

# THE GAME MECHANISM OF UNIVERSITY BUDGET RESOURCE ALLOCATION FROM THE PERSPECTIVE OF INTERNAL CONTROL

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**Abstract:** Budget resource allocation is the core link of university financial management, which is directly related to the high-quality development of education and the efficiency of resource utilization in universities. Against the background of an increasingly improved internal control system, the budget resource allocation in universities involves multiple stakeholders such as university-level decision-makers, functional departments, and secondary colleges. The game behaviors of these stakeholders based on their own interest demands profoundly affect the fairness, scientificity and compliance of budget allocation. Based on the five elements of internal control (control environment, risk assessment, control activities, information and communication, internal supervision), this paper systematically analyzes the interest demands and behavioral characteristics of various game players in university budget resource allocation, constructs a multi-player game model (complete information static game, incomplete information dynamic game), clarifies the game equilibrium conditions through formula derivation, reveals the constraint and guiding role of internal control on game behaviors, identifies the internal control shortcomings existing in the current budget allocation game, and puts forward targeted optimization paths. It provides theoretical support and practical reference for universities to standardize budget resource allocation, resolve game conflicts and improve resource allocation efficiency.

**Keywords:** Internal control; University budget; Resource allocation; Game mechanism; Nash equilibrium

## 1 INTRODUCTION

### 1.1 Research Background

With the rapid development of higher education in China, the scale of universities has been continuously expanding, and funding sources have become increasingly diversified. As the material foundation for teaching, research, administration, and other activities in universities, the rationality and effectiveness of budget resource allocation have become important indicators of the modernization of university governance capacity. The *Guiding Opinions on Further Strengthening the Internal Control Construction of Institutions of Higher Education* clearly stipulates that universities should strengthen budget management, formulate budgets scientifically, establish and improve budget execution, analysis, and adjustment mechanisms, enhance rigid budget constraints, implement whole-process budget performance management, and improve the efficiency of resource allocation and utilization.

However, many problems still exist in the current budget resource allocation in Chinese universities:

The budget allocation of some universities lacks scientific basis, with coexistence of "egalitarianism" and "emphasis on administration over academics".

Secondary colleges and functional departments often engage in game behaviors such as rent-seeking and budget overstatement to compete for more resources.

The constraint function of the internal control system on budget allocation has not been fully exerted, resulting in disconnection between budget execution and supervision, which leads to resource waste and low efficiency.

Budget resource allocation in universities is essentially a process of multi-stakeholder interest game.

The university decision-making level (Party Committee, President's Office Meeting) pursues the maximization of overall efficiency of budget resources, balancing educational equity and strategic development.

Functional departments (Finance Office, Academic Affairs Office, Research Office, etc.), as the executive and coordinating bodies of budget allocation, need to implement university-level decisions while pursuing their own departmental interests.

Secondary colleges, as users of budget resources, aim to achieve their own goals in teaching, research, and talent cultivation, and tend to seek more budget support.

The divergent interest demands among stakeholders lead to numerous game conflicts in the budget allocation process. As a core institutional arrangement to regulate economic activities, prevent risks, and optimize resource allocation in universities, internal control can constrain irrational game behaviors and guide the game toward fairness, efficiency, and

compliance by clarifying the division of powers and responsibilities, standardizing procedures, and strengthening supervision.

At present, academic research on university budget resource allocation and game mechanisms has achieved certain results. Some scholars have analyzed the behavioral strategies of stakeholders in budget allocation from the perspective of game theory, while others have explored the regulatory role of internal control in budget management. However, most existing studies separate the two perspectives: they fail to systematically analyze the constraint and guidance mechanism of internal control on budget allocation games by integrating the five elements of internal control, and lack quantitative models and formula derivation, resulting in insufficiently in-depth analysis of game equilibrium, which makes it difficult to effectively guide the practice of university budget allocation.

Based on the above, this paper constructs a multi-stakeholder game model of university budget resource allocation from the perspective of internal control, reveals the game equilibrium conditions through formula derivation, analyzes the action path of internal control in the game process, and proposes optimization strategies, which has important theoretical value and practical significance.

## 1.2 Research Significance

### 1.2.1 Theoretical significance

This paper organically integrates internal control theory and game theory, enriches the interdisciplinary research of university budget management and game theory, and fills the gap in the research on the game mechanism of university budget resource allocation from the perspective of internal control. By constructing a multi-stakeholder game model, introducing internal control constraint variables, deriving game equilibrium formulas, and clarifying the optimal behavioral strategies of each stakeholder, this paper deepens the understanding of the essence of university budget allocation games.

Meanwhile, combining the five elements of internal control, this paper analyzes their constraint and guidance effects on game behaviors, improves the theoretical system of university internal control and budget management, and provides a new perspective for subsequent related research. In addition, drawing on resource dependence theory, this paper combines intra-organizational power differentiation with budget games, further enriching the theoretical dimensions of university budget decision-making research.

### 1.2.2 Practical significance

The research results of this paper can provide practical guidance for universities to optimize budget resource allocation and improve the internal control system. By identifying the interest demands and irrational behaviors of stakeholders in budget allocation games, clarifying the weak links of internal control, and proposing targeted optimization paths, this paper helps universities standardize budget allocation procedures, resolve game conflicts, and achieve fair distribution and efficient utilization of budget resources.

At the same time, strengthening the constraint of internal control on budget games can prevent violations such as rent-seeking, false claims, and overstatement in budget allocation, reduce budget risks, improve the level of financial management and governance capacity of universities, and promote the high-quality development of higher education. For example, Beijing Technology and Business University has shifted its resource allocation model from administration-led to business-led by establishing discipline teams and allocating budget resources based on performance points, which effectively alleviates game conflicts in budget allocation and provides practical references for university budget reform.

## 1.3 Research Status at Home and Abroad

### 1.3.1 Foreign research status

Foreign research on university budget resource allocation and game mechanisms started early and has formed a relatively mature theoretical system and practical experience. Early studies mainly focused on the fairness and efficiency of budget allocation, using game theory to analyze the behavioral strategies of stakeholders. For instance, American scholars Cyert and March proposed organizational behavior theory, arguing that universities, as multi-objective organizations, conduct budget allocation through games among interest groups, which maximize their own benefits through negotiation and consultation.

Subsequently, scholars gradually integrated internal control theory into budget management, emphasizing the standardization of budget allocation procedures and the restriction of game behaviors by improving the internal control system.

In recent years, foreign research has paid more attention to quantitative analysis and model construction. Game models have been built to derive equilibrium conditions and support budget allocation decisions. For example, the Stackelberg game model has been widely applied in resource competition scenarios. Scholars regard university budget allocation as a sequential decision-making process, analyze the game strategies between the university decision-making level (leader) and secondary colleges (followers), and derive Stackelberg equilibrium conditions. It is found that when the leader's budget exceeds a certain threshold, the utility of both parties can be improved [1].

Some scholars use principal-agent theory to analyze information asymmetry between the university decision-making level, functional departments, and secondary colleges, and propose improving the information and communication mechanism in internal control to reduce information asymmetry and alleviate game conflicts [2].

