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Exploration of the Challenges Facing Intellectual Property Protection in the Age of Digital Economy and Solution Measures Analysis

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ABSTRACT

In the background of the Internet economy, a new type of intellectual property, namely, network intellectual property, has been born. It is based on the traditional intellectual property rights such as copyright and industrial property, and broadens the intellectual property rights in the network environment to include areas such as databases, multimedia, electronic copyrights and computer software. This not only greatly enriches the scope of intellectual property rights, but also intensifies the risk of intellectual property infringement. In the context of the network economy, intellectual property protection faces new challenges and requirements. It has also attracted great attention from countries and international intellectual property organisations. They have conducted in-depth studies on the problems faced by intellectual property rights in the era of network economy and actively sought effective solutions to establish a complete and systematic intellectual property rights protection system to alleviate the pressure on intellectual property rights protection brought about by the complexity of the situation. In the context of network economy, IP protection faces new challenges and requirements. This has also attracted great attention from national and international IP organisations. They have conducted in-depth studies on the problems faced by IP in the era of network economy and actively sought effective solutions to establish a complete and systematic IP protection system to alleviate the pressure of IP protection brought about by complex situations.

1.Introduction

The leading force for social advancement lies in reform and innovation, and the core mode of operation of the modern scientific and technological revolution is embodied in the research and development and construction of intellectual property rights, while the main mode of transaction of the modern market economy is embodied in the trading and exchange of intellectual property rights in the context of globalisation.At the heart of the IP system is the exclusive right of the creator, which has had a significant impact on the knowledge economy, driving the geometric progression of the knowledge widespread dissemination and growth. It has also incentivised competitors to go beyond existing technologies to develop new fields at a higher level, and promoted the transformation of advanced technological achievements, thereby contributing to the development of social productivity. Therefore, the innovativeness of science and technology plays a decisive role in its progress, and this role is reflected in the fierce competition for IP development strategies in the context of the knowledge economy.

2.Overview of intellectual property rights on the Internet

Internet intellectual property (IP) is the results and

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rights and interests in various fields based on the constantly updated and applied Internet, which are created by the enterprises and individuals on the network platform through their own wisdom under the limitations of relevant laws and regulations. Specifically, it can be understood from three aspects:

2.1 Internet property rights

This right and interest is virtual and includes a series of virtual commodities developed based on Internet technology, such as equipment, currencies and props related to online games. In fact, these products belong to a kind of service, and they are acquired by the Internet operator together with the organisation responsible for producing and researching the online game, so both teams own the corresponding rights and interests.

2.2 E-book property rights

The rights and interests of the subject who transforms the traditional IP through the Internet platform, and the most typical example is the copyright of the author who creates the e-book.

2.3 Other copyrights involving the Internet

Creators use part or all of the Internet technology when making and innovating products and works. These products or works, such as software, are not physical entities, and they need to rely on the Internet to survive. Thus, creators' IP is also built on the proper functioning of the Internet. In fact, the coverage of Internet IP is extremely broad, including not only all kinds of physical and virtual information, products, works as well as services in the real world and on network platforms. The Internet is not only an environment, but also a technology and platform, etc [1]. Therefore, with the continuous development of the Internet, the related IP content will become richer and more complex.

3. The Positive Implications of Intellectual Property Protection on the Internet

To create a legal environment for fair competition and to improve China's innovative power. In general, the maintenance of network IP is quite challenging, this is due to the complexity of network information, a little bit of small things may cause the whole situation to change, so the relevant laws and regulations are difficult to clarify, and even so far have not been formally implemented. At present, the problems of sharing information posted by others privately without their permission or even stealing their technology, which exist on the Internet, have still not been effectively solved. These difficulties will not only bring corresponding harm to individuals and the country, but also have a far-reaching impact on the country's innovation ability. The wide openness and freedom of the Internet has led to the breeding and proliferation of problems such as piracy and plagiarism, and has made it less expensive to deal with. Especially when faced with high costs but not fully realised results, the cost of infringing intellectual property rights and imposing penalties becomes negligible, which will seriously dampen the creators' spirit and enthusiasm for innovation. Therefore, strengthening the protection of intellectual property rights on the Internet and cracking down on the infringement of others' intellectual property rights through authoritative legal means is a necessary condition for building a fair and healthy competitive environment on the Internet, as well as a necessary way to motivate enterprises and individuals to make sustained efforts and actively innovate. Promote the normative development of Internet operation and industry. Due to the defects of network services, it provides a good platform for IP violators. Therefore, enhancing the protection of network IP must rely on the optimisation and standardisation of network services, which will positively contribute to the overall progress of the network industry. First of all, strengthening the protection of network IP means that we need to regulate the Internet in all aspects at all levels, including legislation, judiciary and law enforcement, so that there are clear rules and legal bases for website operation operations, and that the development of website operations and the Internet industry can be restricted to a legal scope, thus reducing the incidence of IP infringement. From another perspective, analysing the negative incidents that have occurred on the Internet, including intellectual property infringement, can help us understand some of the specific problems that may arise in Internet operations. This helps website operators and Internet development entities to solve problems as early as possible according to relevant technical specifications and legal regulations, to improve the level of network operation and to promote the standardised development of the Internet industry.

4. Current Problems in Intellectual Property Protection

In the stage of planned economy, China did not establish the system of IP. However, with the advancement of reform and opening up, in order to meet the needs of economic growth, China gradually learnt and introduced IP management institutions and legal systems from abroad, which enabled China to make obvious progress in the management and protection of IP. However, since China's IP system was only just established in the early 1980s,

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it still need to further improve the relevant system and management system. The penalties for IP violations were not strong enough. The problem of IP violation occurred frequently in the society. This was mainly because, due to the relatively low compensation standard set up by the legal system of IP, it was impossible to punish it effectively. Due to territorial protectionism, the enforcement was not sufficient in all territories, leading to a simpler problem. The courts at the bottom were unable to deal with patent-related cases due to the IP's regulatory authority and the state of the economy. At the same time, because IP regulations were not robust, there were some protections in the enforcement process that were contrary to our national environment, which had not been adopted by our domestic companies.

5. Lacking Anti-monopoly Measures to Maintain Fair Competition in IP

The purpose of the IP system is to safeguard the specific rights and interests of IP holders, to authorise and disclose their technology in order to promote the execution of technological achievements and further innovations. The protection system of IP is a two-way street; on the one hand, appropriate protection can benefit IP owners, and on the other hand, over-protection may lead to technological monopoly [2]. However, China's patent legal system has not yet formulated an anti-monopoly patent law, and there are no anti-monopoly restriction clauses implemented in the relevant legal system. In the face of global companies or large consortiums of enterprises using IP to control the global market, China has not taken the appropriate legal means to protect the development of domestic enterprises and the rights and interests of consumers.

6. Lacking Coordination and Early Warning Mechanisms in IP Organisations

The management and protection of IP involves all areas of the economy and society, including innovation, maintenance and use. However, due to human resource constraints, there is insufficient communication between IP management and enterprises, resulting in asymmetric information. From one perspective, companies are often at their wits' end when they suffer from trade mark infringement or technical difficulties. In another perspective, due to the shortage of human resources in IP management organisations, it is difficult for them to have a comprehensive grasp of the company's specific situation, which is unfavourable to the mediation and disposal of the corresponding matters. The failure of enterprises to pay enough attention to and take effective ways to deal with some international IP disputes has led to time delays or mishandling, which in turn has brought losses to enterprises. The lack of national funds for patent protection has led to a serious shortage of talents for IP application. Often, local IP management organisations face a shortage of manpower, funds and equipment due to restrictions imposed by national regulations. As financial management adopts two lines of income and two lines of expenditure, patent application and examination fees need to be submitted to the central government. In practice, the funds for administrative patent enforcement, which the IPO is responsible for administering, are borne by local finances. Local finances are constrained by the fact that central revenues and local expenditures are not at the same level. As a result, local governments regard IP departments as general administrative organisations and provide only the necessary administrative funds, unable to guarantee the expenditure of specialised costs for administrative enforcement. Although some localities have paid sufficient attention to IP protection and implemented short-term ad hoc measures, such as regularly allocating a portion of funds for patent administrative enforcement, this has not built a systematic mechanism.

7. Exploration of the Analysis of the Solution Measures for the Protection of Intellectual Property Rights in the Era of Digital Economy

With regard to the infringement of intellectual property rights on the Internet, the Government of China has attached great importance to the issue and formulated a series of laws and regulations to safeguard intellectual property rights on the Internet, and has already achieved some effectiveness. For example, on the basis of the Copyright Law of the People's Republic of China in 2001, the Measures for the Administrative Protection of Copyright on the Internet in 2005, and the Regulations on the Protection of the Right to Information Network Dissemination in 2006, the Tort Liability Section of the Civil Code has also provided the latest answers to IP-related issues. The establishment and implementation of all these laws and regulations have, to a certain extent, exerted their corresponding influence. At present, China still needs to actively promote the relevant legislative work in the legislative field, and is committed to constructing a comprehensive Internet intellectual property protection system, as well as formulating and improving the relevant legal system. First and foremost, the legislative department needs to exhaustively stipulate the relevant penalty rules for IP infringement in the network environment, clarify the categories of infringement, and effectively distinguish infringement behaviours according to the current judicial practice, so as to

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increase the amount of punitive damages. Next, the legislature needs to learn from foreign legislation and continue to improve the international copyright protection, the use of copyright arising from the downloading and viewing of copyrighted works, and the reproduction rights arising from the digitisation of works, etc., and make clear delineation of the relevant categories. Provide a path for the enforcement of the law. In the end, the staff in the legislative department need to actively refresh their IP legislative thinking to ensure that the legislative task of IP can be smoothly promoted and the current regulations adjusted according to the new changes in the Internet environment. In order to deal with the differences between the actual judicial operation and the situation in our country, or the more difficult problems encountered in the judicial operation, we need to modify the relevant laws and regulations, and we also need to interpret these principles with the help of the announcement of the judicial branch, so that the task of IP protection under the Internet environment can be closely integrated with the judicial operation in our country [3].

The original database function is to store and process information, collect some information and then process it according to a certain system to ensure that it is in orders[4]. Although databases are also essentially a class of data products, their main advantage is that they have a greater investment in research and development and a lower estimated cost. Due to its unique attributes, database infringement is common. Especially in the network environment, the transmission of information is very fast, and the release and collection of information show open qualities; however, the interaction, transmission and storage of data are global and cross-regional in nature, so the IP protection of databases has gained great attention from all parties in the society[5]. We should attach great importance to the task of protecting databases, as it is a key resource whose easily copied qualities often give rise to corresponding infringing behaviours. However, in the process of protection, reasonable regulations should be followed. If we simply protect the database without disclosing all the information in the database, the sharing function of the database will be hindered, and the phenomenon of database exclusivity will occur. Therefore, whether the protection is carried out blindly or avoided selectively, the compliance rights and interests of data creation may suffer losses, which may have a negative effect on the normal flow of information.

The first and foremost task of strengthening the protection of network intellectual property rights and the innovation of detection technology is to enhance the ability to examine data transmission to the Internet, so as to curb infringement at the source and take preventive measures. Next, technical support is provided for the enforcement tasks of judicial departments and network regulators, so as to effectively eliminate the infringement of network intellectual property rights, improve the enforcement capacity, shorten the time and reduce the cost of defending rights, and promote the protection of intellectual property rights. Technical means play a key role in the management of Internet data resources and the protection of IP. There are various forms of network infringement and various technological crimes, therefore, both organisations providing data services and relevant management departments should make full use of data technology to protect themselves. For example, through the use of technologies such as firewalls, anti-copying, limiting the frequency of use, digital watermarking, encryption of information, and identity authentication, we can avoid illegal access to, misappropriation of, copying of, and tampering with copyrighted works[6].

Relying on the functions of the legal department or DOJ alone is not enough to achieve effective management of intellectual property rights; the key lies in establishing a system of universal participation and the concept of respecting and protecting intellectual property rights in all aspects from a social perspective. If the public's respect for intellectual property rights is higher, then more people in the society will be active in the protection of intellectual property rights. However, at present, China's intellectual property law-making process is relatively backward, and many members of the public are unfamiliar with it, which makes it impossible for them to seek redress through judicial channels when they encounter infringing behaviours. In addition, many producers do not pay enough attention to the protection of intellectual property rights due to the lack of relevant legal knowledge, resulting in the infringement of others' intellectual property rights in the production process. Therefore, China's government needs to increase online publicity[7]. Through the creation of WeChat public number or official microblogging, etc., the intellectual property management department and the judicial department can regularly publicise intellectual property laws and regulations to ensure that the relevant legal knowledge is effectively disseminated. In addition, relevant agencies can use online media to publicise incidents of intellectual property infringement in the online environment, so as to achieve its preventive and educational role[8].

8. Conclusion

In the current rapid advances in the Internet background, the creation of a standardised, effective and fair

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IP protection system has become a key issue that needs to be faced in theoretical research and practical operation, IP protection system not only plays a key role in strengthening the maintenance and application of IP, but also has a profound impact on the process of China's scientific and technological innovation, industrial innovation, and cultural innovation, IP protection system plays a key role in enhancing the creation, protection and application of IP, and also has close links with China's scientific and technological development, industrial renewal and cultural development, etc. IP protection system plays a key role in enhancing the creation, protection and application of IP, and also has close links with China's scientific and technological development, industrial renewal and cultural progress. The IP protection system plays a key role not only in enhancing the creation, protection and application of IP, but also has a close connection with our country's scientific and technological development, industrial renewal, and cultural advancement and other fields. If IP cannot be properly protected from the perspective of the Internet, then it will certainly weaken the innovation enthusiasm of our public and adversely affect the development plan of our innovation path. Therefore, we need to improve the legal system of IP according to the IP infringement in the Internet environment in order to provide guidance for the conduct of judicial practice. At the same time, we also need to focus on the construction of a team of professional lawyers, enhance the effect of legal propaganda, create an excellent environment for all people to comply with the law, and promote the continuous reduction of IP infringement on the Internet.

