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Current State, Shortcomings, and Strategies to Improve China's Waste Recycling Network: Optimization of Regional Site Selection for Waste Disposal Systems Based on Supply Chain Management

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Abstract: Based on the basic supply chain model, the status quo of waste recycling in China is examined by analyzing and comparing the changes in the waste recycling network and the problems of siting in relation to China's waste disposal system.

Keywords: China; Waste recycling; Supply chain management; Siting of waste transfer stations

Online publication: December 7, 2022

1. Introduction

With the deepening of urbanization and the maturation of industrialization, environmental resources are in deficit worldwide. Against this background, environmental protectionism, as opposed to developmentalism, has received unprecedented attention and favor from the public, focusing on issues such as the allocation of scarce resources, the reuse of resources, and the protection of ecological civilization. In China, environmental protection has become an important issue for the nation; the rational allocation of natural resources and the construction of an environmentally friendly society are priorities for the government. Waste recycling is an important way to protect the urban environment, and the establishment of a comprehensive waste recycling and disposal mechanism can effectively and continuously maintain the cleanliness of the land and environment. However, in its concrete practice, the weak awareness of waste separation among citizens, the lack of supporting facilities for waste separation, and the lack of involvement of relevant administrative departments have led to frequent planning problems in waste recycling and processing in recent years. At present, landfilling and incineration are still the most common waste disposal methods in China, with a low rate of recycling. Not only that, but the whole recycling process is riddled with problems. China's waste recycling management experience and technical capacity are lacking; hence, the waste recycling network needs to be completed and improved. [1]

2. Current state

The siting of waste treatment stations in China is a major problem. Due to the scarcity of financial and human resources as well as the limited management techniques, the siting of waste disposal stations in China in the early days lacked systematic regulations, which led to environmental problems, such as land

and air pollution, as well as conflicts of interest among local residents, partner companies, and relevant government departments. At present, the development of environmentally friendly cities is being hampered by the fact that a comprehensive waste recycling network has yet to be established. Therefore, optimizing the siting strategy of waste disposal stations, improving their architectural quality, and building a new communication platform for the benefit of the public can effectively improve the traditional image of waste disposal stations and raise the public's awareness of environmental protection.

3. Shortcomings and implications

The siting of refuse collection points (RCPs) is an important stage in the establishment of a waste treatment system. In this stage, the selection of the site should be scientifically planned, transparent, and open. Two-way communication between government departments and the public should be ensured after the site survey in order to determine the Pareto optimality for residents, enterprises, and the government based on meeting the nominal needs and fundamental interests of residents. However, the current layout of waste disposal stations, which is confusing and arbitrary, and the obvious orientation toward targets have led to several problems, such as uneven spatial layout, confusion in the division of the areas under their jurisdiction, and the degradation of the city's image, all of which affect the quality of life of the residents and the development index of the city (**Figure 1**).

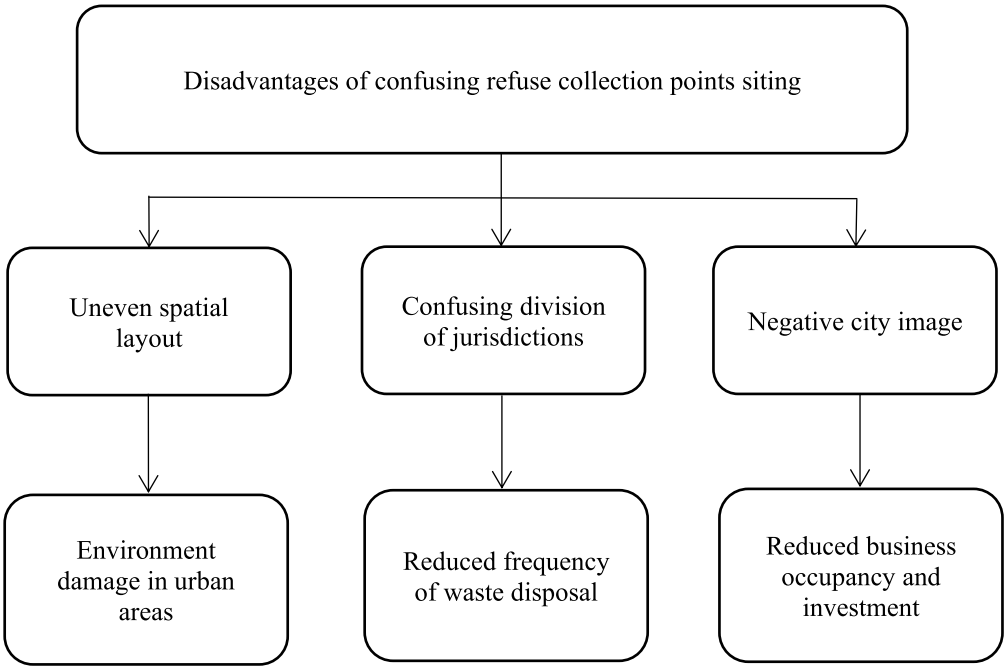

Figure 1. Disadvantages of confusing refuse collection points siting

3.1. Environmental damage and uneven spatial layout

The spatial layout of waste disposal stations is closely related to the quality of the urban living system. A balanced and appropriate layout structure can effectively reduce the cost of waste transfer. However, the current spatial layout of RCPs is uneven, and the public is pleased to see areas without RCPs around them. When RCPs converge in a certain area, all kinds of dangers are superimposed in a multiplicative manner. On the one hand, this chaotic layout perpetuates the odor in the urban environment, and while the quality of life of the residents is not ideal, the operation and maintenance costs for community streets and the implicit cost of living will rise as a result. On the other hand, the call for the continuous existence of RCPs

has made a huge psychological impact on the citizens and compromised the livability of urban life, the happiness index of the citizens, their trust and satisfaction with the local government, and their sense of belonging to the city [2].

3.2. Reduced frequency of waste disposal due to confusing division of jurisdictions

As urban industries continue to develop and the spending power of residents grows, the amount of waste produced per unit time in cities is increasing, thus posing a challenge to China's urban waste disposal system. The confusing division of jurisdictions and the lack of clarity in the departments responsible for waste disposal stations have, to some extent, led to a reduction in the frequency of waste disposal and potentially impacted the quality of life of residents and urban development indicators. The consequence of the reduction in the frequency of waste disposal is not only the impact on the urban landscape, but also the pollution of the environment, water, and soil, which threatens the health of residents, and consequently the phenomenon of rubbish siege, which increases the number of infectious diseases that may spread to people and animals via air, dust, mosquitoes, *etc*., thus leading to disease outbreaks.

Rubbish has become an urban development problem, which not only causes public nuisance, but more importantly, a waste of resources. The occurrence of "rubbish siege" is an indication of the unreasonable division of waste disposal stations, resulting in cumbersome waste collection routes, insufficient relative capacity, which in turn lowers the frequency of waste disposal, and the accumulation of the remaining unprocessed waste. Improving the efficiency of waste disposal in the short term would be difficult due to the high cost of capacity enhancement and the layout of waste disposal stations being a fixed cost. Therefore, as the total volume of waste increases, it is difficult to release its processing capacity, the operating space is continuously squeezed, and pressure is built due to the negative feedback. The waste disposal system constitutes a cycle when the volume of waste does not change, in which the total volume and processing frequency will continue to decrease. If the volume of waste is greater than the dangerous threshold, the whole system is paralyzed, and urban waste disposal will stop, thus falling into a vicious circle [3].

3.3. Reduced business occupancy and investment due to negative city image

City image is the sum of people's perceived impressions of a city's natural and built attributes. The level of community management, the aesthetics of buildings, the quality of life, and the behavior of residents are all important evaluation criteria and influencing factors of the city's image. City image construction is an important part of urban development strategy. It directly affects the layout of the region in terms of attracting and accommodating investments. A good city image is conducive to attracting enterprises and business investments as well as facilitating the improvement of local infrastructure and the rapid growth of the city's industrial chain. Conversely, a poor city image will inevitably lead to a reduction in the number of external companies and investments. In urban construction practice, the confusing siting and layout of waste disposal stations has led to increased difficulties in community management and reduced aesthetic comfort of buildings, affecting the quality of daily life and behavior of residents, which in turn has resulted in the collapse of the city's image and the diversion of external and internal investments from the city. At the same time, its impact on a city's basic services, consumer industries, and even education at a macro level reduces opportunities for urban development, leading to uneven urban development and exacerbating the siphoning effect of "big city disease."

As mentioned above, the chaotic siting of waste disposal stations threatens the quality of life of residents and directly leads to the destruction of ecological indices. In terms of economic decision-making, it manifests itself in negative value judgements made by companies, leading to a double loss involving corporate capital investment and preferential policies for private investment. As a city's development potential decreases, the administration will struggle to maintain the old urban planning strategy and talent

introduction plan, and the development of the city will fall into a circular dilemma. Therefore, in order to effectively play the role of investment in supporting people's livelihood, it is necessary to focus on city image construction to solve the confusion in the siting of waste disposal stations from the root, enhance the city's social evaluation, and improve the external impression of the city [4].

4. Optimization paths

4.1. Redistribution of waste transfer stations

The government and outsourcing companies need to redefine the horizontal distribution between transfer stations and residential buildings to ensure spatial separation between them. At the same time, the size of the transfer stations, the degree of containment, and the level of facilities should be strictly controlled in order to reduce the spatial footprint and the degree of influence. In terms of personnel, relevant departments should cultivate professionalism among their staff, improve the system of relevant laws and regulations, as well as increase supervision and inspection efforts. On the non-personal side, in order to improve the level of harmless waste treatment and to guarantee the safety of personnel, safety prevention and control standards should be upgraded, with a sound emergency mechanism established. It would be crucial to procure technologically advanced facilities, improve the enclosed nature of transfer vehicles, and strictly implement the full closed treatment of waste by setting up a green barrier and regularly checking and verifying it.

In practice, raising the project threshold for transfer station projects is an effective means of ensuring a reasonable layout for transfer stations. On-site inspections and technical analyses allow for the optimal size of the transfer station, the area of influence, and the number of personnel to be determined; the prevention of "non-negotiable" effects; and the inquiry of professional advice from third-party organizations as required. Based on this, the administration is able to make an effective and reasonable long-term systematic urban plan that offers spatial flexibility for complex future urban development.

4.2. Optimizing the administrative agenda for siting decisions

The administrative agenda for site selection decisions should be optimized, and the introduction of public participation should be considered in order to truly realize public involvement and safeguard the public's right to make decisions. The Environmental Impact Assessment (EIA) system is a credible guarantee for administrative decision-making. For engineering construction and development activities that may affect the environment, investigations, predictions, and evaluations are carried out in advance, followed by reports on environmental impacts and prevention as well as control options. A good, transparent, and credible EIA system would increase public support for site selection decisions and facilitate public participation and multilateral consultation. In practice, the government should strictly select third-party EIA organizations to ensure their independence, professionalism, authority, and public acceptance.

At the same time, information disclosure is a guarantee of efficiency in administrative decision-making and can significantly enhance the effectiveness of the EIA system. The government should set up a special column to publicize all information on the draft site of the refuse transfer station, the authority and responsibility for it, and the agenda; subsequently, a comparative analysis of the alternatives should be conducted so that residents may be able to understand the reasons for the re-location. This will alleviate conflicts and pressures as well as ensure the practical usefulness of the re-location.

Similarly, the regulatory mechanism is an administrative guarantee of the EIA system and information disclosure. An upward feedback mechanism should be opened up to encourage the public and businesses to take up the responsibility of monitoring. At the same time, each management should organize regular downward monitoring and parallel self-inspection internally. Complete monitoring and evaluation indicators specified by the government, along with a scientific, legal, and compliant monitoring mechanism

can provide legitimacy for this.

Compensation mechanisms are the last line of defense. Waste transfer stations themselves have negative externalities and can cause psychological, physical, and economic damage to residents. Once the damage has been confirmed, the relevant authorities will have to clarify the scope of compensation, identify the person liable for compensation, and assume responsibility for environmental damage [5].

4.3. Actively changing traditional attitudes

At present, the public generally believes that transfer stations will bring serious harm to the environment and health of the surrounding residents, thus escalating the public's rejection of transfer stations. Only by changing the public's one-sided view of waste transfer stations and helping them gain a comprehensive and objective understanding of transfer stations and other treatment facilities can the construction of waste transfer stations be carried out smoothly. It is therefore important that the government and society as a whole undertake cultural, educational, and practical activities to imperceptibly change the public's perception. First and foremost, the prejudice toward waste transfer stations should be changed, and people should be made aware of the facilities in a positive way. It is also important to promote waste segregation and encourage the public to participate in waste segregation initiatives to raise awareness of environmental protection among the public. Last but not least, education for the next generation should be directed toward the concept of environmental protection and a proper understanding and awareness of waste transfer stations [6].

5. Conclusion

As an important part of urban and rural waste disposal, waste transfer stations play an important role in transferring urban and rural waste and improving the urban environment. The location of waste transfer stations, in terms of distance, spatial layout, and the city image they represent, has many shortcomings and has been an issue of concern and reflection for the public. This paper explains how the shortcomings of waste transfer stations can be addressed through careful advance planning, a more rigorous site selection process, and a change in public stereotypes, thus further rationalizing and enhancing waste transfer stations and bringing about significant environmental benefits.

Disclosure statement

The author declares no conflict of interest.

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Main Contents and Problems of the U.S. "Chip Act" and China's Response in the Context of WTO

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Abstract: With the rise of unilateral protectionism and the blockage of World Trade Organization (WTO) multilateral trading system reform, the United States (U.S.) provides huge financial support to its semiconductor industry through the "Chip Act." Besides, the U.S. attempts to improve the competitiveness of its semiconductor industry and dominate the international semiconductor market by setting up a series of "guardrails provisions" to curb the development of "foreign countries of concern," such as China. Through documentary analysis, the main contents of the "Chip Act" are clarified, and its justiciability and compliance are analyzed from the perspective of WTO rules. In terms of actionability, the "Chip Act" meets the general conditions of subsidies and possesses the traits of specificity but at the same time causes damage to other countries' industries, thus constituting an actionable subsidy. In terms of compliance, the discriminatory provisions of the "Chip Act" violate the principle of non-discrimination. Accordingly, China should actively respond under the WTO framework by promoting the resolution of the Appellate Body crisis and the reform of the dispute settlement mechanism as well as participating in subsidy reform negotiations and contributing Chinese solutions; China should also take the initiative to apply countervailing rules to the "Chip Act" while improving its own trade remedy system.

Keywords: WTO; Chip Act; Principle of non-discrimination; China

Online publication: December 7, 2022

1. Introduction

Against the backdrop of the World Trade Organization (WTO) Appellate Body shutdown and the urgent need for a reform of the dispute settlement mechanism, President Biden, on August 9, 2022, signed into force the CHIPS and Science Act of 2022 ("Chip Act"), which seeks to bypass the WTO multilateral oversight mechanism and boost the United States (U.S.) semiconductor industry through a number of discriminatory measures. In order to curb China's rapid rise in the semiconductor field, the Act has made numerous prohibitive or restrictive provisions specifically for China, which has and will affect Chinese companies to varying degrees in terms of purchasing key technology equipment, participating in U.S. manufacturing programs, obtaining U.S. funding, and bringing in international talents. Therefore, the study of the U.S. "Chip Act" from the perspective of WTO, which points out its justiciability and compliance issues under the WTO system and provides suggestions for China's response to the Act, on the one hand, can promote the Chinese government and enterprises to actively carry out risk analysis and formulate response strategies as well as actively defend their legitimate rights and interests by using legal weapons in the multilateral trade framework; on the other hand, it can promote the WTO to reform the dispute settlement mechanism and counter the adverse effects of economic reverse globalization caused by the "Chip Act," so that the multilateral trading system can be developed in a sustainable manner.

By analyzing the U.S. "Chip Act" through literature analysis and referring to relevant works and articles written by scholars, the main contents of the "Chip Act" and its effects can be clarified. Based on the legal analysis of the "Chip Act," it has been found that the Act meets the constitutive elements of actionable subsidies and violates the non-discrimination principle of WTO. Ultimately, the measures to be taken by China are proposed.

2. Main contents of the United States "Chip Act"

The "Chip Act," in terms of its overall structure, can be divided into three major parts. The first part is the "Chip Act of 2022," which mainly provides financial grants for innovative activities in semiconductor manufacturing and open wireless access networks as well as tax credits for advanced semiconductor manufacturing but prohibits recipients of financial support from expanding chip manufacturing in "foreign countries of concern," such as China. The second part is the "Research and Development, Competition, and Innovation Act," which is a complex bill that allocates $169.9 billion for research and development (R&D) in specific areas and establishes corresponding mechanisms. The third part is the "Supplemental Appropriations to Address Threats to the U.S. Supreme Court Act," which allocates funds to the U.S. Department of Justice and the Supreme Court [1]. Of great concern to China is the inclusion of several discriminatory provisions against "foreign countries of concern" (hereinafter referred to as "guardrails provisions").

The "guardrail provisions" are found in the first two major sections of the "Chip Act." The "guardrail provisions" include the following: (1) companies that receive financial grants and investment tax credits shall be prohibited from expanding advanced semiconductor capacity in "foreign countries of concern"; (2) there shall be strict scrutiny of entities in "foreign countries of concern" like China before being allowed to join the U.S. manufacturing program, and unless exempted, Chinese companies are not allowed to join the "Made in America" program; (3) except as specifically provided or exempted, any funds appropriated to the National Science Foundation (NSF) shall not be appointed to institutions of higher education that enter into contracts or cooperative agreements with the Confucius Institute; (4) institutions of higher education receiving NSF financial support shall immediately disclose the information if they receive financial support of more than $50,000, directly or indirectly, from a "foreign country of concern"; (5) federal research agency personnel are prohibited from participating in foreign talent acquisition programs, and individuals receiving federal research agency R&D grants are prohibited from participating in programs sponsored by "foreign countries of concern" or "foreign institutions of concern" and entities established in those countries [2].