In addition, foreign universities have generally established sound budget performance management and internal control systems, emphasizing the linkage between budget allocation and performance, and restricting stakeholders' game behaviors through performance evaluation to improve resource allocation efficiency [3]. Based on the COSO Internal Control-Integrated Framework, foreign scholars have proposed constructing a university budget management risk prevention and control system from five dimensions: control environment, risk assessment, control activities, information and communication, and monitoring and evaluation, so as to provide institutional constraints for budget allocation games [4].

### **1.3.2 Domestic research status**

Domestic research on the game mechanism of university budget resource allocation began in the early 21st century. With the continuous deepening of university budget management reform, relevant studies have been increasing. Existing research mainly focuses on three aspects:

First, analysis of stakeholders' game behaviors. Scholars generally agree that university budget allocation involves multiple stakeholders such as the university decision-making level, functional departments, and secondary colleges. Differences in interest demands lead to game conflicts, such as budget competition among secondary colleges and power-responsibility games between functional departments and secondary colleges. Some scholars use the "Prisoner's Dilemma" model to analyze competitive games among secondary colleges and find that the Nash equilibrium of non-cooperative games is not conducive to the maximization of the overall interests of the university [5].

Second, construction and application of game models. Some scholars have constructed complete-information static game models and incomplete-information dynamic game models to analyze the optimal strategies and equilibrium conditions of stakeholders in budget allocation. However, most studies lack integration with internal control and fail to consider the constraint effect of internal control on game behaviors [6].

Third, integrated research on internal control and budget management. Scholars emphasize the importance of improving the internal control system for standardizing budget allocation, and propose optimizing budget resource allocation by improving internal control systems, strengthening budget supervision, and standardizing budget procedures [7]. Some studies find that problems such as weak internal control awareness, rigid internal governance structure, and backward risk assessment mechanisms intensify the irrationality of budget allocation games. Other empirical studies show that performance information is an important basis for budget allocation, but low-performance entities may participate in budget games by whitewashing performance information, affecting the fairness of budget allocation [8].

Overall, domestic research has recognized the game problems in university budget allocation and the importance of internal control, but there are still deficiencies:

Most studies separate internal control and game mechanisms, failing to systematically analyze the constraint and guidance of internal control on budget allocation games.

The construction of game models is relatively simple, lacking quantitative analysis and formula derivation, resulting in insufficiently in-depth analysis of game equilibrium.

Most studies focus on theoretical analysis, with few empirical studies combined with actual university cases, and the practical guidance of research results needs to be improved.

## **1.4 Research Methods and Technical Route**

### **1.4.1 Research methods**

This paper adopts a combination of multiple research methods to ensure the scientificity and rigor of the research, including:

**Literature Research Method:** Systematically sort out domestic and foreign literature on university budget resource allocation, game mechanisms, and internal control, clarify the research status, core viewpoints, and deficiencies, and lay a theoretical foundation for this study.

**Game Theory Method:** Based on the basic principles of game theory, construct multi-stakeholder game models of university budget resource allocation (complete-information static game, incomplete-information dynamic game), clarify game equilibrium conditions through formula derivation, and analyze the behavioral strategies of each stakeholder.

**Normative Analysis Method:** Combined with the five elements of internal control, analyze the constraint and guidance of internal control on budget allocation games, identify internal control shortcomings in current budget allocation games, and propose targeted optimization paths.

**Case Analysis Method (Optional):** Verify the rationality of the game model and the feasibility of the optimization paths by combining actual cases of budget resource allocation in a certain university, so as to enhance the practical guidance of the research results.

### **1.4.2 Technical route**

The technical route of this paper is as follows: Firstly, sort out relevant literature, clarify the research background, significance, and status, and determine the research ideas and methods. Secondly, define core concepts, and analyze the game stakeholders, interest demands, and behavioral characteristics of university budget resource allocation from the perspective of internal control. Thirdly, construct a multi-stakeholder game model, reveal game equilibrium conditions through formula derivation, and analyze the constraint effect of internal control on game behaviors. Then, identify existing internal control problems in university budget allocation games. Finally, propose optimization paths, summarize research conclusions, and point out research deficiencies and future research directions.

## 1.5 Research Innovations and Deficiencies

### 1.5.1 Research innovations

**Innovative Research Perspective:** Organically integrate internal control theory and game theory. Starting from the five elements of internal control, systematically analyze the constraint and guidance of internal control on university budget resource allocation games, breaking the limitation of separating the two in existing research. **Innovative Model Construction:** Construct a multi-stakeholder game model including internal control constraint variables, derive game equilibrium conditions through quantitative formulas, clarify the optimal behavioral strategies of each stakeholder, deepen the understanding of the essence of budget allocation games, and improve the scientificity and rigor of the research. **Innovative Practical Paths:** Propose targeted optimization paths combined with practical problems of current university budget allocation and internal control, focusing on operability, which can provide feasible references for university budget management reform and internal control improvement. Meanwhile, drawing on the practical experience of universities such as Beijing Technology and Business University enhances the practicability of the paths.

### 1.5.2 Research deficiencies

The hypothetical conditions of the game model are somewhat different from the actual situation. The setting of stakeholders' utility functions and constraint conditions in the model is relatively simplified, failing to fully consider complex factors in university budget allocation (such as policy changes and external environmental impacts).

**Lack of large-scale empirical research.** This paper mainly adopts normative analysis and model derivation. If empirical tests can be carried out combined with actual data from multiple universities, the persuasiveness and practical guidance of the research results will be further improved.

The analysis of the role of each internal control element in budget games is not detailed enough, failing to deeply explore the differential impacts of different internal control elements on different game stakeholders and different game links.

## 2 DEFINITION OF CORE CONCEPTS AND THEORETICAL BASIS

### 2.1 Definition of Core Concepts

#### 2.1.1 University budget resource allocation

University budget resource allocation refers to the process in which universities allocate limited budget resources (fiscal appropriations, institutional income, social donations, etc.) among teaching, research, administration, infrastructure construction and other activities, as well as among secondary colleges and functional departments, in accordance with their development strategies and annual work objectives. Its core goals are to achieve fair distribution and efficient utilization of budget resources, balance overall interests and local interests, short-term goals and long-term goals, and ensure the healthy development of higher education in universities.

University budget resource allocation is characterized by comprehensiveness, hierarchy and dynamics:

**Comprehensiveness** means that budget resources cover various activities of universities, involving multiple stakeholders and fields;

**Hierarchy** means that budget allocation is divided into university level, functional department level, secondary college level and other levels;

**Dynamics** means that budget allocation needs to be adjusted timely according to the university's development strategy, changes in the external environment and budget implementation.

At present, some universities have explored distinctive budget allocation models. For example, Beijing Technology and Business University adopts a "points-based" budget allocation method, which divides the total annual discipline construction budget by the total annual points of all discipline teams, and allocates budget resources according to points. This practice links resource allocation to performance and provides a new practical paradigm for university budget resource allocation.

#### 2.1.2 Game mechanism

Game mechanism refers to the process and manner in which participants select optimal behavioral strategies based on their own interest demands under certain rules and constraints, and finally achieve game equilibrium. Its core elements include game participants, strategy space, payoff function, information structure, equilibrium results, etc.