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An Analysis of Corporate Headquarters Leadership Promotion Strategies from the Perspective of Organizational Structure

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ABSTRACT

The optimization of organizational structure can promote the scientific development of enterprises and improve the efficiency of the leadership of corporate headquarters. Therefore, in the process of enterprise development, it should constantly play an important role in the organizational structure according to its own actual situation, and strengthen the effectiveness and practicality of strategic deployment in the process of enhancing the leadership of the headquarters, and play a good role in the communication of ideas, information transmission and spiritual implementation of the corporate headquarters. It can be seen that in the process of improving the leadership of corporate headquarters, the idea of corporate headquarters should be optimized and the organizational structure model should be adjusted based on the perspective of organizational structure. Based on the organizational structure, this paper explores the leadership promotion strategy of corporate headquarters, aiming to provide reference for the research of relevant personnel.

1. Introduction

For enterprises, the headquarters is the core of the development of large enterprise groups, so the leadership strength of the headquarters has positive significance for the strategic layout and development of enterprises. Therefore, on the basis of the structural adjustment of big cities and regions, in order to promote the economic level of enterprises, we should keep pace with The Times and continuously improve the leadership of corporate headquarters according to the needs of social development, so as to enhance the competitiveness of enterprises themselves.

2. Overview of Organizational Structure

The organizational structure of the enterprise is the method of classifying and combining the various parts of the enterprise according to the work flow, business activities and geographical distribution, and the division and reporting of authority and responsibility. The difference of organizational structure leads to the problems and differences of information circulation, knowledge sharing and relationship coordination among enterprises. Enterprise architecture is a key link for enterprise information transmission, enhancing enterprise awareness, controlling enterprise behavior, and improving enterprise performance [1].

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3. Increase the Meaning of Leadership

Talent is the key to prosperity. The 20th report put forward the strategy of strengthening the country by talents, insisting that talents are the first resource. For enterprises, in the process of operation and management, the importance of talent management should be emphasized. To improve the leadership level of enterprises can not only effectively improve their core competitiveness, but also promote the planning of new patterns of enterprises, so that enterprises can occupy a favorable position in the fierce market competition [2]. Improving the leadership of the corporate headquarters can promote the high-quality development of the enterprise, actively adjust its structure in the face of risks and challenges, and bravely and actively seize opportunities in the management process, promote the reform of the leadership structure organization, and improve the development system of the enterprise according to the leadership development ladder model (Figure 1), so as to meet the development needs of the enterprise at different stages.

4. Leadership Promotion Strategies of Corporate Headquarters from the Perspective of Organizational Structure

Objectives and strategies are the core content of organizational structure design, and in the actual development process, static organization and dynamic behavior should be adjusted to promote the realization of the established goals. Meanwhile, when the enterprise is large, it can also be divided into different regional organizations or business divisions (Table 1), so as to promote the highly specialized operation and management of enterprise sub-units[3]. For different industries, different strengths of enterprises, and the focus of enterprise development, structural adjustment should be properly carried out to promote the operation of each structure to better enhance the leadership of the headquarters, so in the design of the organizational structure of the headquarters group, attention should be paid to the rapid flow of information to ensure the scientific organizational structure, so that the overall operation efficiency of the enterprise can be improved.

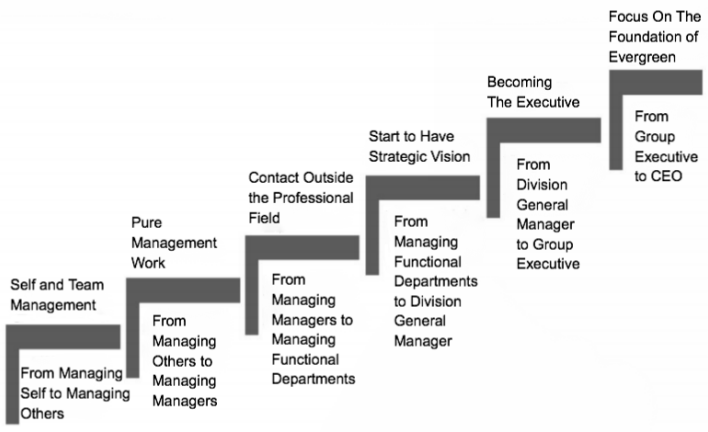

Figure 1: Ladder model of leadership development.

Table 1: Enterprise organizational structure model and improvement direction.

Organizational Structure Model	Functional + Regional	Functional + Divisional	Functional + Regional + Divisional	Functional + Regional + Matrix	Functional + Divisional + Matrix
Primary design variable	Objectives and strategic authority levels	Objectives and strategic authority levels	Organization size specialization	Formalizing the hierarchy of authority	Efficiency and effectiveness of the external environment
Main feature	The setting of regional subsidiary departments is basically the same as that of the headquarters	The organizational structure design matches the enterprise strategy	Coordination and matching between specialized departments and regional departments	Teamwork at the end of the business chain	Cross-boundary coordination and cooperation within and outside the organization
To improve the headquarters leadership as the goal of the direction of improvement	Clearly define the terms of reference of each functional department; Establish a horizontal communication platform	Business division of labor; Establish bottom-up feedback mechanisms	Enhance the professionalization and regularization of leading departments; Strengthen horizontal collaboration	Establishing a temporary liaison department; Develop team system document template	Unifying organizational objectives; Additional industry research office or related full-time positions

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4.1 Combine the Ideological Structure Dimension

In the process of improving the leadership ability of the headquarters and strengthening the work functions of the staff, management communication training should be carried out constantly based on the strategic development goals and needs of the enterprise, to strengthen the professionalism of the staff, and to properly organize internal and external relations and capabilities[4]. At the same time, according to the forefront development trend of the industry, clarify the current enterprise development environment, introduce and develop the strategic policy to promote the development of enterprises, so as to promote the transformation and upgrading of enterprises in the new era.

4.2 Combine Functional and Regional Structure

First, the authority of the headquarters and various functional departments is clearly defined in the organizational structure. In order to improve the guiding role of the group headquarters in the work of middle-level leaders and strengthen the leadership of the headquarters, it is possible to set up a liaison department of lower-level agencies with clear authority in the headquarters. The head of the department can be a senior manager with more corporate information, and a special person can be set up to transfer daily information to the headquarters. At the same time, headquarters contact points have been set up in each department, and designated special personnel to contact each department and report daily news. Through effective communication, it is ensured that the corporate headquarters can effectively communicate with the leaders of lower-level enterprises[5].

Second, to build a horizontal communication platform for the subordinate enterprises in each region, to facilitate the information exchange within the enterprise. For the organizational structure of an enterprise, the transmission of information is of great significance to the effective construction of the structure and the smooth progress of the work. If the work of the upper and lower departments is not timely and effectively connected in the process of the work, or the opinions are not communicated, and the information needs of the staff members are not met, or. In the current organizational structure of large enterprises, there is no platform for horizontal communication, which leads to the division of labor and narrow vision among different departments, thus reducing the overall interests of enterprises. In order to solve this problem, it is necessary to strengthen the horizontal information exchange platform, promote the information exchange and sharing between departments, improve the overall concept and standard concept of enterprises in various regions, and maximize the profits of corporate headquarters through the actions of enterprises.

4.3 Combine Functional and Divisional Structure

First, with the development strategy of enterprises, the organizational structure of enterprises has also changed. For example, in the process of development, state-owned enterprises should implement the Party's principles and policies into their own development goals and behavioral strategies. In order to implement the strategic plan of the corporate headquarters, subordinate departments should be asked to transform the goals of the corporate headquarters into corporate goals and strategic measures, and a regular communication mechanism should be established to communicate with the headquarters on corporate development strategies and other aspects [6].

Second, there is a specialized division of labor in business management. Professional division of labor is to better achieve the purpose, to maximize the overall interests of the enterprise, so as to improve the competitiveness of the enterprise and internal force. For enterprises in industries with more clear division of labor characteristics, special positions can be set up to carry out daily information exchanges with lower-level enterprises, and strive to prevent the problem of unequal dialogue between "experts" and "laymen", to prevent "laymen" from driving the development of "experts", thereby affecting enterprise management and improving the management level of lower-level enterprises at the headquarters.

Third, build a bottom-up feedback mechanism to enhance organizational resilience. A bottom-up feedback system can be set up within lower-level enterprises to listen to the opinions of various departments and employees. In particular, some of the enterprises with more enterprises and a wide business distribution, the market competition in each business is not the same, and, as a subordinate enterprise at the forefront of the market, its competition in the market is the most clear, so the headquarters needs to carefully listen to the opinions of lower-level enterprises, so as not to make mistakes in their own judgment, thus affecting the development of the enterprise.

4.4 Combine Functional, Divisional and Regional Structure

First of all, improve the business level of each enterprise and improve the overall control degree of the enterprise headquarters. At the same time, it has a divisional and regional organizational structure, so that the operation and regional division of the enterprise are interlaced,

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forming a network. It not only has the same operation mode with regional organizations, but also differs from divisional systems, which is because of the optimal combination of enterprise management and geography, so the operation and control of enterprises become more difficult. In order to better achieve this goal, it is necessary to improve the internal organizational structure of the enterprise, carry out special job division, improve the standardization of the enterprise, so that the corporate headquarters can better play their own leadership, and then achieve the overall control of the overall command goal.

Secondly, strengthen the cooperation between enterprises to prevent competition between enterprises and effectively allocate. Enterprises in different regions are not completely independent in their operation, and when facing the same customer base, internal cooperation often turns into external competition. Due to the disorderly competition in the market, it has caused the excessive consumption of production capacity and the problem of unreasonable allocation of resources of enterprises, thus reducing the competitiveness of enterprises. In order to effectively avoid the occurrence of such a situation, it is necessary to strengthen the horizontal cooperation between various regions and various business units, and implement the unified leadership and overall control of the group headquarters.

4.5 Combine Function, Region and Matrix Structure

First, set up an upward contact department within the project team, and maintain good contact with the corporate headquarters. Under the matrix structure, many employees work in different places and cannot participate in various activities held by the enterprise. After a long time, employees will feel a sense of alienation. Therefore, the existing network and digital information technology can be used to enhance the participation of local staff and enhance their identity with their subordinate enterprises through online and offline means.

Second, develop the project team system document template. The design idea of the matrix organization is that all the full-time work is combined according to the needs, which is undertaken by special people with high professionalism. However, it also faces some problems, such as loose team structure and low level of normalization. In order to effectively avoid such problems, the project team system document template can be established at the enterprise level, and the detailed content of some documents can be added according to the actual needs, so as to generate a set of standardized work description, procedure description, work system specification and other book information.

4.6 Combine Function, Division and Matrix Structure

First of all, strengthen horizontal communication, so that the purpose of the enterprise to achieve consistency. The organizational form of matrix structure can help various departments and even the whole enterprise to carry out horizontal communication, but this kind of communication is more scattered, and the result of communication depends on the participants in the communication. Communication is a prerequisite for collaborative work, and only through good communication can the two sides achieve effective collaborative work, thus promoting the overall goal of the enterprise. In addition, in the project team, external personnel are occasionally introduced in order to better coordinate and communicate the work, which makes the communication within the team more complicated. In order to effectively solve this problem, horizontal communication should be carried out so that the existing problems can be solved, so as to improve the level of communication and exchange.

Secondly, by establishing international and domestic industrial development laboratories, enterprises can improve their adaptability to the external environment. In order to better cope with the changing external environment, enterprises must actively learn and study the external and internal environment in the development of the industry, and think about the future development. Therefore, domestic and foreign industrial development research offices or independent industry research institutes can be set up in the headquarters of enterprises to study the development of enterprises from a broader perspective, so as to better improve the comprehensive competitiveness and competitiveness of enterprises.

Finally, the scale and level of the enterprise are scientifically planned and designed to achieve a win-win situation of benefits and benefits. The industry coverage of "functional + divisional + matrix" organization is relatively extensive, and many enterprises carry out irrelevant operations based on associative diversification, which increases the difficulty of vertical management and horizontal coordination of enterprises. If this problem is not solved, the organization model of the core business must be properly regulated to avoid the development of enterprises from the needs and rules of the industry. At the same time, the Internet communication technology is also increasing.

5. Conclusion

To sum up, organizational structure plays a significant role in information transmission, awareness strengthening and action control of enterprises. In order to better promote the rational allocation of resources and the effective

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framework of internal structure during the operation of enterprises, the leadership of corporate headquarters should be promoted on this basis, and the ideological structure should be optimized for different organizations. Improve the various structural forms, so that the leadership of the headquarters of the enterprise can be comprehensively improved, so that the enterprise organization is more strategic, and the development of the industry and social development needs.

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Impact of the Ukraine Conflict on Food Security: A Comprehensive Analysis Using Propensity Score Matching and Difference in Difference

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ABSTRACT

This paper explores the significant impact of the Ukraine conflict on local food security, employing a robust methodological framework that integrates Propensity Score Matching (PSM) and Difference-in-Differences (DiD) estimation, supplemented by placebo tests and the synthetic control method. By examining panel data from 2014 to 2022, the study reveals a causal relationship between the conflict and a notable deterioration in Ukraine's food security index. The conflict, characterized by direct damages to agricultural production and infrastructure, alongside indirect economic and social disruptions, has led to a substantial decline in food security. This research contributes to understanding the dynamics of how war affects food security and provides actionable insights for policy formulation and response strategies to mitigate such impacts in similar conflict scenarios. Through a comprehensive analysis, it highlights the urgent need for international cooperation and humanitarian aid to address the challenges posed to food security by the war, emphasizing the broader implications for global food markets and prices.

