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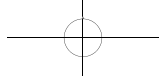
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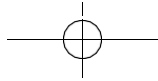
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ISSN (Online): 2209-265X

ISSN (Print): 2209-2641

Submission open for December 2022

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With Warm Regards,

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Proceedings of Business and Economic Studies

Research on the Countermeasures of Smart Tourism Construction in Sanya Under the Background of Free Trade Port Construction

Kun Zhang¹, Xuebin Huang^{1*}, Dongwei Yang¹, Kaparova·Kumushai², Zilu Zhang²

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Abstract: By analyzing the current situation of smart tourism construction in combination with the actual tourism situation in Sanya, this study aims to find out the problems existing in the current smart tourism construction and understand the various factors affecting the smart tourism construction in Sanya. Then, relevant theories and practical applications were used to study the ways to carry out smart tourism construction with the help of policy, location, and other advantages to meet the needs of the development of the times. Based on the study, practical countermeasures and suggestions were given to provide reference for the construction of smart tourism, ensure the continuous improvement of smart tourism construction, and help the upgrading and transformation of tourism in Sanya. Based on the analysis of the construction and data of smart tourism and tourism informatization in Sanya, this article has formed a useful method to help Sanya build an international tourist island and a modern smart tourism city using the Hainan Free Trade Port construction policy.

Keywords: Smart tourism; Construction of free trade port; Traditional tourism; Sustainable development; Tourism informatization

Online publication: September 5, 2022

1. Introduction

In 2009, the first China Tourism Informatization Development Forum (Sanya) proposed the concept of smart tourism, marking its origin in China. Since 2010, the tourism industry has successfully launched the application practice of smart tourism. In 2011, the special plan for informatization of national tourism development plan during the 12th Five Year Plan period proposed to carry out smart tourism demonstration projects nationwide and strive to preliminarily realize “smart tourism” nationwide in about 10 years ^[1]. Mobile phone Internet plus TikTok has accelerated the development of smart tourism. In the era of “Internet plus”, with the emergence of electronic devices such as smart phones, palm computer, and other mobile devices, mobile apps such as micro-blog, WeChat, Xiao Hong, jitter and Alipay, WeChat payment, and other intelligent payment software have brought about constant changes in people’s tourism consumption concepts and methods. People focus more quality, convenience, and experience of tourism. Tourism management departments and tourism enterprises should focus on tourists’ experience and satisfaction, apply information technology industries such as Internet, big data, cloud computing and artificial

intelligence, and digital economy to the real economy, and meet the personalized needs of tourists through the rational use of “smart” means such as integrated communication technology, efficient information processing, and intelligent in-depth data mining. With the integration of information service and management of tourism, smart tourism came into being ^[2].

According to the current development trend of domestic tourism in Hainan province from 2017 to 2030, the development of online tourism market has promoted the upgrading and transformation of tourism industry. Smart tourism is gradually becoming a modern intelligent service industry through the innovation of “Internet plus”. With the emphasis on building a smart tourism service management system and developing smart tourism products, a pilot “travel bubble” (centered on Sanya City was created ^[3]. In July 2020, the office of the group for promoting the comprehensive reformation and opening up in Hainan issued the overall plan for smart Hainan (2020-2025), which proposed to make full use of the new generation of information technology to promote the social and economic development of Hainan, improve the construction of smart Hainan system, build an intelligent experience island for international tourism consumption, and upgrade the tourism service management and marketing model ^[4]. In March 2021, many important contents of the national “14th Five Year Plan” and the outline of long-term goals for 2035 once again involved in-depth smart tourism construction, improving tourism consumption experience, increasing the construction of smart scenic spots, standardizing online tourism services, building Hainan international tourism consumption center, developing digital smart consumption, and accelerating the integrated development of online and offline ^[5]. At present, the construction of smart tourism aiming at improving tourism management and service level in Sanya is ongoing.

As a benchmark city of Hainan free trade port and the only tropical coastal resort tourism city in China, Sanya has been actively exploring and achieved initial results in the construction of smart tourism. In 2017, it won the “China smart city demonstration city” award at the 8th smart city conference held in Beijing. In the same year, it also won the “China smart city innovation” award at the Asia Pacific Smart City selection and award ceremony. In 2020, Sanya was identified as the first batch of national cultural and tourism consumption pilot cities by the Ministry of culture and tourism, the national development and Reform Commission and the Ministry of finance. It can be seen that the information technology industry under construction, rich tourism resources, the booming tourism development status, and the support of various relevant policies have provided Sanya with the basic conditions for the construction of smart tourism. However, Sanya will inevitably encounter a series of problems in the process of carrying out the construction of smart tourism. Therefore, scientific and practical countermeasures need to be put forward to solve the problems existing in the construction of smart tourism in Sanya ^[6].

2. Definition of tourism

2.1. Traditional tourism

Traditional tourism refers to the recreational activities where people temporarily stay from their permanent residence to another place for the purpose of sightseeing, leisure, and entertainment, so as to meet the local knowledge, appreciation, enjoyment, and experience of cultural and natural landscape. There are few types of traditional tourism destinations with a high degree of homogenization of tourism products which are mainly scenic spots. The target market of traditional tourism is mainly the general public. Tourism information is mainly obtained through newspapers, television, and other traditional media by tourists before travelling. Travel agency is the main channel for tourism activities. Besides, tourism products are also ordered through travel agencies and tour groups. Traditional and classic scenic spots are the first choice for tourists. The quality of natural and cultural landscape determines the quality of tourism level. After travelling, tourists share their experience through conversations ^[7]. The operation mode and transaction mode are limited and lack of flexibility. The demand of tourists is not given priority, and the effect of

tourism activities underwhelming, which results in no improvement of the tourism experience. Traditional tourism took place before network information technology was integrated into tourism, and its development has limitations.

2.2. Tourism informatization

The scope of tourism informatization is greater than smart tourism. Tourism informatization is the digitization of tourism information. It involves integration of information technology in various fields of tourism. Tourism consists of traditional service industries such as catering, accommodation, transportation, shopping, and entertainment. Tourism informatization involves collecting and processing tourism information through information technology, and then converting it into words, numbers, graphics, and sound for storage, transmission, and application, so as to redistribute, combine, process, disseminate and sell the tourism industry chain ^[8]. By means of modern science and information technology, the tourism industry is transformed into modern service industry, which is displayed on tourism websites, tourism call systems, digital management, and infrastructure, so as to make the development of tourism more digital, networked, and improve the production efficiency of tourism. When tourism digitization appeared, it solved the problem of information sharing through new system integration technology, but it was only the flow of some system data, which could not fully produce the overall data regarding the demands of tourism. Tourism informatization is the basis for the development of smart tourism.

2.3. Smart tourism

Different from traditional tourism, smart tourism is a new concept derived from the continuous development of information and communication technology. It is not only an upgraded product of tourism informatization development, but also the strategic direction of tourism informatization development. The construction of smart tourism generally belongs to the scope of tourism informatization. The technical system of smart tourism consists of technical framework and technical elements. The technical framework is the collection and application of various information and data through the Internet, Internet of things, and mobile network communication to smart scenic spots, smart travel agencies, traffic command, smart hotels, and other industries. Technical elements include mobile communication technology, Internet of things technology, LBS technology, cloud computing technology, big data technology, and artificial intelligence technology.

The construction of smart tourism is specifically reflected in three aspects: tourism management, tourism marketing, and tourism services. New technologies such as the Internet, cloud computing, big data mining, and handheld terminal devices are used to help tourists, tourism enterprises, and tourism management departments to take initiative in mastering various tourism information resources in the whole tourism process. This improves the connectedness in every aspect of tourism like, food and accommodation, transport, item purchasing. Besides, it also improves the information exchange level and service management level of tourism management departments and tourism enterprises, meets the personalized needs of tourists, and improves tourist satisfaction ^[9].