In university budget resource allocation, the game mechanism is reflected in the process where various stakeholders (university decision-making level, functional departments, secondary colleges, etc.) pursue their own interest maximization by choosing budget application amounts, adjusting behavioral strategies, negotiating and other means in the preparation, implementation and supervision of budget allocation, and finally form a budget allocation plan.

The game of university budget allocation is characterized by the coexistence of non-cooperative games and cooperative games:

In the stage of budget application and competition for quotas, stakeholders mostly behave as non-cooperative games, pursuing their own interest maximization;

In the stage of university-level coordination and negotiation, they mostly show cooperative games, balancing overall interests and local interests.

At the same time, budget allocation games are also characterized by information asymmetry and diverse strategies. Differences in budget information held by various stakeholders lead to diversified game strategies.

### **2.1.3 Internal control in universities**

According to the Guiding Opinions on Further Strengthening the Internal Control Construction of Institutions of Higher Education, internal control in universities refers to the process in which universities prevent and control risks in economic activities and related business activities by formulating systems, implementing measures and executing procedures to achieve control objectives.

Its control objectives include: reasonably ensuring the legality and compliance of university economic activities, asset safety and effective use, true and complete financial information, effectively preventing fraud and corruption, improving resource allocation and use efficiency, and promoting high-quality development of universities.

Internal control in universities covers five elements:

Control environment, the foundation of internal control, including governance structure, institutional setup, division of powers and responsibilities, cultural construction, etc.;

Risk assessment, the process of identifying and analyzing risks in economic activities and related business activities of universities and formulating risk response strategies;

Control activities, specific measures and procedures adopted to achieve control objectives, including budget control, authorization and approval control, separation of incompatible positions control, etc.;

Information and communication, the process of collecting, transmitting and feedback relevant information timely, accurately and completely to ensure smooth information among stakeholders;

Internal supervision, the process of supervising and inspecting the establishment and implementation of internal control, evaluating the effectiveness of internal control, and timely detecting and correcting internal control defects.

Budget management is an important part of internal control in universities. Through budget preparation, implementation, adjustment, final accounts and other links, comprehensive control over university economic activities is realized.

## **2.2 Theoretical Basis**

### **2.2.1 Game theory**

Game theory is a theory that studies the behavioral choices and equilibrium results of multiple decision-making subjects under interaction. Its core idea is the "rational man" hypothesis, that is, each decision-making subject aims to maximize its own interests and adjusts its decisions according to the behavioral strategies of other subjects.

Game theory is divided into complete information game and incomplete information game, static game and dynamic game. Complete information game means that all participants fully understand the strategy space, payoff function and other information of other participants; incomplete information game means that participants do not fully understand the relevant information of other participants. Static game means that participants choose behavioral strategies at the same time and do not know the choices of others; dynamic game means that participants choose behavioral strategies successively, and later movers know the choices of earlier movers.

In university budget resource allocation, the game behaviors of various stakeholders conform to the "rational man" hypothesis of game theory. The university decision-making level, functional departments, secondary colleges and other parties all aim to maximize their own interests and choose optimal strategies for budget application, allocation and implementation.

This paper will apply the basic principles of complete information static game and incomplete information dynamic game to construct a multi-stakeholder game model of university budget resource allocation and analyze the behavioral strategies and equilibrium results of each stakeholder. In addition, the Colonel Blotto game model (resource competition game) also provides a reference for this study. This model is applicable to multi-stakeholder competition scenarios under limited budget resources, which is highly consistent with the actual situation of university budget allocation.

### **2.2.2 Internal control theory**

Internal control theory originated in the early 20th century. After years of development, a theoretical system with the COSO Internal Control-Integrated Framework as the core has been formed. The framework emphasizes the five elements of internal control (control environment, risk assessment, control activities, information and communication, internal supervision) and provides guidance for internal control construction of various organizations.

As non-profit organizations, universities have their own particularities in internal control, focusing on the compliance of economic activities, asset security, efficient use of resources and other objectives.

Internal control plays an important role in restricting and guiding the game behaviors of university budget resource allocation:

Control environment provides institutional basis and cultural atmosphere for game behaviors and standardizes the behavioral norms of each stakeholder;

Risk assessment can identify risk points in budget allocation games (such as false budget reporting, rent-seeking, etc.) and provide a basis for adjusting game strategies;

Control activities restrict the irrational game behaviors of stakeholders by formulating specific measures in budget preparation, implementation, supervision and other links;

Information and communication can reduce information asymmetry among stakeholders and alleviate game conflicts;

Internal supervision can timely detect and correct violations in budget allocation games and ensure the fairness and compliance of the game.

### **2.2.3 Principal-agent theory**

Principal-agent theory is a theory that studies the interest conflicts and coordination mechanisms between principals and agents. Its core problems are "moral hazard" and "adverse selection" caused by information asymmetry.

In university budget resource allocation, there are multiple principal-agent relationships:

The university decision-making level, as the principal, entrusts functional departments (agents) to be responsible for the specific implementation of budget allocation;

Functional departments, as principals, entrust secondary colleges (agents) to be responsible for the use of budget resources;

In addition, universities, as principals, accept entrustment from the government and the public to rationally use budget resources and perform educational public welfare functions.

Due to information asymmetry between principals and agents, agents may take behaviors deviating from the principal's goals in pursuit of maximizing their own interests, such as functional departments seeking departmental interests by using budget allocation power, secondary colleges falsely reporting budgets or misappropriating budget funds. These behaviors are essentially game behaviors under the principal-agent relationship.

As an effective supervision and restraint mechanism, internal control can alleviate information asymmetry, reduce "moral hazard" and "adverse selection", and guide game behaviors toward the principal's goals by standardizing the rights and responsibilities of both principals and agents, improving information communication and strengthening supervision and inspection.

#### **2.2.4 Resource dependence theory**

Resource dependence theory holds that no organization can be self-sufficient and must exchange resources with the environment. The importance and scarcity of resources determine the dependence of organizations. The opposite of dependence is power, and the differentiation of power within organizations will affect the process of resource allocation. In university budget allocation, the scarcity of resources leads secondary colleges and functional departments to depend on budget resources. Differences in dependence form different power patterns, which in turn affect the game behaviors of various stakeholders. For example, secondary colleges with core disciplinary advantages and high performance have weaker dependence on budget resources and have a stronger voice in budget games; while ordinary secondary colleges are in a dependent position with weak game voice.

Internal control can alleviate the game imbalance caused by power differentiation and realize fair distribution of resources by standardizing power operation and improving resource allocation rules.

### **3 GAME PLAYERS AND BEHAVIORAL CHARACTERISTICS OF UNIVERSITY BUDGET RESOURCE ALLOCATION FROM THE PERSPECTIVE OF INTERNAL CONTROL**

#### **3.1 Definition of Game Players**

From the perspective of internal control, the game players of university budget resource allocation mainly include three categories: the university-level decision-making level, functional departments, and secondary colleges. Each player plays a different role in the budget allocation process, with distinct powers, responsibilities and interest demands, forming a complex multi-player game relationship. In addition, external players such as government departments and the public also exert a certain influence on the game of university budget allocation, but this paper mainly focuses on the game behaviors of internal players in universities.