1. Introduction

The core importance of food security lies in its fundamental impact on the quality of human life. Food security is not just about nutritional adequacy but is also the foundation of health and well-being. In 2021, approximately 139 million people globally were in a state of food crisis or severe insecurity, with war and instability being the primary driving [1]. Against this backdrop, the outbreak of the war in Ukraine has not only caused a local humanitarian disaster but also posed a severe challenge to global food security.

The full-scale military invasion of Ukraine by Russia on February 24, 2022, resulted in civilian casualties and damage to key infrastructure, followed by extensive sanctions imposed on Russia by Western countries. The direct consequences of this war are not only a humanitarian crisis in Ukraine but also shocks to the global food and energy markets, particularly with prices remaining high until the end of 2024, further threatening global food security [2].

The outbreak of the war has exacerbated global concerns about food security. Ukraine and Russia, serving as the "breadbasket of the world," play significant roles in the global food and fertilizer industry. Both countries are major producers and exporters of agricultural products, minerals, fertilizers, and energy, with their resources being rich and typically concentrated in a few countries [3]. Therefore, the war in Ukraine has had a significant impact on the global food market and prices, especially against

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the backdrop of supply chain disruptions caused by the COVID-19 pandemic, strong global demand, droughts, and poor harvests in South America [3].

Four months after the outbreak of the war, Ukraine's exports came to a halt, and future harvests became uncertain, leading to soaring global agricultural product prices and potentially plunging millions into hunger and poverty. Price increases and trade disruptions could also limit the supply of humanitarian aid for the prevention and treatment of acute malnutrition, increasing the number of malnourished individuals. The World Food Programme estimates that the number of people facing severe hunger will increase by 47 million compared to the pre-war baseline, with 323 million people expected to face severe food insecurity in 2022 [4]. The World Bank estimates that for every percentage point increase in food prices, 10 million people are pushed into severe poverty [5]

The purpose of this study is to investigate the direct impact of the war in Ukraine on local food security. Employing the PSM-DID method, combined with placebo tests and the synthetic control method for robustness checks of regression results, this study aims to reveal the causal relationship between the war and the local food security index in Ukraine. Through this approach, the specific impact of the war on food security in Ukraine can be more accurately determined, providing policy recommendations and response strategies for similar conflicts that may occur in the future.

2. Literature review

The direct impacts of war on food security are profound, with the most noticeable being disruptions to the harvesting and transportation of agricultural products, directly affecting staple supply and prices. The war has compromised Ukraine's ability to transport agricultural products both domestically and internationally, especially when port facilities and railways are damaged [6]. In fact, the war has caused a disruption to 95% of Ukraine's grain exports, primarily corn, especially during spring and early summer. Due to the lack of an effective railway system, even though alternative transportation routes, such as exporting through Poland or Romania, are feasible, these paths face many challenges, such as differing railway gauges and limited storage capacity. Additionally, increased insurance costs in the Black Sea region further exacerbate transportation costs, affecting food import prices [7].

The war has also made it impossible for Ukrainian farmers to farm normally, with conscription and displacement causing labor shortages, thereby affecting agricultural activities. The lack of key agricultural inputs, such as fertilizers, exacerbates this issue, potentially disrupting ongoing spring planting and the upcoming winter crop harvests. According to the Food and Agriculture Organization, by 2022, up to a third of crops and farmland may be unharvested or unfarmed [8].

On the other hand, the economic sanctions against Russia create uncertainty for Russian exports. While Russia's Black Sea ports remain temporarily open, financial sanctions have led to currency depreciation, which could hinder productivity and development, and ultimately raise the costs of agricultural output. Moreover, Russia's restrictions on exporting agricultural products and food to non-"friendly" countries will exacerbate global food supply shortages, raise prices, and weaken the food security of hundreds of millions [9].

The indirect effects of the Ukraine war cannot be overlooked either. First, the rise in prices of basic inputs, such as fertilizers, leads many farmers globally to switch to crops with lower fertilizer requirements, like soybeans, which may exacerbate the supply shortages of high fertilizer-demand crops like wheat and corn [1]. Second, many countries have implemented export restrictions to ensure local food supply, which, although may be effective in the short term, could have profound effects on global food pricing and security in the long term. Moreover, panic buying behaviors at the national and individual levels, especially during the COVID-19 pandemic, indicate high levels of concern for food security during crises [8].

The war could also affect the economy's ability to access food, especially against the backdrop of the global economy impacted by the COVID-19 pandemic. This could lead to an increase in the costs of food and energy, disproportionately affecting the poor and middle class. The rise in international prices affects those dependent on grain [9].

An important aspect when discussing the impact of the Ukraine war on food security is the consideration of endogeneity issues. In recent years, food security and its consequences have garnered widespread attention, with research primarily focused on the conceptual understanding of food insecurity, such as insufficient dietary energy supply and malnutrition, and how to mitigate these issues. Additionally, researchers and practitioners have begun to explore the impact of food insecurity on conflict, a relatively new but crucial field [10].

Food security issues vary across regions and societies, influenced by the type, intensity, and income levels of armed conflicts. Its impacts stem from multiple levels, including the nutritional and economic opportunities at the individual and household levels, which may directly affect the likelihood of engaging in antisocial behaviors (Briones Alonso, Cockx, and Swinnen, 2018). Moreover,

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more macro-level factors, such as global food prices, policies, and wartime institutions, markets, governance, and climate conditions domestically and locally, also have significant impacts [11].

Especially at the individual level, food insecurity or its threat may stimulate material and immaterial motivations, prompting individuals to engage in antisocial behaviors. However, due to the complexity of motivations and the lack of empirical evidence, it is challenging to measure precisely. These motivations are often complex and difficult to measure empirically, and the presence of alternative mechanisms not directly associated with food insecurity (such as kidnapping, peer pressure, ideology, and sentiment) makes it difficult to distinguish empirically.

Charles P. Martin-Shields and Wolfgang Stojetz in 2019 [12] researched the causal relationship between food security and conflict, finding robust quantitative evidence of a bidirectional relationship between food security and violent conflict, which explains the endogeneity issues. They summarized existing evidence and identified limitations in both directions: (i) the impact of violent conflict on food insecurity; and (ii) the impact of food insecurity on violent conflict as discussed in section 3.3. They utilized the Russia-Ukraine conflict as an exogenous shock, effectively mitigating the bidirectional

3. Data and methodology

This paper employs the Difference-in-Differences (DiD) estimation method, referenced from Card and Krueger (2000) [13], to compare changes in the food security index over time between matched treatment and control groups, while considering both time and individual fixed effects. This approach helps isolate the causal impact of the Ukraine war on food security, controlling for both observable and unobservable confounding factors. The model is specified as follows:

$$Y_{it} = \beta 0 + \beta 1 * War_{it} + \beta 2 * Treat_i + \beta 3 + Post_t + \beta 4 * X_{it} + \alpha_i + r_t + \varepsilon_{it}$$

Where Y_{it} represents the food security score of country i at time t. Food security, the dependent variable in this study, is a multidimensional and flexible concept with multiple definitions. This paper adopts the definition proposed by the Food and Agriculture Organization (FAO) in 1996 and revised in 2001: "Food security exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" [13]. To measure food security, this paper utilizes the food security index data from The Economist Intelligence Unit, which covers aspects such as affordability, availability, quality and safety, sustainability, and adaptability.

War_{it} represents the interaction term for the treatment group (Ukraine) and the post-treatment period (after 2022). Treat_iis a binary variable indicating Ukraine (1 for Ukraine, 0 for others). $Post_t$ is a binary variable for the period after 2022. X_{it} includes control variables such as GDP, consumption, savings, secondary industry development, inflation CPI, the index of economic freedom, population, and arable land area. α_i and r_t represent country and year fixed effects, respectively. ε_{it} is the error term.

The index of economic freedom is calculated using the Principal Component Analysis (PCA) method, based on sub-indices such as property rights, integrity, fiscal freedom, government spending, business freedom, labor freedom, monetary freedom, trade freedom, investment freedom, and financial freedom. Data for all control variables are sourced from the United Nations Statistics Division, the World Bank database, and the International Monetary Fund database.

To further reduce endogeneity issues, this study combines the use of Propensity Score Matching (PSM) and DiD estimation. PSM matches Ukraine with other countries that have not experienced war, based on observable covariates such as GDP, consumption, savings, and secondary industry development, helping to reduce biases that may arise from unobserved differences between the treatment and control groups [14]. By matching countries that are similar in these characteristics, PSM helps to reduce bias.

The original dataset includes samples from 141 sovereign countries from 2014-2022. Given that war conflicts and food security are highly correlated with national characteristics, prone to selection bias, this paper matches control group firms closest to Ukraine in national characteristics using the Propensity Score Matching method to avoid the impact of selection bias on the accuracy of causal inference. Specifically, this study uses GDP and population as covariates, estimates propensity scores through logistic regression, and employs nearest neighbor matching to match each treated unit with 8 untreated units with similar propensity scores, constructing a comparable control group (Leuven & Sianesi, 2018). A caliper value of 0.05 is set to limit the difference in propensity score values between the control and treatment group samples. The matching results passed the balance test proposed by Rosenbaum and Rubin (1985). Figures 1 and 2 show the control group countries are essentially the same as Ukraine after matching.

Descriptive statistics are reported table 1 below, with the score being log-transformed. The mean and median are relatively close, indicating a normal distribution.

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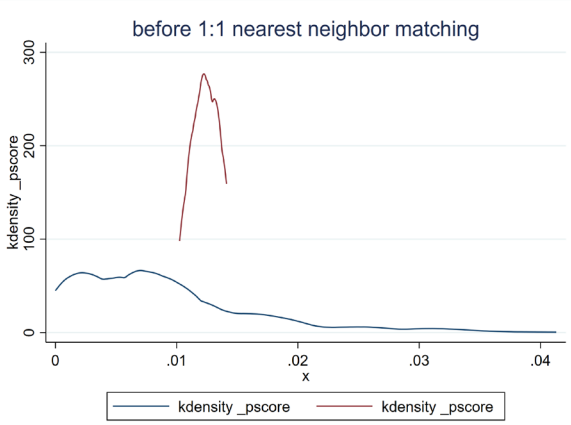

Figure 1. Before matching

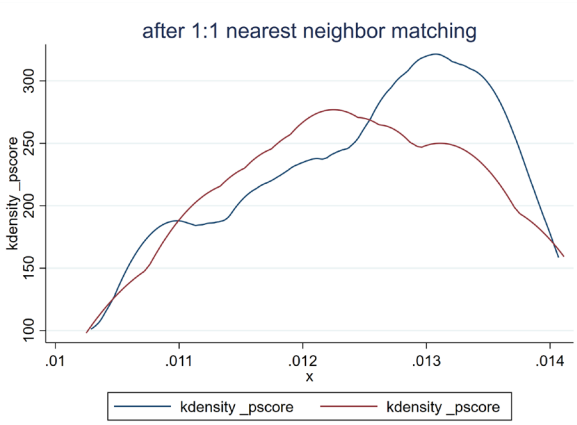

Figure 2. After matching

Table 1. Descriptive Statistic

Variable Name	Obs	Mean	Median	Min	Max	SD
score	50	4.050	4.032	3.525	4.406	0.196
treat	50	0.160	0.000	0.000	1.000	0.370
post	50	0.100	0.000	0.000	1.000	0.303
War	50	0.020	0.000	0.000	1.000	0.141
GDP	50	24.841	24.893	21.802	28.121	1.880
consumption	50	0.766	0.763	0.428	1.061	0.125
saving	50	0.004	0.002	-0.010	0.021	0.006
secondary	50	3.957	3.587	1.667	7.630	1.560
InflationCPI	50	9.329	5.023	4.473	23.163	7.089
EconFreeIndex	50	4.058	4.124	3.845	4.196	0.100
Population	50	1.250	1.255	0.870	1.675	0.220
AgrArea	50	12.981	13.019	12.497	13.019	0.107

4. Results

The results presented in the first column in table 2 illustrate the average impact of the Ukraine war on local food security in Ukraine, showing a significant decline in food security with a regression coefficient of -0.337 at the 1% significance level. This indicates that food security in Ukraine has significantly deteriorated following the war. The second column, which includes control variables on top of the first column's model, shows a regression result of -0.263, significant at the 1% level. Columns three and four, which regress using robust standard errors on the basis of previous models, maintain consistency with the first and second columns, indicating a certain robustness in the regression results.

From an economic perspective, these results clearly demonstrate the destructive impact of war on a country's food security. Particularly for Ukraine, the war has not only directly affected its agricultural production capacity but may also exacerbate food security issues through indirect means such as infrastructure damage, economic turmoil, and social instability. Therefore, policy measures and aid during and after the war are crucial for mitigating these negative impacts.

