in the practical application of the model, and the contradictions between risk prevention, operational efficiency, control expenses, and user services become more obvious. The poor risk control performance not only decreases the operational efficiency of the payment platforms and raises the operating costs of enterprises, but also frequently causes a bad payment experience for users and restricts the continuous development of the digital payment industry. Therefore, it is necessary to use multi-objective optimization theory to establish an ideal risk control model, solve the multidimensional

performance inconsistency problem of the traditional models, and offer efficient technical optimization methods for the high-quality development of digital payment risk control business.

1. Current Situation of Performance Imbalance in Digital Payment Risk Control Model

1.1 Operation Status of Digital Payment Risk Control Model

Digital payment risk control models serve as the main technical basis for financial institutions and third-party payment websites to prevent payment fraud, alteration of transactions, and capital security threats during the present financial digitalization process [1]. The majority of the popular payment risk control systems depend on machine learning techniques and big data processing to gather and examine the users' transaction habits, account characteristics, device information, and transaction environment data in real time, in order to carry out real-time recognition, early warning, and interception of suspicious transactions. With the increasing variety of digital payment situations such as offline scanning payment, international transfer, and installment spending, the transaction quantity and data scale of the payment business keep growing steadily. The existing risk control models focus mainly on the prevention of individual risks and establish strict risk judgment rules to decrease the number of risky transactions. Nevertheless, the fixed rule structure and the static judgment system of traditional models show significant lag when dealing with complicated and changing payment risks, and the single evaluation criterion makes the model performance gradually disassociated from the practical business requirements, leading to the uncoordinated operation of different components of the risk control [2].

1.2 Main Manifestations of Risk Control Model Performance Imbalance

The performance discrepancy of the digital payment risk control models is mainly shown in the serious deviation of several important operation indicators, resulting in multiple conflicting relationships affecting the good operation of the payment business. Firstly, there exists an imbalance between the ability to prevent risks and the transaction processing efficiency, because the striving for a risk-free rate excessively will cause a 15%-20% year-on-year significant rise in the abnormal transaction interception rate and the delay of users' transactions, thereby decreasing the overall operational efficiency of the payment system. Secondly, there is an imbalance between the risk control expenses and the service quality, since the continuous investments in manpower, technology, and equipment for enhancing the accuracy of risk recognition will push up platform operational costs by nearly 12% annually, while strict control on expenses will result in decreased risk recognition accuracy and poor payment experiences of the users. Lastly, there is an imbalance between model adaptability and business updating, because more than 70% of the traditional risk control models cannot carry out real-time updates of parameters and adjustments of rules according to the newly emerged payment situations and the new kinds of risks, leading to the model's inability to meet the dynamic market changes and causing many mistakes and omissions in the actual operation [3].

2. Construction of Multi-Objective Optimized Risk Control Performance Equilibrium Model

2.1 Model Construction Principles and Optimization Objectives

The construction of a multi-objective optimized risk control performance equilibrium model is based on three fundamental scientific principles in order to guarantee the rationality and feasibility of the model. The principle of multi-dimensional synergy considers the interactive relationships among various risk control performance indicators and prevents the single optimization of a single indicator. The principle of practical adaptability integrates the actual operating features of the digital payment business and the real risk conditions of the industry to ensure that the model fits the actual application situations. The principle of dynamic scalability maintains the flexibility of model parameters and structures to meet future business modifications and risk variations. The model establishes several interrelated optimization goals around the main problems of performance imbalance. It regards accurate and efficient risk recognition as the essential assurance to decrease payment security risks, treats stable transaction processing efficiency as the operational aid to achieve smooth payment business, regards reasonable risk control cost management as the economic restriction to lighten the platform's operating burden, and aims at providing high-standard payment services to maintain a balance between risk control and user satisfaction.

2.2 Selection of Multi-Objective Optimization Variables and Setting of Constraint Conditions

The risk control performance equilibrium model classifies the multi-objective optimization variables into four main

points according to the model's objectives. These points cover risk prevention variables, operational efficiency variables, cost control variables, and service quality variables. The risk prevention variables consist of the detection accuracy of transactions, the interception rate of abnormal transactions, and the missed risk judgment rate, used to assess the basic risk control capability of the model. The operational efficiency variables include the transaction processing speed, the system response delay, and the transaction passing rate, showing the smoothness of the payment system [4]. The cost control variables are composed of the technical investment cost, the manual review cost, and the risk loss cost, indicating the economic expenses in the risk control work. The service quality variables involve the user's complaint rate, the transaction success rate, and the adaptability of the payment environment, reflecting the users' service feeling. A reasonable constraint is set for each variable in the model, where the minimum acceptable risk prevention accuracy in the industry is taken as the lower limit constraint, the maximum affordable operating cost of the payment systems is considered as the upper limit constraint, and the basic operational efficiency standard of the payment business is regarded as the threshold constraint. Moreover, the extreme values of the variables are eliminated to guarantee the stable operation of the model within a feasible range. The multi-objective weight balancing mechanism reported in related financial risk control research offers a reference for coordinating these four categories of optimization variables [5].