Smart tourism focuses on people who are good at using smart mobile terminals to obtain public tourism information, and pays more attention to the interactive experience of tourists. Different from the traditional tourism mode of relying solely on tour guides and personal experience to obtain tourism product information and services, the tourism information of smart tourism is more comprehensive, and the sharing of tourism information services in the whole process of tourism is realized at a technical level. The service management system of tourism management departments and tourism enterprises are also more refined,

breaking through the traditional functions of enterprise informatization, e-commerce, and e-government at the application level. Smart tourism can not only realize tourism informatization, but also solve new problems in the process of tourism development, meets the new needs of tourism development, and helps to realize new ideas and ideas of tourism development^[10]. **Table 1** shows the list of the differences between traditional tourism, tourism informatization, and smart tourism

Table 1. List of the differences between traditional tourism, tourism informatization, and smart tourism

Timeline	Type	Access to travel information channels	Where to buy travel products	Share how the travel process
1980–1995	Traditional tourism	Newspapers, TV media	Travel group	Talk-style
1995–2010	Tourism informatization	Network	Network booking	Forums, blogs, and other websites
2010–2021	Smart tourism	Mobile phone	Handset provides overall information services	Weibo, WeChat, and other new media

3. Purpose and meaning of the research

3.1. The purpose of the smart tourism construction countermeasures in Sanya city

Due to difference in tourism resources, economic strength, and level of technical skills, the construction and development of smart tourism is also different. Sanya is located in the southernmost tip of China. It is a popular tourist city at home and abroad. It is also a well-known coastal resort. Its development prospect of tourism is unlimited. In recent years, tourism, as the leading industry in Sanya, is developing rapidly, but its economic benefits, social benefits, and resource and environmental benefits are facing challenges. Although it has been developing in an international tourism destination, the international tourist source is always insufficient, the quality of tourism experience is low, and the development of high, middle, and low-end tourism market is uneven. By analyzing the current situation of smart tourism construction in Sanya and combining with the actual situation of tourism, this study aims to find out the problems existing in the current smart tourism construction in Sanya, understand the various factors affecting the smart tourism construction in Sanya, and use relevant theories and practical applications to study the ways of carrying out smart tourism construction with the help of policy, location, and other advantages to meet the needs of the development of the times. Based on that, practical countermeasures and suggestions were put forward to provide reference for the construction of smart tourism in Sanya, ensure the continuous improvement of smart tourism construction, and help the upgrading and transformation of tourism in Sanya. Through analysis and comparison, and summaries of tourist experiences, we came up with methods to build Sanya into a high-quality, colorful, comfortable, and convenient international tropical coastal tourism city, an international tourism consumption center, promote the integration of industries in various fields, and truly integrate tourism into all walks of life and into the economic development of Sanya, improve the overall social and economic benefits of Sanya, and enable the tourism industry to truly achieve sustainable development.

3.3. Location based service (LBS)

LBS is a service derived from the ability to identify and transmit location information in e-commerce. LBS is defined as an application where the user's location determines the services and information provided. In other words, users can receive the most appropriate service provided by the service provider according to

his location at a specific time. Therefore, both the users and content providers can benefit from it. In addition to meeting business needs, its services can also be extended to general consumer applications, in which different services can be provided to consumers according to their different locations. Recently, telecom companies in many countries are actively introducing new applications of information services. Due to its location-tracking ability in mobile communication, LBS is expected to play an important role in the telecommunications industry. However, the problem with LBS is that it is aimed at mobile users. Because the operation interface of Web services of mobile devices is completely different from that of computer web services, any complex application services will lead to consumer resistance ^[11]. Therefore, the development of LBS must make effective use of mobile devices and correctly introduce recommendation mechanism.

$$ScoreR = \sum_{i=1}^n \sum_{j=1}^m W_{I_i} a_j \times I_i a_j \quad (1)$$

ScoreR represents the recommendation score given by the system. The number of attribute items is n , and the number of values of each attribute item is m . $I_i a_j$ represents the j -th attribute value in the i -th attribute item in the advertisement. $W_{I_i} a_j$ represents the user preference represented in the j -th attribute value of the i -th attribute item.

In addition, the recommendation system also has an important function, that is, the ability to record user behavior and build personalized “historical data”. By analyzing the “historical data”, the goal of making the recommended items closer to the actual user preferences can be achieved. In the design of recommendation mechanism, a recommendation equation with different recommendation scores based on item attribute form is proposed.

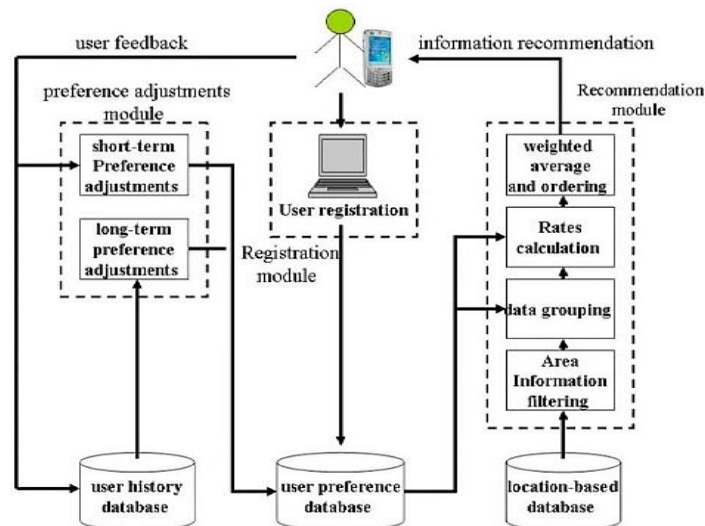
Location-based information is a set of items that portray location attributes. Assuming that H_{ik} is an attribute set of LBS items, and then datasets can be represented as follows:

$$\begin{pmatrix} (H_{11}, H_{12}, H_{13}, \dots, H_{1m},) \\ (H_{21}, H_{22}, H_{23}, \dots, H_{2m},) \dots \\ (H_{n1}, H_{n2}, H_{n3}, \dots, H_{nm},) \end{pmatrix} \quad (2)$$

$$i = 1, 2, 3, \dots, n \text{ (the number of data items)} \quad (3)$$

$$k = 1, 2, 3, \dots, m \text{ (the number of attributes)} \quad (4)$$

Data sets include dynamic and static attributes. Since static attributes do not affect user preferences, this search will not use static attributes when calculating recommendation scores. On the contrary, dynamic attributes can be simply divided into two types: digital attributes and directory attributes. Therefore, the recommendation scores will be calculated according to these two different attribute types ^[12]. The specific model structure is shown in **Figure 1**.



The location-based service recommendation model can integrate mobile services and realize personalization and location-tracking. The model is divided into registration module, recommendation module, and preference adjustment module, which are interconnected through the database.

3.4. The significance of the smart tourism construction countermeasures in Sanya

The construction of smart tourism is the result of scientific and technological progress and the development of the information age. It is also an inevitable requirement for the transformation and upgrading of traditional tourism to modern tourism. The degree of smart tourism construction in a place determines the level of development of local tourism and also affects the level of local socio-economic development. Smart tourism can not only improve the service management level of tourism enterprises and tourism management departments, help tourists more convenient, personalized, and efficient to achieve tourism purposes and meet tourism needs, but also promote the construction of modern economic system and urban construction in Sanya, as well as improve the opening-up level in the field of tourism consumption and the comprehensive competitive strength. The construction of smart tourism in Sanya is in line with the spirit of the 19th National Congress of the Communist Party of China and the overall requirements and strategic direction of socialism with Chinese characteristics in the new era. It is an important deployment of China's reform and opening up 40th anniversary and Hainan Province's 30th Anniversary Special Economic Zone to adhere to reform and innovation, implement new development ideas and supply side structural reform. Therefore, it is imperative. This study can not only enrich the theoretical system of smart tourism construction in Sanya, but also has great practical significance to improve the smart tourism construction in Sanya and promote the economic and social development of Sanya.

4. Review of local and international research

4.1. Summary of local and international smart tourism research

Domestic scholars' research on smart tourism mainly focuses on two aspects: theory and practice. On one hand, it is about the concept of smart tourism, mainly from two angles: one is to discuss the concept of smart tourism from the perspective of means of tourism development and tourists; another one is to discuss the concept of smart tourism from the perspective of tourism management, service, and marketing. On the other hand, it is mainly about the construction and practical application of smart tourism system, focusing

on smart tourism public service system, smart tourism comprehensive management system, and smart tourism marketing system. Through reading and analyzing retrieved foreign literatures, it was found that foreign scholars' research on smart tourism also focuses on two aspects which are theory and practice.

4.2. Analysis of local and international research status

Scholars at home and abroad have studied smart tourism from both theoretical and practical aspects. In the research on the concept of smart tourism, the content ranges from the perspective of tourists to tourism service, management, and marketing, thereby putting forward the related research on practical application. By combining the core viewpoints of high-quality local literature and abroad, and classifying and comparing their theories, it can be found that the pertinence and practicability of foreign research on smart tourism are very prominent. First of all, smart ecotourism system for tourism destinations need to be formed, and the construction of smart tourism need to be combined with the construction of smart cities, so as to realize the integrated development of multiple industries. The sharing of tourism information resources needs to be maximized, the development of the whole tourism supply chain needs to be improved, and fair distribution of the benefits of tourism development in the local society needs to be ensured, which will more conducive to the harmonious and healthy development of tourism. Secondly, an integrity system of the tourism market needs to be established by using the network evaluation platform to help tourists in searching information before travelling through effective data exchange, reduce the risks encountered during purchase, improve tourism quality, and enable tourists to spend more in tourism destinations. Besides, it provides a service guarantee for tourists which will help in realizing a benign and sustainable development of a smart tourism industry chain.