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Table 2. Baseline regression

	(1)	(2)	(3)	(4)
	score	score	score	score
War	-0.337***	-0.263**	-0.337***	-0.263**
	(-4.704)	(-2.306)	(-6.658)	(-2.515)
treat	0.220***	1.177	0.220***	1.177
	(3.273)	(1.589)	(3.570)	(1.306)
post	0.000	0.167**	0.000	0.167*
	(.)	(2.238)	(.)	(1.911)
GDP		0.007		0.007
		(0.047)		(0.033)
consumption		-1.378*		-1.378
		(-2.019)		(-1.401)
saving		-3.949		-3.949
		(-1.189)		(-0.791)
secondary		0.067		0.067
		(1.399)		(1.588)
InflationCPI		0.138		0.138
		(1.002)		(0.889)
EconFreeIndex		-0.022		-0.022
		(-0.089)		(-0.071)
Population		0.001		0.001
		(0.380)		(0.296)
AgrArea		0.000		0.000
		(.)		(.)
_cons	3.765***	1.154	3.765***	1.154
	(50.523)	(0.292)	(53.272)	(0.240)
Year FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
N	50	50	50	50
r2_a	0.914	0.909	0.914	0.909

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5. Robustness Check

To further verify the robustness of the experimental results and address endogeneity issues, this paper employs three methods: parallel trend tests, placebo tests, and synthetic control methods to further examine the robustness of the regression results.

5.1 Parallel Trend Test

The parallel trend assumption is a prerequisite for employing DID in empirical papers. The target variable for both the treatment and control groups before the policy implementation (pre-treatment) must satisfy the parallel trend assumption for DID to be applicable. Conversely, if there are pre-existing differences between the treatment and control groups before the policy, the DID results may not represent the net effect of the policy, as other factors could influence the changes in the dependent variable. Therefore, a parallel trend test is conducted first.

Figure 3 is a time trend graph showing that before the start of the Russia-Ukraine war (2022), the food security index trends of both the treatment and control groups were generally consistent and upward. However, during the two years of 2022, the directions of the target variable changes for the two groups diverged. Ukraine experienced a sharp decline after the war, while the synthetic control group continued an upward trend. Thus, it can be preliminarily judged that the parallel trend assumption before the Russia-Ukraine war is basically satisfied, and the difference in trend lines after 2022 is likely caused by the war. Howev-

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er, this conclusion is not robust and requires further examination of the dynamic effects between the two groups.

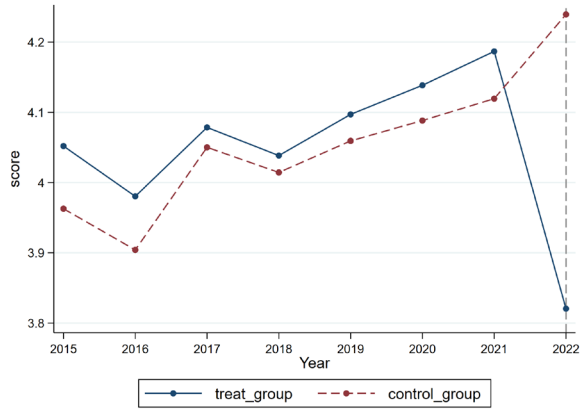

Figure 3. Parallel trend test

Figure 4 is a dynamic effect test graph, where the vertical capped short lines perpendicular to the horizontal axis represent the 95% confidence intervals of the regression coefficients of the interaction terms with the treatment group dummy variable for each period. Before period 0 (2022), the pre-war coefficients are not significant (the 95% confidence intervals do not cross the coefficient = 0 horizontal line), whereas the coefficients after the war are generally significant.

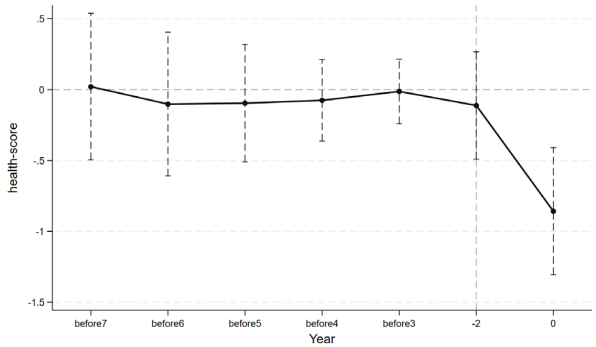

Figure 4. Dynamic effect test

5.2 Placebo Test

The placebo test, following the approach of Xu Si et al. , is employed to rule out the influence of time trends and ensure that the deterioration in food security is not due to local policies or other random factors, but rather a consequence of the war. To exclude this potential possibility, the study randomly selects individuals as the treatment group and repeats this process 100 times to test whether the coefficients of the "pseudo-policy dummy variables" are significant. The graph displays the distribution of the 100 "pseudo-policy dummy variable" estimation coefficients and their corresponding p-values, where the x-axis represents the t-values of the regression of the constructed pseudo-experimental group dummy variable on food security, the y-axis represents density values, and the curve is the kernel density distribution of the estimated-coefficients. The red dots represent the p-values of the estimated coefficients, the vertical dashed line represents the real estimated value of the DID model (-0.171), and the horizontal dashed line represents the significance level of 0.1. From the graph, it is evident that the estimated coefficients are mostly concentrated around zero, with most of the estimated values having p-values greater than 0.1 (not significant at the 10% level). This indicates that the estimation results are unlikely to be obtained by chance and are thus unlikely to be influenced by other policies or random factors.

This placebo test provides robust evidence supporting the validity of the original findings by demonstrating that the observed effects on food security are indeed attributable to the impact of the war, rather than being driven by other time-varying unobserved confounders. This strengthens the argument that the war has had a significant negative effect on food security in Ukraine, reinforcing the need for targeted policy interventions and support to address these challenges.

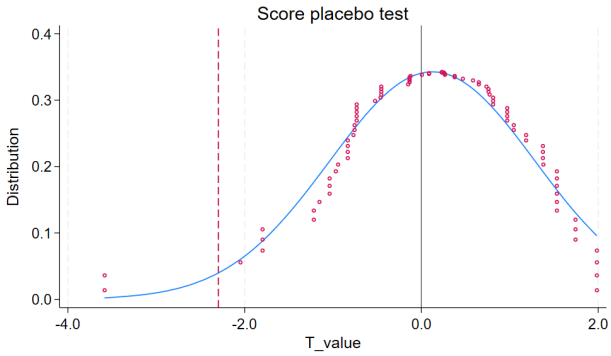

Figure 5. Placebo test

5.3 Synthetic Control Method

To further validate the results of this study, we employed the Synthetic Control Method (SCM) proposed by Abadie and Gardeazabal (2003) [15] for the final robustness check. Using the original sample of 141 sovereign countries and further selecting samples that did not experience war from 2014 to 2022, we chose a set of control units from countries that were not affected by war intervention. Then, through a data-driven approach, weights were assigned to these control units to construct a "synthetic Ukraine." This synthetic Ukraine's pre-war characteristics

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are as similar as possible to the real Ukraine, but it did not undergo the same policy changes during and after the war. The graph shows the food security trend of synthetic Ukraine compared to Ukraine, with the dashed line representing synthetic Ukraine closely following the trend of Ukraine. However, after the outbreak of the war in 2022, the food security of synthetic Ukraine declined, but not as severely as in Ukraine. This method reduces errors from subjective selection and effectively avoids endogeneity issues in policy. It allows us to simulate the target entity (i.e., Ukraine) before policy implementation through the weighting of multiple control units. This not only clearly reflects each control entity's contribution to constructing the "counterfactual" scenario but also avoids the problem of excessive extrapolation.

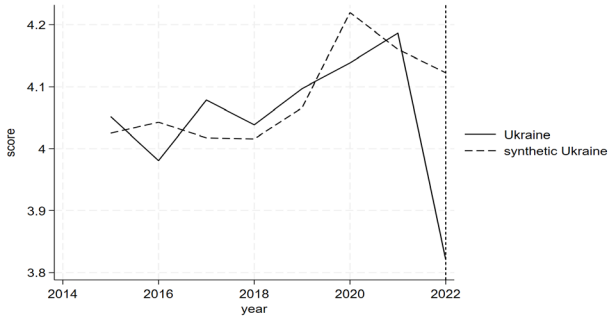

Figure 6. SCM

6. Conclusion

This study, using panel data from 2014 to 2022 years, delves into the direct impact of the war in Ukraine on local food security, revealing the causal relationship between the war and Ukraine's food security index. By integrating the Propensity Score Matching (PSM) and Difference-in-Differences (DiD) estimation methods, along with placebo tests and the synthetic control method for robustness checks, this research offers a new perspective on how war affects food security and proposes policy recommendations and response strategies for similar conflicts that may occur in the future [16].

The findings indicate that the war in Ukraine has had a significant negative impact on its food security, with a significant decline in the food security index by 0.3. This finding is not only statistically significant but also carries important economic implications. The war has directly destroyed agricultural production and infrastructure and indirectly caused economic turmoil and social instability, further weakening food security.

The methodological framework employed in this study provides an effective tool for quantifying and analyzing the impact of similar international conflicts on food security. With the PSM-DiD method, we were able to construct a comparable control group, effectively reducing bias from unobserved differences. Moreover, by conducting parallel trend tests, placebo tests, and applying the synthetic control method, the results of this study demonstrate good robustness, adding credibility to our conclusions.

However, this study has limitations. First, it only covers the short-term impact of one year after the war. This may limit the statistical power of the analysis and increase the risk of Type II errors (false negatives). Secondly, due to the limited time range of the data, this paper does not provide an analysis of the long-term effects of the war on Ukraine's food security. Future research could explore this area further for a more comprehensive understanding of the long-term impacts of war.

Finally, this study emphasizes that mitigating the negative impacts of war on food security requires the collective efforts of the international community, including providing humanitarian aid, improving agricultural production conditions, and enhancing international cooperation. These efforts are crucial for securing food security in war-torn regions and globally. We hope this research can provide reference for understanding and responding to the impacts of similar conflicts on food security in the future, and promote the development of more effective policies and strategies.

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An Empirical Study of Factors Affecting Sudden Deteriorations in Performance of Newly Listed Companies in China

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ABSTRACT

Using the three Jones models, this paper analyzes earnings management in newly listed companies in China. We find that the use of earnings management practices is prevalent among firms in China and these practices increase the possibility of a sudden deterioration in performance (SDP) for the firm. The characteristics of the firm's underwriter or sponsor also significantly impact on the possibility of a SDP. Finally, we find that the financial data of newly listed companies are not good indicators of a SDP.

1. Introduction

Since the re-launch of initial public offerings (IPOs) in 2009, newly listed companies on China's stock market are increasingly likely to see a quick reversal in their performance in the first year after their IPO. By newly listed companies, we are referring to companies listed for less than one year. Statistics show that the proportion of newly listed companies that see a sudden deterioration in their performance was 15.15% in 2009, but this increased substantially to 41.84% in 2010. A sudden deterioration in performance, hereinafter referred to as a SDP, is often regarded as one of the factors that cause high volatility in newly listed companies' stock prices.

Most of the studies on SDPs of newly listed companies are associated with the issue of earnings management. Chaney and Lewis (1998) find that the performance of a newly listed company is positively related to income smoothing practices before an IPO. Teoh et al. (1998) find that there is a trend of enhancing income through adjusting provision and depreciation policy. Aharony (2000) also finds that there is deliberate earnings management in companies undertaking an IPO. Since the SDP phenomenon in newly listed companies has only recently become prominent in the stock market in China, there are few studies that tackle this issue.

This paper contributes to the existing literature in two ways. First, this paper, to our knowledge, is the first to comprehensively analyze the factors affecting SDPs of newly listed companies in China's stock market. By employing the three Jones models, we find that earnings management is still widespread. This increases the possibility of a SDP. Second, we include the characteristics of a firm's underwriter or sponsor in the SDP model and find that these characteristics have a significant impact on

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a SDP.

2. The Models

2.1 Earnings Management Models

Since earnings management is one of the factors affecting SDPs of newly listed companies, we utilize an overall accrual model to measure a company's earnings management practices. Healy (1985) divides accounting earnings (*Earnings*) into operating cash flow (*CFO*) and total accrued surplus (*TA*), *Earnings* = *CFO* + *TA* . *TA* can be divided further into discretionary accruals (*DA*) and non-discretionary accruals (*NDA*), where *TA* = *DA* + *NDA*. *DA* is the degree to which earnings management occurs. Since *DA* is unobservable, the overall accrual model obtains *DA* by calculating *NDA* using the following three Jones models:

(1)The Jones Model

$$\frac{TA_{i,t}}{Asset_{i,t-1}} = k_1 \frac{1}{Asset_{i,t-1}} + k_2 \frac{\Delta Sales_{i,t}}{Asset_{i,t-1}} + k_3 \frac{PPE_{i,t}}{Asset_{i,t-1}} + \varepsilon_{i,t} \quad (1)$$

$OP_{i,t}$ is the operating profit of firm *i* at time *t*, $CFO_{i,t}$ is the cash flow of firm *i* at time *t*, $Asset_{i,t-1}$ is the total assets of firm *i* at time *t-1*, $\Delta Sales_{i,t}$ is the change in the main business income of firm *i* between time *t* and *t-1*, and $PPE_{i,t}$ is the fixed assets of firm *i* at time *t*.