3. Problems of the United States "Chip Act" from the World Trade Organization perspective

Comparing to the purpose stated in the introduction and the content of the text, it can be seen that the U.S. "Chip Act" completely deviates from the purpose of trade and investment liberalization as pursued by the international community; rather, it is a "draconian law," full of trade and investment protectionist colors. Focusing on the WTO framework, the content of the bill fulfills the Subsidies and Countervailing Measures (SCM) Agreement on the requirements of actionable subsidies and seriously violates the WTO non-discrimination principle, namely the most-favored-nation treatment and national treatment principle.

3.1. Justiciability: The "Chip Act" constitutes an actionable subsidy

Under the WTO framework, according to the provisions of Articles 1, 2, and 5 of the SCM Agreement, for a measure to constitute an actionable subsidy, the following three conditions must be met: (1) the measure constitutes a "subsidy" under the SCM Agreement; (2) the key idea of the subsidy is specificity; and (3) the targeted subsidy causes adverse effects to the industrial interests of another country [3]. Among them,

there are three sub-conditions that need to be satisfied in order to constitute a "subsidy," namely the subjective element, the formal element, and the effect element.

Through the analysis of the aforementioned constituent elements, the U.S. "Chip Act" constitutes an actionable subsidy. First, the funds provided by the U.S. through the "Chip Act" are directly granted by the U.S. federal government to relevant enterprises through financial subsidies and tax credits, so that the U.S. semiconductor enterprises obtain additional benefits that cannot be obtained in the market. Therefore, the measure provided by the U.S. government meets the conditions of the subject, form, and effect, which constitute subsidies under the SCM Agreement. Second, the financial support of the U.S. "Chip Act" is explicitly limited to the U.S. semiconductor industry, and there are no objective criteria or conditions for obtaining subsidies, which are industry-specific subsidies with legal exclusivity. Lastly, the measure "injures" the development of another member country's semiconductor industry and adversely affects other countries' semiconductor industry, thus constituting an actionable subsidy, whereby the injured country may resort to the multilateral dispute settlement mechanism or assume unilateral countermeasures, including countervailing duties and countermeasures.

3.2. Compliance: The "Chip Act" violates the World Trade Organization non-discrimination principle

In addition to constituting an actionable subsidy under the SCM Agreement, the U.S. "Chip Act" also violates the most fundamental legal principle of the WTO – the non-discriminatory treatment principle.

The most-favored-nation treatment principle and the national treatment principle together constitute the WTO non-discriminatory treatment principle, which is regarded as the cornerstone of the WTO multilateral trading system [4]. The most-favored-nation treatment principle requires that the treatment given by WTO members to one member should be unconditionally given to other members, while the national treatment principle requires that the treatment given by WTO members to enterprises and products of other members should not be lower than the treatment given by them to domestic enterprises and products.

In contrast, the U.S. "Chip Act" raises discriminatory and obvious restrictive provisions, such as prohibiting enterprises from receiving subsidies that would increase the production capacity of advanced process chips in China and other "foreign countries of concern" for a period of 10 years and enforcing companies that violate the ban or fail to rectify the situation to return the full amount of subsidies and bear significant legal liability. The above provision reflects a serious discrimination against "foreign countries of concern," such as China, which is a clear violation of the most-favored-nation treatment and national treatment principle.

The purpose of trade and investment liberalization is the cornerstone of the international economic and trade rules system since World War II and is the fundamental guarantee of global economic prosperity and development. In recent years, the U.S. has introduced various bills that run completely counter to trade and investment liberalization for its own geopolitical interests, and the introduction of the "Chip Act" is a blatant and undisguised violation of WTO rules, disregarding the international law obligations that the U.S. itself should assume. This despicable act should be jointly condemned by the international community. China, as a member of the WTO, should take various active measures, granted by the WTO, to oppose this illegal behavior of the U.S. and resolutely defend the purpose of trade and investment liberalization as well as the legal dignity of WTO rules.

4. China's proposals to deal with the threat of the United States "Chip Act" under the World Trade Organization framework

Against the background of the suspension of the WTO Appellate Body and the urgent need for the reform of the dispute settlement mechanism, the U.S. has taken the opportunity to evade the supervision and

constraints of the multilateral trading system and adopted unilateral trade protectionist measures in an attempt to maintain its dominant economic and trade position. The U.S. enacted and implemented the "Chip Act" to distort the international semiconductor market in an attempt to curb the development of China's and other countries' semiconductor industry as well as regain its dominant position in the semiconductor field. In order to safeguard the multilateral trading system and national interests, China must act swiftly in response to this and take active measures to confront the hegemonic practices of the U.S.

4.1. Resolving the crisis of the Appellate Body and promoting the reform of the dispute settlement mechanism

In December 2019, the dispute settlement mechanism came to a halt because there were no new judges on the Appellate Body to fill the vacant positions, bringing the operation of the WTO to a near standstill. Against this backdrop, if the U.S. "Chip Act" is to be internationally monitored and regulated, it is imperative to resolve the Appellate Body's suspension crisis, restore the function of the dispute settlement mechanism, and promote the reform and development of the mechanism.

In the short term, China should thoroughly examine Article 25 arbitration and other relevant rules of the Dispute Settlement Understanding (DSU), draw on or replicate the well-functioning system and experience of the ordinary litigation procedures of WTO, as well as support and improve the operation and practice of the WTO appellate arbitration mechanism. Specifically, these include the following three points: (1) China may attempt to enter into bilateral arbitration agreements with interested WTO members, thus agreeing to submit trade disputes to arbitration; (2) China should discuss with disputing parties the possibility of reaching agreements to initiate appellate arbitration on a case-by-case basis for cases involving China that are currently being heard by WTO panels; (3) China should take the initiative to play a constructive role, advocate and join WTO members with a common will to reach a consensus, lead the negotiation of the plurilateral Arbitration Agreement to gain more initiative, and speak up in the construction of systematic rules for the settlement of trade disputes by arbitration.

In the long run, the Appellate Body's suspension should be addressed, and the DSU should be revised and improved to solve the mechanical problem fundamentally. Under the existing system, "member-driven" is an important feature of the WTO, which requires that rules under the WTO framework should be negotiated and agreed upon by member governments prior to adoption [5]. As one of the mechanisms under the WTO framework, the appointment mechanism of Appellate Body members adheres to the principle of consensus adoption, *i.e.*, if one member opposes the appointment of another member of the Appellate Body, the appointment process will be stopped naturally. The existence of this principle has become the fatal flaw of the appointment mechanism, which is the direct cause of the present stalemate. Accordingly, China should propose to add relevant provisions to the DSU, especially to make clear provisions for member states to deny the appointment of justices and prevent the event of member states obstructing the normal operation of the dispute settlement mechanism without any reason. If a member state opposes the appointment or reappointment of an Appellate Body member, there should be reasonable grounds with sufficient evidence. For example, violation of DSU or other relevant rules by the incumbent, unfairness during the hearing of the case, violation of confidentiality obligations, *etc*.

4.2. Participating in subsidy reform negotiations and actively contributing Chinese solutions

The WTO subsidy rules are mainly led and formulated by the U.S. and other developed countries in the west. The subjects who formulate these rules will certainly design them based on their own interests, which will lead to the biasness and skewness of the existing WTO subsidy rules system and is unfavorable for developing countries such as China to participate in multilateral trading [6]. If China intends to take the U.S. "Chip Act" to the WTO dispute settlement mechanism, the reform of the existing subsidy rules will provide

a more solid basis for China to win this dispute. Therefore, in future WTO subsidy rules reform process, China must take a more active stance to effectively promote and even lead the WTO subsidy rules negotiations from the starting point of safeguarding its own trade interests and promoting fair trade.

China's reform proposals on subsidy rules should combine active defense and a proactive approach. In recent years, the U.S., Japan, Europe, and other developed countries have argued that the SCM Agreement is not binding enough on subsidies, and thus advocated the restructuring of WTO subsidy rules, politicizing the issue of subsidies and linking it to non-market economy models or even political systems, with strong ideological focus. These advocates fundamentally deviate from the core value of WTO non-discrimination, making WTO a tool for developed countries to seek private interests. In this regard, China, should take an active defensive approach and resolutely oppose the introduction of country-specific discrimination rules as proposed by the U.S., Japan, and Europe in the negotiations, including ownership discrimination against state-owned enterprises and the abuse of external benchmarks for subsidies. On the other hand, China should take the initiative and make reciprocal and reasonable claims against developed countries on subsidies. Firstly, China should improve its transparency rules and urge developed countries to strictly fulfill their subsidy notification obligations. Secondly, China should improve the rules on trade remedies, clarify the rules and procedures of countervailing investigations, prevent the abuse of trade remedies, and promote the standardization of countervailing investigations. Thirdly, the special situation of developing members should be considered in the application of subsidy rules, so as to achieve relative equality in the application of rules among different members.

To sum up, under the rise of trade protectionism and the critical period of WTO subsidy rules reform, China should play a more constructive role to safeguard the multilateral trading system and the interests of developing countries in the negotiation of subsidy rules; promote the development of subsidy rules toward effectiveness, fairness, and transparency; curb the spread of the wave of anti-economic integration; and promote the development of the WTO multilateral trading system.

4.3. Proactive application of countervailing rules to improve China's trade remedy system

The WTO dispute settlement mechanism is a statutory safeguard of the WTO and an effective way to resolve trade disputes. However, as a member of the WTO, China has only completed its transition from passive response to active prosecution since its accession to the WTO in 2001 to the "copperplate case" in 2007, which is in sharp contrast to other WTO members, especially the U.S. and other western countries [7]. It is worth noting that although China's initiative to prosecute the case is relatively small, there have been successful cases, among which the most typical one is the case of "United States – Definitive Anti-Dumping and Countervailing Duties on Certain Products from China (DS379)." Therefore, when the U.S. introduced the "Chip Act" in an attempt to dominate the semiconductor market, China should change its passivity, take the initiative to apply countervailing rules at the international level, and improve its trade remedy legal system in order to cope with the current complex and treacherous international economic and trade environment.

From the perspective of international countervailing practice, it was only in 2009 that China applied countervailing measures for the first time despite having formulated the Foreign Trade Law as early as 1994 to include provisions for subsidies and countervailing measures [8]. In most cases that have occurred, China has been passively involved in countervailing investigations, and the enterprises involved have mostly been imposed high countervailing duties or even passively accepted countervailing sanctions due to their lack of knowledge about countervailing. On the contrary, the U.S. and other developed western countries are the ones who initiated most of the countervailing investigations, but they themselves have been subject to few countervailing investigations. Based on the above phenomenon, China should learn from the experience of western countries, take initiative in the international arena, actively apply

countervailing rules, initiate countervailing investigations against other countries' subsidies that are suspected of violating WTO subsidy rules and damaging Chinese industries, as well as take unilateral countermeasures or resort to multilateral dispute settlement mechanisms when necessary.

On the other hand, the U.S. and other developed countries are able to launch frequent trade remedy investigations on China because they have a comprehensive domestic trade law and legal system, which can provide sound legal support for the protection of local enterprises. On the contrary, China's trade remedy legal system is relatively weak, and its efforts to initiate trade remedies as a complainant country are limited. With regard to this, China should make more efforts not only to explore the use of existing international rules on trade remedies, but also to improve its trade remedy laws and regulations as well as respond to trade frictions by strengthening the rule of law to safeguard its own interests and industrial security.

5. Conclusion

The introduction and implementation of the U.S. "Chip Act" is a derivative and concrete manifestation of the prevailing unilateral protectionism in the international community and the traumatic impact on the WTO multilateral trading system. The U.S. "Chip Act" consists of three main parts. Among them, the bill for China and other "foreign countries of concern" has set several restrictive provisions in an attempt to curb the development of China's and other countries' semiconductor industry. Under the existing WTO rules, the U.S. "Chip Act" has a series of problems, including the constitution of an actionable subsidy and the violation of the most-favored-nation treatment and national treatment principle. In order to safeguard the multilateral trade order and national interests, China should actively exercise the rights granted by the WTO, including specific measures to help resolve the crisis of the Appellate Body, promote the reform of the dispute settlement mechanism, participate in subsidy reform negotiations, actively contribute Chinese solutions, and take the initiative to apply countervailing rules and improve China's own trade remedy system.

Against the background of the rise of unilateral protectionism and the weak multilateral trading system, the fiscal measures of the U.S. "Chip Act" are only one of the manifestations of the current anti-globalization and anti-economic integration. Therefore, it is of great significance to deter unilateral protectionist forces, resist the wave of anti-economic integration, and maintain the operation of the multilateral trading system by promoting the improvement and development of the WTO and other multilateral trading systems as well as using the rights and means granted by it to timely qualify and curb the above fiscal measures.

Disclosure statement

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Application of Hidden Markov Models in Stock Forecasting

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Abstract: In this paper, we tested our methodology on the stocks of four representative companies: Apple, Comcast Corporation (CMCST), Google, and Qualcomm. We compared their performance to several stocks using the hidden Markov model (HMM) and forecasts using mean absolute percentage error (MAPE). For simplicity, we considered four main features in these stocks: open, close, high, and low prices. When using the HMM for forecasting, the HMM has the best prediction for the daily low stock price and daily high stock price of Apple and CMCST, respectively. By calculating the MAPE for the four data sets of Google, the close price has the largest prediction error, while the open price has the smallest prediction error. The HMM has the largest prediction error and the smallest prediction error for Qualcomm's daily low stock price and daily high stock price, respectively.

Keywords: Hidden Markov model; Mean absolute error, Stock market

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1. Introduction

The stock market is unpredictable, but its trend can be predicted. Although the stock market cannot be predicted with 100% accuracy [1], it can be operated probabilistically. For example, by combining historical data with other information, it is possible to determine the current position of the stock market and the probability of the next stock market rise or fall. The magnitude of this probability will affect the next operation strategy development. This is the importance of forecasting. Since the stock market is running on a cyclical pattern, this cyclical law is the only law that we humans can grasp from the stock market [2]. Therefore, although the stock market is said to be unpredictable, it is in fact predictable. Prediction is a prerequisite for operation. Therefore, improving the accuracy of prediction is an important basis for stockholders to make money with a high probability. Economists have established various non-linear equation models to study various movements in the economic and financial markets, such as stock market indices, exchange rate changes, *etc*. [3].

Stock market forecasting has been one of the more active research areas in the past due to the interest of many large companies [4]. Historically, various machine learning algorithms have also been applied to this area with varying degrees of success. There are many ways to use deep learning and deep machine learning to predict the stock market. For example, moving average, linear regression, K-nearest neighbors, automatic auto-regressive integrated moving average (ARIMA), Prophet, and long short-term memory network (LSTM). However, stock price forecasting is still limited by many factors due to its volatile, seasonal, and unpredictable nature. Forecasting based on previous stock price data alone is an even more challenging task as some marginal factors are not considered. Stock prices are affected by company news

and other factors, such as demonetization or mergers/spinoffs of companies [5]. There are also intangible factors that often cannot be predicted in advance.

In this study, we used four different stocks to evaluate this approach: Apple, Google, Qualcomm, and Comcast Corporation (CMCST). In our analysis, a single variable was controlled, and the data for each stock were observed and recorded separately for their corresponding change curve. This paper is arranged as follows: in section 2, we review the specific elaboration of the hidden Markov model (HMM) technique from multiple dimensions; section III provides the mathematical proof of our approach to the HMM; in section IV, we describe the dataset and provide the experimental results; section V discusses the results and concludes the paper.

2. Literature review

Stock price prediction has become one of the hottest research fields in recent years as people have become increasingly enthusiastic about trading stocks based on the high returns they can bring. In this paper, HMM was used to predict the daily stock prices of four companies. HMM is the simplest structured dynamic Bayesian network that is capable of modeling hidden state transitions based on ordered observations [6]. HMM has been successfully applied in various fields, including speech recognition [7], computational biology [8], and signature verification [9]. Stock forecasts follow the same pattern, with stock prices depending on factors (implied variables) that are usually imperceptible to investors. Stock price changes are complex and volatile, and they are inextricably linked to corporate policies and decisions, financial conditions, and management decisions, all of which affect stock prices beyond the control of investors. Therefore, HMMs are naturally suitable for price prediction problems [10].

HMM is now used in stock prediction analysis. In a study, Hassan and Nath [10] used HMM to forecast the share prices of four airlines, providing a new method for stock forecasting. The basic principle is to use HMM to screen the appropriate behavioral variables from previous data, and then combine the interpolation data near values, and use the mean absolute percentage error (MAPE) to predict the stock. Zhang *et al.* [11] have proposed the use of dynamic high-order HMM to forecast stock prices of CSI 300 index and S&P 500 index. High-order HMM transforms high-dimensional state vectors into single state vectors, allowing the simultaneous consideration of the stock market's short-term and long-term time dependency. The relationship between the hidden state and the predicted value can be obtained following the statistical analysis of historical daily returns. This suggests that dynamic high-order HMM has higher accuracy in predicting stock prices. In addition, Hassan [12] combined HMM with a fuzzy model to predict stock prices and found that the prediction accuracy could be improved. The key feature of this study is the division of the data space after the use of HMM for data training, the generation of a fuzzy model using the data space, and the use of the fuzzy model to predict the stock price. MAPE is then used to determine the prediction effect of the model. In a study conducted by Gupta and Dhingra [13], MAPE was also used in the prediction of stocks using HMM; they took into account the fractional change of stock prices to train HMM, so as to improve the accuracy of predicting future stock prices as much as possible.

According to previous analysis of stock price prediction using HMM, HMM was also used in this study to train and model the open price, close price, daily high price, and daily low price of four companies, and these four hidden states were continuously observed. Following the stock price prediction, we calculated the MAPE to compare and analyze the accuracy of HMM in predicting the stock prices.

3. Methods

HMM was used to forecast the stock price of four companies. The formula of HMM is as follows:

$$\lambda = (\pi, A, B) \tag{1}$$

In this formula,
(1) π refers to the initial probability, such as the probability when $t = 1$;
(2) A refers to the transition matrix, which represents the probability of state transition of an element;
(3) B refers to the emission matrix; use $b_j(\overrightarrow{O_t})$ to represent the probability of O, given state j.