In contrast, domestic research on smart tourism focuses on service, management, marketing, and other development models in theory and practice. Practice precedes theory. Most of them are through scientific demonstration, induction and summary of the existing service, as well as management and marketing technologies and methods in tourism scenic spots, hotels, and other industries. This creates a practice first technical system, causing lack of overall research, loss of direction in specific practices, and waste of resources. First of all, in practice, the pilot construction of smart tourism is mainly aimed at the scenic spot. Although it has achieved initial results, its practicability needs to be improved. Compared with the construction of smart tourism abroad, it is lacking in the development of ecotourism, does not integrate the resources of various industries in the city to form a complete tourism supply chain, and the sharing of tourism information and data is insufficient. Secondly, each research direction is also relatively independent, and there is a lack of detailed research on different aspects as well as combining different aspects as a whole. The wisdom of smart tourism should be based on data, integrating the services, management and marketing data of tourism, realizing "Internet plus" big data, and accelerating the integration of management and control platform. According to the current situation and development needs of smart tourism construction, attention should be given to the self-scalability of tourism information system design and development.

5. Research methods

The research methods mainly include literature research, comparative analysis, questionnaire survey and field interview. The specific research methods are as follows:

5.1. Literature research method

Literature research method is an investigation and research based on the collection of previous research results. In this study, the data was collected from China National Knowledge Infrastructure (CNKI), Baidu

Academic, VIP, and other foreign academic websites and library materials. Besides, a large number of relevant literatures and information regarding the development process of smart tourism at home and abroad were sorted out. The core concept connotation of smart tourism were studied and understood, and the achievements made in the construction of smart tourism and its related theories at home and abroad were summarized. Furthermore, the relevant reports on the construction of smart tourism in Sanya were comprehensively analyzed by collecting the mainstream media and official networks, as well as the relevant documents issued by the government on the construction of smart tourism in Sanya. In this way, more theoretical basis for this study can be provided thus ensuring the reliability of this study.

5.2. Comparative analysis

By analyzing the successful cases of domestic smart tourism construction, the success factors were summarized and used as references in this study. Through comparison and comprehensive thinking, it was found that there is a gap between Sanya's smart tourism construction and other successful domestic smart tourist spots. Sanya's own characteristics were incorporated to learn from each other and explore the path of smart tourism construction in line with the actual situation of Sanya.

5.3. Questionnaire survey method

Questionnaire survey is a research method widely used in the field of social science research. In this study, a Sanya smart tourism experience questionnaire were created using “questionnaire star” intelligent software and was distributed through WeChat. This platform was used due to its openness thus making the questionnaire data more comprehensive. With that, the current situation and existing problems of smart tourism construction in Sanya can be better understood. Then, the statistical data and opinions and suggestions in the questionnaire were sorted out for in-depth research.

5.4. Field interview method

By diving deep into tourism management departments, scenic spots, hotels, travel agencies, and other tourism enterprises, participating in observation and experience, interviewing relevant personnel, personally experiencing the construction of smart tourism in Sanya, more first-hand data were obtained, enhancing the credibility of the research, and providing an effective basis for this research and analysis. The detailed technical route is shown in **Figure 2**.

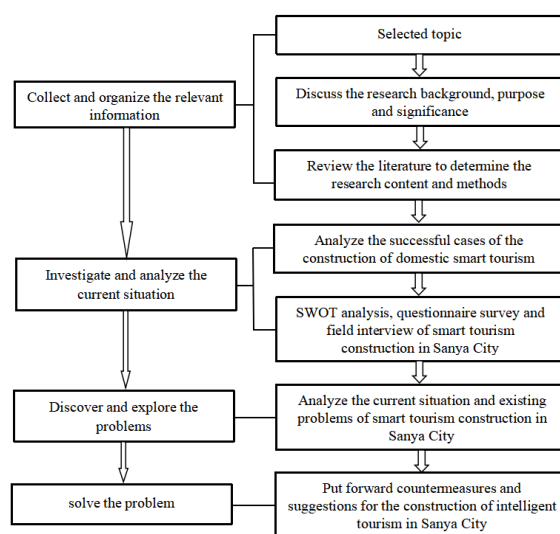


Figure 2. Technical route

6. Conclusion

From the above analysis, this study is mainly based on the new public service theory, new public management theory, AISAS (Attention-Interest-Search-Action-Share) marketing theory, and smart tourism 3S (Sun, Sea, and Sand) theory. The smart tourism construction in Sanya was used as an example, the current situation of smart tourism construction in Sanya was investigated through a variety of research methods, and the existing problems were analyzed. Countermeasures for the construction of smart tourism in Sanya were also put forward from the perspective of tourism management departments, tourism enterprises and tourists, as well as smart tourism service, management, marketing, and talent training. Based on the research on the construction of domestic smart cities, this paper draws a conclusion that the construction of smart tourism and smart cities should also learn from foreign experience, use the new generation of information technology, optimize the allocation of tourism resources, integrate resources, nurture professional talents, and realize the goal of Sanya's comprehensive development of tourism construction.

Funding

This research was financially supported by the Sanya Planning Projects of Philosophy and Social Sciences (Project Number: SYSK2021-06), the Key Laboratory of Island Tourism Resource Data Mining and Monitoring, Ministry of Culture and Tourism (Project Number: KLITRDMM 2022-03), and the 2021 "Double First Class" Construction Project of General Universities in Hainan Province: "Business Management (Marine and Island Tourism)" (Project Number: 2021-9-3).

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Central People's Government Portal, 2012, Tourism Administration: China Will Strive to Preliminarily Realize "Smart Tourism" in 10 Years, viewed November 8, 2012, http://www.gov.cn/jrzq/2012-11/08/content_2260257.htm
- [2] Zhang K, Zhu J, Zhang W, 2020, Proceedings of the 2020 International Conference on Education, E-learning and Social Science (EELSS 2020), June 20–21, 2020: Research on the Tourism Destination Development of Hainan's Uninhabited Islands under the Construction of Free Trade Area, Beijing, 225–233. <https://doi.org/10.12783/dtssehs/eelss2020/34621>
- [3] Hainan Provincial People's Government General Office, 2017, Overall Tourism Development Plan of Hainan Province from 2017 to 2030, viewed December 8, 2017, <https://www.hainan.gov.cn/hainan/szfbgtwj/201712/a95c8633397e44298a7b5eb4a2e746ee.shtml>
- [4] Zhang K, Zhu J, Wang H, et al, 2020, Research on Tourism Destination Development and Countermeasures of Hainan Island Without Residents Under the Background of Free Trade Zone Construction – Taking Jiaping Island as an Example. *Advances in Social Science, Education and Humanities Research (ASSEHR)*, 455: 216–223.
- [5] Liu C, (eds) 2021, The 14th Five Year Plan for National Economic and Social Development of the People's Republic of China and the Outline of Long-Term Objectives for 2035, viewed March 13, 2021, http://www.gov.cn/xinwen/2021-03/13/content_5592681.htm

- [6] Zhang K, Shen C, Li H, et al., 2020, Direction of Arrival Estimation and Robust Adaptive Beamforming with Unfolded Augmented Coprime Array. *IEEE Access*, 8: 22314–22323.
- [7] Editorial Board of Introduction and Practice of Smart Tourism, (eds) 2013, Introduction and Practice of Smart Tourism. Science Press, Beijing, 1–8.
- [8] Li Y, Chao X, Shen Y, 2013, Smart Tourism – From Tourism Informatization to Tourism Intelligence. Beijing: China Tourism Press, 1–8.
- [9] Baidu Encyclopedia, n.d., Smart Tourism, viewed January 15, 2020, <http://baike.baidu.com/view/5217093.htm>
- [10] Xie Y, 2016, Research on Early Stage Demand of Smart Tourism Construction — Taking the Construction of Smart Tourism Demonstration Circle in Wenjiang District, Chengdu as an Example. *Tourism Overview*, 2016(2): 158–159.
- [11] Kuo M-H, Chen L-C, Liang C-W, 2009, Building and Evaluating a Location-Based Service Recommendation System with a Preference Adjustment Mechanism. *Expert Syst. Appl.*, 36(2): 3543–3554.
- [12] Zhai K, Jiang B and Chan WK, 2014, Prioritizing Test Cases for Regression Testing of Location-Based Services: Metrics, Techniques, and Case Study. *IEEE Transactions on Services Computing*, 7(1): 54–67.

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Research on Financial Lease Pricing Model

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Abstract: Financial leasing is a financial innovation product with leasing and financing functions. The research on the theory of financial leasing and risk pricing methods should be highly valued. Rent is set based on the total revenue of the lessor and the total cost of the lessee. The factors that affect pricing include project costs, security deposits, fees, lease terms, revenue, interest rates, *etc.* Using the principle of net present value to elaborate the components of financial leases and constructing a financial lease pricing model from the perspective of maximizing the profit and interests of the lessor, an empirical analysis of the model was carried out using an actual case, thus concluding that the model is effective.