From this we can obtain $NDA_{i,t}$ by substituting the estimated coefficients of Equation (1) into Equation (2):

$$NDA_{i,t} = \hat{k}_1 \frac{1}{Asset_{i,t-1}} + \hat{k}_2 \frac{\Delta Sales_{i,t}}{Asset_{i,t-1}} + \hat{k}_3 \frac{PPE_{i,t}}{Asset_{i,t-1}} \quad (2)$$

Equation (3) showshow $DA_{i,t}$ is calculated. This can then be used as a proxy for the use of earnings management in firms:

$$DA_{i,t} = \left(\frac{TA_{i,t}}{Asset_{i,t-1}} \right) - NDA_{i,t} \quad (3)$$

(2) The Modified Jones Model

Dechow et al. (1995) construct the modified Jones model by adding the change in accounts receivable, $\Delta ARE_{i,t}$, and subtracting the change in main business income, $\Delta Sales_{i,t}$, from the original Jones model. This is shown in Equation (4) below:

$$\frac{TA_{i,t}}{Asset_{i,t-1}} = k_1 \frac{1}{Asset_{i,t-1}} + k_2 \frac{\Delta Sales_{i,t} - \Delta ARE_{i,t}}{Asset_{i,t-1}} + k_3 \frac{PPE_{i,t}}{Asset_{i,t-1}} + \varepsilon_{i,t} \quad (4)$$

(3) The Extended Modified Jones Model

By adding the summation of intangible assets and other long-term assets, $IA_{i,t}$, to the modified Jones model, Lu (1999) constructs the following extended modified Jones model:

$$\frac{TA_{i,t}}{Asset_{i,t-1}} = k_1 \frac{1}{Asset_{i,t-1}} + k_2 \frac{\Delta Sales_{i,t} - \Delta ARE_{i,t}}{Asset_{i,t-1}} + k_3 \frac{PPE_{i,t}}{Asset_{i,t-1}} + k_4 \frac{IA_{i,t}}{Asset_{i,t-1}} + \varepsilon_{i,t} \quad (5)$$

2.2 Sudden Deterioration in Performance Model (SDP Model)

Based on the above earnings management models, we establish the following SDP model to analyze the impact of a number of factors on SDPs of newly listed companies:

$$SDP = \alpha_0 + \alpha_1 INDG + \beta_1 NETM + \beta_2 ASTT + \beta 3 EQTM + \beta_4 SALG + Y_1 FCAP + Y_2 CXSA + Y_3 UDWN + Y_4 UDWF + \delta DA + \varepsilon \quad (6)$$

Since the dependent variable, *SDP*, is a discrete parameter, Equation (6) is a discrete choice model (DCM). As for the independent variables, we conclude that several factors with four categories affect SDPs of newly listed companies. We show this in Table 1 below.

Table 1. Factors Affecting a Sudden Deterioration in Performance (SDP)

Category	Variables	Definitions and Calculating Methods
Macro-industy factor	INDG	Industry sales revenue growth (quarter growth)
Performance factors	NETM	Sales margin (net income divided by sales revenue)
	ASTT	Asset turnover (sales revenue divided by total assets)
	EQTM	Equity multiplier (total assets divided by equity)
	SALG	Sales growth rate (compound annual growth rate of sales before IPO)
Financing factors	FCAP	Size of the financing
	CXSA	Asset level of underwriting agencies
	UDWN	Absolute number of underwriting business
	UDWF	Average expense
Financial manipulation factor	DA	Discretionary accruals earnings (residuals of Modified Jones model)

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3. Analysis of Earnings Management

The data is from the Wind Financial Database and the sample period extends from the date IPOs were relaunched in 2009 to the end of 2012. In our study, we adopt the three Jones models to examine earnings management in newly listed companies, the regression results of which are shown in Table 2. The value in brackets is the p-value of the estimated coefficients. The regression results show that the three Jones models ' explanatory powers are quite low. This means that *DA* has a greater impact on the dependent variable.

Their t-test results which determine the earnings management are reported in Table 3. These results show that all of the mean residuals of *DA* are significant at the 5% level. Thus, we believe that earnings management is prevalent in newly listed companies in China. Since the modified Jones model has the smallest standard deviation, we use the regression residuals of this model to reflect the level of usage of earnings management practices in the SDP model.

Table 2. Regression Results of the Three Jones Models

Variable	Jones Model	Modified Jones Model	Extended Modified Jones Model
1/Asset	5201041	7843204	7774594
	(0.0000)	(0.0000)	(0.0000)
Sales/Asset	0.1394	-	-
	(0.0000)	-	-
PPE/Asset	-0.0502	-0.0396	-0.0418
	(0.0002)	(0.0042)	(0.0083)
(Sales-ARE)/Asset	-	0.1080	0.1077
	-	(0.0000)	(0.0000)
IA/Asset	-	-	0.0167
	-	-	(0.7683)
R-squared	0.1338	0.0668	0.0669
Adjusted R-squared	0.1318	0.0646	0.0636

Table 3. T-tests of Mean DA

Test of Hypothesis: Mean=0.0000			
Model	Jones Model	Modified Jones Model	Extended Jones Model
Mean	0.0098	0.0124	0.0123
Standard Deviation	0.1170	0.1213	0.1213
t-statistics	2.4726	3.0175	2.9709
Prob.	0.0136	0.0026	0.0031

4. Factors Affecting a Sudden Deterioration in Performance

Table 4 reports the estimated results of Equation (6) using Probit and Logit regressions, respectively. The estimated coefficients display consistent signs, which indicate that model selection does not have a significant impact on the regression results. Most of them in the two regressions are not significant, with the exception of *CXSA, UDWF, UDWN* , and *DA*.

Therefore, we establish the following SDP model by excluding the insignificant variables:

$$SDP = \theta 0 + \theta 1 CXSA + \theta 2\ UDWF + \theta 3 UDWN + wDA + \varepsilon \quad (7)$$

Table 5 reports the regression results, using Probit and Logit regressions, for Equation (7). The regression results show that all the estimated coefficients are significant at the 90% level. It is worth noting that these four variables are from the financing and financial manipulation categories, which means that the features of a firm's earnings management practices and the characteristics of a firm's underwriter or sponsor all significantly impact on SDPs of newly listed companies.

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Table 4. Regression Results Using Probit and Logit Models

Variable	Probit Model				Logit Model			
	Coefficient	Std.Error	z-Statistic	Prob.	Coefficient	Std.Error	z-Statistic	Prob.
C	-1.747	0.789	-2.216	0.027	-2.954	1.343	-2.199	0.028
INDG	-0.005	0.006	-0.752	0.452	-0.009	0.011	-0.783	0.433
NETM	0.384	0.746	0.515	0.606	0.652	1.276	0.511	0.609
ASTT	-0.099	0.136	-0.726	0.468	-0.152	0.231	-0.655	0.512
EQTM	-0.001	0.021	-0.045	0.964	-0.001	0.033	-0.033	0.974
SALG	-0.293	0.204	-1.437	0.151	-0.522	0.381	-1.372	0.170
FCAP	0.000	0.000	-0.557	0.577	0.000	0.000	-0.519	0.604
CXSA	-0.840	0.263	-3.192	0.001	-1.412	0.456	-3.098	0.002
UDWN	0.005	0.003	2.024	0.043	0.009	0.004	2.047	0.041
UDWF	0.000	0.000	1.883	0.060	0.000	0.000	1.898	0.058
DA	0.808	0.342	2.364	0.018	1.298	0.567	2.288	0.022
McF. R2 LR statistic LR Prob.		0.030	20.869	0.035		0.029	20.413	0.040

Table 5. Regression Results Using Probit and Logit Models

Variable	Probit Model				Logit Model			
	Coefficient	Std.Error	z-Statistic	Prob.	Coefficient	Std.Error	z-Statistic	Prob.
C	-0.932	0.195	-4.779	0.000	-1.536	0.331	-4.640	0.000
CXSA	-0.795	0.258	-3.076	0.002	-1.355	0.450	-3.009	0.003
UDWF	0.000	0.000	1.804	0.071	0.000	0.000	1.833	0.067
UDWN	0.005	0.002	1.959	0.050	0.008	0.004	1.986	0.047
DA	0.681	0.331	2.058	0.040	1.088	0.547	1.988	0.047
McF. R2 LRstatistic LRProb		0.022	15.470	0.004		0.022	15.163	0.004

The negative estimated coefficient on *CXSA* indicates that the stronger the comprehensive strength of the sponsor, the smaller the possibility of a SDP. Strong sponsors tend to be more rigorous in their underwriting processes, thus the companies tend to be more reliable and less prone to short-term deteriorations in performance. In addition, the estimated coefficient on *UDWN* is positive, which indicates that the more IPO business underwriters have, the greater the possibility of a SDP. This means that if sponsors have a large amount of IPO business, they are more likely to underwrite bad quality companies. Finally, the estimated coefficient on *UDWF* is positive, which indicates that the higher the underwriting fee charged by underwriters, the greater the possibility of a SDP. This could be because the higher the underwriting fees companies pay, the more likely underwriters or sponsors are to add excessive packaging on IPO companies.

The coefficient on the earnings management proxy, *DA*, is positive, which means that the more earnings management conducted, the bigger the possibility of a SDP. Before an IPO, companies have strong incentives to conduct financial packaging through earnings management practices in order to ensure the success of an IPO. After the IPO has been completed, newly listed companies may lose the motivation for further manipulation of earnings.

5. Conclusion

In this paper, we conduct an empirical analysis of the factors affecting SDPs of newly listed companies and have the following three main conclusions:

First, the use of earnings management is very common in the financial year prior to an IPO. In fact, the greater the use of earnings management practices, the higher the possibility of a SDP. Moreover, the new regulatory specifications on how to report companies' financial data introduced for the re-launch of IPOs in 2009 clearly did not have a significant impact as there have been no improvements in the validity or reliability of firm's financial data since the IPO re-launch.

Second, the characteristics of a sponsor also have a

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significant impact on SDPs of newly listed firms. In the regression results from our SDP model, all of the three factors associated with underwriters or sponsors are significant, which indicates that underwriters or sponsors may be involved in the process of financial packaging for the firms they are underwriting.

Finally, our results indicate that the financial data of listed companies are not good indicators for predicting a SDP. Factors reflecting companies ' performance do not significantly increase the possibility of a SDP. As a result, the information disclosed by companies undertaking an IPO cannot genuinely reflect their operating profits or risks.

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Pricing the Extreme Mortality Bonds Based on the Double Exponential Jump Diffusion Model

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ABSTRACT

Extreme mortality bonds (EMBs), which can transfer the extreme mortality risks confronted by life insurance companies into the capital market, refer to the bonds whose nominal values or coupons are associated with mortality index. This paper first provides the expected value of mortality index based on the double exponential jump diffusion (DEJD) model under the risk-neutral measure; then derives the pricing models of the EMBs with principal reimbursement non-cumulative and cumulative threshold respectively; finally simulates the bond prices and conducts a parameter sensitivity analysis. This paper finds that the jump and direction characteristics of mortality index have significant impacts on the accuracy of the EMB pricing.

1. Introduction

Extreme mortality risk is derived from the situation that the actual mortality rate confronted by life insurance companies is higher than predicted when underwriting the policies. Traditional measures of dealing with the extreme mortality risk include using economic capital to absorb actual losses, selling policies to spread the risk, raising policy rates to transfer costs, and using reinsurance to mitigate risk. However, all these four traditional measures have their own limitations. Therefore, life insurance securitization has been utilized to transfer the extreme mortality risk to the capital market. In 2003, Swiss Reinsurance initiated to apply the method of life insurance securitization to successfully issue the EMBs whose underlying assets are life insurance policies. Since then, life insurance companies and the academia have been bringing out continuous innovations on the EMBs.

Researches on the EMBs are mainly concentrated in the following three aspects: first, in terms of operational mechanism, Cowley and Cummins (2005), Blake et al. (2006a; 2006b; 2006c), Cairns et al. (2006) and Chen and Cox (2009) study the Vita series EMBs issued by Swiss Reinsurance; Bauer and Kramer (2007) analyze the Tartan EMBs issued by Scottish Reinsurance; second, in terms of mortality index, Dhal et al. (2004), Dowd et al (2006), Cox and Lin (2008), and Deng et al. (2012) explore the jump characteristic of mortality index; third, in terms of pricing model, scholars focus on the imperfect market

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pricing, which includes Wang transform model (Wang, 2000; 2002) , Sharp Ratio model (Milevsky et al., 2005), and LFC pricing model (Lane, 2000; Chen and Cummins, 2010).

Although the existing researches on the design and pricing method of mortality index have achieved certain progress, the accuracy of mortality prediction and the rationality of the triggering mechanism still need to be improved. Therefore, based on the double exponential jump diffusion (DEJD) theory proposed by Kou and Wang (2003), employing the research method of Deng et al. (2012), this paper first provides the expected value of mortality index based on the DEJD distribution under the risk-neutral measure, then derives the specific pricing analytic expressions of the EMBs with principal reimbursement non-cumulative and cumulative threshold respectively, and finally simulates the bond prices and conducts the parameters sensitivity analysis.

This paper contributes in the following three aspects: first, based on the assumption that mortality index follows the DEJD process, this paper sufficiently features the direction and frequency of mortality jump, improving the accuracy of the EMB pricing; second, this paper illustrates a much more explicit expression for pricing the EMBs. The results of bond price simulation shows that the EMBs with principal reimbursement non-cumulative threshold are less risky and thus more attractive to investors; third, the parameter sensitivity analysis suggests that the specification of jump direction and frequency influences bond prices significantly, indicating that the description of jump characteristics plays a vital role in the accuracy of the EMB pricing.

2. Mortality Index Following DEJD Distribution

The pricing of the EMBs is based on the characterization of mortality index. Different mortality movements result in different bond prices. Considering the changes of mortality rate may not be continuous in reality, which means the standard Brownian motion cannot sufficiently describe the movement of mortality rate, and based on the DEJD theory proposed by Kou and Wang (2003; 2004), this paper argues that the scope of mortality jump follows the DEJD distribution instead of the normal distribution. Utilizing the DEJD distribution to describe the movement of mortality has two obvious advantages. On one hand, it conveniently depicts the mortality jump by simply using different parameters under the same exponential distribution; on the other hand, it effectively characterizes the asymmetry and exponential property of actual mortality jump.