Since all the observed variables in this experiment are random continuous variables, the emission distribution probability is assumed to be continuous, and the Gaussian mixture model (GMM) with parameter μ is used.

$$b_j(\overrightarrow{O_t}) = \sum_{m=1}^{M} p(m)p\left(\overrightarrow{O_t}\middle|m\right) = \sum_{m=1}^{M} c_{jm}N\left(\overrightarrow{O_t}, \overrightarrow{\mu_{jm}}, \Sigma_{jm}\right) \tag{2}$$

where,
(1) c_{jm} is the weight of the m_{th} mixture component (Gaussian model) under state j;
(2) M is the number of components of the Gaussian mixture;
(3) $\overrightarrow{\mu_{jm}}$ is the mean vector for the m_{th} component in the j state;
(4) $p\left(\overrightarrow{O_t}\middle|m\right) = N\left(\overrightarrow{O_t}, \overrightarrow{\mu_{jm}}, \Sigma_{jm}\right)$ refers to the probability density function of the m_{th} Gaussian model.

In our experimental observations, four continuous random variables are used: the stock's opening price (open), closing price (close), daily high price (high), and daily low price (low). These data are stored in the form of four-dimensional vectors:

$$\begin{aligned} \overrightarrow{O_t} &= \left(\frac{close - open}{open}, \frac{high - open}{open}, \frac{open - low}{open}\right) \\ &= (fracChange, fracHigh, fracLow) \end{aligned} \tag{3}$$

4. Analysis and results

(1) Datasets

The algorithm was tested on four different companies: Apple, CMCST, Google, and Qualcomm. For simplicity, we considered four main features in these stocks: open, close, high, and low prices. In the experiment, we collected information of the four groups of stocks of 2520 groups, and each group of information contains the information of four variables (open price, high price, low price, and close price). HMM was used to predict the next day's open price, close price, daily high price, and daily low price.

(2) Implementation

(a) HMM parameters
- (i) n_components: N = 4
- (ii) covariance_type: full covariance matrix
- (iii) tol = 0.0001: stop threshold
- (iv) n_iter = NUM_ITERS: maximum number of iterations
- (v) init_params: determine which parameters are initialized before iteration

(b) Result

In order to evaluate the prediction effect of HMM, the MAPE is calculated as the evaluation standard. Each MAPE in our experiment refers to the average absolute error between the actual data and the predicted data in percentage, such as actual open price and predicted open price.

According to the MAPE results calculated for Apple, it can be seen that the prediction error of its open price is the largest, followed by the prediction error of its close price, daily high stock price, and daily low stock price. Since the difference between the close price and the daily high stock price is 0.0001547, the prediction error is approximately the same, suggesting that the difference in the prediction effect is very small. According to the four panels in **Figure 1**, the fitting effect of the daily low stock price is relatively the best. Therefore, when using HMM for Apple's stock price prediction, HMM has the best prediction effect on the daily low stock price.

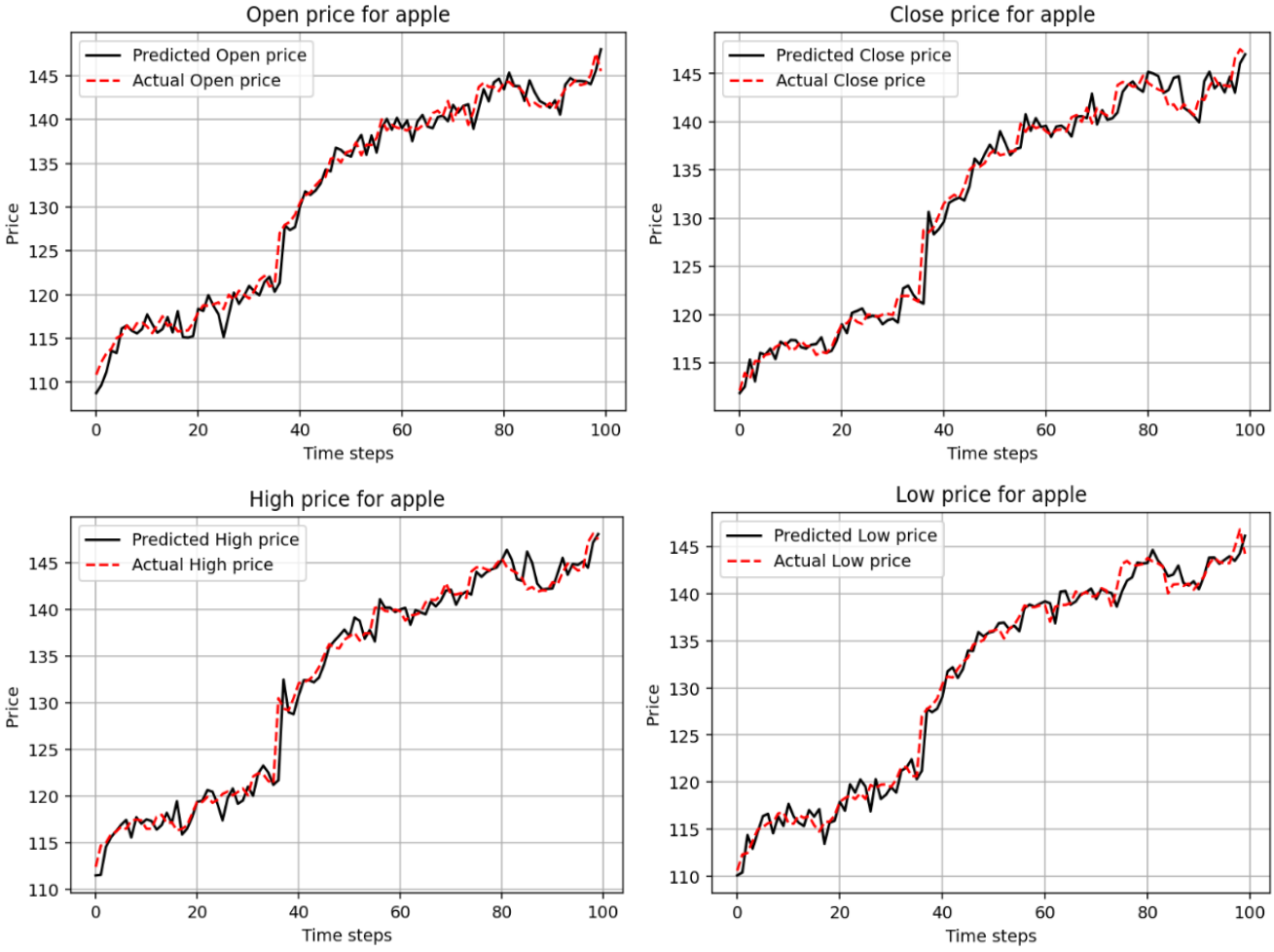

Figure 1. Actual and predicted values of the close, open, high, and low prices of Apple

Table 1 shows that the prediction error of the open price of CMCST is the largest, while the prediction error of the daily high stock price of CMCST is the smallest. The difference between the close price and the daily low stock price is 0.00000622, which is approximately equal to zero, suggesting that the prediction effect of HMM is approximately the same for these two data sets. The four panels in **Figure 2** show that the deviation of the daily high stock price is the smallest, suggesting that the fitting effect is relatively the best. Therefore, when using HMM for CMCST's stock price prediction, HMM has the best prediction effect on the daily high stock price.

Table 1. Mean absolute percentage error of stock

Stock name	MAPE for close price	MAPE for open price	MAPE for high price	MAPE for low price
Apple	0.00782133	0.00847303	0.00766663	0.0073681
CMCST	0.00807595	0.01008364	0.00657925	0.00806973
Google	0.00879857	0.01101522	0.01006594	0.00881552
Qualcomm	0.01475157	0.01488613	0.01332355	0.01612613

Abbreviation: MAPE, mean absolute percentage error.

According to the above data, the overall error of using HMM to predict stock prices is small. This shows that this model can be used in this kind of scenario.

$$MAPE = \frac{1}{n}\sum_{i=1}^{n}\frac{|p_i - a_i|}{|a_i|} \times 100\% \quad (4)$$

where a_i is the actual stock value, p_i is the predicted stock value of i, and n is the number of days of test data.

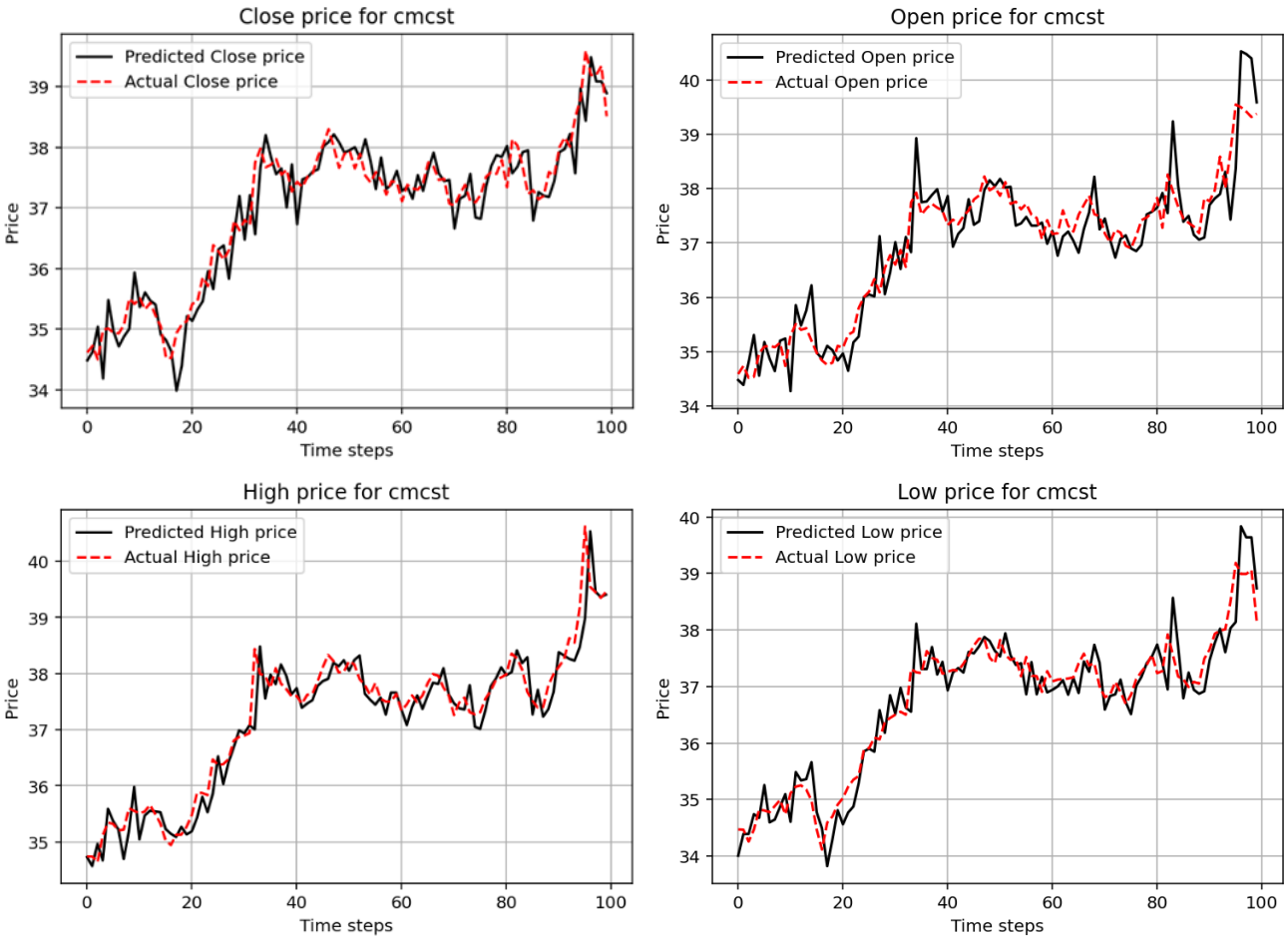

Figure 2. Actual and predicted values of the close, open, high, and low prices of CMCST

By calculating the MAPE for the four data sets of Google, the prediction error is the largest for the open price but the smallest for the close price. However, the difference between the close price and the daily low stock price is 0.00001695, while the difference between the open price and the daily high stock price is 0.00094928, both of which are approximately 0. HMM predicts that the open price and the daily high stock price are about the same, similar to the close price and the daily low stock price. According to the four panels in **Figure 3**, the fitting effect of the close price and the daily low stock price is the best, suggesting that the prediction effect is the best.

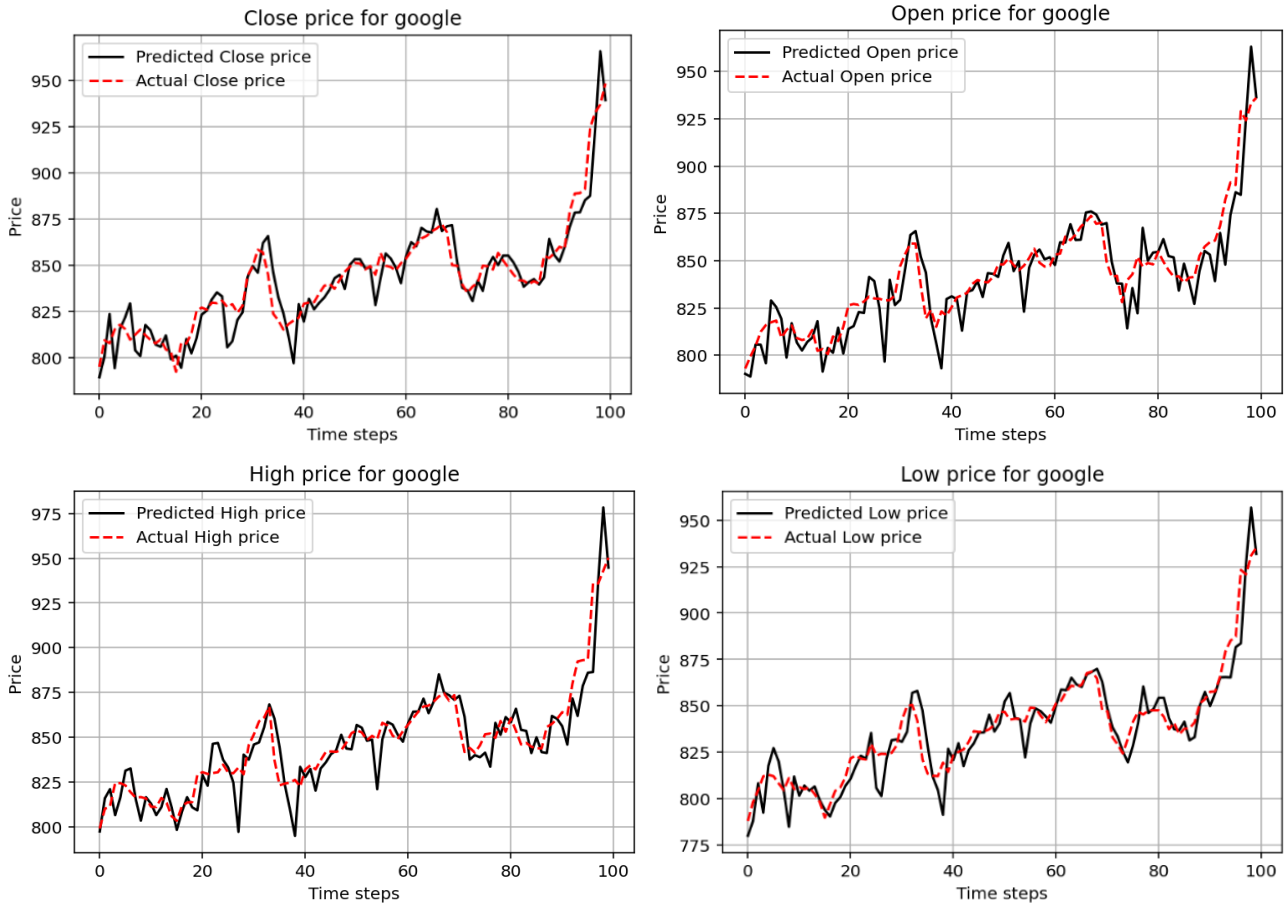

Figure 3. Actual and predicted values of the close, open, high, and low prices of Google

According to the data in **Table 1**, with regard to Qualcomm, it can be seen that HMM has the largest prediction error for its daily low stock price, and the smallest prediction error for its daily high stock price. The difference between the close price and open price is only 0.00013456. Therefore, HMM predicts approximately the same for these two sets of data. According to four panels in **Figure 4**, the fitting effect of the daily low stock price is the worst, while the fitting effect of the daily high price is the best. This suggests that HMM has the best prediction effect for the daily high stock price and the worst prediction effect for the daily low stock price.