##### **3.1.1 University-level decision-making level**

The university-level decision-making level mainly includes the University Party Committee and the President's Office Meeting, which is the supreme decision-making body of university budget resource allocation. Its core powers and responsibilities are to formulate the overall principles and allocation plans of university budget allocation, approve the annual budget, and supervise budget implementation. The interest demand of the university decision-making level is to maximize the overall interests of the university, balancing educational equity, strategic development and resource utilization efficiency, ensuring that budget resources can support the completion of core tasks such as teaching, research and talent cultivation, while complying with relevant national policies and internal control norms.

The university decision-making level is in a dominant position in the budget allocation game, and its decision-making behaviors directly affect the game strategies and budget allocation results of other players. As the core leader of internal control, the university decision-making level is responsible for building the internal control framework, clarifying the division of powers and responsibilities of each player, promoting the implementation of the internal control system, and restricting the irrational game behaviors of other players.

##### **3.1.2 Functional departments**

Functional departments mainly include the Finance Office, Academic Affairs Office, Scientific Research Office, Personnel Office, Asset Management Office, etc., which are the executive and coordinating bodies of university budget resource allocation. Their core powers and responsibilities are to assist the university decision-making level in formulating detailed rules for budget allocation, collect and review budget application materials from secondary colleges, allocate budget resources, supervise budget implementation, and coordinate contradictions and conflicts in budget allocation.

The interest demands of functional departments are dual: on the one hand, they need to implement the requirements of the university decision-making level, ensure the fairness and scientificity of budget allocation, and perform internal control duties; on the other hand, they have their own departmental interest demands, tending to strive for more budget

resources for their own departments to expand departmental power and influence. For example, the Scientific Research Office tends to allocate more budget resources to scientific research, the Academic Affairs Office inclines to teaching fields, and the Finance Office focuses on the compliance and controllability of the budget. As the specific implementers of internal control, functional departments are responsible for carrying out control activities, information communication, risk assessment and other specific tasks, and their behaviors directly affect the effectiveness of internal control and the trend of budget allocation game.

### **3.1.3 Secondary colleges**

Secondary colleges are the users of university budget resources and the core participants in the budget allocation game. Their core powers and responsibilities are to declare annual budgets according to the needs of teaching, research, talent cultivation and other work of the college, use budget resources rationally, and accept supervision and assessment from functional departments. The interest demand of secondary colleges is to maximize the interests of their own colleges, striving for more budget resources to improve teaching conditions, enhance research levels, introduce outstanding talents, and improve faculty benefits.

Due to differences in scale, disciplinary advantages and development stages among secondary colleges, their budget application demands and game strategies also vary: Colleges with advantageous disciplines (such as food-related and business-related colleges in Beijing Technology and Business University) tend to apply for higher budget quotas by virtue of their disciplinary strength and performance advantages, and have a stronger voice in the game [1]; ordinary colleges may strive for more budget resources by overstating budgets and exaggerating demands. As the executive bodies of internal control, secondary colleges are responsible for implementing budget control and risk prevention in their own colleges. Whether their behaviors are compliant directly affects the fairness of the budget allocation game and the utilization efficiency of budget resources.

## **3.2 Interest Demands and Behavioral Characteristics of Each Player**

### **3.2.1 Interest demands and behavioral characteristics of the university-level decision-making level**

The core interest demand of the university decision-making level is to maximize the overall interests of the university, which is embodied as follows: First, ensure the normal operation of higher education and the smooth development of teaching, research, management and other activities; Second, promote the strategic development of the university, tilt budget resources to core disciplines and key fields, and enhance the core competitiveness of the university; Third, realize the fair distribution and efficient utilization of budget resources to avoid waste and imbalance; Fourth, prevent budget risks, ensure that budget allocation and implementation comply with relevant national policies and internal control norms, and eliminate violations.

Its behavioral characteristics are as follows: First, integrity, paying attention to the overall interests of the university in the decision-making process, balancing the interests of various departments and colleges to prevent local interests from damaging the overall interests; Second, strategic nature, integrating budget allocation decisions with the university's development strategy and focusing on the realization of long-term goals rather than short-term interests; Third, compliance, strictly abiding by relevant national laws, regulations, policies and internal control systems to standardize the budget allocation process; Fourth, supervisory nature, strengthening the supervision of the budget allocation and implementation process, timely detecting and correcting violations to ensure the achievement of budget objectives. In addition, the university decision-making level will dynamically adjust budget allocation strategies according to changes in the external environment and internal actual conditions to meet the needs of high-quality development of the university.

### **3.2.2 Interest demands and behavioral characteristics of functional departments**

The interest demands of functional departments are dual. On the one hand, as the executive and coordinating bodies of budget allocation, they need to ensure the fairness, scientificity and compliance of budget allocation, perform internal control duties, and implement the decisions of the university decision-making level; on the other hand, as independent interest subjects, they tend to strive for more budget resources for their own departments, expand the scope and influence of departmental work, and improve departmental performance.

Its behavioral characteristics are as follows: First, coordination, needing to reconcile interest conflicts between the university decision-making level and secondary colleges, as well as among secondary colleges, and balance the demands of all parties; Second, self-interest, consciously tilting towards their own departments or fields closely related to them in the budget allocation process; Third, compliance, constrained by the internal control system, needing to carry out work in accordance with budget allocation rules and authorization and approval procedures to avoid illegal operations; Fourth, information intermediation, as the transmitter of budget allocation information, responsible for collecting, sorting out and transmitting budget application information of secondary colleges and decision-making information of the university decision-making level. The accuracy and timeliness of information transmission directly affect the behavioral strategies of all game players. Some functional departments may have the phenomenon of "emphasizing approval while neglecting supervision", which weakens the restrictive effect of internal control and intensifies the irrationality of budget allocation game.

### **3.2.3 Interest demands and behavioral characteristics of secondary colleges**

The core interest demand of secondary colleges is to maximize the interests of their own colleges, which is embodied as follows: First, strive for more budget resources to improve teaching and research conditions and enhance disciplinary

strength; Second, improve the treatment and welfare of faculty and staff to enhance the cohesion of the college; Third, complete various tasks assigned by the university and improve the college's assessment ranking.

Its behavioral characteristics are as follows: First, competitiveness, fierce competition among secondary colleges for limited budget resources, and even adoption of irrational game strategies (such as overstating budgets, exaggerating demands, lobbying functional departments, etc.); Second, self-interest, giving priority to the interests of their own colleges and ignoring the overall interests of the university, which may lead to phenomena of "emphasizing declaration while neglecting implementation" and "emphasizing utilization while neglecting performance"; Third, adaptability, adjusting their own budget application strategies and behaviors according to the budget allocation principles of the university decision-making level and the review standards of functional departments; Fourth, information asymmetry, as the users of budget resources, secondary colleges master the actual demand information of their own colleges, while the university decision-making level and functional departments cannot fully grasp such information, leading to the possibility that secondary colleges may use information advantages to seek improper benefits. For example, low-performance secondary colleges may whitewash their performance by abnormally filling in performance information to strive for more budget resources.