Keywords: Financial lease; Pricing model; IRR

Online publication: October 12, 2022

1. Introduction

Financial leasing is a transaction activity in which the lessor purchases leased goods from the supplier, leases them to the lessee for use, and collects rent from the lessee according to the lessee's requirements for the leased goods and the supplier. Financial leasing has financing attributes, and it is a product of the development of market economy to a certain extent. In view of its flexible transaction structure and absence of collateral, financial leasing has been favored by customers since its launch. The penetration rate of the financial leasing market in the United States, Canada, Australia, and Spain has exceeded 20%, becoming the second largest financing method after bank credit.

The leasing industry has entered a high-growth period and benefited from the development of bank-based leasing companies. The establishment of financial leasing companies by banks is not only an inevitable market-oriented operation, but also the result of interest rate marketization. Bank-based leasing companies have flexible transaction structures, multiple profit models, strong financing capabilities, no established deposit and loan spread returns, no housing and land collateral required, and their pricings are not bound by interest rate controls. Therefore, under the conditions of interest rate marketization, an in-depth study of lease pricing methods and models is conducive to the construction of credit pricing models, the adaptation of banks to the competitive environment of interest rate marketization, and their core competitiveness.

Whether from theoretical research or empirical research, financial lease pricing is the core of financial leasing research. From existing studies, there are financial lease pricing based on certain perspectives and also financial lease pricing for a single industry. First of all, neither industrial differences are fully considered nor the different operating characteristics of different industries are integrated to design different pricing schemes in financial lease pricing. Secondly, the design of the pricing scheme of financial leasing products is inflexible in the design of the rental payment method and does not take into account the real economic activities of the lessee, especially the outflow and inflow patterns of the lessee's operating cash

flow. A lease transaction involves three parties and two contracts, namely the purchase contract between the lessor and the supplier as well as the lease contract between the lessor and the lessee. The two contracts correspond to each other, are intertwined, and mutually exist; together, they constitute a financial leasing transaction. Although the lessee is not a party to the purchase contract, the terms of the purchase contract shall be approved by the lessee and the lessee's terms shall be confirmed by the lessee. Although the supplier is not a party to the lease contract, it should be accepted that the leased property of the purchase contract will become the leased property of the lease contract and be shipped directly by the supplier to the lessee. Financial leasing plays a role in serving the real economy. In financial leasing transactions, higher requirements have been put forward for financial lease pricing due to the individual needs of lessees, risk avoidance of lessors, and the development of the financial market.

We reviewed several studies under Section 2 and established a pricing model under Section 3. We discussed the results and analyzed a case under Section 4. We then concluded the study in Section 5.

2. Literature review

The initial results of research on financial lease pricing are as follows: Ding Yong and Ge Xiang ^[1] quantified the factors affecting the pricing of aircraft depreciation, tax credit, and residual value, and used the net present value method to conduct a static study on leasing pricing; according to Yang Chunmei ^[2], the main factors affecting the rental pricing of the leasing formula include the leasing company's discount rate, the purchase price of the leased property by the leasing company, and the rate of return required by the leasing company; the study analyzed the income fluctuation model under the influence of interest rate risk, default risk, and exchange rate change; White Clarke Group published a global leasing report ^[3] that includes real-time information of the global leasing industry, sorted out the current situation and development of the global mainstream leasing companies, and provided authoritative data of the global leasing industry; Chen Wei Ting and Huang Kuan Cheng ^[4] proposed that with improvement in asset-liability ratio, financial leasing is conducive to reducing costs by establishing a lease pricing model; based on the cost plus method, combined with the lessor's investment in financial leasing aircraft projects, Wu Guoxiang ^[5] constructed a lessor's aircraft financial leasing rent pricing model under the condition of dynamic interest rate financing and used the Monte Carlo method, based on the CIR Interest rate model, to simulate the path of dynamic financing interest rate, discount the initial investment cost, expected profit, risk return, and management expenses of the lessor, as well as calculate the rent under this path, concluding that the Monte Carlo simulation method can be used to theoretically determine the rent price.

The focus of financial lease pricing research has been on option pricing theory. There are challenges in applying the aforementioned methods due to the difficulty in quantifying a company's value. This paper uses a case of financial leasing, adheres to the basic concept of asset pricing model, analyzes the basic elements that affect lease pricing, establishes lease pricing models, and conducts an empirical analysis.

3. Model

3.1. Pricing principle

The lessor owns the leased property, and the lessee pays rent to the lessor on a regular basis. The ownership of the leased property is transferred to the lessee after the lessee pays the rent. From the lessee's perspective, financial leasing is preferred over purchasing, owing to the lessee's own business development strategy and market risk management level. When using a financial lease to procure a leasehold appraisal, it is a requirement of the lessee that the discounted value of the benefit of the leased item is greater than that of the rental income. With financial leasing, the lessee is able to control costs, maintain the stability of cash flow, prevent fluctuations in net profit caused by fluctuations in interest rates, and achieve profit growth. The centralized procurement of leased goods allows for preferential prices, and the bargaining power of

customers can be improved through financial leasing. Financial leasing companies have stronger market risk management level and financing ability with respect to their professionalism.

Leasehold is an investment instrument; the lessee pays the rent on time, and the lessor receives a stable cash flow. The risks faced by the lessor include the lessee's credit default and financial market fluctuations. The lessee's credit risk can be hedged by mortgage or margin. The lessor's lease price includes the follows: the first is principal and interest, in which the principal is the cost of the initial investment, while the interest is generated by the lessor's installment payments; the second is expected profit and risk reward, where the lessor uses the leased property as an investment instrument, with a purpose of obtaining a return on investment and a reward for risk; this means that the lessor obtains a reward for risk based on the lessee's creditworthiness; the third is transaction costs, which include fees incurred, salaries, travel expenses, *etc.*

3.2. Influencing factors of pricing models

On the lessee's side, when calculating the annual rental payment, the size of the expected revenue from the operation of the project may vary to a significant degree among companies of different nature and operating levels. The factors that affect lease pricing are revenue, cost, tax rate, depreciation, *etc.*, as shown in **Table 1**.

Table 1. Factors to be considered by lessees when pricing a lease

Factors	Parameters	Meaning
Cost	V_t	Lease cost in period t
Revenue	F_t	Lease revenue in period t
Lease term	n	Lease term
Principal amount	I	Principal amount
Tax rate	π	Tax rate
Rent	H	Rent per period
Residual value	S	Residual value at end of period
Discount rate	i_0	Discount rate
Depreciation period	j	Depreciation period
Depreciation amount	Z_t	Depreciation charged in period t

From the perspective of the lessor, the costs and risks of the financial leasing project need to be considered in the pricing process. The factors that affect pricing are the cost of capital, the cost of risk, the cost of carrying out the project, the term of the lease, and the expected rate of return. The total revenue comes from the rent paid by the lessee in the financial leasing project. The handling fee and deposit are paid in a lump sum, but can be apportioned to the rent of each period. These factors are further discussed in **Table 2**.

Table 2. Factors to be considered by lessors when pricing a lease

Factors	Parameters	Meaning
Cost of risk	R	All risks included
Cost of funds	C	Cost of funds
Purchase cost	u	Price
Rent	H	Rent per period

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Factors	Parameters	Meaning
Lease duration	N	Lease duration
Age of aircraft	Y	Years of use
Down payment percentage	λ	Percentage without financing
Residual value rate	ε	Residual value rate
Depreciation	Z_t	Depreciation per period
Cost of capital	b	Cost of capital
Risk premium	w	Risk premium
Depreciation period	N_0	Depreciation period
Tax rate	π	Tax rate
Discount rate	i_0	Discount rate
Earnings rate	g	Revenue net of cost of capital and cost of risk
Internal rate of return	IRR	Real rate of return

3.3. Model establishment

The determination of rent is a game between the lessor and the lessee to maximize revenue. From the lessee's perspective, financial leasing expands the scale compared to the purchase of equipment, which is more beneficial to the customer's own operations and superior in financing difficulties. From the lessor's perspective, the premise of financial leasing is that the expected recovery will cover the total investment in the project and bring profit. Financial lease pricing considerations include calculating the price of rent distribution and rent based on the lessor's cost, while taking into account of the lessee's risk and the lessor's expected profit; as well as considering the lessee's rental affordability, where the discounted value of the rent should be less than the lessee's additional benefit from the lease.