Meanwhile, this paper constructs the mortality index by adopting the risk-neutral pricing measure which is widely used to price financial derivatives. Based on the risk neutral pricing theory, we can choose a specific risk neutral measure, denoted as Q^*. Under it, the expected discount for all marketable assets is martingale, and we can obtain the fair price of any security. By the maximum likelihood estimate method, it can implement the risk neutral adjustment to each of the parameters in the mortality time series model, and finally reach the market value of the securities under the risk neutral hypothesis.

Following the research of Deng et al. (2012) and under Lee-Carter (1992) framework, $\mu_{x,t}$denotes the mortality rate of the group whose age is x at time t. The mortality rate can be expressed by the age-specific parameters a_x, b_x and the mortality time series k_t:

$$\ln\left(\mu_{x,t}\right) = a_x + b_x k_t + e_{x,t} \tag{1}$$

By exponentiating both sides of Equation 1, we can get:

$$\mu_{x,t} = \exp(a_x + b_x k_t + e_{x,t}) \tag{2}$$

To capture the jump characteristic of the mortality time series, k_t should satisfy the following equation:

$$\frac{dk_t}{k_t} = \alpha dt + \sigma dW(t) + d(\sum_{i=1}^{N(t)}(V_i - 1)) \tag{3}$$

$N(t)$ is the Poisson process with parameter λ, which represents the jumping frequency. $Y^* = \ln(V^*)$ follows the double exponential distribution:

$$f_{Y^*}(y) = p\eta_1 e^{-\eta_1 y} 1_{\{y \geq 0\}} + q\eta_2 e^{\eta_2 y} 1_{\{y<0\}} \tag{4}$$

Where $p \geq 0,\ q \geq 0,\ p+q=1,\ \lambda > 0,\ \eta_1, \eta_2 > 0$. This distribution specifies the upward and downward directions of mortality jump. When $y \geq 0$, it describes the sudden surge of mortality rate caused by extreme events. When $y \leq 0$, namely the downward jump, it suggests the reduction of mortality rate as a result of the economic development, the increase of living standards, and the improvement of medical and health conditions.

Under the risk-neutral measure, the mortality rate time series satisfies:

$$\frac{dk_t}{k_t} = (\mu^* - \lambda^* \xi^*)dt + \sigma^* dW^*(t) + d(\sum_{i=1}^{N^*(t)}(V_i^* - 1)) \tag{5}$$

Utilizing *Itô lemma* to solve the above differential equation, we can get:

$$k_t = k_0 + (\mu^* - \frac{1}{2}\sigma^{*2} - \lambda^* \xi^*)t + \sigma^* W_t^* + \sum_{i=1}^{N^*(t)} Y_i^* \tag{6}$$

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Therefore, the expected value of overall mortality index is:

$$E^*(\mu_{x,t}) = \exp(a_x) \times E^*\left[\exp(b_x k_t)\right]$$
$$= \exp\left(a_x + b_x k_0 + b_x t(\alpha^* - \frac{1}{2}\sigma^{*2} - \lambda^*\gamma^*)\right) + \frac{1}{2}\sigma^{*2} b_x^2 t + \lambda^*(\frac{p^*\eta_1^*}{\eta_1^* - b_x} + \frac{q^*\eta_2^*}{\eta_2^* + b_x} - 1)t \quad (7)$$

Furthermore, the life table can be divided into x age groups, and each of them is allocated with a weight of W_x. Then the expectation of the overall mortality rate is:

$$E^*(\mu_t) = \sum_x W_x \times \left\{\exp(a_x) \times E^*\left[\exp(b_x k_t)\right]\right\}$$
$$= \sum_x W_x \times \left\{\exp\left(a_x + b_x k_0 + b_x t(\alpha^* - \frac{1}{2}\sigma^{*2} - \lambda^*\gamma^*)\right) + \frac{1}{2}\sigma^{*2} b_x^2 t + \lambda^*(\frac{p^*\eta_1^*}{\eta_1^* - b_x} + \frac{q^*\eta_2^*}{\eta_2^* + b_x} - 1)t\right\} \quad (8)$$

3. The Pricing Models of Extreme Mortality Bonds based on DEJD Model

According to whether the current principal compensation payment sets the accumulation of past reimbursement ratios as the trigger condition, the EMBs can be divided into two types of principal reimbursement with non-cumulative threshold bonds and cumulative threshold bonds.

3.1 Pricing Model of Principal Reimbursement with Non-cumulative Threshold EMBs

The trigger condition of the EMBs with principal reimbursement non-cumulative threshold is solely based on the predetermined mortality rate benchmark, i.e. the annual mortality rate benchmark k_0. SPV obeys the following principles when compensating life insurance companies: (1) if at the time of t, the mortality index k_t surpasses the lower bound of the annual mortality rate benchmark (M), SPV will start to reimburse the life insurance companies using the principal raised from the EMBs investors; (2) if the level of mortality rate reaches or even exceeds the upper bound of annual mortality rate benchmark (U), SPV will compensate life insurance companies with no more than the entire principal raised by issuing the EMBs; (3) if the mortality level is between the two bounds, SPV will utilize the linear interpolation method to evaluate the compensation ratio from life insurance companies.

From the perspective of a life insurance company, it in fact obtains a series of multi-period call options as the return for the reinsurance premiums it has paid to the SPV. As for bond investors, if trigger events do not happen during the specified period, they will acquire the agreed interest and principal; if extreme events do occur, the bond buyers will lose some or all of the principals. The Vita I EMB of Swiss Reinsurance is a typical representative for the EMB with principal reimbursement non-cumulative threshold, which means the year by year recalculation of the annual withdrawal and the compensation ratio for the life insurance companies from the SPV, and no relevance to cumulative compensation ratios in the past.

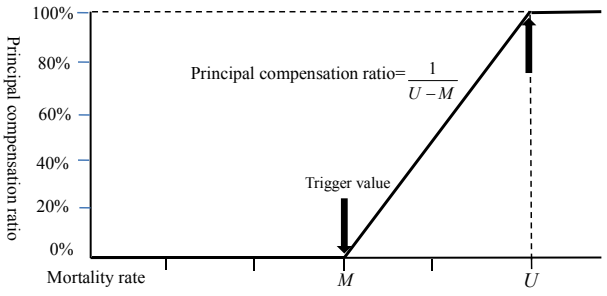

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Figure 1. The Reimbursement Mechanism of the Non-cumulative Threshold EMBs

Figure 1 shows the reimbursement mechanism of the EMBs with principal reimbursement non-cumulative threshold. The black solid line shows the relationship between the principal compensation ratio and the current mortality rate for each year. Let q_t be the mortality rate at the time of t, then the principal compensation ratio $loss_t$ for SPV to compensate the life insurance company is:

$$loss_t = \frac{Max[q_t - M, 0] - Max[q_t - U, 0]}{U - M}$$
$$= \begin{cases} 0, & q_t < M \\ \dfrac{q_t - M}{U - M}, & M < q_t < U \\ 1, & q_t > U \end{cases} \quad (9)$$

At the maturity date T, investors can obtain the remaining principal FV as:

$$FV = \begin{cases} Par(1 - \int_{t=1}^{T} loss_t dt) & if \quad \int_{t=1}^{T} loss_t dt \le 1 \\ 0 & if \quad \int_{t=1}^{T} loss_t dt > 1 \end{cases} \quad (10)$$

Where Par is the face value of the bond, and r_f is the risk-free interest rate. Under the risk neutral measure, at maturity date T, the pricing formula of the EMBs with principal reimbursement non-cumulative threshold can be written as:

$$P = e^{-r_f T} E^*(FV) = Par \cdot e^{-r_f T} E^*\left[1 - \int_1^T loss_t dt\right]$$
$$= Par e^{-r_f T}\left[1 - E^*\left(\int_1^T loss_t dt\right)\right]$$
$$= Par \cdot e^{-r_f T}\left[1 - \int_1^T \left(\frac{E(\mu_t^*) - M}{U - M}\right) dt\right] \quad (11)$$

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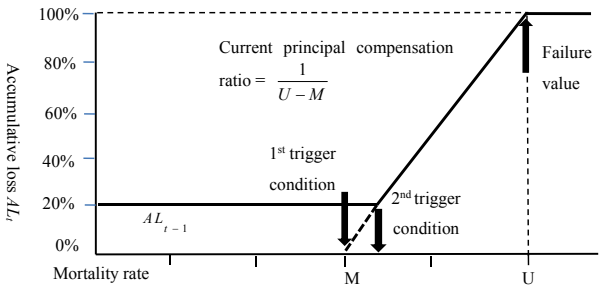
3.2 Pricing Model of Principal Reimbursement with Cumulative Threshold EMBs

Due to the fact that mortality rates for successive years generally have sequential correlations, the calculation of mortality rate is usually based on the historical mortality rates. To properly settle the problem of sequential correlations, Scottish Reinsurance issued the Tartan EMBs by designing a double-trigger in 2006. The first trigger condition is the same as that of the non-cumulative threshold EMBs mentioned above, i.e. whether the mortality index surpasses the lower bound of benchmark (M); The second trigger condition is whether the principal compensation ratio which is calculated from Formula (9) is greater than the accumulative principal compensation ratio (Accumulated Loss, AL_{t-1}), which is the sum of the compensation ratios in last periods.



Resource: Klein R., 2006, Mortality catastrophe bonds as a risk mitigation tool, *Society of Actuaries Newspaper*, (57).

Figure 2. The Reimbursement Mechanism of the Cumulative Threshold EMBs

In Figure 2, the black solid line represents the relationship between the accumulated principal compensation ratio of each period and the level of mortality in current period. It can be noted that the accumulated compensation ratio for this period is between the accumulated compensation ratio for the last period and 100%. Only when the current compensation ratio exceeds the cumulative ratio threshold for the last period AL_{t-1}, will SPV reimburse using the principal. That is to say, at the time of t, SPV will pay back to life insurance companies at the scale of the accumulated compensation ratio AL_t:

$$AL_t = Min\left\{Max\left\{AL_{t-1}, \frac{k_t - M}{U - M}\right\}, 100\%\right\} \tag{12}$$

When the accumulated principal payment ratio hasn't yet reached 100% in the last period, the current principal compensation ratio $loss_t$ is:

$$\begin{aligned} loss_t &= AL_t - AL_{t-1} \\ &= Min\left\{\max\left\{AL_{t-1}, \frac{q_t - M}{U - M}\right\}, 100\%\right\} - AL_{t-1} \\ &= \begin{cases} 0, & \frac{q_t - M}{U - M} < AL_{t-1} \\ \frac{q_t - M}{U - M} - AL_{t-1}, & AL_{t-1} < \frac{q_t - M}{U - M} \le 100\% \\ 1 - AL_{t-1}, & \frac{q_t - M}{U - M} > 100\% \end{cases} \end{aligned} \tag{13}$$

When the bond matures at T, SPV will pay the principal back to all the bond investors at the scale of P_T:

$$P_T = 1 - AL_T \tag{14}$$

Therefore the pricing formula of the EMBs with principal reimbursement cumulative threshold is:

$$\begin{aligned} P &= e^{-r_f T} E^*(FV) \\ &= e^{-r_f T} E^*\left[1 - \left(AL_t - AL_{t-1}\right)\right] \\ &= e^{-r_f T}\left[1 - E^*\left(AL_t - AL_{t-1}\right)\right] \\ &= Par \cdot e^{-r_f T}\left[1 - \int_1^T \left(\frac{E^*(\mu_t) - M}{U - M} - AL_{t-1}\right) dt\right] \end{aligned} \tag{15}$$

In conclusion, the biggest difference between the two types of the EMBs lies in whether the principal compensation ratio over each mortality assessment period (usually a year) sets the accumulated compensation ratio of last period as the threshold of its lower bound. For the EMBs with principal reimbursement non-cumulative threshold, principal compensation ratios in each year are not related. Once the mortality rate exceeds the lower bound of benchmark (M), the principal compensation ratios will increase $1/(U-M)$% with every 1% increase in mortality index. At the same time, if the sum of independent principal reimbursement ratios accumulates to surpass 100% before maturity, SPV will not pay for the bond investors.

However, for the EMBs with principal reimbursement cumulative threshold, not only will the current level of mortality exceed the lower bound of benchmark (M), but the proportion of the principal reimbursement ratio should surpass the accumulated proportion in last period AL_{t-1} as well. Only under this circumstance, SPV will compensate to life insurance companies. In other words, only when the extreme mortality rate is large enough in the second year and meets the double trigger conditions, will the bond investors suffer principal losses, which is more secured to the interests of bond investors. The pricing models of these two types of the EMBs are derived from their corresponding reimbursement mechanisms.

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4. Numerical Analysis

4.1 The Estimation of Extreme Mortality Bond Prices

Assuming that one extreme mortality bond has a maturity of 3 years ($T = 3$) and with a face value of 1 billion RMB ($Par = 1000000000$). This bond was issued at the end of 2013 and will expire at the end of 2016. Risk-free interest rate, represented by the one-year Shibor interest rate, is 0.044. The Benchmark of mortality rate μ_0 in 2013 is 0.00743. The lower bound of mortality index (M) is 1.1 times of the mortality rate in the base year, and the upper bound (U) is 1.2 times of the mortality rate in the base year. This paper assumes $AL = 0.05$ in the pricing formula of the EMBs with principal reimbursement cumulative threshold. Table 1 shows the parameters of annual mortality index. W_x is a weight associated with the age category.