### **3.3 Restriction and Guidance of Internal Control on the Game Behaviors of Each Player**

Through the synergistic effect of the five elements, university internal control effectively restricts and guides the budget allocation game behaviors of each player, standardizes the game process, alleviates game conflicts, and promotes the game to develop in a fair, efficient and compliant direction.

#### **3.3.1 Basic role of control environment**

The control environment provides an institutional basis and cultural atmosphere for the game behaviors of each player by improving the university's governance structure, clarifying the division of powers and responsibilities of each player, and cultivating an internal control culture. For example, clarifying the powers and responsibilities of the university decision-making level, functional departments and secondary colleges in budget allocation to avoid overlapping powers and responsibilities and buck-passing; cultivating an internal control culture of "fairness, impartiality, compliance and efficiency" to guide each player to establish a holistic awareness, abandon irrational game behaviors, and consciously abide by budget allocation rules. At the same time, strengthen the leading role of the University Party Committee in internal control construction, and submit important internal control-related issues to the Party Committee for decision-making and deliberation to ensure that the budget allocation game is in line with the university's overall development goals.

#### **3.3.2 Early warning role of risk assessment**

Risk assessment provides a basis for each player to adjust game strategies and prevent risks by identifying risk points in the budget allocation game (such as false budget reporting, rent-seeking, budget misappropriation, etc.) and analyzing the possibility and impact of risks. For example, through risk assessment, identify the risk of false budget reporting by secondary colleges, and functional departments can strengthen the review of budget application materials; identify the risk of rent-seeking by functional departments using allocation power, and the university decision-making level can strengthen supervision over functional departments. In addition, establish a regular risk assessment mechanism to timely respond to game risks caused by changes in the external environment and internal management adjustments.

#### **3.3.3 Restrictive role of control activities**

Control activities restrict the irrational game behaviors of each player by formulating specific measures in budget preparation, implementation, supervision and other links (such as authorization and approval, separation of incompatible positions, budget performance evaluation, etc.). For example, through authorization and approval control, clarify the authority and process of budget application, review and approval to avoid unauthorized operations; through separation of incompatible positions, separate posts of budget preparation, review, implementation and supervision to prevent power concentration and fraud; through budget performance evaluation, link budget allocation with implementation performance, restrict the behavior of "emphasizing declaration while neglecting implementation" in secondary colleges, and guide them to use budget resources rationally. At the same time, adhere to the principle of "no expenditure without budget", strengthen rigid budget constraints, and standardize budget implementation behaviors.

#### **3.3.4 Coordination role of information and communication**

Information and communication reduce information asymmetry among players and alleviate game conflicts by establishing a sound information transmission mechanism to deliver budget allocation-related information timely, accurately and completely. For example, establish a budget information disclosure system to publicize budget allocation principles, allocation plans, implementation status and other information, so that each player can understand the whole process of budget allocation and reduce suspicion and irrational competition; establish a communication and coordination mechanism among players to timely solve contradictions and problems in budget allocation and promote consensus among players. In addition, promote the informatization construction of internal control, break information islands, realize real-time sharing of budget information, and improve the efficiency of information communication.

#### **3.3.5 Guarantee role of internal supervision**

Internal supervision guarantees the fairness and compliance of the game by supervising and inspecting the budget allocation and implementation process, evaluating the effectiveness of internal control, and timely detecting and correcting illegal game behaviors of each player. For example, the internal audit department audits the budget allocation process and investigates and punishes violations such as false budget reporting and rent-seeking; the university

discipline inspection and supervision department supervises the game behaviors of each player and standardizes power operation. At the same time, link supervision results with the assessment of each player to strengthen the deterrent effect of supervision and guide each player to consciously abide by the internal control system and budget allocation rules.

#### 4 CONSTRUCTION AND FORMULA DERIVATION OF THE GAME MODEL FOR UNIVERSITY BUDGET RESOURCE ALLOCATION FROM THE PERSPECTIVE OF INTERNAL CONTROL

Based on the above analysis, this paper combines the five elements of internal control to construct a multi-player game model for university budget resource allocation, focusing on the game relationships between the university decision-making level and secondary colleges, as well as between functional departments and secondary colleges. The game equilibrium conditions are clarified through formula derivation, revealing the constraint effect of internal control on game behaviors. This paper constructs a complete-information static game model and an incomplete-information dynamic game model respectively, taking into account different scenarios of budget allocation (e.g., budget application stage, budget review stage).

##### 4.1 Model Assumptions

To simplify the model and highlight the core variables, this paper puts forward the following assumptions:

Assumption 1: All game participants are "rational persons", that is, the university decision-making level, functional departments, and secondary colleges all aim to maximize their own interests and choose optimal behavioral strategies.

Assumption 2: The total budgetary resources are fixed at  $M$ , with the sum of allocations from all entities equaling  $M$ . This scarcity of resources forms the basis for the game's emergence.

Assumption 3: The internal control constraint variable is defined as  $\lambda$  ( $0 \leq \lambda \leq 1$ ), the larger the  $\lambda$ , the more perfect the internal control is, the stronger the restraint effect on the game behavior of each subject is. When  $\lambda=0$ , the Internal control is ineffective, and all parties can freely engage in game. When  $\lambda=1$ , The internal control is completely effective, and the game behavior of each subject is completely in line with the norms.

Assumption 4: The strategy space of each game player is clear: the strategies of the university decision-making level are "strict supervision" and "loose supervision"; the strategies of functional departments are "fair allocation" and "biased allocation"; the strategies of secondary colleges are "truthful declaration" and "false declaration".

Assumption 5: During the game, the payoff function of each player consists of its own benefits, costs, and internal control penalty costs, where the penalty cost is positively correlated with the internal control constraint variable  $\lambda$ .

Assumption 6: Under the scenario of information asymmetry, secondary colleges know their actual needs and the authenticity of their declarations, while the university decision-making level and functional departments can only judge the authenticity of the declarations through review, with certain judgment errors.

##### 4.2 Complete Information Static Game Model (Game Between University Decision-Making Level and Secondary Colleges)

###### 4.2.1 Game players and strategy space

Game players: University Decision-Making Level (Player 1), Secondary College (Player 2). Both players are under complete information: that is, the University Decision-Making Level knows the strategy space and payoff function of the Secondary College, and the Secondary College also knows the strategy space and payoff function of the University Decision-Making Level.

Policy space: The decision-makers' policy is  $S_1 = \{\text{strict regulation } (R) \text{ versus lenient regulation } (L)\}$ ;

The strategy for the secondary college is  $S_2 = \{\text{truthful declaration } (T) \text{ versus false declaration } (F)\}$ .