3.3.1. Pricing models for lessees

The lease price is affected by the rights, obligations, risks, and rental payment method. The rental price can be determined only by setting reasonable trading conditions. The following assumptions are made: (1) the lease contract stipulates that the ownership of the leased property is transferred to the lessee after the payment of the last installment of rent; (2) the lessee has a stable income; (3) the lessor uses leverage lease, the initial investment is raised from the market, and the lessee provides guarantee. The equal principal method is used by the lessor to repay the capital. The rolling loan method is adopted, and the principal and interest repayment method is consistent with the lease contract. The lessee should meet the basic assumptions when using financial leasing; the present value of rent should be less than the profit and tax saving effect of the lessee, which can bring benefits to customers.

When

$$F_t = \frac{F(i_0 + 1)^n i_0}{(i_0 + 1)^n - 1}, \quad V_t = \frac{V(i_0 + 1)^n i_0}{(i_0 + 1)^n - 1}, \quad \text{and} \quad \sum_{t=1}^n \frac{(1 - \pi)(F_t - V_t) + D_t \pi}{(i_0 + 1)^t} \geq \sum_{t=1}^n \frac{H}{(1 + i_0)^t},$$

the results are as follows:

$$\sum_{t=1}^n \frac{(1 - \pi)(F_t - V_t) + D_t \pi}{(i_0 + 1)^t} \times \frac{(i_0 + 1)^n i_0}{(i_0 + 1)^n - 1} \geq H.$$

Therefore,

(1) if depreciation is accrued by the sum of years method,

$$Z_t = \frac{2(1-t+j)}{j(1+j)} \times (I-S);$$

(2) if the straight-line depreciation method is adopted,

$$Z_t = \frac{I(S+1)}{j};$$

(3) if the double declining balance depreciation method is adopted,

$$Z_t = \frac{I}{2} \times \left[\left(1 - \frac{2}{j} \right)^{j-3} - S \right]$$

$$Z_t = I \times \left[\left(1 - \frac{2}{j} \right)^{t-1} - \left(1 - \frac{2}{j} \right)^t \right]$$

There are many factors that affect the rental income, such as risk preference and credit rating, so the transaction structure must be designed according to the needs of customers. The risk portfolio management requirements and risk management objectives are achieved using the risk premium to adjust the asset structure.

3.3.2. Pricing models for lessors

Trading conditions may have an impact on the yield. The impact of different trading conditions on the lease offer is analyzed. The following assumptions are made: (1) customers can generate stable cash flow; (2) the principle of profit maximization for lessors; (3) the equal principal method is the rental payment method. Direct leases, which generally use the equal principal method, are considered in this paper. The payment method of rent is postpaid without security deposit.

For the lessor, the present value of the cost recovery is the purchase price of the aircraft less the salvage value and the present value of depreciation. Translating this cost into rent is shown in the following equation:

$$H = \left[u(1-\varepsilon) - \sum_{t=1}^N \frac{Z_t \pi}{(i_0 + 1)^t} \right] \frac{IRR(IRR+1)^n}{(IRR+1)^n - 1},$$

where $\frac{IRR(IRR+1)^n}{(IRR+1)^n - 1}$ is the investment return factor, and $\left[u(1-\varepsilon) - \sum_{t=1}^N \frac{Z_t \pi}{(i_0 + 1)^t} \right]$ is the purchase cost of the machine net of salvage value less the tax credit gain. $IRR = b + w + q$.

When the lessor's return is 0, $IRR = b$.

(1) When $N_0 \leq Y$,

$$H = u(1 - \varepsilon) \frac{b(b+1)^n}{(b+1)^n - 1};$$

(2) When $N_0 - N \leq Y \leq N_0$,

$$H = \left[u(1 - \varepsilon) - \sum_{t=Y}^{N_0} \frac{Z_t \pi}{(i_0 + 1)^n} \right] \frac{b(b+1)^n}{(b+1)^n - 1};$$

(3) When $0 \leq Y \leq N_0 - N$,

$$H = \left[u(1 - \varepsilon) - \sum_{t=1}^{Y+N} \frac{Z_t \pi}{(i_0 + 1)^n} \right] \frac{b(b+1)^n}{(b+1)^n - 1}$$

The rent is related to the market power of the lessee and the lessor. Small airlines have weak resistance to market risk and high credit risk, resulting in weak bargaining power and high rents for small airlines and leasing companies; on the other hand, big airlines have an advantage in market share and scale and will hold down rents. In market segment regional aircraft leasing, some leasing companies have a monopoly in the selection of aircraft, fleet planning, and lease term; the rent is the result of negotiations between the two sides.

4. Analysis

Considering macroeconomic and regional economic characteristics, the pricing offset by industry risk premium and regional risk premium, leasing company funding sources, and liquidity risk pricing are not only conducive to the use of price leverage to optimize the asset mix and adjust the asset structure, but also to the achievement of business objectives and risk management.

The pricing model established is used in the empirical analysis. The financial reports published by Shanghai Stock Exchange were compiled to analyze the composition of NH Airlines' fleet and estimate the annual cash flow that a particular aircraft could generate. Subsequently, the data were used in the pricing model for analysis to derive the model's quoted price, and the quoted price was compared with the transaction price of the actual business to verify the reasonableness of the model.

The revenue structure of NH Airlines is shown in **Table 3**.

Table 3. Proportion of income in 2019

Revenue	Amount (M USD)	Proportion
China	16,320.14	68.74%
Europe	2,687.58	11.32%
North America	2,191.37	9.23%
Asia-Pacific	2,542.75	10.71%
Total	23,741.84	100%

In terms of the percentage of aircraft types, NH Airlines' aircraft types are divided into passenger and cargo aircraft. NH Airlines' 2019 fleet composition is shown in **Table 4**.

Table 4. Number of aircrafts in 2019

Model	Self-possession	Financial leasing	Operating lease	Total
380	4	1	0	5
350	0	8	0	8
330	4	29	12	45
320	96	103	116	315
787	4	25	8	37
777	8	21	0	29
737	157	81	163	401
747	2	0	0	2
EMB190	6	0	6	12
ARJ21	1	4	0	5
Total	282	272	305	859

NH Airlines' return on equity (ROE) is shown in **Table 5**.

Table 5. Financial analysis (M USD)

Year	Net profit	Income tax	Shareholders' equity	Depreciation	Interest	EBIDT	ROE
2019	476	150	12,092	2,323	1,138	4,087	3.94%
2018	531	159	12,015	2,077	785	3,552	4.42%
2017	1,051	302	9,554	2,046	169	3,568	11%
2016	906	271	8,415	1,831	892	3,900	10.77%

Abbreviations: EBIDT, earnings before interest and taxes; ROE, return on equity

The data in **Table 5** were taken from the financial statements in NH Airlines' annual reports from 2016–2019. EBIDT, which is an abbreviation for earnings before interest and taxes, is the net income plus interest, depreciation, and corporate income tax for the year. Using EBIDT to determine the company's revenues is more logical than using net income because the airline industry is capital-intensive with high depreciation charges, and NH Airlines has high financial leverage and pays a high amount of interest per year. Adding net income to the current year's depreciation, interest, and income taxes paints a better picture of the airline's profitability.

The aircraft types for European and North American routes are mainly large passenger aircrafts, such as the A350 and B787, and the revenue from this segment is excluded from EBIDT as a percentage of total revenue. Most of the Chinese domestic airlines operate international routes at a loss, and extrapolating the above ratios to estimate the revenue of aircraft other than those flying to Europe and the United States would underestimate the EBIDT. From the financial leasing company's perspective, a deal can be reached if the final pricing rate is within an acceptable range for both parties.

With the exception of European and American routes, the revenue from other routes accounts for 79.45% of the total revenue, and the EBIDT is 18,862.89M USD ($18,862.89 = 23,741.84 \times 79.45\%$). The models that generated this EBIDT and the relevant data are shown in **Table 6**.

Table 6. Number of aircrafts

Model	Number	Seating capacity	Total seats
A330	45	301	13,545
A320	315	177	55,755
B737	401	159	63,759
Total	761	637	13,3059

This short- and medium-haul model has a 79.93% level passenger load factor, and the EBIDT generated is 178.43K USD (178.43K USD = 18,862.89M USD/[13,3059*79.45%]).

The case study is based on Boeing B737. One B737 can generate an annual revenue of 25.09M USD (25.09M USD = 177*18,862.89/13,3059). The above data were matched with the model parameters shown in **Table 7**.

Table 7. NH Airlines' related data

Parameter	Amount (M USD)	Description
$F_0 - V_0$	25.09	Cash flow in period 0
u	76	Boeing 737 price
Z_t	3.8	Depreciation amount
N_0	20	Depreciation period
π	25%	Tax rate
q	6%	Growth rate
i_0	3.80%	Discount rate
ROE	7.53%	Return on net assets

In **Table 7**, the Boeing B737 price is the price of the B737 aircraft purchased by NH Airlines in December 2019, the discount rate is the interest rate of China's three-year treasury bonds, the growth rate is projected according to the level of China's GDP growth, and the return on net assets refers to the average of the last 4 years for NH Airlines.