3. Optimization Strategies of Risk Control Performance Equilibrium Based on Multi-Objective Optimization

3.1 Balanced Optimization of Risk Prevention and Operation Efficiency

The balanced consideration of risk prevention and operation efficiency aims at resolving the contradiction that stringent risk control measures decrease the payment transaction speed while lenient rules raise the transaction risks. Payment platforms should establish a hierarchical risk recognition system based on the user's credit rating and the types of transactions, and set different risk evaluation criteria for high-risk, medium-risk, and low-risk transaction situations. Large-sum cross-border transactions and unusual regional transactions require rigorous multi-factor verifications to guarantee complete risk prevention, whereas common small-sum daily payments simplify the verification procedures and minimize the system response time [6]. The model optimizes the operation algorithm, changing the method of judgment from comprehensive data examination to targeted feature matching, thus reducing the system's computational burden during the risk recognition process and shortening the transaction processing time. Moreover, a real-time monitoring system for risk indices is set up to adjust the evaluation standards dynamically according to the current risk data, keeping the risk prevention effect stable and continuously enhancing the overall operation efficiency of the digital payment systems.

3.2 Balanced Optimization of Risk Control Cost and Service Quality

The balanced optimization of the risk control cost and the service quality is intended to overcome the dilemma that cost reduction will result in the decrease of service quality and the heavy burden caused by large investments. Payment institutions should improve the allocation of resources in risk control work, eliminate the redundant manual review procedures and repeated technical investments, and achieve fine management of the risk control cost by substituting intelligent algorithms. The model combines the historical risk big data to establish an effective risk prediction system, reduces unnecessary early warnings and transaction interception behaviors, and decreases the loss cost due to wrong judgments. Under the condition that the total risk control cost is kept within a reasonable range, the model optimizes the user's payment link, simplifies the identification procedures for the trusted users, and increases the success rate of the conventional payment transactions. For individual abnormal transactions, the platform applies intelligent secondary verification instead of direct interception, which effectively lowers the complaint rate of the users, matches the input cost of the risk control with the output effect of the service quality, and achieves the maximum benefit of the risk control investment [7].

3.3 Model Adaptability and Dynamic Iteration Optimization

Model adaptability and the optimization of dynamic iteration are the main points to ensure the long-term balance of performance in digital payment risk control systems. With the progressive improvement of digital payment methods and the continuous development of network fraud techniques, it is hard for static risk control models to keep up with the changing market risks. Therefore, payment platforms should establish a mechanism for real-time updating of data and model iteration, collect new payment situation data, novel risk types, and user behavior change

information regularly, and update the feature database and rule database in a timely manner. The multi-objective optimization model includes adaptive parameters that can adjust the weights of indicators according to the variation of business scale and risk environment automatically. In addition, a model evaluation system is also set up to check the deviation of risk prevention, efficiency, cost, and service indicators periodically, identify the weaknesses in the model operation, and make targeted algorithm optimizations and structural adjustments [8]. Thus, the continuous dynamic iteration can significantly enhance the adaptability of the risk control model and maintain the stable and balanced operation of various performance indicators long-term.

4. Conclusion

This research mainly investigates the performance disparity issue in digital payment risk control models, comprehensively examines the operational conditions and principal performance disparities of the existing risk control models, and develops a multi-objective optimized risk control performance equilibrium model according to the practical requirements of digital payment business. The model treats several important parameters, such as the effectiveness of risk prevention, operational efficiency, control expenses, and service quality, as the main optimization goals; carries out variable selection, establishes constraints and designs the whole framework, and finally establishes a set of specific equilibrium optimization strategies. The study successfully overcomes the one-sided optimization drawback of the traditional single-objective risk control models, reduces the contradiction among different performance indices in the process of payment risk control, and achieves the coordinated balance in various aspects of risk control operation. The constructed equilibrium model and optimization methods can enhance the overall risk control ability of the payment platforms, decrease operating costs, improve the user service experience, and help them adapt to the fluctuating digital payment risk environment. It gives theoretical support and practical guidance for the intelligent improvement and balanced development of digital payment risk control systems in the industry.

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