###### 4.2.2 Payment function setting

(1) Payment Function for Secondary Colleges Set the actual budget requirement for the secondary college as  $X$ . When declaring truthfully, the declared amount is  $X$ , the budget allocation amount obtained is  $X$ , the revenue is  $U_T$ ; In the case of false declaration, the declared amount is  $X + \Delta X$  ( $\Delta X > 0$ , refers to the overstated amount). If the false declaration is not detected, the allocated budget obtained is  $X + \Delta X$ , and the payoff is  $U_{F1}$ . If detected by the university decision-making level, a penalty  $C_F$  will be imposed, the allocated budget obtained is  $X - k\Delta X$  ( $0 < k < 1$ , refers to the penalty coefficient), and the payoff is  $U_{F2}$ .

When the university decision-making level adopts strict supervision, the probability of detecting false declaration by the secondary college is  $P$  (where  $P$  is positively correlated with the internal control constraint variable  $\lambda$ , i.e.,  $P=\lambda \cdot P_0$ ,  $P_0$  is the basic detection probability). When adopting loose supervision, the probability of detecting false declaration is  $q$  ( $q < p$ , and  $q=(1-\lambda) \cdot P_0$ ).

When secondary colleges submit truthful declarations, the outcome remains consistent regardless of the regulatory strategies adopted by the university's decision-making level:

$$U_T = X - C_T \quad (1)$$

Here,  $C_T$  represents the actual costs reported by the secondary college, including human and material resources allocated for budget preparation.

When secondary colleges submit false declarations, the expected returns under strict supervision are:

$$E_{F(R)} = p \cdot U_{F2} + (1-p) \cdot U_{F1} = p \cdot (X - k\Delta X - C_F) + (1-p) \cdot (X + \Delta X - C_F) \quad (2)$$

Simplified:

$$E_{F(R)} = X + \Delta X(1-p-kp) - C_F \quad (3)$$

The expected return under relaxed regulation is:

$$E_{F(L)} = q \cdot U_{F2} + (1-q) \cdot U_{F1} = q \cdot (X - k\Delta X - C_F) + (1-q) \cdot (X + \Delta X - C_F) \quad (4)$$

Simplified:

$$E_{F(L)} = X + \Delta X(1-q-kq) - C_F \quad (5)$$

(2) Payoff Function of the University Decision-Making Level

The cost of strict supervision for the university decision-making level is  $C_R$  (e.g., labor and material costs for supervision), and the cost of loose supervision is  $C_L$  ( $C_L < C_R$ ).

When the secondary college submits truthful declarations, the benefits of both strict and lenient supervision by the university's decision-making level are:

$$U_{R(T)} = U_{L(T)} = M - \sum X_i - C_{Supervision} \quad (6)$$

Here,  $\sum X_i$  represents the aggregate budgetary requirements of all secondary colleges, while  $C_{Supervision}$  represents the Supervision Cost for School Decision-Making (Strict supervision is  $C_R$ , while relaxed supervision is  $C_L$ ).

When secondary colleges submit false declarations, the university's decision-making level strictly monitors the resulting benefits:

$$U_{R(F)} = M - [p \cdot (X - k\Delta X) + (1-p) \cdot (X + \Delta X)] - C_R \quad (7)$$

Simplified:

$$U_{R(F)} = M - X - \Delta X(1-p-kp) - C_R \quad (8)$$

The benefits of deregulation are:

$$U_{L(F)} = M - [q \cdot (X - k\Delta X) + (1-q) \cdot (X + \Delta X)] - C_L \quad (9)$$

Simplified:

$$U_{L(F)} = M - X - \Delta X(1-q-kq) - C_L \quad (10)$$

#### 4.2.3 Derivation of game equilibrium

The equilibrium of the perfect information static game is Nash equilibrium, that is, neither of the two sides has the motivation to change their own strategy, given the other's strategy, their own strategy is the best.

Optimal Strategy Choice of the Secondary College

When the university decision-making level chooses strict supervision (R), the payoff of truthful declaration  $U_T E_{F(R)}$ :

If  $U_T \geq E_{F(R)}$ , that is  $X - C_T \geq X + \Delta X(1-p-kp) - C_F$ , Simplified:

$$C_F - C_T \geq \Delta X(1-p-kp) \quad (11)$$

In this case, truthful declaration (T) is the optimal strategy for the secondary college. Otherwise, false declaration (F) is optimal.

Substitute  $P=\lambda \cdot P_0$  into (11):

$$C_F - C_T \geq \Delta X(1-\lambda P_0 - k\lambda P_0) = \Delta X[1-\lambda P_0(1+k)] \quad (12)$$

From Equation (12), the larger the internal control constraint variable  $\lambda$ , the smaller the right-hand side, and the easier the inequality is satisfied. That is, the secondary college is more inclined to choose truthful declaration (T), indicating that internal control can effectively restrain false declaration.

When the university decision-making level chooses loose supervision (L), the payoff of truthful declaration  $U_T E_{F(L)}$ :

If  $U_T \geq E_{F(L)}: X - C_T \geq X + \Delta X(1 - q - kq) - C_F$ , Simplified:

$$C_F - C_T \geq \Delta X(1 - q - kq) \tag{13}$$

Substitute  $q = (1 - \lambda) \cdot p_0$  into (13):

$$C_F - C_T \geq \Delta X[1 - (1 - \lambda)p_0(1 + k)] \tag{14}$$

Since  $(1 - \lambda)p_0(1 + k) < \lambda p_0(1 + k)$ , the right-hand side of (14) is larger than that of (12). Therefore, under loose supervision, the secondary college is more likely to choose false declaration (F), which further demonstrates the importance of internal control.

(2) Optimal Strategy Choice of the University Decision-Making Level When the secondary college chooses truthful

declaration (T), the payoff of strict supervision  $U_{R(T)}$  is compared with that of loose supervision  $U_{L(T)}$ :

Since  $C_R > C_L, U_{R(T)} = M - \sum X_i - C_R < U_{L(T)} = M - \sum X_i - C_L$ , Thus, loose supervision (L) is the optimal strategy.

When the secondary college chooses false declaration (F), the payoff of strict supervision  $U_{R(F)}$  is compared with that of

loose supervision  $U_{L(F)}$ :

If  $U_{R(F)} \geq U_{L(F)}, M - X - \Delta X(1 - p - kp) - C_R \geq M - X - \Delta X(1 - q - kq) - C_L$ , simplified:

$$\Delta X[(1 - q - kq) - (1 - p - kp)] \geq C_R - C_L \tag{15}$$

Substitute  $p = \lambda \cdot p_0, q = (1 - \lambda) \cdot p_0$ :

$$\Delta X p_0(1 + k)(2\lambda - 1) \geq C_R - C_L \tag{16}$$

When  $\lambda \geq 0.5$ , the left-hand side is positive. If the inequality holds, strict supervision (R) is optimal.

When  $\lambda < 0.5$ , the left-hand side is negative, and loose supervision (L) is optimal.

(3) Nash Equilibrium Results

Combined with different values of  $\lambda$ , the Nash equilibria are as follows:

When  $\lambda \geq \lambda_1$  (where  $\lambda_1$  is the critical value satisfying (12) and (16), the Nash equilibrium is (strict supervision, truthful declaration). Internal control is sound, and the budget game achieves a fair and compliant equilibrium.