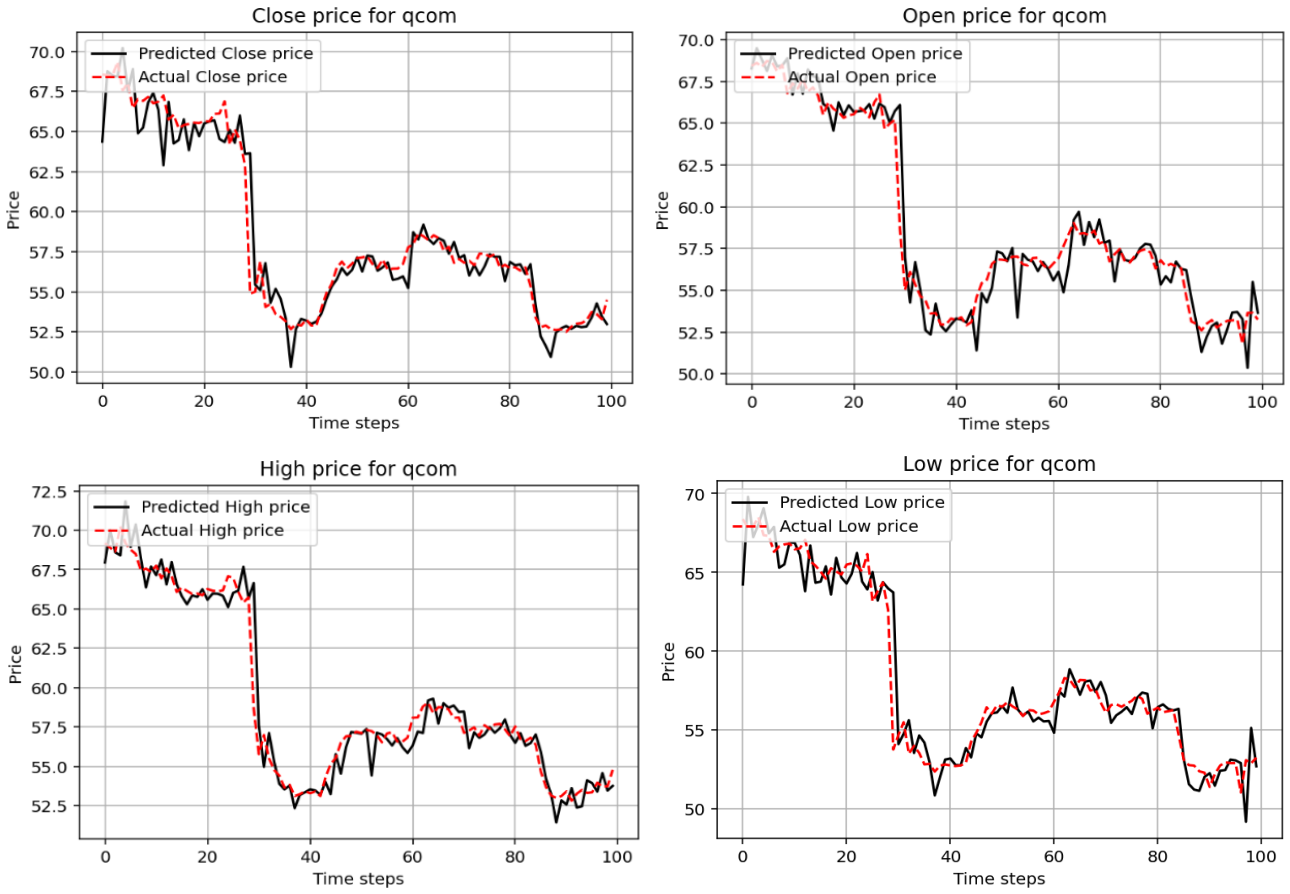

Figure 4. Actual and predicted values of the close, open, high, and low prices of Qualcomm

5. Conclusion

We predicted the stock markets of Apple, CMCST, Google, and Qualcomm using HMM. By analyzing the values of the four continuous variables and MAPE listed in **Table 1**, the prediction results of Apple's stock price were found to be more accurate. Given that stock price fluctuations depend on a variety of factors, including environment and policy, errors in stock price prediction using HMM are inevitable. Therefore, the development of a new prediction model should be considered in the future to ensure more accurate prediction results.

Disclosure statement

The author declares no conflict of interest.

Author contributions

P.W. was responsible for collecting data and proposing ideas. T.W. was responsible for literature review and method selection. M.Y. was responsible for experimental analysis and conclusions.

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Discussion on Local Asset Management Companies' Approach to Revitalizing Uncompleted Real Estate Projects: Taking ZS Asset Management Company as an Example

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Abstract: In recent years, with the vigorous development of the real estate market, the price and scale of real estate have been growing explosively year by year. At the same time, the continuous macro-control of the state and the debt of real estate enterprises are both thundering. The high turnover and leverage operation mode is challenged, and uncompleted real estate projects are constantly emerging. Uncompleted residential buildings are considered scars to developers or cities where these projects are located. If this issue can be solved, uncompleted residential building projects can be revitalized, and the parties involved will also benefit from it. Asset management companies play a key role in the revitalization of uncompleted real estate projects by injecting new vitality into these projects and obtaining relevant policy support from the local government for the pain points and difficulties in these projects, thus promoting the revitalization of uncompleted projects. In order to discuss the approach taken by local asset management companies to revitalize uncompleted real estate projects, this paper takes ZS Asset Management Company as an example.

Keywords: Local asset management company; Revitalize; Uncompleted projects; Real estate

Online publication: December 7, 2022

1. Introduction

Real estate is an industry that is subjected to strict policy regulation. Price fluctuations and industry prosperity have a significant impact on real estate. Some real estate projects are affected by the downturn of the real estate market, and the sales progress is slow. Especially in recent years, with the popularity of online e-commerce platforms such as JD and Taobao, commercial real estate is in serious recession. Due to the large proportion of business in some real estate projects, the funds returned from sales are unable to cover the high financing costs and project construction costs, thus leading to uncompleted projects that are difficult to revitalize. For uncompleted real estate projects in the local stock, the local government makes effort by establishing a linkage leading group, organizing regular working meetings, studying and coordinating the settlement of issues, as well as coordinating and promoting the disposal of uncompleted real estate projects from judicial, financial, planning, construction, acceptance, and other perspectives.

Local asset management companies tend to focus on non-performing assets and bear the responsibility of defusing local financial risks, with their main business scope in revitalizing uncompleted real estate projects. However, each uncompleted project has its own reasons. There are several cases and studies that

focus on the role of local asset management companies in revitalization. Two acquisition methods, transfer of development projects and equity transfer, have been proposed by Yan [1]. In a study [2], Yan analyzed the advantages and operation path of trust in the disposal of uncompleted residential buildings. Wang [3], on the other hand, discussed the steps and pricing methods for the securitization of uncompleted residential buildings. Several measures and the legal basis for the disposal of uncompleted residential buildings have also been proposed [4]. This paper discusses the approach taken by local asset management companies to revitalize uncompleted real estate projects, taking ZS Asset Management Company as an example.

2. Local asset management companies' approach to revitalizing uncompleted real estate projects

2.1. Direct acquisition of uncompleted real estate project assets

Local asset management companies would establish a two-layer special purpose vehicle structure (generally, a limited partnership and limited liability company) with the new project company, directly participate in judicial auctions to purchase the assets of uncompleted real estate projects (including but not limited to land, construction in progress, *etc*.), change or rehandle the development certificates of the original projects, and carry out subsequent development and sales. Not only can local asset management companies develop and sell by themselves, but they can also act as investors of judicial auctions. The transaction structure is designed as follows:

(1) as a shareholder in the new project company (the acquirer of assets), local asset management companies participate in judicial auctions for asset acquisition in the form of shareholder contribution or shareholder contribution and shareholder loan in addition to carrying out subsequent development and sales;

(2) local asset management companies and investors with real estate development capabilities form a limited partnership to participate in asset acquisition; the modes of establishment of this limited partnership include the following: local asset management companies as the priority limited partner and investors as the inferior limited partner and general partner; financial institutions as the priority limited partner, local asset management companies as the mezzanine limited partner, and investors as the inferior limited partner and general partner.

2.2. Participation in the bankruptcy reorganization of uncompleted real estate projects

Local asset management companies may participate in the bankruptcy reorganization of uncompleted real estate projects as reorganization investors, without changing or rehandling the development certificates of the original projects or changing the property owner of the project assets. They can then carry out subsequent development and sales after paying off the debts of the original projects according to the bankruptcy reorganization plan ruled by the court.

(1) Roles of local asset management companies

The roles local asset management companies include the following: (1) restructuring investors, where local asset management companies and investors with real estate development capabilities set up limited partnerships to participate in project restructuring; (2) creditors, where local asset management companies purchase the financial claims involved in uncompleted projects, apply to the court for bankruptcy reorganization, and obtain the basis for project intervention; they are paid-off after the adoption of the subsequent reorganization plan, thus generating income; (3) co-beneficial creditors, where their rights are paid-off preferentially during bankruptcy reorganization, and funds are provided by local asset management companies for the continued construction of projects that belong to the co-beneficial creditors.

(2) Transaction structure involved in bankruptcy reorganization

The transaction structure involved in bankruptcy reorganization includes the following: (1) local asset management companies independently invest in reorganization, directly hold shares in the project

company, and carry out subsequent development and sales through shareholder capital injection, shareholder loans, *etc*.; (2) local asset management companies and investors with real estate development capabilities form limited partnerships to participate in project restructuring and subsequently develop and sell the project through shareholder capital injection, shareholder loans, *etc*.

The advantage of the approach taken by local asset management companies that participate in the bankruptcy reorganization of uncompleted projects is that local asset management companies can continue with the existing real estate development procedures of projects, accelerate the progress of project development and sales, as well as reduce the relevant tax and expenses of these projects. The advantage of a local asset management company's direct acquisition of uncompleted project assets is that it is completely isolated from the original project and is developed as a new project, so as to be protected from the adverse impact of the original project and the related problems of the project company. However, the disadvantage is that local asset management companies have to pay more taxes when handling the transfer of land, the projects under construction, and other assets. In addition, the acquisition cost will also be taken as the tax basis in subsequent land value-added tax, generated by the project. At the same time, changing or rehandling the development certificate of the original project would take up more time and cost.

2.3. Key points to revitalize uncompleted projects

(1) Comprehensive due diligence on the project

Local asset management companies need to investigate the history of projects in an all-rounded way, including the equity situation, business license, past tax payment, payment of land transfer fees, asset mortgage and pledge, and litigation of the project company. They also need to evaluate and calculate the feasibility of project planning adjustment, various nodes of subsequent projects, development, and construction costs, the completion of sales cycle, *etc*.

(2) Renewal of projects under construction

Local asset management companies need to investigate the quality of the original projects under construction, the completion of municipal supporting projects and project supporting facilities, as well as hire professional institutions to issue complete feasibility plans for the continuation of uncompleted projects.

(3) Support from the local government

Uncompleted projects may have different planning requirements from those approved, incomplete real estate development certificates, and problems in maintaining the stability of creditors, which require the government to issue relevant policy support. Some uncompleted projects are more likely to have expired planning and construction permits due to long downtime, which may require re-approval by relevant government departments. The rights and debts of creditors from the long history of uncompleted projects are complex, and the legal disputes caused by them require the government's communication and coordination support. Therefore, in order to ensure that the revitalization of uncompleted projects is effective, a full support from the local government is a prerequisite, especially in aspects of housing construction, judicial, administrative approval, taxation, *etc*.

(4) Public opinion support

Uncompleted projects are like scars to cities, and they tend to be the focus of the media and the public. In the process of revitalization, local asset management companies should strengthen communication with media institutions, carry out positive and effective publicity, and create a good public opinion environment, which are all conducive to creating a positive market reaction toward these projects.

3. Case analysis of ZS Asset Management Company in revitalizing a stale real estate project

3.1. Background of the uncompleted real estate project

In 2014, a real estate development company obtained a piece of commercial and residential land in Guilin city through public listing and bidding for land transfer, covering an area of 82.44 mu. The planned use includes commercial land and residential land, including 33,363.1 m^2 of another commercial land and 40 years of land use right. The residential land area is 21,596.7 m^2, the tenure of land use is 70 years, the total building area is 122,057 m^2, the plot ratio of the commercial land is 2.5, the building height is limited to 40 m, the building density is 40%, and the green space rate is 20%; the residential land is compatible with commerce, with a compatible proportion not higher than 30% of the total building area, its floor area ratio is 2.0, its building density is 30%, its building height limit is 34 m, and its green space ratio is 20%. There are some projects under construction on the land, including the first phase basement, D1 #, D2 #, H1 #, and H2 # buildings, with a built area of 57,327.62 m^2; the second phase basement, A8 #, A9 #, and A10 # buildings, with a built area of 19,525.14 m^2. The actual controller of the real estate developer was arrested by the Shanghai Municipal Procuratorate due to suspicion of economic crimes; most of the assets were preserved and frozen by litigation. This led to the rupture of the project company's capital chain, which affected the construction and operation of the real estate project and the ability to pay off due debts; thus, it was ruled bankrupt and liquidated in 2019. Due to the impact of COVID-19 and the national real estate industry regulation policies, the project has been auctioned repeatedly by Ali judicial auction without participation. In 2021, ZS Asset Management Company and Guilin Company A reached an intention to cooperate on revitalizing the project by means of bankruptcy restructuring investment.

On June 14, 2020, the web portal of Guilin Municipal People's Government put forward the Notice of Guilin Municipal People's Government Office on Printing and Distributing the Implementation Plan for Disposal of "uncompleted residential buildings" in the main urban area of Guilin. The notice made it clear that an overall coordination mechanism for the disposal of "uncompleted residential buildings" at the municipal level should be established, along with a leading group, which will be led by the People's Government of Guilin, with the involvement of the Municipal Intermediate People's Court and the participation of the Municipal Housing and Urban Rural Development Bureau, the Natural Resources Bureau, the Urban Administration Bureau, the Real Estate Registration Center, the local financial supervision and administration and other departments, as well as relevant urban people's governments, for the coordination and promotion of "uncompleted residential buildings."

3.2. Motivation for revitalizing the uncompleted project

(1) The uncompleted real estate project is located in the core area of the main urban area of Guilin city. The surrounding facilities are complete, and the transportation is convenient. There are minimal competing residential products in its surrounding areas. The residents have a strong desire to improve their living conditions. In addition, the sales of residential products are expanding rapidly.

(2) The uncompleted real estate project is Guilin Municipal Government's target. Revitalizing the uncompleted real estate project can help the local government solve the residual problems from history, improve the city appearance, and optimize the allocation of resources in the local real estate market.

(3) Although the residential proportion of the uncompleted real estate project is only slightly more than half, the local government of Guilin has made clear the policy support to adjust the project use function, land nature, plot ratio, and other planning and design conditions according to the actual situation of the project and in accordance with laws and relevant policies and procedures as well as to confer appropriate preferential policies on other projects to the development enterprises that are taking over the "uncompleted residential buildings" project in accordance with the law, so as to increase the operability of the project. In addition, Guilin Natural Resources Bureau, in view of the pain point of the project's

high commercial ratio, issued the SNZZ [2021] No. 139 document, namely the Notice of Guilin Natural Resources Bureau on Printing and Distributing the Implementation Rules for Adjusting the Ratio of Commercial and Residential Buildings to Real Estate Projects under Construction in Guilin (for Trial Implementation), which clarified the scope of application, working procedures, application conditions, and review focus of the Implementation Rules for Adjusting the Ratio of Commercial and Residential Buildings to Real Estate Projects. It will greatly help investors to promote the progress of the uncompleted real estate project's reorganization.

(4) The uncompleted real estate project has obtained four licenses, namely land license, construction land planning license, construction project planning license, and construction project construction license, as well as several pre-sale licenses. After taking over the real estate project company, subsequent development, construction, and sales can be carried out. The original construction, design, earthwork, and other development costs can still be used as tax credits to reduce relevant tax expenses.

3.3. Specific operation mode and risk control means

3.3.1. Specific operation mode

The real estate project adopts the mode of "participating in the bankruptcy reorganization of the uncompleted real estate project." ZS Asset Management Company, together with Guilin Company A, as the investor, forms a limited partnership to participate in the project reorganization, pays for the bankruptcy reorganization consideration through shareholder capital injection and shareholder loans, and carries out the subsequent development, construction, and sales of the real estate project. The specific transaction structure of the project is detailed in **Figure 1**.

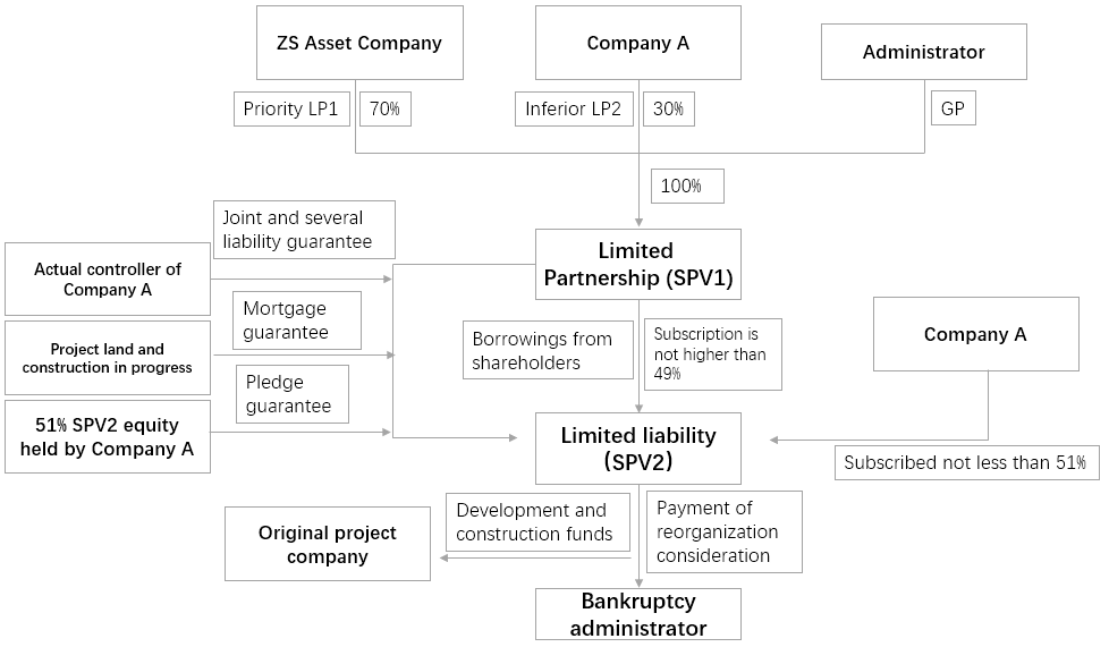

Figure 1. Transaction structure

The specific operation steps are as follows: (1) ZS Asset Management Company, Guilin Company A, and the general partner jointly set up a special purpose vehicle 1 limited partnership; special purpose vehicle 1 limited partnership and Guilin Company A jointly fund the establishment of special purpose vehicle 2 limited liability company, with ZS Asset Management Company, as the priority financial investor, whose contribution shall not exceed 70%, and Guilin Company A, as the inferior investor, whose contribution shall not be less than 30%; special purpose vehicle 2 participates in the bankruptcy reorganization of the

original real estate project company; (2) special purpose vehicle 2 submits a bankruptcy reorganization plan to the People's Court, and after the bankruptcy reorganization plan is approved by the creditors' meeting, the People's Court makes a ruling, which takes effect; special purpose vehicle 2 pays the reorganization consideration to the bankruptcy administrator; (3) after the payment of the reorganization consideration, special purpose vehicle 2 acquires 100% of the original real estate project company's equity and takes over the original real estate project company's seals, licenses, and certificates; (4) after the real estate project starts development, construction, sales, and other work, the return on investment generated is returned and distributed to ZS Asset Management Company and investor company A according to the agreement made by all parties.