Following the input of the above data into the established pricing model, it has been found that NH Airlines paid a minimum of 6.12M USD and a maximum of 8.43M USD per year with an IRR between 5.71% and 10.65%.

5. Conclusion

This paper establishes a financial lease pricing model based on the financial lease offer strategy, taking into account the cost of capital, operating capacity, depreciation, residual value, and other factors. The model was empirically validated through a case study of Boeing B737 aircraft lease pricing, concluding that the model can provide a more accurate price floor for financial leasing companies. Based on the established pricing model, once the transaction price floor of the financial leasing company is determined, the financial leasing company can play the price game with the lessee according to the market competition and develop a leasing plan that is more in line with the maximization of revenue based on its own price floor. If there are other parameters that are measured and found to have a greater impact on the lease pricing results in the aircraft leasing case, these parameters can be dealt with by referring to the aforementioned method of establishing the pricing model, so as to further optimize the existing model and better protect the interests of the financial leasing company.

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Ding Y, Ge X, 2015, Pricing Model Research on Aircraft Operating Lease. *Journal of Xi'an Aeronautical University*, 2015(7): 16–22.
- [2] Yang CM, Liang CH, Wang ZS, 2015, Innovative Research on Financial Lease Pricing – Portfolio Decomposition Method Based on Complex Real Options. *Financial Market*, 2015(3): 90–92.
- [3] The White Clarke Group, 2017, Global Leasing Report, The White Clarke Group, London, 1–16.
- [4] Chen WT, Huang KC, Ardiansyah MN, 2018, A Mathematical Programming Model for Aircraft Leasing Decisions. *Journal of Air Transport Management*, 69: 15–25.
- [5] Wu GX, Zeng XZ, Shen JY, 2019, Research on the Rent Pricing of Aircraft Financial Leasing Based on Monte Carlo Simulation. *Journal of East China Jiaotong University*, 2019(6): 64–71.

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An Exploration of the Existing Problems of Enterprise Asset Restructuring Accounting, the Causes, and Their Countermeasures

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Abstract: With the rapid development of social economy, the sense of urgency among enterprises is increasing. The primary reason for this is the fierce competition among enterprises. As an important strategy for establishing a modern enterprise system, asset restructuring plays a pivotal role in improving the economic efficiency of enterprises, optimizing the allocation of social resources, and promoting both, social and economic development. Therefore, based on the existing problems of enterprise asset restructuring accounting, this paper discusses the causes of the accounting deficiencies in enterprise asset restructuring from various perspectives, including asset restructuring concept, financial authority and responsibility authority, as well as commercial credit, and subsequently proposes corresponding optimization strategies, which include strengthening asset valuation, enhancing information disclosure of connected transactions, improving relevant accounting standards, as well as strengthening information audit and improving related systems.

Keywords: Asset restructuring; Accounting problems; Analysis of causes; Optimization strategies

Online publication: October 21, 2022

1. Introduction

It is important to analyze the existing problems of enterprise asset restructuring accounting, the causes, and their countermeasures.

1.1. Research background and significance

With the expansion of economic globalization and the deepening of international division of labor, there is a high degree of integration in the world economy. Economic integration is the result of contemporary world economy and a trend reflecting long-term stable development in the future. For enterprises, it is of utmost importance to meet the development trend of market economy and occupy a presiding position in the fierce market competition^[1]. In the face of continuous competition and improvement, enterprises will eventually undergo asset restructuring; hence, analyzing the existing problems of enterprise asset restructuring accounting, the causes, and their countermeasures is critical.

1.2. Current status of local and international research

The current status of local and international research is relatively sound.

1.2.1. Accounting practice in asset restructuring

There are two methods. The first is the equity combination method, which involves the union of two or more parent companies to another subsidiary or group under them in terms of economic or other aspects ^[2]. The second is the purchase method. This method involves the merger of one or more companies for cash or the transfer of assets, the assumption of debt or the issuance of stock, as well as the acquisition of rights to control their net assets.

With regards to the accounting practice in asset restructuring, China adopts a combination of both methods in dealing with businesses ^[3]. Theoretically speaking, the purchase method can better reflect the essence of asset restructuring, but the development of appraisal institutions and even China's market economy is still flawed. However, it is feasible to adopt the purchase method of accounting to replace the equity method for business restructuring provided that the market economy improves.

1.2.2. Accounting standards and system level

The national accounting standard is an established system of the current management process system for state asset restructuring. However, this accounting standard has certain irregularities in some aspects, especially those pertaining to the recognition of profit and loss as well as the measurement and calculation of profit and loss attribution for asset restructuring in the actual accounting work ^[4]. Although most of the listed companies in China adopt enterprise asset restructuring, which can effectively avert the accounting disadvantages and loopholes that may be brought about by the traditional enterprise accounting method, and thus promote the convergence of the asset restructuring accounting standard and other international accounting standards by modern Chinese enterprises, its practical role is still limited ^[5].

At present, China only has a general management for asset restructuring without any specific guidelines to regulate it, which permits enterprises to take advantage of these gaps. Therefore, there is a need for the relevant management to make strict and explicit regulations as soon as possible to improve the restructuring of assets ^[6].

1.2.3. Accounting environment level

The accounting management activities of many large companies is primarily carried out in an economic environment with a certain degree of objective reality following asset restructuring. If the accounting environment we now live in is not above average, the work carried out after asset restructuring will be cumbersome, thus leading to inefficiencies.

First of all, economic and social activities are often the sequelae of various enterprise accounting problems, including the corruption and illegal accounting practices of many large companies ^[7].

As a result, the actual work of enterprises will be substantially more than the pre-planned cost. This is not conducive to the sustainable development of enterprises in the long run.

A more standardized and accurate accounting information collection, which is strictly in accordance with the high standard quality requirements of enterprises, can effectively improve the quality of enterprise accounting information collection. In China's enterprise system reform, maintaining international financial stability and other aspects plays a role in promoting the development of its capital foreign currency market ^[8].

1.2.4. Financial reporting level

Some listed companies believes that the primary goal of launching preparations for asset restructuring is to be able to achieve the beautification of financial statements in a relatively short period of time. However, the actual purpose is to optimize the allocation of resources by enhancing the core competitiveness of listed companies and to transform the expenses arising from the loss of assets into company profits through

effective and legal means.

The consolidation of financial statements of the parent company and the group over which it has control of is required to understand the company's operations and obtain aggregated information on the various divisions of the company^[9]. These consolidated financial statements of the parent company are required to prevent the parent company from transferring assets or assuming liabilities and internal transactions to obtain and manipulate profits.

Therefore, in order to preserve the company's external investors' and shareholders' confidence in the company's blueprint as well as to prevent fluctuations in the company's share price, the usual tactic used in the process of mergers and acquisitions is the preparation of consolidated financial statements and a deliberate whitewashing of these statements to disguise them as required by the group company through its control relationship with the parent company and subsidiaries, thus categorizing them as enterprises generating high profits and releasing false financial reports. This engenders restructuring a tool for some enterprises to whitewash their financial statements and achieve the purpose of artificially manipulating enterprise profits, which would inevitably affect their long-term development^[10].

2. Analysis of the causes of accounting deficiencies in enterprise asset restructuring

Enterprises may have various accounting deficiencies in the process of asset restructuring. Therefore, it is imperative to analyze the causes of these deficiencies.

2.1. Asset restructuring concept

Large enterprises do not have the resources to carry out business activities, while small enterprises simply do not have the ability and lack professional and technical personnel to carry out business management activities^[11]. The dominant position of enterprises often causes significant problems in corporate awareness or management concepts, such as satisfying the status quo of enterprises and not seeking for everything as well as the sole focus of enterprises in seeking for regularity, but not advancement. This fully reveals the poor management of some of our large enterprises and also the primitive moral concepts, poor risk awareness, and weak awareness of benefit distribution of some of our large enterprise managers^[12].

2.2. Financial authority and responsibility authority

Managers are directly linked to the management of enterprises, while shareholders are responsible for enterprises as their legal entity. Investors should accurately grasp the major strategic decisions of state-owned asset restructuring. Additionally, when exercising their power, they must control the major corporate financial budget issues accurately and decisively, consider the direction of state-owned enterprises for a sound and healthy development, as well as improve the stability of capital in the future development stage of enterprises^[13].