Table 1. The Parameters of Annual Mortality Index

Age Scope	W_x	a_x	b_x
<1	0.013818	-3.4087	0.1455
1-4	0.055317	-6.2254	0.1960
5-14	0.145565	-7.1976	0.1942
15-24	0.138646	-6.2957	0.0994
25-34	0.135573	-5.9923	0.1044
35-44	0.162613	-5.4819	0.0855
45-54	0.134834	-4.7799	0.0608
55-64	0.087247	-4.0137	0.0468
65-74	0.066037	-3.2347	0.0426
75-84	0.044842	-2.4196	0.0409
>85	0.015508	-1.6119	0.0290

Table 2 shows the estimated results of the parameters involved in the pricing model (Deng et al., 2012).

Table 2. The Estimates of Parameters

k_0	α^*	σ^*	p^*	γ^*	η_1^*	q^*	η_2^*	λ^*
-10.302	-0.2	0.31	0.035	-1.25	0.89	0.065	0.93	0.029

Based on the above pricing models of the EMBs, the bond prices of the two types can be calculated and summarized in Table 3. Comparing the estimated prices of the two EMBs, we can find that the price of the EMB with non-cumulative threshold is lower than that of the EMBs with cumulative threshold, which indicates that the EMBs with non-cumulative threshold are more risky than the cumulative ones, and demand more risk premiums.

Table 3. The Estimated Results of the EMB Prices

EMB Type	Principal Non-Cumulative	Principal Cumulative
EMB Price	4.7260×10^9	4.9087×10^9

4.2 Parameter Sensitivity Analysis

Figures 1 to 6 plot the relationship between the prices of the EMBs and the main parameters in the pricing models respectively. As in Figure 1 and 2, the parameters p^* and q^* which describe the directions of mortality jump have significant impacts on the EMB prices. The upward jump parameter p^* is negatively correlated with the bond prices; however, the downward jump parameter q^* is positively correlated with the bond prices. It suggests that when the probability of upward jump rises, the mortality risk in the future will increase, higher compensation bond holders will demand and lower bond prices will be. On the contrary, when the probability of downward jump rises, the mortality risk in the future will decrease, the lower compensation bond holders will demand and higher bond prices will be.

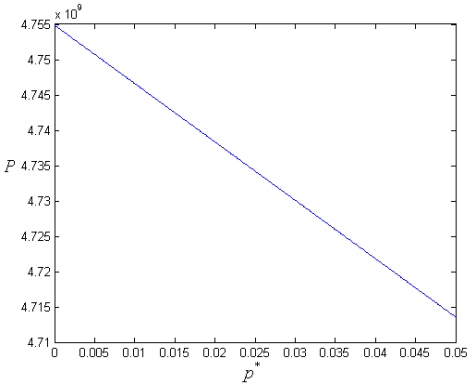

Figure 1. The Relation between Price P and p^*

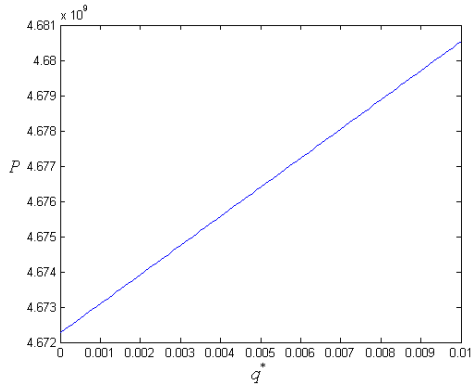

Figure 2. The Relation between Price P and q^*

Moreover, Figure 3 shows that the frequency parameter of mortality jump λ also exerts a significant sensitivity impact. When the probability of upward jump is smaller than the downward jump, the frequency parameter λ and the bond prices are linearly positively correlated. This proves that the frequency of mortality jump plays a significant role in the accuracy of pricing the EMBs. Furthermore,

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after the distinction of jump directions, both the frequency and direction will influence the mortality risk at the same time, rather than an increase in jump frequency will certainly lead to the increase in the mortality risk when only considering the positive jump. In addition, Figure 4 shows that the bond price is negatively correlated with the parameter α^*, and has a significant sensitivity.

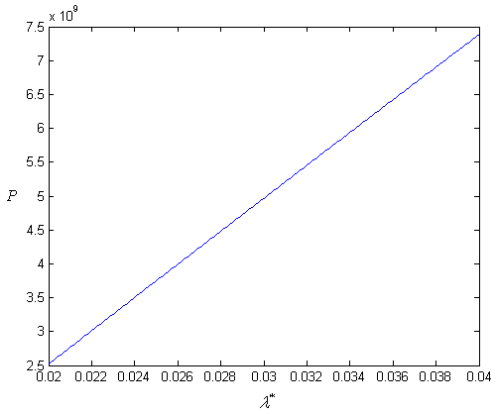

Figure 3. The Relation between Price P and λ^*

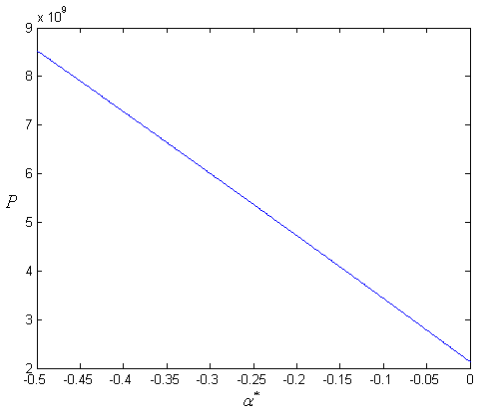

Figure 4. The Relation between Price P and α^*

Finally, Figure 5 and 6 reveal that parameters η_1 and η_2 which describe the jump scope have a weak correlation and sensitivity relationship with the bond prices. This phenomenon happens after distinguishing the directions of mortality jump.

From the above analysis, it's not hard to notice that when considering the more dedicate descriptions of mortality jump, especially the distinction of the jump directions, can more effectively measure mortality risk and increase the rationality and accuracy of the EMB pricing. Otherwise, only considering upward jump or not distinguishing jump directions is likely to lead to bigger errors in the prediction of mortality index, thus affecting the accuracy of the EMB pricing.

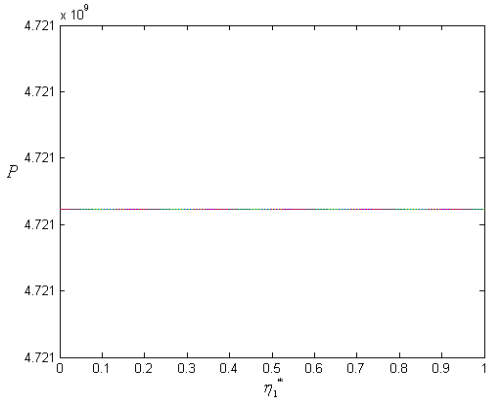

Figure 5. The Relation between Price P and η_1^*

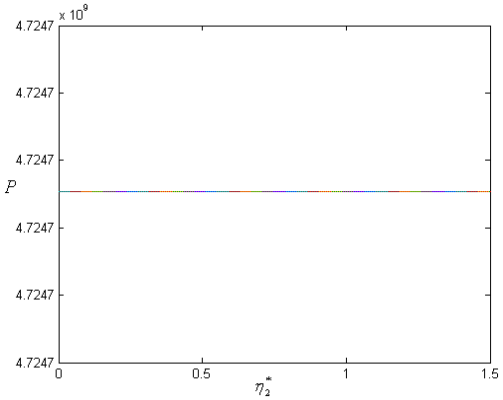

Figure 6. The Relation between Price P and η_2^*

5. Conclusion

Given the large exposure of extreme mortality risk faced by life insurance companies, how to manage the extreme mortality risk for them has become a hot topic. Since accurately pricing the EMBs is vital to the success of their issuing in the capital market, the focus of this paper is to derive and analyze the EMB pricing model. This paper first introduces a stochastic diffusion model with a double exponential jump diffusion (DEJD) process for mortality time-series. Then, this paper applies the risk neutral pricing theory to derive the pricing models for the EMBs with principal reimbursement non-cumulative and cumulative threshold respectively. The prices of the cumulative threshold EMBs are higher than those of the non-cumulative threshold EMBs, thus more appealing for risk-averse investors. Finally, the results of parameter sensitivity analysis indicate that the mortality jump description, especially the distinction of jump directions, has a significant impact on the rationality of the EMB pricing.

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The Scale and Structure of Funding Expenditures for China's First-class Universities

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ABSTRACT

Adequate funding is identified as a crucial factor in ensuring the success of these universities, impacting talent cultivation, scientific research, and social services. Since the 1990s, China has launched several key projects to enhance the development of its first universities and aimed at elevating these institutions to world-class status. Using data from 34 first-class universities in China from 2014 to 2022, this study analyzes the characteristics and differences in expenditure. It employs an independent sample t-test model to compare the C9 League universities with other first-class universities. The findings reveal significant gaps in total expenditure and varying priorities in expenditure categories, with education being the dominant expenditure item. The study concludes with suggestions for optimizing the efficiency of fund utilization to support the development of world-class universities in China.

1. Background

In the era of the knowledge economy, economic growth is increasingly inseparable from the creation, processing, and dissemination of knowledge. The construction level of comprehensive and research-oriented universities that integrate teaching, scientific research, and social services is also receiving increasing attention from the country. Since the 1990s, the Chinese government has successively launched key construction projects such as "Project 211", "Project 985" and "985 Project Innovation Platform", aiming to empower a number of key universities and key discipline construction projects to reach world-class levels. In 2015, The State Council of the People's Republic of China issued documents which requires accelerating the construction of a number of world-class universities and disciplines. In 2017, the ministry of education, the ministry of finance, and the national development and reform commission jointly released a selected list of universities and colleges. It emphasizes increasing supports for leading talents, boldly attempting in fundraising and utilization, highlighting performance orientation, dynamically adjusting support, and aiming to promote a new stage of improvement in higher education level.

Adequate funding is a key factor in ensuring the construction of universities, which has a significant impact on talent cultivation, scientific research, and social services.[1] Education funding is the material foundation of higher education, and its use has also received increasing attention from the government and the public. The top research universities in the United States have been increasing their

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funding year by year, accounting for the vast majority of research funding in domestic universities while providing the main output of scientific research.[2] To strive for world-class status, Chinese first-class universities should follow leaders as benchmarks. There is still a gap between the level of China's first-class universities and world-class universities. Besides, it is urgent to maintain high-intensity and long-term funding investment, optimize funding allocation methods, grasp our own educational positioning, and explore advantages and characteristics.

2. Literature review

Higher education expenditure is an important guarantee for achieving modernization of higher education. The scale of university expenditure often reflects the degree of importance that a country or region attaches to higher education investment, as well as the current development status of higher education scale. The expenditure on higher education in China has doubled from 881.5 billion yuan in 2014 to 1639.7 billion yuan in 2022, with an average annual growth rate of 11%, which is the driving force behind its vigorous development. As early as 2007, top universities in countries such as the United States and the United Kingdom had spent billions of dollars solely on research funding.[3] The total funding for contract research and donations at the University of California, Berkeley increased from $462 million in 2003 to $714 million in 2012, with a growth rate of 54.55%.[4] Compared to the world's top level, the current scale of university funding expenditure in China is still relatively small.

University expenditure details are often divided according to the purpose of use. From a functional perspective, the National Center for Education Statistics (NCES) divides the core expenditure structure of education funds for top universities in the United States into other expenditure categories such as teaching, research, public services, academic support, institutional support, student services, and independent operations. According to Dearden (2012), the funding expenditure of research universities in the UK mainly consists of four parts: personnel expenses, other operating expenses, depreciation of fixed assets, and interest expenses. Among them, personnel expenses include salaries paid to faculty and staff, social security contributions, and retirement funds, accounting for half of the total expenditure.[5] Christiana (2011) has outlined the expenditure structure of Nigerian universities, which is roughly divided into teaching, research and management costs, enrollment and training costs, faculty benefits and salaries, and facility maintenance.[6]

World-class universities all attach great importance to the rational allocation of resources in their operations to promote comprehensive development. Just (2009) analyzed the structure of university funding expenditures in the United States and found that teaching, public affairs, and personal support for faculty and staff are the three main components of expenditures.[7] Pittman (2012) summarized the commonalities of various funding expenditures of world-class public universities in the United States. Setting aside teaching and research expenditures, the expenditure on providing resources and services for the daily work and learning of teachers, students, and faculty is increasingly valued.[8] Ota (2014) analyzed the use of funds at the University of Tokyo and found that the salaries and welfare expenses of full-time and part-time faculty and management personnel have been increasing year by year, with a growth level close to research expenses, but accounting for about three times the total expenditure of research expenses. This provides a superior development environment for top talents.[9]

In today's rapidly changing society, the competition for high-end knowledge is becoming increasingly fierce. As a social organization, although universities have the influence to safeguard their own interests, their dependence on external funding is also constantly increasing, thus possessing the dual characteristics of strong independent development and high resource dependence. Funding is the most basic material condition for building a first-class university, and the adequacy of funding is closely related to the development and construction strategy of the university.[10] For China's first-class universities, the imperfect expenditure structure and rough data still exist, and there are significant differences between different types of schools. To build a world-class university, it is not only necessary to obtain huge financial support, but also to continuously optimize the efficiency of fund utilization. Therefore, based on the expenditure data of first-class universities in China from 2014 to 2022, this study analyzes the characteristics and differences of expenditure, hoping to provide effective suggestions for the scientific and rational allocation of university funds.