3.3.2. Risk control means

(1) Guarantee measures

A total of 51% of the shares of special purpose vehicle 2 held by investor company A are pledged to special purpose vehicle 1. The actual controller of investor A provides joint and several liability guarantees. The project land and construction in progress are mortgaged to special purpose vehicle 1 (after consulting the local mortgage registration department of Guilin, special purpose vehicle 1 can be assumed as the mortgagee to go through the mortgage registration procedure). The original real estate project company is added as a co-borrower of the loan from special purpose vehicle 1 to special purpose vehicle 2.

(2) Supervision measures

The supervisors appointed by ZS Asset Management Company and the investors appointed by Company A jointly supervise the official seal of the project company, the name seal of the legal representative, the special financial seal, the bank account, the online banking key, and the business license. A supervisor appointed by ZS Asset Management Company and an employee appointed by Company A jointly manage the capital account, financial seal, U shield, password, *etc*. of special purpose vehicle 2 and the real estate project company. The capital, shareholder loan capital, principal of creditor's rights and capital occupation fees, daily expenses, management fees, taxes and other capital transactions, receipts, payments, and settlement of special purpose vehicle 2 and the real estate project company should be implemented through a regulatory account.

(3) Decision making mechanism

At the level of special purpose vehicle 1 limited partnership, the general meeting of partners is the highest decision-making body, voting on major issues such as entering and exiting partnerships, capital increase and reduction, share transfer, project investment, project exit, income and principal distribution beyond the authority of executive partners, foreign financing loans, foreign guarantees, liquidation, and cancellation. One partner has one vote, and all major issues shall be unanimously approved by all partners. At the level of special purpose vehicle 2 limited liability company, the company's authority belongs to the shareholders' meeting. Shareholders exercise their voting rights at the shareholders' meeting in accordance with the proportion of their capital contributions. Major matters involving equity transfer, merger, division, dissolution, dividend, foreign investment, asset transfer and disposal, foreign financing loans, foreign guarantee, and other major issues must be unanimously approved by all shareholders at the shareholders' meeting.

(4) Income distribution mechanism

Before the exit of ZS Asset Management Company's priority principal and interest, the inferior part of the income of Company A will not be distributed.

3.4. Effect of revitalizing the uncompleted real estate project

Under the extremely complex macroeconomic environment, the revitalization of the uncompleted real estate project has a positive effect.

(1) By resuming the uncompleted real estate project, it becomes a landmark building in the center of the city, reviving the urban scars, meeting the needs of the residents, and improving their living conditions. The completion of the investment promotion and supporting facilities for the commercial part of the project addresses the issue of insufficient proportion of surrounding businesses.

(2) The overall plan for the participation of local asset management company in bankruptcy restructuring investment provides a more referential case support for the local government and also solutions for other local real estate projects that have not been completed.

(3) The issuance of policy plans by the local government to address the issues in the uncompleted project helps solve the pain points of the project and further promotes the reorganization and revitalization of the project more smoothly.

4. Conclusions and suggestions

The revitalization of uncompleted real estate projects by local asset management companies belongs to the comprehensive "non-performing and investment bank" business. The ability of local asset management companies to professionally dispose non-performing assets, effectively control risks, and take into account of social and economic benefits can be effectively played out by establishing a reasonable transaction structure based on the actual situation of the project. From the perspective of revitalization, if the original real estate project planning is clear and the development and construction procedures are complete, it is recommended that local asset management companies and investors form a limited partnership to participate in the bankruptcy reorganization of uncompleted real estate projects. If there are many residual problems from the original project and given a complex relationship between the creditor's rights and debt, it is recommended that local asset management companies and investors form a limited partnership to directly purchase the real estate project assets the through judicial auctions. From the perspective of risk control, most local asset management companies lack the ability to operate real estate projects. Hence, they should choose partners with strong financial strength, rich real estate development experience, and good reputation as cooperative investors. At the same time, they should obtain relevant support from the local government in the early stage of the project and obtain relevant written documents on communication and coordination with relevant departments from the local government. Local asset management companies should try their best to acquire policy support from the local government for the pain points and difficulties in the uncompleted projects, so as to promote the reorganization and revitalization of uncompleted real estate projects.

Disclosure statement

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Research on the Impact of Financial Development on Industrial Structure Upgrading: Evidence from China's Provincial Panel Data

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Abstract: On the basis of analyzing the mechanism of the impact of financial development on industrial structure upgrading, this paper comprehensively considers the state of the industrial structure among provinces from three dimensions: rationalization, optimization, and equalization. This research finds that financial development promotes the rationalization and optimization of industrial structure but has no significant effect on the equalization of industrial structure.

Keywords: Financial development; Rationalization; Optimization; Equalization

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1. Introduction

Finance, as the engine of modern economy, provides powerful resource support for industrial structure upgrading. Its abundance, depth, and support of investment are the core elements for the success of industrial structure upgrading. Therefore, the correlation between financial development and industrial structure upgrading is an important research topic.

With the gradual deepening of theoretical research on financial development, the significance of financial factors in promoting industrial structure upgrading and national economic growth is widely concerned and recognized [1]. According to research, financial development is closely related to changes in economic resources [2]. The former is reflected in the joint development of financial intermediaries and financial markets [3]. The development of financial markets plays a positive role in improving the allocation efficiency [4] and the growth rate of inter-industry correlation; thus, it can promote the upgrading of industrial structure [5].

In China, Gu studied the mechanism involved in the optimization and upgrading of China's financial industrial structure [6]. According to Qian and Zhou, financial development has a significant positive role in promoting industrial structure adjustment [7]. Zhou *et al*. have found that the effects of credit and stock market development on the optimization rate of industrial structure in China are different [8]. In a study, He found that financial development will change the internal structure and proportion of the tertiary industry and promote rationalization [9], but excessive financialization will squeeze out investment in the real economy and inhibit the rationalization of industrial structure. According to Luo, the expansion of financial development scale will improve the degree of industrial structure upgrading [10]. Financial development will also increase the investment in growth industries by allocating resources to promote industrial structure optimization [4]. However, excessive reliance on financial resources will have a negative effect on capital

accumulation, which is adverse to the optimization of industrial structure. According to Chen, speculative nature disrupts the industrial balance [11]. Hence, this paper aims to explore whether financial development, as the core of economic resources, would render industrial upgrading dependent upon it.

2. Functional mechanism

The mechanism of financial development and industrial structure upgrading can be analyzed from two aspects: direct financing and indirect financing.

In terms of direct financing, how to direct the flow of incremental funds into industries with high operating efficiency and great development potential depends on the issuance function of the primary market. The upgrading of industrial structure depends on the secondary market and is mainly achieved through mergers and acquisitions of enterprises, stock adjustments, and other means. In addition, the small and medium-sized enterprise (SME) board market is also very important, as it provides financial resources and services to high-risk industries and emerging industries.

In terms of indirect financing behavior in the bank credit market, the dependence of financial development and industrial restructuring on financial resources is reflected in policy subsidy and market commercial credits. The development and planning of specific industries in China are closely related to policy-based credit subsidies. It is through credit rationing, loan subsidies, and other means that credit funds are allocated to specific industries that need support, so as to achieve the purpose of macroeconomic regulation. Market commercial credit includes consumer loans and production loans. The former is aimed at adjusting the stock capital, which indirectly affects the level of industrial structure from the aspect of demand through the intertemporal allocation of consumption; the latter uses the incremental adjustment method of investment tilt to reshuffle and transfer financial resources and provide loans to specific industries, which have an indirect impact on industrial upgrading from the supply side.

3. Model construction

This paper selects 31 provinces (municipalities directly under the Central Government) in China as research samples and uses the annual data from 2009 to 2020. The data are mainly derived from China Statistical Yearbook (2009–2020), China Economic and Social Development Statistics Database, China Financial Yearbook, and WIND information. The definitions and calculation methods of the selected variables are described below.

3.1. Variable selection

3.1.1. Industrial structure upgrading

This article measures industrial structure upgrading from three levels.

(1) Rationalization of industrial structure (IR)

The rationalization of industrial structure not only reflects the degree of effective resource allocation and utilization among industries, but also the interaction and coordination between industries. In the past, most scholars used structural deviation measurement. Based on Gan's research [12], this paper uses Theil index to measure the rationality of industrial structure. Compared with the structural deviation index, the Theil index not only retains the theoretical basis and economic meaning of the structural deviation index, but also takes into account the relative importance of the industry without including absolute value calculation. IR is calculated as follows:

$$IR = \sum_{i=1}^{3} \left(\frac{Y_i}{Y}\right) \ln\left(\frac{Y_i}{L_i} \Big/ \frac{Y}{L}\right) \quad (1)$$

where Y represents output value, L represents employment, i represents industry, productivity, and the relative importance of industry. According to the assumption of neoclassical economics, when the economy is in equilibrium and the productivity level of each industrial sector is the same, IR is a reverse indicator.

(2) Optimization of industrial structure (IO)

The optimization of industrial structure is a process of promoting the development of sunrise industries by improving the level of resource utilization, so as to increase its proportion in the industry. This paper uses the ratio of output value of tertiary industry to output value of secondary industry as the measurement index of the optimization of industrial structure. Compared with the traditional measurement method, it clearly shows whether the industrial structure is advancing toward the tertiary industry.

$$IO = Y_3 / Y_2 \tag{2}$$

Y_2 and Y_3 represent the output value of the secondary industry and the tertiary industry, respectively. A rising IO value indicates that the industrial structure is advancing toward the tertiary industry and the industrial structure is in the process of optimization. Therefore, IO is a positive indicator.

(3) Equilibrium of industrial structure (IE)

The equilibrium of industrial structure is the ultimate ideal state of industrial structure upgrading. The process of adjustment is a gradual transition from disequilibrium to equilibrium, from low-level equilibrium to high-level equilibrium, and the harmonious coexistence between industries. Based on Xu's general equilibrium analysis framework [13], this paper selects the economic deviation measure to represent the industrial structure equalization.

$$\begin{aligned} IE &= \sqrt{\sum_{i=1}^{3}\left(\frac{y_i}{l_i}-1\right)^2 \Big/ 3} \qquad (IE \geq 0) \\ y_i &= Y_i \Big/ \sum_{i=1}^{3} Y_i \\ l_i &= L_i \Big/ \sum_{i=1}^{3} L_i \end{aligned} \tag{3}$$

Among them, y_i and l_i refer to the income composition and labor force composition of the i-th industry, respectively; y_i/l_i refers to the relative labor income ratio of the industry. When $IE = 0$, the industrial structure is in equilibrium; when $IE > 0$, the industrial structure is in an unbalanced state, in which the greater the IE value, the more unbalanced the industrial structure is. Therefore, IE is a reverse indicator.

3.1.2. Financial development

This paper uses the ratio of annual total stock price of listed companies in each region to regional GDP to measure the development scale of the stock market in different regions; the ratio of total amount of loans at the end of the year of financial institutions in different regions to regional GDP to measure the development scale of credit markets in different regions; and the ratio of sum of development scale of stock and credit markets in different regions to GDP to measure the overall development scale of financial markets in different regions.

3.1.3. Control variables

The factors that affect economic growth are important factors that affect the adjustment of industrial structure. This paper selects four factors as control variables, including physical investment, government behavior, openness, and human capital in each province (municipality directly under the Central Government).

3.2. Model construction

This paper uses a two-step system generalized method of moments (GMM) model for estimation. The upgrading of industrial structure is continuous, which implies that the upgrading effect of industrial structure in the early stage may have an impact on the later stage. Most of the explanatory variables in the empirical model are autoregressive, while the endogenous variables are the lagged terms of the explanatory variables. The GMM estimation method includes the most abundant dynamic panel data information, which makes the parameter estimation more accurate. At the same time, the tool variable rationality test and Sargan test are also better. This paper uses the financial development scale that lags behind two periods as a tool variable. This paper constructs the following dynamic panel model:

$$\begin{aligned} Ind\left(IR,IO,IE\right)_{i,t} = {} & \beta_0 + \sum_{j=1}^{p} \lambda Ind_{i,t-j} + \beta_1 Equity_{i,t} + \beta_2 Credit_{i,t} \\ & + \beta_3 FAI_{i,t} + \beta_4 FE_{i,t} + \beta_5 Open_{i,t} + \beta_6 HC_{i,t} + \varepsilon_{i,t} \end{aligned} \tag{4}$$

where, $Ind(IR,IO,IE)$ refers to the upgrading of industrial structure in region i during period t, including three indicators: IR, IO, and IE. $Ind_{i,t}$ represents the development of capital market and credit market. At the same time, control variables are introduced, including fixed asset investment variables and other control variables. in order to determine whether there is adjustment inertia in the industrial structure, the lag value is introduced into the model, and j is the maximum lag order.

4. Empirical analysis

4.1. Descriptive statistics

Table 1 is the descriptive statistics of variables.

Table 1. Descriptive statistics of variables

Variable name	Mean value	Standard deviation	Skewness	Kurtosis
Rationalization of industrial structure (IR)	1.172	0.446	0.341	2.664
Optimization of industrial structure (IO)	0.966	0.488	2.834	11.989
Equilibrium of industrial structure (IE)	0.884	0.431	2.706	14.752
Scale of stock market development (Equity)	0.562	1.587	9.008	100.797
Scale of credit market (Credit)	1.057	0.357	1.341	5.097
Fixed asset investment (FAI)	0.589	0.181	0.362	2.373
Fiscal expenditure (FE)	0.227	0.175	3.713	19.257
Total imports and exports (Open)	0.350	0.417	1.779	5.125
Human capital (HC)	0.013	0.007	0.949	3.873

4.2. Estimation results and analysis

Table 2 shows the estimation results. The second column shows that financial development plays a positive

role in promoting the rationalization of industrial structure. The coefficient of capital market development level is -0.003, which is significant at the level of 1%. This indicates that for every 1% increase in the degree of capital market development, IR will decrease by 0.3%, that is, the degree of rationalization of industrial structure will increase by 0.3%. Therefore, capital market development plays a positive role in promoting the rational development of industrial structure. On the other hand, the coefficient of credit market development level is -0.069, which is significant at the level of 1%. This indicates that the scale of credit market is negatively correlated with the IR index, suggesting that the scale of credit market has a positive interaction with the rationalization of the industrial structure. The degree of industrial rationalization depends on the scale of credit market by 6.9%.

The third column shows that financial development plays a positive role in promoting the optimization of industrial structure. The coefficient of capital market development level is 0.002, which is significant at the level of 1%. This indicates that for every 1% increase in capital market development, IO will increase by 0.2%, that is, the degree of industrial structure optimization will increase by 0.2%. On the other hand, the scale of credit market has no significant effect on the upgrading of industrial structure. The fourth column shows that the role of financial development in industrial structure equalization is not significant.

Table 2. Estimation results

Variable	IR	IO	IE
I(-1)	0.736***	0.799***	0.467***
	(36.587)	(20.452)	(4.548)
Equity	-0.003***	0.002***	-0.021
	(-2.913)	(3.109)	(0.574)
Credit	-0.069***	0.015	-0.856
	(-2.379)	(0.218)	(0.278)
FAI	-0.225***	0.329**	1.734***
	(-5.587)	(2.163)	(2.976)
FE	0.583***	-0.222***	2.925
	(4.832)	(-2.845)	(1.567)
Open	0.168*	0.276***	-1.789**
	(3.676)	(2.656)	(-2.535)
HC	0.435***	-0.178**	-1.721***
	(8.734)	(-2.234)	(-2.956)
Year	Yes	Yes	Yes
AR(2)	0.443	0.214	0.489
Sargan test	0.251	0.231	0.956

Note: $^{***}P < 0.001$, $^{**}P < 0.01$, $^{*}P < 0.05$.

5. Conclusions

This paper uses the GMM estimation method, empirically analyzes the role of financial development in the rationalization, optimization, and equalization of China's industrial structure. Several conclusions can be drawn.

5.1. Financial development promotes the rationalization of industrial structure

The influence of the credit market on the rationalization of China's industrial structure upgrading is evident. It may be attributed to problems in the development of China's stock market. For example, at the beginning

of the establishment of China's stock market, the selection of listed companies was administratively oriented due to policy considerations. Moreover, the legal supervision and initial public offering (IPO) review systems are still flawed. These problems have led to companies committing financial fraud at the beginning of listing, thus affecting the role of the stock market in promoting the upgrading of economic structure.

5.2. Financial development has multiple effects on the optimization of industrial structure

Capital market development plays a positive role in promoting the optimization of industrial structure. However, the scale of credit market development has not formed any positive interactions with the optimization of industrial structure.

5.3. Financial development has no significant impact on the equalization of industrial structure

Theoretically speaking, the speculative nature of financial resources tends to cause investment to flow into high profit sectors, which would result in industrial fluctuations and uneven development, reducing the degree of equilibrium of the industrial structure. However, at the current stage of development in China, the impact of financial resources on industrial equalization is still very small. Equalization is the ultimate goal and the highest level of industrial structure adjustment. At present, China is still in the stage of continuously promoting industrial rationalization and optimization. Therefore, financial development has no significant impact on the equalization of industrial structure.

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Volatility Prediction via Hybrid LSTM Models with GARCH Type Parameters

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Abstract: Since the establishment of financial models for risk prediction, the measurement of volatility at risky market has improved, and its significance has also grown. For high-frequency financial data, the degree of investment risk, which has always been the focus of attention, is measured by the variance of residual sequence obtained following model regression. By integrating the long short-term memory (LSTM) model with multiple generalized autoregressive conditional heteroscedasticity (GARCH) models, a new hybrid LSTM model is used to predict stock price volatility. In this paper, three GARCH models are used, and the model that can best fit the data is determined.