2.3. Commercial credit

Commercial credit is a loan relationship between enterprises formed in a commodity transaction due to late payment or advance receipt of payment. Many state-owned enterprises are using it at this stage. During the economic transition period in China, it is not an easy task for enterprises to borrow from the bank; thus, when enterprises are unable to borrow from the bank, commercial credit has become a way for external financing^[14]. As the economy in China continues to grow in real terms, banks are becoming more and more stringent in their lending conditions to enterprises, and commercial credit is gradually replacing bank lending. However, more research is needed on the problems encountered by enterprises in obtaining commercial credit and borrowing from third parties through commercial credit^[15].

3. Optimization strategies for enterprise asset restructuring accounting

3.1. Strengthening asset valuation

As the primary component of asset restructuring in China, asset valuation is pivotal in the process of enterprise asset restructuring. Firstly, it is necessary to strengthen the supervision of relevant valuation agencies, so that they can truly become the principal organs of the national unified asset management services in the true traditional sense of the contemporary state-owned asset management appraisal service industry in China. Secondly, it is imperative to enhance the basic professional ethical standards and relevant professional and technical qualities of the practitioners in fixed asset valuation service institutions. The development prospect of the enterprise asset valuation management business is directly affected by the professional qualification of asset valuation managers^[16]. By setting a series of technical standards that are both, broad and guiding for industry valuation institutions' practice management, it is possible to achieve accurate regulation of industry appraisal management results by relevant technical standards. Relevant valuation laws and regulations can be established and optimized through research. In that way, government valuation investigators and business valuation investigation results would be based on laws and regulations, thus achieving a fair competition in the industry^[17].

3.2. Enhancing information disclosure of connected transactions

In the process of enterprise asset restructuring, certain connected asset transactions that are jointly carried out between listed companies and other unrelated companies are ineffective in helping these companies avoid taxes and regulate corporate profits in the long run. Therefore, regulating the public disclosure of information on other related asset transactions have significant guiding significance in the process of asset restructuring, whether for effectively realizing the reasonable allocation and use of investors' and other relevant co-interest holders' funds or for promoting the effective optimization and rational allocation of resources as well as improving the operational efficiency of our market^[18].

3.3. Improving accounting standards and system level

High-quality accounting standards can improve the quality of accounting information. They also play certain roles in promoting enterprise reform and the development of capital markets to maintain financial stability. Therefore, it is important to strengthen the publicity work and education for relevant personnel, as well as strictly manage the accounting personnel within the enterprise and evaluate their professional capabilities to achieve merits^[19]. In order to ensure that the aforementioned strategies are implemented, enterprises should increase their publicity, so that the accounting standards would be able to reside in the hearts of every employee and manager, thus enabling them to effectively play their own roles^[20].

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Zhang H, 2021, Reflections on Accounting for Intra-Group Asset Reorganization. *Modern Industry*, 2021(12): 174–175.
- [2] Wang M, 2022, Research on the Protection of Small and Medium Shareholders in Major Asset Restructuring of Listed Companies. *Climbing*, 41(1): 103–111.
- [3] Liu S, 2017, Research on Financial Accounting Issues of Asset Restructuring of Listed Companies. *Mall Modernization*, 2017(10): 217–218.

- [4] Liu B, Li A, Du M, et al., 2021, The Impact of Asset Restructuring. *International Journal of Frontiers in Sociology*, 30(8): 121–124.
- [5] Meher BK, Puntambekar GL, 2018, Asset Reconstruction Companies: An Analysis of Growth (A Case Study of ARCIL). *Abhigyan*, 36(1): 11–20.
- [6] Zhang B, 2017, Research on Financial Problems and Countermeasures of Enterprise Asset Restructuring. *Knowledge Economy*, 2017(1): 110–111.
- [7] Yu J, 2018, Research on Accounting Issues in Enterprise Asset Restructuring. *Financial Accounting Study*, 2018(29): 116–117.
- [8] Cascio WF, Chatrath A, Christie-David RA, 2020, Antecedents and Consequences of Employment and Asset Restructuring. *Academy of Management Journal*, 2020(10): 134–144.
- [9] Li H, Chen Q-X, Hong L-Y, et al., 2019, Asset Restructuring Performance Prediction for Failure Firms. *Journal of Corporate Accounting & Finance*, 30(4): 151–168.
- [10] Ao N, 2018, Analysis of Accounting Issues in Corporate Asset Restructuring. *Chinese and Foreign Entrepreneurs*, 2018(18): 5–8.
- [11] Wu N, 2018, Research on Accounting for Corporate Asset Restructuring. *Modern Business*, 2018(16): 139–144.
- [12] Shen Z, 2018, Discussion on the Problems of Asset Restructuring of State-Owned Enterprises and Its Measures. *Enterprise Reform and Management*, 2018(19): 22–26.
- [13] Fan S, 2018, Research on the Financial Synergy Effect of Corporate M&A Restructuring. *Enterprise Reform and Management*, 2018(16): 120–127.
- [14] Kuai L, 2017, Accounting Problems of Asset Restructuring and Its Improvement Strategies. *Journal of Zhejiang Industrial and Commercial Vocational Technology College*, 2017(3): 6–8.
- [15] Li Y, 2017, Research on Accounting Issues in Asset Restructuring. *Finance and Economics (Academic Edition)*, 2017(22): 87–88.
- [16] Li S, Yang R, Yang N, 2022, Research on the Effect of the Approval System for Major Asset Restructuring. *Financial Research*, 2022(07): 190–206.
- [17] Kang L, 2021, Analysis of Financial Accounting Issues of Enterprise Asset Restructuring. *Contemporary Accounting*, 2021(14): 80–82.
- [18] Zheng Y, 2021, Research on the Application of Asset Restructuring in Resolving the Risk of Local Non-Performing Assets. *Modern Marketing (Academy Edition)*, 2021(7): 151–153.
- [19] Olga Em, 2019, Improving the Restructuring of Distressed Assets Through Securitization on Emerging Markets. *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, 2019(8): 21–35.
- [20] Li S, 2019, Analysis of Accounting Problems Involved in Enterprise Asset Reorganization and Thoughts on Improvement. *China Township Enterprise Accounting*, 2019(10): 80–81.

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A Study of the Impact of Fiscal Decentralization on the Efficiency of Public Health Expenditure

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Abstract: In this present-day global pandemic that has not been completely resolved, health is a major concern among people, and correspondingly, people are demanding higher standards for public health products and services provided by the government. In this paper, we measure the technical efficiency of public health expenditure in each province by using the data envelopment analysis (DEA) model, and examine the impact of decentralization on the efficiency of public health expenditure under the fiscal decentralization system using the panel data from 31 provinces from 2012–2019 in a panel model subject to fixed effects.

Keywords: Fiscal decentralization; Fiscal expenditure efficiency; Public health expenditure

Online publication: October 21, 2022

1. Introduction

The question of whether fiscal decentralization is conducive to more efficient public health expenditure requires further discussion.

With the outbreak of the pandemic, public health issues have garnered widespread attention from all around the world. The efficiency of public health expenditure is directly related to the health environment in which the public lives. The efficiency of public health expenditure in all regions of the country has been a concern as the scale of expenditure increases. In addition, the existence of the “sticky paper effect” in fiscal decentralization has caused an inefficiency in the use of central to local transfer funds ^[1-6]. Therefore, in the context of China’s fiscal decentralization, it is necessary to further investigate the impact of fiscal decentralization on the efficiency of public health expenditure.

2. Theoretical analysis

2.1. Positive impact of fiscal decentralization on the efficiency of public health expenditure

First, the competition in public health services will stimulate the efficiency of public health expenditure in each locality. As proposed by Tiebout ^[7] in 1956, fiscal decentralization has inspired local governments to design various tax systems and public goods delivery mechanisms based on local realities. Second, the reduction in the size of government improves the efficiency of public health expenditure. Generally speaking, when the size of the relevant sector of public health expenditure is reduced, the operating cost of the sector will also be reduced, thus forcing the health sector to improve its overall expenditure efficiency ^[8-13]. Third, the reduction of corruption following decentralization will increase the efficiency of public health expenditure. Arian ^[14] argues that the higher the degree of fiscal decentralization, the greater the horizontal competition among governments, and the lesser the corruption. Furthermore, the number of

voters is another reflection of the performance of local governments, which can place competitive pressure on local officials.

2.2. Negative impact of fiscal decentralization on the efficiency of public health expenditure

First, the reduction in the size of government public health expenditures reduces the efficiency of public health expenditures. The efficiency of public health expenditure is affected by the fact that each government will voluntarily reduce the tax rate in its region due to the competition for capital and residents, which in turn reduces local tax revenues^[15-19]. Second, the efficiency of government health expenditure is reduced by increasing the size of government. According to Oates^[20], fiscal decentralization leads to an increase in the size of government in China. The reduction in the size of government cannot be explained by this principle. Third, the increase in corruption reduces the expenditure efficiency. There is no academic consensus on the impact of horizontal competition among governments on corruption under fiscal decentralization.