3. Methods

3.1 Research object

In 2017, the Chinese government announced the list of world-class universities and first-class discipline construction universities and disciplines. The "Double First-Class Initiative" proposes that a number of universities and disciplines are developed into world-class ones, making China an international higher education power. The list of "Double First-Class Initiative" includes 42 universities and colleges which will be developed into first-class ed-

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ucational institutions. Among them, there are 36 A-level universities. Taking into account their construction backgrounds and major settings, this study selected 34 A-level universities, as shown in Table 1.

At the same time, C9, the first university alliance between top universities in China, represented the highest level of higher education in China, was compared and analyzed with other first-class universities, as shown in Table 1.

At the same time, the C9 League, also known as the China's top university alliance, is a consortium of nine prestigious Chinese universities established in 2009.The members of the C9 League are the highest-ranking universities in China, representing the country's best academic and research institutions. In this article, the C9 League is compared and analyzed with other first-class universities, representing China's best universities. We integrated the departmental budget data of 34 top universities in China from 2014 to 2022, and comprehensively considered the expenditure structure. It was found that each university had a total of 15 expenditure subjects. In addition, Beijing University of Aeronautics and Astronautics, Beijing Institute of Technology, Harbin Institute of Technology, and Northwestern Polytechnical University only disclose departmental final account information for 2020, 2021, and 2022 to the public as of now.

Table1. List of universities

No.	School Name	Type	No.	School Name	Type
1	Peking University	C9	18	Southeast University	/
2	Renmin University of China	/	19	Zhejiang University	C9
3	Tsinghua University	C9	20	University of Science and Technology of China	C9
4	Beijing University of Aeronautics and Astronautics	/	21	Xiamen University	/
5	Beijing Institute of Technology	/	22	Shandong University	/
6	China Agricultural University	/	23	Ocean University of China	/
7	Beijing Normal University	/	24	Wuhan University	/
8	Nankai University	/	25	Huazhong University of Science and Technology	/
9	Tianjin University	/	26	Central South University	/
10	Dalian University of Technology	/	27	Sun Yat-sen University	/
11	Jilin University	/	28	South China University of Technology	/
12	Harbin Institute of Technology	C9	29	Sichuan University	/
13	Fudan University	C9	30	University of Electronic Science and Technology of China	/
14	Tongji University	/	31	Chongqing University	/
15	Shanghai Jiao Tong University	C9	32	Xi'an Jiaotong University	C9
16	East China Normal University	/	33	Northwestern Polytechnical University	/
17	Nanjing University	C9	34	Lanzhou University	/

3.2 Research design

For different types of universities, there are significant differences between their environment, size, and other basic characteristics, so they will present development strategies that are more suitable for their own characteristics in terms of expenditure scale and structure. This study introduces an independent sample t-test model to test whether the difference between the mean of two unrelated samples and their respective populations is significant, so as to more accurately determine the group characteristics between different categories of schools and obtain more reliable conclusions. The best universities in China, represented by the C9 League, and other first-class universities are independent samples, denoted as x_{ai} and x_{bj}. Meanwhile, sample sizes are respectively denoted as n_a and n_b. The difference between the samples is expressed as t. The calculation is demonstrated in equations as follows:

$$\overline{x_a} = \frac{\sum_{i=1}^{n_a} x_{ai}}{n_a}$$

$$\overline{x_b} = \frac{\sum_{j=1}^{n_b} x_{bj}}{n_b}$$

$$S_p^2 = \frac{\sum_{i=1}^{n_a} (x_{ai} - \overline{x_a})^2 + \sum_{j=1}^{n_b} (x_{bj} - \overline{x_b})^2}{n_a + n_b - 2},$$

$$t = \frac{\overline{x_a} - \overline{x_b}}{\sqrt{S_p^2 (\frac{1}{n_a} + \frac{1}{n_b})}}$$

where $i = 1, \ldots, n_a, j = 1, \ldots, n_b$.

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4. Results

4.1 Descriptive analysis

This study conducted descriptive statistics on 282 observations from 34 first-class universities in China from 2014 to 2022, as shown in Table 2.

As shown in the table, there is a significant gap in the total expenditure scale of China's fist-class universities, with an average of 6,294,027.0 thousand yuan, a maximum of 17,324,005.0 thousand yuan, and a minimum of 3,658,897.0 thousand yuan. From the perspective of expenditure function, except for education, science and technology, and housing security, there are some universities that do not have this expenditure for other projects. For categories that have consistently incurred expenditures over the past nine years, the average education expenditure is 5,689,900.7 thousand yuan, with a maximum of 23,267,300.0 thousand yuan and a minimum of 1,291,597.0 thousand yuan; the average expenditure on science and technology is 568,990.7 thousand yuan, with a maximum of 23,267,300.0 thousand yuan and a minimum of 1,291,597.0 thousand yuan; the average expenditure on housing security is 568,990.7 thousand yuan, with a maximum of 23,267,300.0 thousand yuan and a minimum of 1,291,597.0 thousand yuan.

The expenditure structure of China's first-class universities shows a more obvious characteristic that exists one core and multiple elements. For each school, education occupies an absolute dominant position, with an average of 90.99%. But the gap between schools still exists, with a maximum value of 98.08% and a minimum value of 42.60%. The proportion of science and technology and housing security is relatively small compared to education expenditure, but they are still important components. The average proportion of science and technology is 5.01%, with a maximum of 54.43% and a minimum of 0.10%; The average proportion of housing security is 2.90%, with a maximum of 7.23% and a minimum of 0.64%. In addition, expenditure items with an average proportion of over 0.01% include general public services, culture, sports and media, social security and employment, health and hygiene, energy conservation and environmental protection, and resource exploration information.

Table 2. Descriptive statistics

Items of expenditure	Amount (thousand yuan)				Proportion (%)			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
General public service	1535.9	1896.8	0	11019.2	0.0292	0.0315	0	0.1559
Diplomacy	133.5	562.4	0	5547.2	0.0023	0.0094	0	0.0932
Education	5689907.0	3333776.0	1291597.0	23267300.0	90.9913	11.7891	42.6003	98.0763
Science and technology	322001.7	766529.9	5747.4	3990666.0	5.0101	11.9046	0.1029	54.4275
Culture, Sports and media	2349.7	7047.9	0	77625.5	0.0477	0.1525	0	1.4349
Social security and employment	57233.3	144939.4	0	1130013.0	0.7025	1.6713	0	12.2496
Hygiene and health	47138.5	259443.9	0	1773917.0	0.2741	1.4805	0	9.6248
Energy saving and environmental protection	401.8	1308.7	0	10477.5	0.0110	0.0453	0	0.6048
Agriculture, forestry and water conservancy	265.2	1534.4	0	14723.8	0.0068	0.0405	0	0.3852
Transportation	89.8	602.2	0	5621.7	0.0012	0.0076	0	0.0659
Resource exploration information	1493.9	7008.7	0	88583.7	0.0155	0.0538	0	0.3508
Territorial and Marine meteorology	432.3	3116.6	0	35870.5	0.0094	0.0675	0	0.7649
Housing security	170918.5	98104.9	23176.0	549741.7	2.8970	1.3166	0.6374	7.2251
Disaster prevention and emergency management	82.9	1375.0	0	23088.8	0.0014	0.0228	0	0.3832
Others	42.8	245.8	0	2505.9	0.0006	0.0039	0	0.0398
Total	6294027.0	3658897.0	1732405.0	26775140.0	/	/	/	/
N	282				282			

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4.2 T-test analysis

This study divided 34 first-class universities in China into the best universities and other first-class universities. The T-test analysis was conducted on the observed values from 2014 to 2022, and the results of the entire dataset in this thesis are shown in Table 3.

The test suggests that from the perspective of education investment level, the best universities in China have demonstrated significant advantages. In terms of the total expenditure scale, the best universities in China have a much higher expenditure level than other first-class universities, with a confidence level of 99%. At the same time, in terms of general public services, education, science and technology, social security and employment, health, and resource exploration information, the expenditure level of the best universities is significantly higher than other first-class universities, with a confidence level of 99%. In addition, in terms of housing security, the expenditure level of the best universities in China is slightly better, with a confidence level of 95%. However, in terms of transportation, the expenditure level of other first-class universities is relatively high, with a confidence level of 90%.

From the perspective of expenditure structure, the best universities in China and other top universities have their own emphasis on the use of funds. In terms of science and technology, health, and resource exploration information, the best universities in China have a significantly higher proportion of expenditure, with a confidence level of 99%. In terms of education and housing security, other first-class universities have a higher proportion of expenditure, with a confidence level of 99%. In addition, in terms of energy conservation, environmental protection, and transportation, other first universities also have a higher proportion of expenditure than the best universities, with a confidence level of 90%.

Table 3. T-test by groups divided by university category

Items of expenditure	Amount			Proportion		
	$\bar{x}_a$	$\bar{x}_b$	t	$\bar{x}_a$	$\bar{x}_b$	t
General public service	2201.9	1294.6	3.62***	0.0281	0.0296	-0.36
Diplomacy	150.3	127.4	0.30	0.0011	0.0027	-1.19
Education	8495707.0	4673313.0	9.86***	86.4783	92.6265	-3.97***
Science and technology	653349.5	201948.2	4.52***	9.7541	3.2913	4.14***
Culture, sports and media	2501.5	2294.8	0.22	0.0288	0.0545	-1.25
Social security and employment	92948.9	44292.9	2.51***	0.6813	0.7102	-0.13
Hygiene and health	174711.7	916.3	5.20***	0.9967	0.0123	5.15***
Energy saving and environmental protection	331.5	427.2	-0.54	0.0055	0.0130	-1.23
Agriculture, forestry and water conservancy	183.5	294.9	-0.54	0.0015	0.0087	-1.32*
Transportation	5.2	120.4	-1.42*	0.0000	0.0016	-1.50*
Resource exploration information	4228.5	503.1	4.05***	0.0324	0.0094	3.23***
Territorial and Marine meteorology	256.0	496.2	-0.57	0.0056	0.0108	-0.56
Housing security	190792.5	163717.7	2.06**	1.9859	3.2271	-7.68***
Disaster prevention and emergency management	0	112.9	-11.29	0	0.0019	-0.61
Others	65.7	34.5	0.941	0.0007	0.0006	0.21
Total	9617434.0	5089894.0	10.95***	/	/	/
N	75	207	/	75	207	/

Note: ***p<0.01, **p<0.05, *p<0.1

5. Findings

5.1 Expenditure characteristics

This study found a significant gap in the funding expenditures of China's first-class universities, although the overall structure remains relatively stable, presenting a "one superpower and several major powers" pattern. Education constitutes the main part of the funding expenditure, accounting for about 90% of the total expenditure of each school, followed closely by science and technology and housing security expenditure. Despite the existing gaps between universities, education, science and technology, and housing security remain the three principal expenditure areas for the best universities in China, represented by the C9 League, as well as other first-class universities. Specifically, these three expenditures account

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for 98.22% of the total expenditure in China's best universities, while other first-class universities account for 99.14%.

5.2 Differences in expenditure scale

The Chinese government's funding support for the best universities in China significantly exceeds that of other first-class universities, resulting in a considerably higher expenditure level for these top institutions, with an average total expenditure 1.89 times that of other first-class universities. Expenditure items that surpass this ratio include science and technology, social security and employment, health and hygiene, transportation, and others. Notably, the gap in health and hygiene expenditure is the largest, with top universities in China spending 190.66 times more than other top universities. This disparity may be attributed to the relatively comprehensive affiliated medical system structure of the best universities in China. Additionally, other first-class universities exhibit higher expenditures in areas such as energy conservation and environmental protection, agriculture, forestry, water resources, transportation, national land, marine meteorology, disaster prevention, and emergency management, due to their unique professional focuses.

5.3 Differences in expenditure structure

For the best universities in China, areas such as science and technology, health and hygiene, and resource exploration information receive significant attention. Science and technology are the core of university development, and this expenditure is crucial for ensuring research efficiency and stability. Furthermore, top universities undertake responsibilities entrusted by the state and society. Conversely, for other first-class universities, education and housing security are currently the primary focuses of their expenditures. Education forms the foundation of university development, with increased education expenditure directly impacting teaching quality, teacher training, and the learning environment. Housing security expenditure alleviates the concerns of high-quality talents, enabling them to fully commit to university work.

6. Conclusion and discussion

With the deepening of public finance system reforms and the proposal to establish and improve a modern university system, the efficiency of university fund usage has become a prominent topic in higher education. Although theoretically, the most efficient mode of production is low input and high output, low input can introduce negative factors for development.[11] Hence, high input and high output reflect the current status in higher education.[12] This study conducted a comprehensive analysis of various university expenditures, including the resources consumed for normal operations, aiming to identify appropriate resource allocation models for different types of universities to meet their development needs.

Different types of universities should focus on different financial expenditures. While expanding funding, resources should be allocated according to the university's educational positioning, emphasizing support for advantageous disciplines and characteristic projects. This differentiated expenditure strategy can better fulfill the developmental needs of universities, ensuring effective fund utilization and enhancing the quality and level of the entire Chinese higher education system. However, this does not imply that any university should neglect certain expenditures. Each expenditure is essential, and in practical operation, they need to be coordinated and complemented to achieve the overall development goal of building China's "Double First-Class Initiative".

At present, issues such as extensive financial management, deficiencies in institutional mechanisms, and weak management foundations are becoming more pronounced, necessitating urgent solutions and improvements. Objectively, higher requirements are being placed on universities to use higher education funds efficiently. Concurrently, the higher education development strategy is shifting from large-scale expansion to connotative development. To ensure transparency and effectiveness in fund usage, universities need to promote information disclosure and strengthen performance evaluation. Establishing a scientific performance evaluation system to regularly assess fund usage will improve management levels and educational efficiency.

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