Keywords: Time series; Exchange rate forecast; GARCH model; Stock market volatility; Error

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1. Introduction

Since the establishment of KOSPI 200 options market on July 7, 1997, there has been a significant increase in the volume of trade, alerting investors and financial institutions of the risks brought about by the increased volatility of KOSPI 200. Accurate volatility prediction is an important aspect of risk management, especially when allocating assets to various portfolios to effectively hedge the risks of these portfolios. It has been shown that a low level of financial management expertise, a large amount of financial assets, and a high time opportunity cost could increase the perceived value of information intermediaries, thereby raising the possibility of using information intermediaries. We have also found that the use of information intermediaries is positively correlated with the overall scope of information search and affects the likelihood of using other sources of information. In section 2, we explain the generalized autoregressive conditional heteroskedasticity (GARCH) financial time series model and the hybrid long short-term memory (LSTM) model involving the artificial neural network (ANN) and multiple GARCH models. We explain how the experiment is conducted and present the experimental results and analysis in sections 3 and 4, respectively. Section 5 provides several conclusions to this study and the forecast of future research.

2. Literature review

The volatility of asset market, like the stock market, is a measurement of the degree to which asset prices fluctuate and the degree of uncertainty in forecasting. Investment firms and private investors measure the instabilities of underlying asset prices [1]. In order to determine the risk of investment profile, it is essential to determine the volatility of constituent assets. Volatility is significant not only to evaluate such intangible derivative goods as stock index options but also in price detection. In such cases, volatility is a deductive

topic within different types of financial time series models. In order to deduce the future trends with the heteroscedastic condition of past information, an autoregressive conditional heteroskedasticity (ARCH) model that uses the present error term as a function of the previous time has been proposed [2]. By using the proposed GARCH model, it is feasible to reduce the estimated number of parameters [3]. When the volatility is high, a high volatile state is more likely to maintain to some extent, but when the volatility is low, a low volatility state is maintained up to a certain threshold. In addition, Morgan and Reuters have put forward the exponentially weighted moving average (EWMA) model based on GARCH(1,1) [4]. The former emphasizes recent data more than other models. It clearly forecasts recent changes and is less influenced by the quantity of data. A number of scholars have used time series [5-7] and deep learning models [8,9] to estimate stock prices and stock return movements.

These econometric methods are theoretically described based on statistical charts and data. However, if qualitative variables are used, the stability of model-based predictions will be significantly reduced. In order to avoid restrictions and assumptions on the model, ANN, which is more stable and connected, is considered. The comparison of the two models shows that the density estimation neural network without specific target distribution has better performance than the multi-layer perceptron. Therefore, in volatility prediction, the nonlinear characteristics that cannot be captured by econometric models can be clearly extracted using the neural network-based method, which has been proven to be successful. Therefore, the LSTM model can be used by the recurrent neural network (RNN) to forecast exchange rates and foreign exchange. LSTM is obviously superior to the feedforward neural network model as a functioning financial time model. This paper studies the model combining neural network with econometric model and the single neural network model for forecasting volatility. By taking into account of these characteristics and analyzing the volatility of S&P 500 index futures options, it has been found that ANN can surpass the financial time series model [10]. By forecasting the volatility of financial time series, the feasibility of using ANN has been proven [11].

3. Materials and methods

3.1. Data

This study takes the volatility of KOSPI 200 index in South Korea as the research subject, tracking the market value of 200 stocks represented by South Korea as the fundamental analysis target. The data is derived from the Data Guide and consists of 4922 data points from January 1, 2000, to August 30, 2020. It is estimated that there will be 3315 data points during this process. The interest rate of three-year Korean Treasury Bond (KTB) and three-year AA corporate bond (CB) is based on the daily data provided by the Korean Asset Management Corporation. The daily closing prices of gold and crude oil are derived from Bloomberg during the same period. We integrate the hybrid GARCH-exponential (E)GARCH-EWMA model and the hybrid GARCH-EGARCH model into the LSTM model, respectively, and compare the error and volatility between them to determine which of those two is a better model.

3.2. Financial time series models

3.2.1. Generalized autoregressive conditional heteroscedasticity (1,1) model

In order to understand the GARCH model, we must first look at the ARCH model. The ARCH model plays a significant role in predicting risks in the short-term period and aims to identify economic variables that can be used to predict volatility. It is assumed that the conditional variance is constant, and the estimator is unbiased; however, it cannot be used for valid estimation. Therefore, it cannot be used to acquire the settings of the confidence interval and commonly used tests. In 1982, Engle proposed the ARCH(p) model, which is a conditional heteroscedasticity model, to model the volatility of the conditional distribution. The ARCH model is as follows:

$$y_t = \mu_t + \sigma_t \eta_t,\ \eta_t \sim N\ (0,1) \tag{1}$$

$$\varepsilon_t = \sigma_t \eta_t,\ \varepsilon_t | \chi_{t-1}\ \sim N(0, \sigma_t^2) \tag{2}$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \cdots + \alpha_q \varepsilon_{t-q}^2 \tag{3}$$

Equation (1) comprises μ_t, which can be predicted by the average equation for the y_t time series, and the unpredictable error term ε_t. Equation (2) states that the error ε_t follows a normal distribution when time (t–1) is known. Equation (3) states that the conditional variance depends on the past square of the errors.

ARCH is circumscribed because it cannot avoid too many parameters when the p-value is too large nor explain the leverage effect on financial time series. In 1986, Bollerslev established the GARCH model. The GARCH(p, q) model is as follows:

$$y_t = \mu_t + \sigma_t \eta_t,\ \eta_t \sim N\ (0,1) \tag{4}$$

$$\varepsilon_t = \sigma_t \eta_t,\ \varepsilon_t | \chi_{t-1}\ \sim N(0, \sigma_t^2) \tag{5}$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \cdots + \alpha_q \varepsilon_{t-q}^2 + \beta_1 \sigma_{t-1}^2 + \cdots + \beta_p \sigma_{t-p}^2 \tag{6}$$

The GARCH model is the extension of the ARCH model. The first two equations of the GARCH model are as the same as those in the ARCH model. Equation (6), however, indicates the square of residuals and conditional variance in the GARCH model. This equation is significant, as it has helped to solve the problem of excessive parameters when the p-value is too large.

When p = 1 and q = 1, the GARCH(1,1) model is as follows:

$$\alpha_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 \tag{7}$$

We can then infer the following:

$$\sigma_t^2 = \frac{\alpha_0}{(1-\beta_1)} + \alpha_1 \sum_{j=1}^{\infty} \beta_1^{j-1}\ \varepsilon_{t-j}^2 \tag{8}$$

The GARCH model enhances the ARCH model so that there will be less parameters; thus, it will be easier to calculate. It predicts the volatility of the current period of KOSPI 200 index returns from the past, but it still has its limits. It has to satisfy the condition that every coefficient must be nonnegative. In addition, it cannot measure the leverage effect in financial pricing. However, the EGARCH model can explain the leverage effect on financial series.

3.2.2. Exponential generalized autoregressive conditional heteroscedasticity model

The EGARCH model, which was innovated by Nelson in 1991, considers the influence of the leverage effect on financial series. More importantly, it does not have to satisfy the condition in the GARCH model that "every coefficient must be nonnegative" because this model also defines the logarithm of conditional variance. Unlike the ARCH and GARCH models, the EGARCH model cannot solve the problems of negative future volatility. The EGARCH model is as follows:

$$r_t = X_t M + \varepsilon_t \tag{9}$$

$$ln\sigma_t^2 = \alpha_0' + \beta ln\sigma_{t-1}^2 + \omega\left(\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right) + \gamma\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| \tag{10}$$

In equation (9), X_t is the explanatory variable, M is the parameter, and ε_t is the residual term. Equation (10) states the logarithm of conditional variance. This model assumes the conditional variance is positive even if the parameters are negative.

3.2.3. Exponentially weighted moving average model

The EWMA model is a model that can reduce the influence of actual data in the past. The model is as follows:

$$\sigma_t^2 = \rho\sigma_{t-1}^2 + (1-\rho)\varepsilon_{t-1}^2 \quad (0 < \rho < 1) \tag{11}$$

In equation (11), we can see that the variable ρ has significant influence on the autoregressive moving average (ARMA) model. When ρ is infinitely close to one, there will be almost no influence from past information. This is not significant because it will only reflect recent information. However, if ρ is too small, there will be excessive past information and the residual term will be large. Hence, it will be better if ρ is large and not too close to 1. In that way, the accuracy is higher, and the data in the past would not be avoided.

3.2.4. Long short-term memory

LSTM is a type of recurrent neural network. Traditional RNNs use backpropagation through time. Hence, over a long period of time, the residual term will decrease exponentially; thus, the long-term memory effect of RNNs will not be reflected. In view of that, Hochreiter and Schmidhuber proposed LSTMs that can store memories and catch necessary information, while ignoring unnecessary information.

$$g_t = \sigma(U_g x_t + W_g h_{t-1} + b_f) \tag{12}$$

$$i_t = \sigma(U_i x_t + W_i h_{t-1} + b_i) \tag{13}$$

$$\widetilde{c_t} = \tanh\left(U_c x_t + W_c h_{t-1} + b_c\right) \tag{14}$$

$$c_t = g_t * c_{t-1} + i_t * \widetilde{c_t} \tag{15}$$

$$o_t = \sigma(U_o x_t + W_o h_{t-1} + b_o) \tag{16}$$

$$h_t = o_t * \tanh\left(c_t\right) \tag{17}$$

LSTM consists of memory blocks. As shown in **Figure 1**, LSTM includes a memory cell and three gates: an input gate (i_t), a forget gate (g_t), and an output gate(o_t). Equation (13) is an input gate equation. When the sigmoid function is 0, there is no input getting through the gate; when it is 1, all information will pass through the gate. Equation (12) demonstrates the weighted average of x_t and h_{t-1}, which will be too large if the input gate is 1. When the input value is large, the gradient of tanh and sigmoid function will basically disappear. Hence, a forget gate is added to eliminate the information in memory. The main innovation of LSTM is its storage unit c_t, which essentially acts as the accumulator of state information.

The unit is accessed, written, and cleared by several self-parameterized control gates. Whenever a new input arrives, if the input gate i_t is activated during *t*, its information will be accumulated into the unit. In addition, if the forget gate is on, then the past cell status c_{t-1} may be "forgotten" in the process. When the latest unit outputs c_t, it will be propagated to the final state h_t, and further controlled through the output gate o_t. One advantage of using memory cells and gates to control the information flow is that the gradient will be captured in the cell (also known as the constant error turntable) and prevented from disappearing too quickly, which is a key problem of ordinary RNN models.

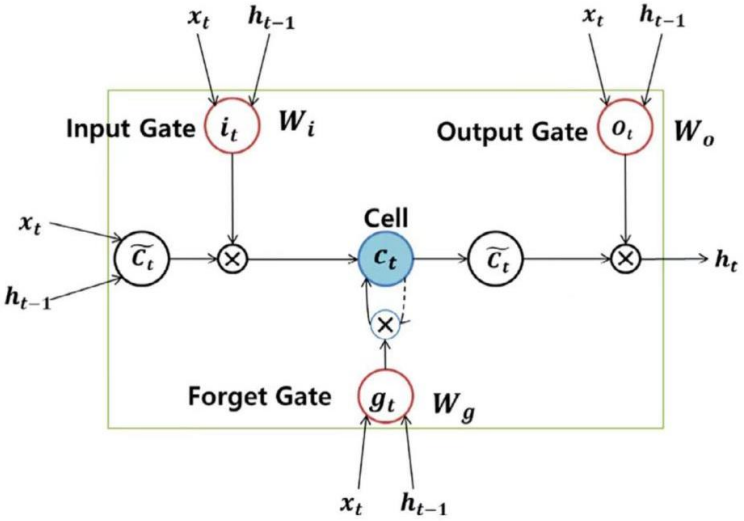

Figure 1. Process of long short-term memory

3.3. Measurement and statistical test

3.3.1. Realized volatility

Realized volatility is also historical volatility. Realized volatility measures the volatility of stock prices in one day. Realized volatility at time *t* is calculated as follows:

$$RV_t = \sqrt{\frac{1}{\rho_t}\sum_{t=1}^{\rho_t}(S_t - \overline{S_t})^2} \tag{18}$$

In equation (18), ρ_t is the days remaining after *t*, s_t is the logarithmic return at time *t*, and s_t is the average return of the log return at time *t* days, during the time period of ρ_t after time *t*.

3.3.2. Loss functions

There are four types of loss functions. Mean absolute error (MAE) is the mean of all absolute values of all errors and is unaffected by outliers. Mean square error (MSE) is the average of the square of the difference between the real value and the predicted value. These two are basic, and the equations of MAE and MSE are as follows:

$$MAE = \frac{1}{T}\sum|\widehat{v_t} - RV_t| \tag{19}$$

$$MSE = \frac{1}{T}\sum(\widehat{v_t} - RV_t)^2 \tag{20}$$

Heteroskedasticity adjusted MAE (HMAE) and heteroskedasticity adjusted MSE (HMSE) are forms of MAE and MSE adjusted through heteroscedasticity, respectively. They are non-linear loss measurements. The functions of HMAE and HMSE are as follows:

$$HMAE = \frac{1}{T}\sum |1 - \widehat{v_t}/RV_t| \tag{21}$$

$$HMAE = \frac{1}{T}\sum (1 - \widehat{v_t}/RV_t)^2 \tag{22}$$

$\widehat{v_t}$ is the predicted volatility at time t, RV_t is the realized volatility at time t, and T is of population predictions.

4. Experiment

The steps of our experiment are as follows: first, the hybrid model consisting of three models (GARCH, EGARCH, and EWMA) integrated into LSTM is analyzed to predict volatility; second, the hybrid model of GARCH-EGARCH integrated into LSTM is used. These two models help us to compare and predict volatility. There are four types of errors that are crucial, including MAE, MSE, HMAE, and HMSE. In the experiment, we also use the Durbin Watson (DW) and Wehner Schulze (WS) tests, whose purpose is to ensure a more accurate prediction.

In total, there are 4922 KOSPI 200 index data points between January 5, 2000, and August 21,2020 in the following three parameters: GARCH, EGARCH, and EWMA. The actual train size is 3315, which is taken from this range. We measure the number of classes, number of layers, input size, and hidden sizes, all of which can influence the LSTM model. The train size and the data of predicts affect the errors, including MAE, MSE, HMAE, and HMSE. By identifying the specific errors and learning about the ability of this model, we can predict the time series.

5. Results and discussion

Figure 2 illustrates the fact that the larger the epochs, the lower the loss. The data in **Table 1** correspond to **Figure 2**. We can reach a conclusion that when the loss is 0.00376, the epoch set is approximately 180, suggesting that when we have a larger epoch set, the loss will be nearer to 0.

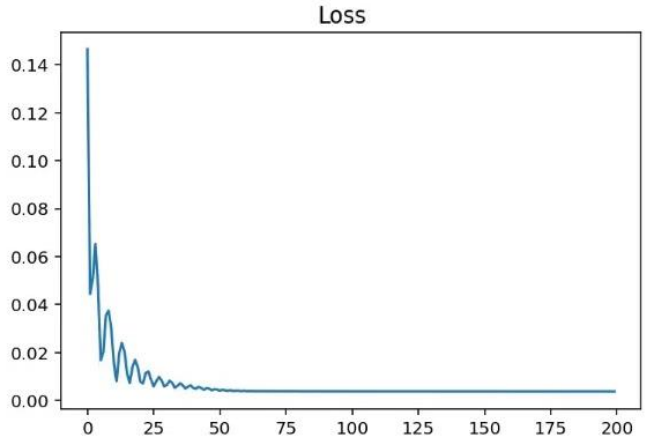

Figure 2. Relationship between epochs and loss in the hybrid model of GARCH, EGARCH, and EWMA integrated into LSTM

Table 1. Errors of the hybrid model of GARCH, EGARCH, and EWMA integrated into LSTM

Epoch	Loss
0	0.14644
20	0.00779
40	0.00517
60	0.00390
80	0.00381
100	0.00379
120	0.00378
140	0.00377
160	0.00377
180	0.00376

Figure 3 shows the volatility predicted by the hybrid model. This hybrid model consists of GARCH, EGARCH, and EWMA integrated into LSTM. The x-axis and y-axis represent the total days and the realized volatility, respectively; the orange and blue lines represent the training volatility and the time series of realized volatility, respectively. When the days increase, the training volatility is nearer to the time series of volatility.