When  $\lambda_2 < \lambda < \lambda_1$  (where  $\lambda_2$  is the critical value satisfying (14), the Nash equilibrium is (loose supervision, truthful declaration). Internal control has a certain restrictive effect.

3) When  $\lambda < \lambda_2$ , the Nash equilibrium is (loose supervision, false declaration). Internal control fails, leading to irrational behaviors and inefficient resource allocation.

### 4.3 Dynamic Game Model with Incomplete Information (Game Between Functional Departments and Secondary Colleges)

#### 4.3.1 Game players and strategy space

Players: Functional Department (Player 1), Secondary College (Player 2).

Information asymmetry: The secondary college knows its own type (truthful or false declaration), while the functional department does not and can only judge by posterior probability.

Game sequence:

The secondary college chooses its declaration strategy.

The functional department chooses an audit strategy (strict or loose).

The budget is allocated according to the audit result, and payoffs are realized.

#### 4.3.2 Prior and posterior probabilities

Let the prior probability of truthful declaration (T) be  $\alpha$  ( $0 < \alpha < 1$ ), and false declaration (F) be  $1 - \alpha$ .

Under strict audit:

Correct identification rate of truthful declaration:

$r$ , The probability of being judged as false declaration when the error is truthfully declared is  $1 - r$ ; The probability of correctly identifying false declarations is  $s$ , The probability of misclassifying a false declaration as a true declaration is

$1 - s$ . Both  $r$  and  $s$  are positively correlated with the internal control constraint variable  $\lambda$ , i.e.,  $r = \lambda \cdot r_0, s = \lambda \cdot s_0$  (where  $r_0, s_0$  are the base identification probabilities, with  $0 < r_0, s_0 < 1$ ).

According to Bayes' theorem, when the administrative department observes the declaration behavior, the posterior probability that the secondary college has truthfully declared is:

$$P(T|\text{declared}) = \frac{\alpha \cdot r}{\alpha \cdot r + (1-\alpha) \cdot (1-s)} \quad (17)$$

The posterior probability for judging the false declaration by the secondary college is:

$$P(F|\text{declared}) = \frac{(1-\alpha) \cdot s}{\alpha \cdot (1-r) + (1-\alpha) \cdot s} \quad (18)$$

When functional departments adopt a lenient audit approach, the accuracy rate of identification is relatively low. The probability of correctly distinguishing between truthful declarations and false declarations is both equal to  $t$  ( $t < r, t < s$ ), and  $t = (1-\lambda) \cdot t_0$  ( $t_0$  is the base probability of relaxed audit identification). The corresponding posterior probability can be derived using the aforementioned formula, which will not be elaborated here.

#### 4.3.3 Payoff function specification

##### (1) Payoff Function of the Secondary College

When a secondary college submits an accurate declaration (T), regardless of the review strategy adopted by the functional department, if correctly identified, it will receive a budget quota of  $X$ , The benefit is  $U_{T1} = X - C_T$ ; If the declaration is erroneously classified as false, the budget allocation is  $X - m$  ( $m > 0$ , represents the penalty for misclassification), and the profit is  $U_{T2} = X - m - C_T$ .

Therefore, the expected returns reported truthfully by the secondary colleges are:

$$E_T = \alpha[r \cdot U_{T1} + (1-r) \cdot U_{T2}] + (1-\alpha)[t \cdot U_{T1} + (1-t) \cdot U_{T2}] \quad (19)$$

Substituting  $U_{T1}$ ,  $U_{T2}$ , simplified:

$$E_T = X - C_T - m[\alpha(1-r) + (1-\alpha)(1-t)] \quad (20)$$

When a secondary college submits a false declaration (F), if the functional department correctly identifies it, the budget allocation is  $X - n\Delta X$  ( $n > k$ , the penalty coefficient for falsified reports), The benefit is  $U_{F3} = X - n\Delta X - C_F$ ; If falsely declared as truthful, the budget allocation would be  $X + \Delta X$ , with the revenue calculated as  $U_{F4} = X + \Delta X - C_F$ . Therefore, the expected returns from the false declarations by the secondary colleges are:

$$E_F = \alpha[s \cdot U_{F3} + (1-s) \cdot U_{F4}] + (1-\alpha)[t \cdot U_{F3} + (1-t) \cdot U_{F4}] \quad (21)$$

Substituting  $U_{F3}$ ,  $U_{F4}$ , simplified:

$$E_F = X - C_F + \Delta X[1 - n(\alpha s + (1-\alpha)t)] \quad (22)$$

functional payment function

The cost of strict review by the functional department is  $C_A$ , The cost of relaxed auditing is  $C_B$  ( $C_B < C_A$ ).

When a secondary college submits an accurate declaration (T), the revenue subject to strict review by the functional department is:

$$U_{A(T)} = M - [rX + (1-r)(X-m)] - C_A = M - X + m(1-r) - C_A \quad (23)$$

The benefit of relaxed review is:

$$U_{B(T)} = M - [tX + (1-t)(X-m)] - C_B = M - X + m(1-t) - C_B \quad (24)$$

When a secondary college submits a false declaration (F), the revenue subject to strict review by the functional department is:

$$U_{A(F)} = M - [s(X - n\Delta X) + (1-s)(X + \Delta X)] - C_A = M - X - \Delta X[1 - s(n+1)] - C_A \quad (25)$$

The benefit of relaxed review is:

$$U_{B(F)} = M - [t(X - n\Delta X) + (1-t)(X + \Delta X)] - C_B = M - X - \Delta X[1 - t(n+1)] - C_B \quad (26)$$

The expected benefits for the functional department are:

$$E_A = \alpha \cdot U_{A(T)} + (1-\alpha) \cdot U_{A(F)} \quad (27)$$

$$E_B = \alpha \cdot U_{B(T)} + (1-\alpha) \cdot U_{B(F)} \quad (28)$$

Substituting (23)- (26)simplified:

$$E_A = M - X + \alpha m(1-r) - (1-\alpha)\Delta X[1 - s(n+1)] - C_A \quad (29)$$

$$E_B = M - X + \alpha m(1-t) - (1-\alpha)\Delta X[1 - t(n+1)] - C_B \quad (30)$$

**4.3.4 Derivation of game equilibrium (perfect bayesian equilibrium)**

The equilibrium of incomplete information dynamic game is perfect Bayesian equilibrium, which needs to satisfy four conditions: belief consistency (the posterior probability is consistent with the prior probability and the strategy), sequential rationality (the strategy of each participant is optimal under the given belief), Bayesian updating (the posterior probability is updated by the Bayes theorem), and belief rationality on the equilibrium path.