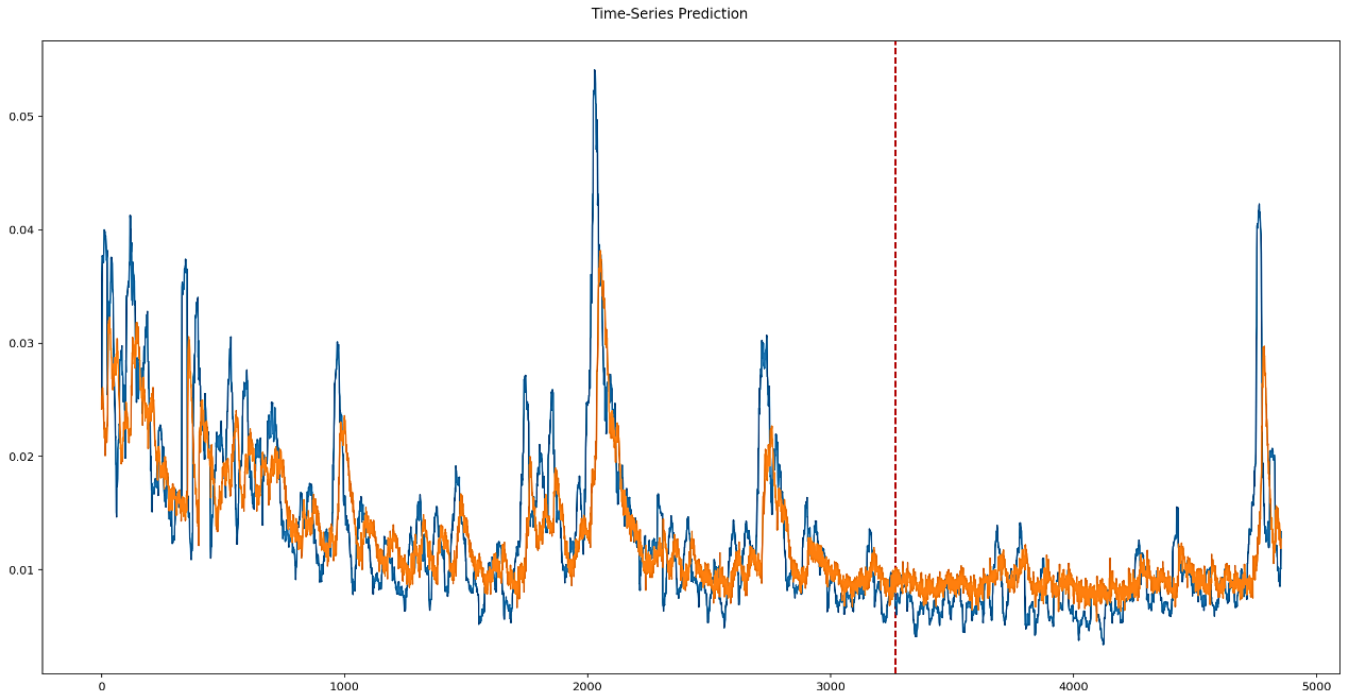

Figure 3. Volatility of the hybrid model consisting of GARCH, EGARCH, and EWMA integrated into LSTM

We use four different kinds of loss functions, including MAE, MSE, HMAE, and HMSE. From **Tables 2** and **3**, we can clearly see that the hybrid model of GARCH, EGARCH, and EWMA integrated into LSTM has a larger error compared to the hybrid model of GARCH and EGARCH integrated into LSTM. The overall MAE, MSE, HMAE, and HMSE of the former are 33.71%, 28.03%, 26.05%, and 14.47%, respectively. The latter model is better because its overall MAE, MSE, HMAE, and HMSE are 33.12%, 27.34%, 25.58%, and 14.06%, respectively. Additionally, both the test volatility and the train volatility of MAE, MSE, HMAE, and HMSE in the latter model are better compared to the former. **Tables 2** and **4** are

summary tables. Evidently, the latter model has less error in every single term (overall, train, and test) and better performance in terms of accuracy. Hence, we can reach the conclusion that the hybrid model of GARCH and EGARCH integrated into LSTM is a better model that has less errors, suggesting that it has a better capability in predicting time series.

Table 2. Errors of the hybrid model of GARCH, EGARCH, and EWMA integrated into LSTM

	GARCH + EGARCH + EWMA + LSTM		
Error type	**Test**	**Train**	**Overall**
MAE	0.25172916	0.37858	0.33706298
MSE	0.18135291	0.32844272	0.28030145
HMAE	0.24960087	0.26586163	0.2605397
HMSE	0.13646944	0.14871801	0.14470914

Table 3. Errors of the hybrid model of GARCH and EGARCH integrated into LSTM

Epoch	**Loss**
0	0.05432
20	0.00855
40	0.00468
60	0.00381
80	0.00379
100	0.00378
120	0.00378
140	0.00377
160	0.00376
180	0.00376

Table 4. Errors of the hybrid model of GARCH and EGARCH integrated into LSTM

	GARCH + EGARCH + LSTM		
Error type	**Test**	**Train**	**Overall**
MAE	0.24651265	0.37245804	0.33123732
MSE	0.17731652	0.3201486	0.27340057
HMAE	0.246911	0.26009637	0.2557806
HMSE	0.13532783	0.14317173	0.14060462

Figures 3 and **4** correspond to **Tables 1** and **3**, respectively. The former represents the hybrid model of GARCH, EGARCH, and EWMA integrated into LSTM, while the latter represents the hybrid model of GARCH and EGARCH integrated into LSTM. Comparing **Table 1** with **Table 3**, the similarity is that when epochs increase, loss decreases. This shows that increasing epochs will reduce the errors, thus making it more accurate. As shown in **Tables 1** and **3**, loss decreases from 0.14644 to 0.00376 when epochs increase from 0 to 180 in the former model, whereas in the latter model, loss decreases from 0.05432 to 0.00370 when epochs increase from 0 to 180. Based on these data, it is evident that the loss of the latter model is less than in the former model. Therefore, there is less error in the hybrid model of GARCH and EGARCH integrated into LSTM.

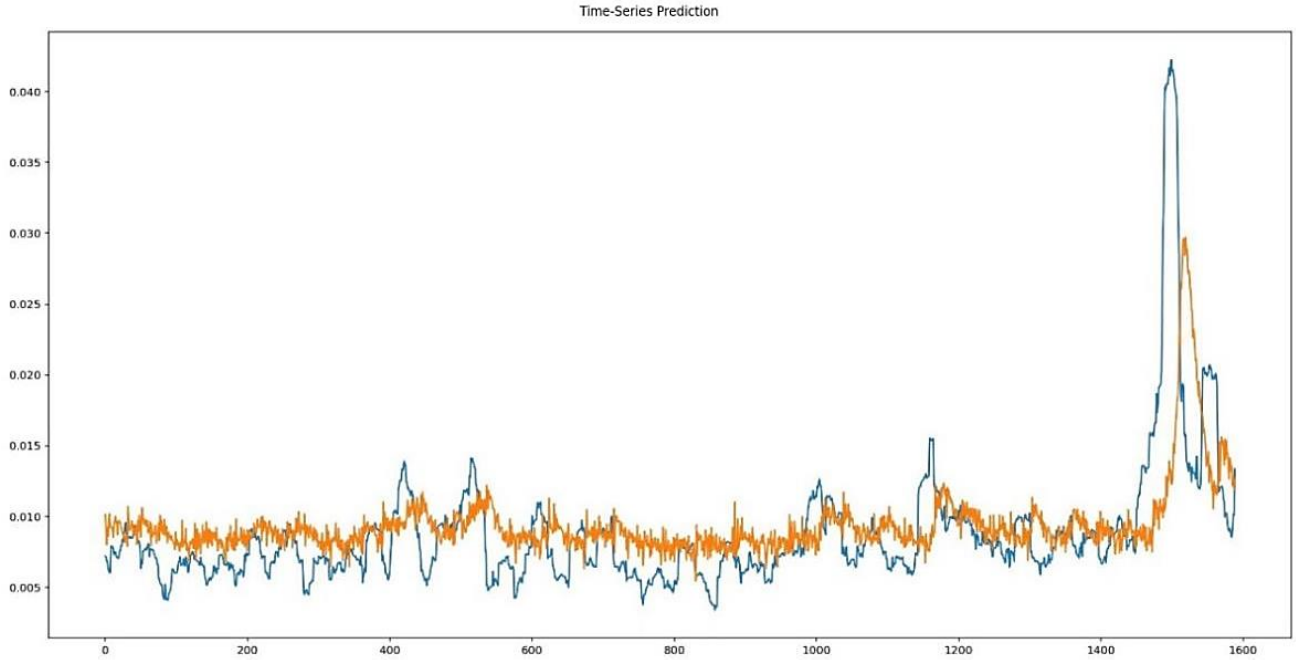

Figure 4. Inverse of the time series prediction

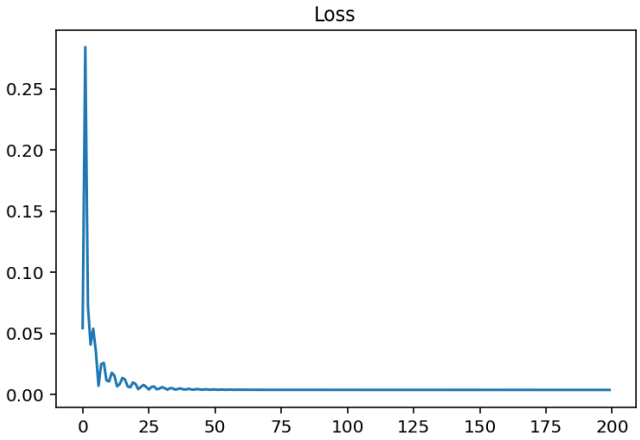

Figure 5. Relationship between epochs and loss in the hybrid model of GARCH and EGARCH integrated into LSTM

6. Conclusion

By comparing several composite models at different stages, it can be concluded that the hybrid model of GARCH and EGARCH integrated into LSTM is a better model with smaller error as it has better time series prediction ability. With this model, investors will be able to make rational investments based on their actual ability and risk preference, reduce risk as much as possible while ensuring a certain return, and obtain the highest return at the same risk level within the observation range of LSTM model portfolio.

It should be noted that not all securities portfolios are situated on the effective boundary and the risk and return are not always positively correlated as well. There are some differences under the target prediction and actual boundary. Therefore, investors must be prudent and use scientific concepts when choosing securities, judging investment proportion, and analyzing the market environment. In addition, they should avoid blindly pursuing returns, while neglecting the existence of risks. Due to the limitations of this model, this theory should not be applied blindly to investment decisions. While giving full play to investment diversification, investors should make appropriate corrections and adjustments according to the actual situation to avoid unnecessary investment losses.

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Disclosure statement

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A Study of the Role of the Board of Directors in Corporate Governance Based on UK Listed Companies

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Abstract: Companies are directed and controlled by corporate governance. It acts on the company internally and externally. The board of directors is responsible for the governance of the company; that is to say, the board of directors is the brain of the company, while corporate governance is the blood distributed throughout the company, which not only supplies blood to the whole, but also reflects the situation. Therefore, with regard to the role of the board of directors in corporate governance, this paper objectively analyzes the importance of the board of directors in corporate governance from theory to practice and from the internal composition of the board of directors to the impact of the board's actions on the enterprise as a whole based on United Kingdom (UK) listed companies.

Keywords: UK listed company; Corporate governance; Board of directors

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1. Introduction

Any listed company will have a board of directors. Some companies that have limited shares require standardized corporate governance during the brokerage counseling period before listing. During this period, the board of directors would have had existed. Ever since Berle and Means pointed out that the core feature of modern companies is the separation in rights of ownership and control, the role of the board of directors in corporate governance has become increasingly prominent [1]. As long as the board of directors has the ability to mitigate risk or boost innovation, the board can make business decisions and guide the development of the company [2]. Without governance constraints, managers are more likely to deviate from the interests of shareholders. Therefore, it can be said that the board of directors is an important factor in the governance structure of large companies in connecting the preceding and the following. The board should not only be responsible for the shareholders' meeting and protecting the interests of stakeholders, but also provide decision-making support for the operation of the management team. How the board of directors affects corporate governance is a practical issue that is worth discussing. The composition of the board of directors lays the foundation for corporate governance, the members of the board guide corporate governance, and the effectiveness of corporate governance is reflected by the development dynamics of the enterprise, which means that the board of directors is the beginning of corporate governance, and the two interact with each other to identify, realize, and manage the enterprise.

In this paper, it is important to first understand how the board of directors is structured. Exploring how the board of directors is structured would enable us to understand the allocation of corporate governance

content. Each member of the board has a value to realize in the process of corporate governance. Therefore, it is important to discuss the impact of board composition on corporate governance. Secondly, it is important to consider how corporate governance is measured. The management's consideration of shareholder rights is a direct reflection of the level of governance in each company. Shareholder equity is seen at the level of shareholder wealth, where shareholders are concerned with how much profit the company makes and how that profit is distributed. In addition to this, the level of corporate governance is reflected in the share price. These measures of the level of corporate governance are determined by the behaviors of the board of directors. Therefore, the impact of the behaviors of the board of directors on corporate governance is also discussed. Last but not least, the role and importance of the board of directors in corporate governance is outlined based on theoretical and real-life examples of corporate governance in UK listed companies.

2. Impact of board composition on corporate governance

One of the roles of the board of directors in corporate governance is to balance the company structure and set up the Committee of the board of directors to form the adhesive for a good company structure. The board of directors includes the Chairman, Chief Executive Officer (CEO), an audit committee, a nomination committee, a remuneration committee, and other board committees [3]. The board needs to handle the relationship with the management in a proper manner. Holding a combination of interests and judiciously authorizing work can increase the flexibility in corporate governance.

The Institute of Directors (IoD) Good Governance Index (GGI) reduces information asymmetry to display the intuitive standard of corporate governance and compare the largest United Kingdom (UK) listed companies. The score consists of five evaluation indicators, one of which is the board effectiveness. In 2017, Diageo PLC gained an average unweighted score of 841, ranking the first worldwide. Based on the 47 data sources collected, the percentage of board meeting attendance was relatively high, corporate governance frameworks were established by the boards, and a clear separation of the roles of the Chairman and the Senior Independent Director was observed.

The UK Corporate Governance Code was released by the Financial Reporting Council. It points out the areas of corporate governance that should receive more attention in the future, including salary distribution, diversity of the board of directors, as well as efficiency and composition of the board of directors. In 2017, women in board positions made up 27% of the Financial Times Stock Exchange (FTSE) 100, a raise from 13% in 2010. The FTSE 100 company ranking proves the importance of gender diversity on the board of directors in corporate governance. ITE Group (listed on the London Stock Exchange [LSE]) transparently matches compensation to performance. The board of directors of ITE Group achieved board transformation and strategic growth through compensation-performance reform. In 2018, De La Rue won the "Corporate Governance Award" from World Finance Magazine, owing to the effectiveness of its board. Good cooperation and mutual support had played a significant role. At the same time, the board had the ability to adapt to the company environment in terms of supervision and governance.

3. Impact of board behavior on corporate governance

Another role of the board of directors in corporate governance is to serve the overall interests of the company as an important decision-making body. The board of directors sets goals and carries out strategies. Through analyzing and approving plans, investigating the use of large capital contingencies, and building strong connections in support of the company's strategy, the value and importance of the board of directors are evident [4].

The board of directors is usually composed of people with experience, resources, and foresight by reasonable planning. Having professional abilities and sound judgement in making decisions would be very helpful in guiding the company. According to the International Register of Certificated Auditors (IRCA),

British American Tobacco PLC (BAT) ranked the first in terms of governance. In its annual report for board performance summary (2016), Chairman Richard Burrows regarded 2016 as a vintage year, driven by a successful strategy. Compared with 2015, the cigarette volume, the share of key market, and other indicators have made progress to varying degrees. Among them, total shareholder return (TSR) was 16.1%, which demonstrated good corporate performance as a Fortune 500 company in 2018. The board includes the Chairman, two Executive Directors, one Senior Independent Director, and seven Non-Executive Directors in the main board and management board. The members of the main board come from seven countries with varied expertise aligned to the needs and provide the leadership. The management board comprises senior leaders with about 300 years of industry experience in total that creates wealth for BAT. BAT also has corporate responsibility and contributed good social benefits to the tobacco industry. The board meets at least six times a year to ensure effective communication. Such a reasonable composition and meeting frequency reduce the possibility of unreasonable decision-making. All members of the board of directors balance each other and serve the overall interests of the company from different directions and angles.

However, regardless of the healthy development of the industry and the finance environment, if the board of directors does not have a correct strategic goal and constantly touches the bottom line to serve itself, it is considered to be poor governance, which may even lead to the bankruptcy and demise of the company. Thomas Cook Group (TCG), the world's first and oldest travel agency, announced that it had submitted an application for compulsory liquidation to the British High Court in 2019. Its share price decreased by 98% from £151 in May 2018 to £3.2 in September 2019. This signifies that the tourism enterprise, which has survived for 178 years, declared bankruptcy. Company failures are often caused by many factors. The decline of tourism or political factor is one of the reasons of TCG failure, but the root cause is poor management. This can be traced back to the huge dividends of nearly £48 million paid to the top management of the board in the past decade [5]. The precarious profits were divided up, in the meantime, the board thought that the British government could allocate funds to save the company. This corporate governance led the company to liquidation. In addition to the profit distribution, the board of directors did not solve the issues related to its own core competitiveness and adaptability. The board failed to grasp the advantages of a century old enterprise, and the accumulated resources could not be effectively transformed to adapt to the industry situation. The board of directors is responsible for the formulation of strategy. This case, on the contrary, demonstrates that the board is intended to ensure the sustainability of the long-term value built.

4. Conclusion

In general, corporate governance and the board of directors are all serving the company; there is no containment relationship intended. Based on the case studies of large listed companies in the UK, this paper analyzes the important role of the board of directors in corporate governance. In terms of corporate governance, an objective composition of the board ensures strategic guidance and effective supervision for the company and management, respectively. The dynamic behaviors of the board of directors demonstrate a concrete realization of the company's strategic development. At the same time, the board of directors demonstrates its responsibility and loyalty to the company and shareholders. Since the establishment of LSE, many companies have experienced ups and downs. Both excellent and poor corporate governance cases have also witnessed the change of board of directors. Corporate governance and the board of directors are growing together. It can be said that corporate governance is inseparable from the role of the board of directors.

Disclosure statement

The author declares no conflict of interest.

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Empirical Analysis of the Relationship Between Altman's Z-Score and Stock Performance Based on Airline Companies Listed in the United States

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Abstract: This research looks at any relevance between Altman's Z-score and the stock market performance of airline companies in the United States (US). Nearly a thousand pieces of data on various aspects of operation and financial status from 81 airline companies in the US are available. Additionally, stock return is used as an indicator of firm stock performance in this paper. In order to satisfy the purpose of determining the relationship between Z-score and stock performance as well as what may be inferred from high stock returns with regard to Z-score, two different regression processes are carried out. The first regression tests the relationship between Z-score and stock return, while the second regression examines whether there is a difference in Z-scores between well-performing airline companies and poorly performing ones using dummy variables. The results reveal that there is a significant positive correlation between the Z-scores of US airline companies and their stock performance; besides, high stock returns potentially imply relatively high Z-scores and vice versa. Therefore, one of the crucial steps that US airline companies must make is to strengthen their balance sheets in order to draw investors to make investments in their businesses.

Keywords: Z-score; US airline companies; Stock performance

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1. Introduction

The United States (US) airline industry has always been an industry with high concentration of assets and risks. The industry is highly vulnerable to changes in the economic environment, including oil prices, labor costs, and the state of economy [1,2]. Additionally, it is easily affected by non-human factors, such as weather condition, natural disasters, terrorist attacks, *etc*. [3]. In the past 20 years, the US airline industry has suffered from the 9/11 terrorist attacks, the overall economic downturn in the United States, and the rise in global oil prices [4]. This industry, which is extremely sensitive to external events, has inevitably suffered a huge blow, and almost every airline company has been affected to some extent. As a result, airline bankruptcies and mergers (acquisitions) have become increasingly common in the past decade [5].

Considering that the airline industry has a high asset density, studying the relationship between the operating conditions of the companies and the performance of their stock market may provide some insights into how to effectively reduce the negative impact of external factors on the performance of the market or to attract investors.

Based on the purpose of this research, this paper selects 81 airlines either from local or abroad but registered in the US. The data samples of each company's operating conditions at different time periods,

with a total time span between 1990 and 2013, are collected and analyzed using Altman's Z-score model to explore two aspects: whether there is a correlation between Z-score and the performance of the stock market and whether there is a significant difference between the Z-scores for companies with poor market performance and those for companies with better stock return. Based on these two discussions, this paper attempts to determine how to attract investors, *i.e.*, whether it is necessary for airline companies to strengthen their balance sheets in order to ensure better stock market performance.

2. Literature review

In 1968, Edward Altman introduced a bankruptcy predictor that is now widely recognized. This predictor is a statistical model that combines five financial ratios to produce a product called a Z-score [6]. It turns out that this model is a reliable instrument for predicting the failure of various business entities. He devised this score as a quantitative measure of bankruptcy risk of firms for investors. According to this theory, a Z-score can be calculated for all non-financial companies, in which the lower the score, the greater the risk of the firm falling into financial distress [7].

Later, Altman suggested the use of a slightly different model when evaluating the financial status of a service company [8,9]. As early as the 1980s, Altman's model has been used in air transport to predict carrier failures, where it successfully predicted the bankruptcy of both Braniff and Continental [10].

3. Stock price and Z-score

In the debate of the relationship between share price and Z-score, Sukmawai *et al*. believe that the Z scoring method has no significant impact on stock prices [11]. Besides, Afrin also supported this conclusion in 2017 [12]. However, Apergis *et al*. have suggested a significant relationship between these two entities, in which the higher the risk of bankruptcy, the lower the share price, and vice versa. They claimed that this is due to holding investors' careful monitoring of companies' bankruptcy level with Z score each time an economic analysis is performed [13]. This conclusion has received support from Issabella, where she found that Altman's Z-score has a significant positive correlation with stocks return, but systematic risk does not add any impact on the latter [14].

Another supporter of the hypothesis that Z-score would have an impact on stock price is Morgan Stanley's strategy analyst, Graham Secker [15], who have ranked European companies with Z-scores. According to Secker, companies with weak balance sheets are considered by lenders to be at higher risk and face higher capital costs, thus causing their share prices to be lower than their peers.

4. Basic information regarding the airline industry

The airline industry is a highly competitive industry worldwide, not only in the US market and other markets in developed countries, but also in those emerging economies, such as India [16] and United Arab Emirates (UAE). This results in a lower margin, which is a typical characteristic of airline companies.

An important characteristic of airline companies is that they operate based on the significant level of fixed costs, derived from the purchases, leases, and maintenance of their aircrafts. In 1999, Behn and Riley pointed out that this specific characteristic limits the validity of past information. Besides that, other important characteristics must not be overlooked; for example, airline companies operate in strong business cycle caused by seasonality, and their profit is inversely correlated with energy prices [17].

With regard to the analysis of the financial status of airline companies, Schefczyk has pointed out the difficulties caused by the different taxation and accounting policies when analyzing several multinational airline corporations [18]. In 2004, Scheraga discovered a strong post 9/11 environment effect on airline companies and asserted that companies with relatively higher operating efficiency does not suggest higher financial mobility [19].

5. Relationship between Z-scores and stock returns

5.1. Data and method

In 1968, Altman came up with the original Z-score model, which can be used to predict bankruptcy. The model is as follows:

$$Z = 0.012X_1 + 0.014X_2 + 0.033X_3 + 0.006X_4 + 0.999X_5 \quad (1)$$

where *X1* = working capital/total assets; *X2* = retained earnings/total assets; *X3* = earnings before interest and taxes/total assets; *X4* = market value of equity/book value of total liabilities; and *X5* = sales/total assets. Before 1980s, the original model successfully predicted bankruptcy in the airline industry. However, due to the substantial increase in the use of lease to finance assets in recent years, the use of off-balance sheet leverage through operating lease will underestimate the assets generating the revenues [20], thereby exaggerating the X_5 variable in the model, which can in turn affect the effectiveness of the model to a certain extent. In view of that, Altman came up with a slightly different model, which can be used to assess the financial condition of service firms. For these reasons, the developed model is used in this paper. The model takes the following form (X_1, X_2, X_3, and X_4 are defined in the same way as the original formula. However, the data are in percentage form):

$$Z = 6.56X_1 + 3.26X_2 + 6.72X_3 + 1.05X_4 \quad (2)$$

First, we calculated the Z-scores. The data for Capital (WACP), Total Asset (AT), Retain Earnings (RE), Earning Before Interest Tax (EBIT), Market Value (MKVALT), and Total Liabilities (LT) were taken directly from Bloomberg. However, the market value data of some companies were incomplete or missing; thus, the sample size was greatly reduced. In order to ensure a more convincing result, we used as many data as we can to conduct the regression tests. The data PRCC (Price Close – Annual), CSHO (Common Shares Outstanding) and PSTK (Preferred/Preference Stock (Capital) – Total) were taken to calculate the market value using the following formula:

$$\text{MV= PRCC* CSHO+ PSTK} \quad (3)$$

Following the steps, we calculated the Z-scores for different companies in different years. A total of 840 results were obtained.

Second, we calculated the stock return by applying the following formula:

$$R_t = Ln\left(\frac{P_t}{P_{t-1}}\right) \quad (4)$$

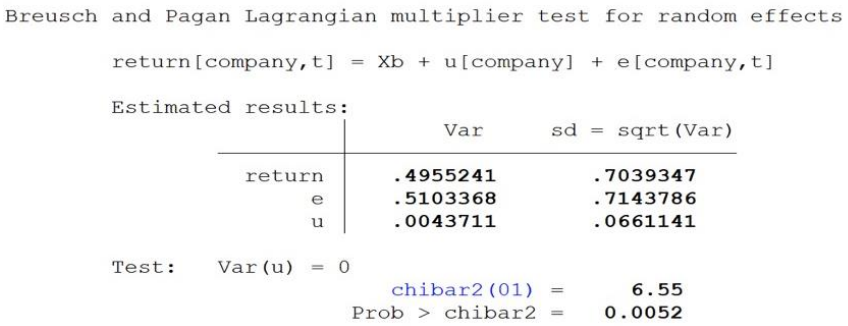
where P_t and $P_{t\text{-}1}$ represent the closing price of year *t* and *t-1*, respectively.

We are unable to obtain the first-year stock returns of the companies because the closing price for year 0 is not known. Moreover, some companies only had one-year data, while some others presented with abnormal data. Since these data cannot be used for regression, they were eliminated.

5.2. Empirical result

We used the panel data to establish the linear regression equation in Stata. We decided to select the best estimator. We first examined the Stock Returns-Z-scores relationship with robust standard errors and ran the random effects generalized least square (GLS) regression. After that, we tested the random effects

model against the pooled ordinary least squares (OLS) model using the Breusch-Pagan (B-P) Lagrange multiplier (LM) test. The results are shown in **Figure 1**.

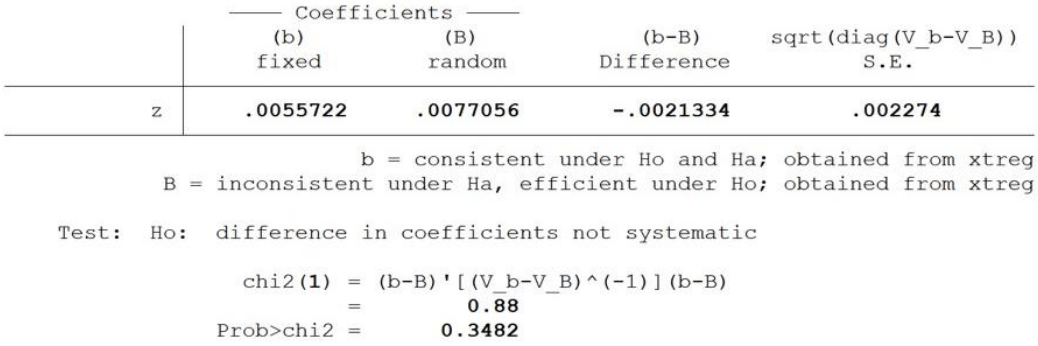


```
Breusch and Pagan Lagrangian multiplier test for random effects

        return[company,t] = Xb + u[company] + e[company,t]

        Estimated results:
                         |       Var      sd = sqrt(Var)
                ---------+------------------------------
                  return |    .4955241        .7039347
                       e |    .5103368        .7143786
                       u |    .0043711        .0661141

        Test:   Var(u) = 0
                                chibar2(01) =      6.55
                              Prob > chibar2 =    0.0052
```

Figure 1. Breusch-Pagan Lagrange multiplier test results

According to **Figure 1**, the p-value is 0.0052, so we reject the null hypothesis and choose the random effects model. We then ran the fixed-effects (within) regression and performed the Hausman test.

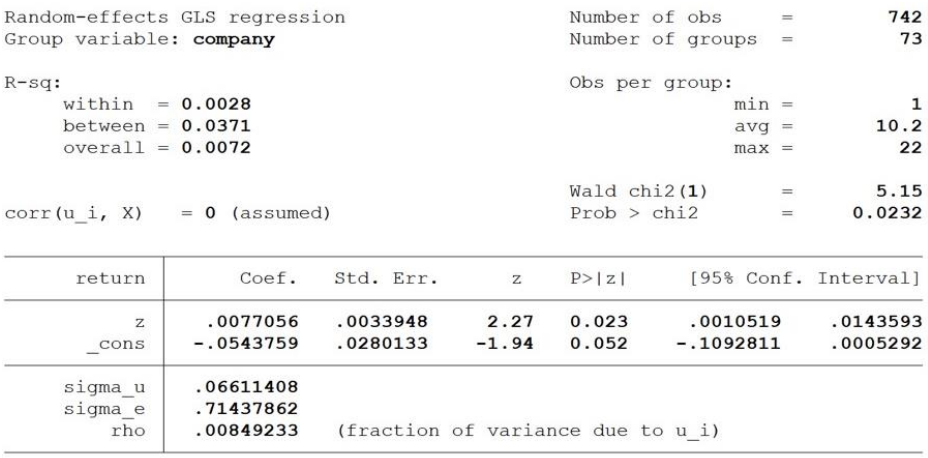
The results shown in **Figure 2** indicate that the null hypothesis cannot be rejected and that the random effects model is the best estimator.



```
                 ---- Coefficients ----
                 |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
                 |    fixed        random       Difference          S.E.
-----------------+------------------------------------------------------------
               z |   .0055722     .0077056      -.0021334         .002274
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(1) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =          0.88
                Prob>chi2 =        0.3482
```

Figure 2. Hausman test results

According to **Figure 3**, the regression equation is R = 0.0077Z – 0.0544. The slope is greater than 0, and the p-value is 0.023, suggesting that Stock Returns has a positive relationship with Z-scores, and it is significant at 95% confidence level.



```
Random-effects GLS regression                   Number of obs      =       742
Group variable: company                         Number of groups   =        73

R-sq:                                           Obs per group:
     within  = 0.0028                                        min =         1
     between = 0.0371                                        avg =      10.2
     overall = 0.0072                                        max =        22

                                                Wald chi2(1)       =      5.15
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0232

------------------------------------------------------------------------------
      return |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           z |   .0077056   .0033948     2.27   0.023     .0010519    .0143593
       _cons |  -.0543759   .0280133    -1.94   0.052    -.1092811    .0005292
-------------+----------------------------------------------------------------
     sigma_u |  .06611408
     sigma_e |  .71437862
         rho |  .00849233   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Figure 3. Random effects model regression

In conclusion, the research and analysis of US airline companies' data showed that there is a relationship between Z-scores and stock returns, in which the two entities are positively correlated. Firms with greater Z-scores tend to have higher stock returns, while those with weaker balance sheets underperformed the stock market. Measures should be taken to strengthen the balance sheets of companies in order to attract investors.

6. Reflection of different stock returns on Z-scores

6.1. Data and method

In order to determine the difference in Z-scores between firms with poor stock market performance and those with better performance, the procedure we followed can be briefly described in three steps: first, defining stock market performance and sorting out the data collected; second, testing the difference in Z-scores between the two general groups; third, concluding the results.

We first ranked the companies' stock performance based on their average historical price return. Since it is not possible to calculate the average stock return for a single year's worth of data and the average stock return for two years is much larger than that of firms with many years' worth of historical price returns, we culled the firms that have only one- or two-year stock returns. A ranking list consisting of the top ten firms with better stock performance and the top ten firms with poor market performance was created (as shown in **Table 1**).

Table 1. List of top 10 companies with better and poor stock performance

Group0	Average Return	Group1	Average Return
CCAIR INC	0.243382	TROPIC AIR CARGO INC	-0.330052
HUDSON GENERAL CORP	0.157466	TRANS WORLD AIRLINES	-0.331950
AIR METHODS CORP	0.155662	PINNACLE AIRLINES CORP	-0.353703
CONTINENTAL AIRLS INC -CL B	0.129239	GREAT LAKES AVIATION LTD	-0.353848
GRUPO AEROPORTUARIO SURESTE	0.128991	TOWER AIR INC	-0.381156
ALLEGIANT TRAVEL CO	0.128468	HAL INC	-0.418944
COPA HOLDINGS SA	0.127507	VANGUARD AIRLINES INC	-0.452353
COMAIR HOLDINGS INC	0.102844	TIMCO AVIATION SERVICES INC	-0.526034
ASA HOLDINGS INC	0.070337	MIDWAY AIRLINES CORP	-0.560758
ALASKA AIR GROUP INC	0.069357	VIRGIN EXPRESS HOLDINGS PLC	-0.604340

6.2. Empirical results

Second, we allocated the data of 20 companies into two groups, with the top ten average historical price return companies in Group 0, and the remaining in Group 1. We used t-test in Stata to examine whether the Z-scores differ based on the companies' stock performance. We formulated a null hypothesis (H0) and an alternative hypothesis (H1), as shown below.

$$H0: \mu z0 = \mu z1$$
$$H1: \mu z0 \neq \mu z1$$

Figure 4 shows the results of the experiment. As can be seen, the calculated value is greater than the critical value at 95% significance level with 180 degrees of freedom, and p-value = 0.000, which is smaller than 0.05, so we reject the null hypothesis and conclude that the means of both groups' Z-scores are different at the 5% level. The mean of Group 0's Z-scores is 3.83, which is higher than that of Group 1.

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	125	3.829601	.5189119	5.801611	2.802529	4.856673
1	57	-2.022742	.8620919	6.508651	-3.74972	-.2957645
combined	182	1.996724	.4893005	6.601025	1.031257	2.962191
diff		5.852343	.9638165		3.950511	7.754176

diff = mean(0) - mean(1) t = 6.0721
Ho: diff = 0 degrees of freedom = 180

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 1.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 0.0000

Figure 4. t-test results

In conclusion, the analysis of US airline companies' data showed that there is a difference in Z-scores between firms with distinct stock performance. Firms that performed better are more likely to have higher Z-scores; on the contrary, those firms that have poor performance tend to have lower Z-scores.

7. Conclusion

This study is based on a number of relevant literatures. Most of these literatures have indicated that Altman's Z-score model is a very effective tool for predicting the likelihood of a company's bankruptcy. The model can also be used to assess, to some extent, the market performance of companies and the stock price trend; however, some studies have demonstrated that Z-scores do not necessarily reflect the stock return of companies.

After screening, processing, and sorting 840 pieces of data generated from 81 airline companies, we attempt to prove the ability of Z-scores in evaluating the market performance of US airline companies. Under the premise of using the annual stock return rate as an indicator of stock returns, this paper finds that Z-scores have a positive correlation with the annual return rate of airline companies in the US market, *i.e.*, a high Z-score implies better market performance in the US market. In addition, this paper divides the sample companies into two groups, one with relatively good market performance and the other with relatively poor market performance, in order to determine whether the Z-scores of the two groups would show significant difference. The results show that, except for Trans World Airlines, the Z-score values will be different provided that the companies' market performances are different: in the US market, the Z-score value of an airline company with high annual return on stock will be higher than that of a company with lower annual return on stock.

The two experiments in this paper, to some extent, prove the effectiveness and feasibility of Altman's Z-score model in evaluating the stock performance of US airline companies. In other words, the strength of a company's balance sheet has certain reference value as an indicator to the outcome of stock return. Therefore, in order to attract more investors, measures should be taken by US airline companies to strengthen their balance sheet, which will be reflected in their stock price ultimately.

Disclosure statement

The authors declare no conflict of interest.

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[1] Yao Y., Xia B. Application of Phase Frequency Feature Group Delay Algorithm in Database Differential Access. Computer Simulation, 2014, 31(12): 238-241.

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Book

Book with one to three authors

[5] Schneider Z., Whitehead D., Elliott D. Nursing and midwifery research: methods and appraisal for evidence-based practice. 3rd edn. 2009, Elsevier Australia, Marrickville, NSW.

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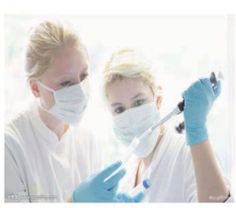
In-service Doctors



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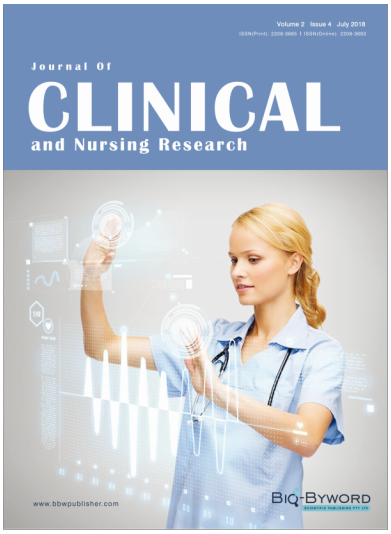

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