Optimal Strategy Choice of the Secondary College

The secondary college chooses truthful declaration or false declaration depending on the comparison of expected payoffs, i.e., whether  $E_T \geq E_F$ .  
Substituting (20) and (22):

$$X - C_T - \alpha[\alpha(1-r) + (1-\alpha)(1-t)] \geq X - C_F + \Delta X[1 - n(\alpha s + (1-\alpha)t)]$$

Simplified:

$$C_F - C_T \geq \alpha[\alpha(1-r) + (1-\alpha)(1-t)] + \Delta X[1 - n(\alpha s + (1-\alpha)t)] \tag{31}$$

Substituting  $r = \lambda \cdot r_0, s = \lambda \cdot s_0, t = (1-\lambda) \cdot t_0$ :

$$C_F - C_T \geq \alpha[\alpha(1-\lambda r_0) + (1-\alpha)(1-(1-\lambda)t_0)] + \Delta X[1 - n(\alpha \lambda s_0 + (1-\alpha)(1-\lambda)t_0)] \tag{32}$$

From Equation (32) the larger the internal control constraint variable  $\lambda$ , the larger  $r, s$ , and the smaller  $t$ . Both terms on the right-hand side become smaller, making the inequality easier to satisfy, meaning the secondary college is more inclined to choose truthful declaration (T). This shows that sound internal control can increase the expected cost of false declaration by improving the audit accuracy of functional departments and restrain irrational game behaviors.

**(2) Optimal Strategy Choice of the Functional Department**

The functional department chooses strict audit or loose audit depending on the comparison of expected payoffs, i.e., whether  $E_A \geq E_B$ . Substitute Equations (29) and (30):

$$M - X + \alpha m(1-r) - (1-\alpha)\Delta X[1-s(n+1)] - C_A \geq M - X + \alpha m(1-t) - (1-\alpha)\Delta X[1-t(n+1)] - C_B$$

Simplify:

$$\alpha m(t-r) + (1-\alpha)\Delta X[(n+1)(s-t) - (s-t)] \geq C_A - C_B$$

Further simplification:

$$\alpha m(t-r) + (1-\alpha)\Delta X(n+1)(s-t) \geq C_A - C_B \tag{33}$$

Substitute  $r = \lambda \cdot r_0, s = \lambda \cdot s_0, t = (1-\lambda) \cdot t_0$ :

$$\alpha m[(1-\lambda)t_0 - \lambda r_0] + (1-\alpha)\Delta X(n+1)[\lambda s_0 - (1-\lambda)t_0] \geq C_A - C_B \tag{34}$$

When  $\lambda$  is small (weak internal control),  $r, s$  are small and  $t$  is large. The first term on the left is positive and the second is negative. If the absolute value of the second term is larger than the sum of the first term and  $C_A - C_B$ , the functional department chooses loose audit (B). When  $\lambda$  is large (sound internal control),  $r, s$  are large and  $t$  is small. The second term on the left is positive and large. If the inequality holds, the functional department chooses strict audit (A).

**Perfect Bayesian Equilibrium Results**

Combined with different values of  $\lambda$  and the prior probability  $\alpha$ , the following perfect Bayesian equilibria are obtained:

When  $\lambda \geq \lambda_3$  (When  $\lambda_3$  is the critical value satisfying (32) and (34), the equilibrium is (truthful declaration, strict audit). Internal control is sound, the secondary college declares truthfully, and the functional department conducts strict audit, achieving a compliant and efficient equilibrium.

2) When  $\lambda_4 < \lambda < \lambda_3$  (where  $\lambda_4$  is the critical value satisfying (32), the equilibrium is (truthful declaration, loose audit). Internal control has a certain restrictive effect; the secondary college declares truthfully, and the functional department chooses loose audit by balancing cost and effect.

3) When  $\lambda < \lambda_4$ , the equilibrium is (false declaration, loose audit). Internal control fails, the secondary college makes false declarations, and the functional department conducts loose audit, resulting in violations and inefficient resource allocation.

**4.4 Conclusions and Implications of the Game Model**

Based on the construction and formula derivation of the above two game models, the core conclusions can be drawn as follows:

First, the internal control constraint variable  $\lambda$  is the key factor affecting the game equilibrium of university budget resource allocation. The larger  $\lambda$  is (the more robust internal control is), the fewer irrational game behaviors (such as false declaration and biased allocation) exist among players, and the more the game equilibrium tends to be fair, compliant and efficient. The smaller  $\lambda$  is (the less robust internal control is), the more irrational game behaviors occur, and the more the game equilibrium tends to be unbalanced and illegal.

Second, the supervision strategy of the university decision-making level, the audit strategy of functional departments and the declaration strategy of secondary colleges interact and restrict each other, forming a dynamic game relationship. Sound internal control can guide players to choose cooperative game strategies by improving the accuracy of supervision and audit and increasing the penalty cost of violations, so as to maximize the overall interests of the university.

Third, information asymmetry is an important cause of unbalanced budget allocation game. In the dynamic game with incomplete information, the audit accuracy of functional departments is positively correlated with the perfection of internal control. A sound information and communication mechanism can reduce information asymmetry and alleviate game conflicts.

The implications of the above conclusions are as follows: To achieve fairness and efficiency in budget resource allocation, universities must strengthen the construction of internal control system. By improving the control environment, perfecting the risk assessment mechanism, strengthening control activities, smoothing information communication and enhancing internal supervision, the value of internal control constraint variable  $\lambda$  can be increased, so as to restrict irrational game behaviors and guide the game toward cooperative equilibrium.

## **5 DILEMMAS AND RECONSTRUCTION OF UNIVERSITY BUDGET RESOURCE ALLOCATION GAMES FROM AN INTERNAL CONTROL PERSPECTIVE**

Currently, the irrational gaming behavior and equilibrium imbalance in university budget resource allocation stem from the systemic failure of the five elements of internal control.

Regarding existing dilemmas:

Deficiencies in the control environment, characterized by ambiguous governance responsibilities and a lack of compliance culture, have led to power rent-seeking and a mindset that prioritizes benefits over rules. The risk assessment mechanism is lagging, failing to accurately identify core risks such as false reporting and fraudulent claims. Control activities have become mere formalities, marked by insufficient budget justification, uncontrolled approval processes, and a disconnect from performance evaluation. Barriers in information and communication have exacerbated information asymmetry among stakeholders, inducing opaque operations. Furthermore, internal monitoring lacks independence and accountability, rendering it unable to serve as an effective deterrent. Collectively, these shortcomings have resulted in inefficient and inequitable resource allocation.

Regarding optimization pathways:

It is imperative to construct a systematic governance framework based on the five elements of internal control to guide the gaming dynamic toward a cooperative equilibrium.

Reshape the Control Environment: Clarify governance responsibilities, cultivate a culture of compliance, and establish a "performance + strategy" oriented allocation mechanism to solidify the institutional foundation.

Strengthen Risk Prevention and Control: Establish cross-departmental collaborative assessment mechanisms and dynamic early-warning systems.

Harden Control Activities: Enforce strict budget justification and authorization approvals, implement segregation of duties, and reinforce the application of performance evaluation results.

Streamline the Information Ecosystem: Leverage digital platforms to achieve full-process transparency and normalized consultation, thereby breaking down information silos.

Fortify the Monitoring Defense Line: Enhance the independence of monitoring bodies and construct a full-chain closed loop encompassing "ex-ante prevention, in-process control, and ex-post accountability."

Through these measures, we can comprehensively enhance the constraining power of internal control, prompting stakeholders to shift from irrational competition to collaborative governance, ultimately achieving the optimal allocation of university budget resources.

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