3. Evaluation of the efficiency of public health expenditure

3.1. Test method for efficiency evaluation

In this study, the data envelopment analysis (DEA) model oriented to the output was used. Since the payoffs to scale of public health outputs are changing as the public health expenditure profile changes, the final model used was the BCC model with variable payoffs to scale and an output-oriented model. If the k^{th} assessment unit is DMU $_k$, and the efficiency score is h_k , then its efficiency assessment input-oriented BCC model is as follows:

$$\begin{aligned} \max h_k = & \sum_{r=1}^s u_r Y_{rk} - u_0 \\ \text{s. t. } & \sum_{i=1}^m v_i X_{ik} = 1 \\ & \sum_{r=1}^s u_r Y_{rj} \sum_{i=1}^m v_i X_{ij} - u_0 \leq 0, \\ & j = 1, \dots, n; u_r, v_i \geq \varepsilon, r = 1, 2, \dots, s, i = 1, 2, \dots, m \end{aligned} \quad (1)$$

3.2. Data source

The five output indicators of fixed reported infectious disease incidence rate and population mortality rate of 31 provinces were used as the efficiency decision unit (DUM). Meanwhile, the data used in this article were from China Health Database, China Macroeconomic Database, and relevant health data reports in the EPS data platform from 2012–2019. In this paper, 31 provincial governments across China were selected as the research subjects, and considering the timeliness of the empirical analysis and the availability of data, the data of 8 consecutive years from 2012–2019 were selected for the empirical analysis.

3.3. Analysis of measurement results based on the DEA model

From the analysis results, Hainan and Qinghai are the provinces that are on the frontier surface and are relatively efficient. The public health expenditures in these areas are characterized by high output and reasonable input structure. Provinces with relatively high efficiency are Liaoning and Hunan, whose efficiency values are above 0.7. For these provinces, the way to achieve high efficiency is to maintain the existing level of public health expenditure inputs, further reduce redundant inputs, and effectively manage public health expenditure. Relatively inefficient provinces are remote areas with low-income levels, such as Jiangxi, Guizhou, and Yunnan, with output efficiency values below 0.6.

4. Empirical analysis of fiscal decentralization on the efficiency of public health expenditure

Having obtained these results on the efficiency of public health expenditures, a new model is needed to

study the impact of the role of fiscal decentralization in it.

4.1. Indicator selection

The fiscal decentralization indicator was measured as the ratio of local per capita fiscal budget expenditure to national per capita fiscal budget expenditure and expressed as Fd . From the economic and social perspective, three control variables were set: regional economic development level ($Agdp$), local general public budget revenue ($Arevenue$), and population density ($Density$).

4.2. Data description

The data in this paper were obtained from China Urban and Rural Construction Database, China Finance and Taxation Database, and China Macroeconomic Database in the EPS data platform. Public health expenditure efficiency, as the core explanatory variable, refers to the integrated technical efficiency (EFF) evaluated by the DEA model. Fiscal decentralization, as the key explanatory variable, was quantified using local per capita fiscal budget expenditure divided by national per capita fiscal budget expenditure. The three control variables, which included the economic development level of each region, local general public budget revenue, and population density, were processed. The descriptive statistical characteristics of the variables are shown in **Table 1**.

Table 1. Descriptive statistical characteristics of variables

Variable name	Variable meaning	Quantity	Average value	Standard deviation	Minimum value	Maximum value
EFF	Integrated technical efficiency	248	0.720	0.249	0.159	1
Fd	Degree of fiscal decentralization	248	1.084	0.591	0.562	3.656
$Agdp$	Gross domestic product per capita	248	10.84	0.422	9.889	12.01
$Arevenue$	Total general budget revenue	248	16.74	0.952	13.37	18.66
$Density$	Population density	248	7.874	0.404	6.939	8.620

4.3. Econometric model

Based on the basic structure of the model and relevant studies from previous literature, the following baseline regression econometric model was obtained:

$$EFF_{it} = \beta_0 + \beta_1 Fd_{it} + \beta_2 Agdp_{it} + \beta_3 Arevenue_{it} + \beta_4 Density_{it} + \epsilon_{it} \quad (2)$$

4.4. Analysis of empirical results

Table 2. Results of fixed effects regression

Variables	(1) EFF	(2) EFF	(3) EFF
Fd	-0.4108** (0.1787)	-0.8255*** (0.1656)	-0.8938*** (0.1763)
$Agdp$		0.0251 (0.1561)	0.0035 (0.1622)

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Variables	(1) EFF	(2) EFF	(3) EFF
Areveue		0.5985*** (0.1466)	0.6266*** (0.1555)
Density		-0.1514 (0.0987)	-0.1946* (0.1039)
Constant	1.1655*** (0.1943)	-7.4800*** (1.2876)	-7.4321*** (1.3821)
Observations	248	248	240
R-squared	0.0239	0.2882	0.2954
Number of var8	31	31	30
Province FE	Y	Y	Y

Note: standard errors in parentheses; *** $P < 0.01$, ** $P < 0.05$, * $P < 0.1$

From **Table 2**, it can be seen that the antecedent coefficient of fiscal decentralization is negative, indicating that fiscal decentralization has a significant negative impact on the efficiency of public health expenditure. Second, the level of economic development, local general public budget revenue, and the control variable set to population density in model 2 have different effects on the efficiency of local health care expenditure. Third, since the degree of financial autonomy of the Tibetan local government is low, the regression results of model 3 were obtained after excluding the extreme variable of the degree of financial decentralization in Tibet, and there was no obvious change in the significance level of each variable, thus verifying the conclusion of the negative effect of financial decentralization on the efficiency of public health expenditure.

5. Conclusion

On the one hand, the overall level of China's public health expenditure's efficiency has declined since 2014 with certain regional differences, and the decline in its scale is the main reason for the decline in its efficiency. Although there is a certain degree of inefficiency in public health expenditure, the performance varies from province to province, and each province adjusts its scale of investment according to its own situation. On the other hand, control variables were also added to investigate the effect of fiscal decentralization on the efficiency of public health expenditure, which can also be used to examine the effect of other influential factors on the efficiency of public health expenditure in each province. This study concludes that fiscal decentralization is significantly detrimental to the efficiency of local public health expenditure, which is in line with the majority of studies emphasizing on the negative effect of fiscal decentralization on the efficiency of local public goods supply.

Funding

This study was supported by the Foshan Social Science Planning Project in 2022, based on "How to Improve the Enterprise Service System and Promote the Reform of the Foshan Business Enabling Environmental System" (Project Number: 2022-ZDA01), Foshan Social Science Planning Major Project in 2022, Foshan Social Science Federation, 2022(5); and the Student Academic Foundation of Foshan University in 2022, based on "Cultivating a Refreshing 'Soft Environment' to Build 'Hard Power' for Development: A Study on the Influencing Factors and Enhancement of Business Environment in Foshan Oriented on Entrepreneurial Satisfaction" (Project Number: xsjj202214zsa02), Communist Youth League

Foshan University Committee, 2022(6).

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Bouckaert G, 1992, Productivity Analysis in the Public Sector: the Case of the Fire Service. *International Review of Administrative Sciences*, 58(2): 175–200.
- [2] Retal VB, 1993, Risperidone as Add-On Therapy in Behavioural Disturbances in Mental Retardation: A Double-Blind Placebo-Controlled Cross-Over Study. *Acta psychiatrica Scandinavica*, 87(3): 167–171.
- [3] Fare R, Grosskopf S, 1997, Profit Efficiency, Farrell Decomposition and the Mahler Inequality. *J Economics Letters*, 57(3): 283–287.
- [4] Wang J, 2007, Research on the Size of Government Health Expenditure in China-Three Misconceptions and Empirical Evidence. *Management World*, 2007(2): 27–36.
- [5] Han HW, Miao YQ, 2010, An Empirical Study of Local Government Health Expenditure Efficiency Accounting and Influencing Factors-DEA-Tobit Analysis Based on Panel Data of 31 Chinese Provinces. *Finance and Economics Research*, 36(5): 4–15 + 39.
- [6] Grossman M, 1972, The Demand for Health: A Theoretical and Empirical Investigation. *Michael Grossman*, 137(2): 279.
- [7] Tiebout CM, 1956, A Pure Theory of Local Expenditures. *Journal of Political Economy*, 64(5): 416–424.
- [8] Xiao HX, Zhou F, Shao CX, 2011, Accounting for the Efficiency of Local Government Health Expenditure and Analysis of Influencing Factors. *Statistics and Decision Making*, 2011(23): 80–83.
- [9] Tu Y, 2015, A Study on the Efficiency of China's Government Health Care Spending and Its Influencing Factors. *Finance and Accounting Monthly*, 2015(33): 69–73.
- [10] Hayek FA, 1945, Social Goals and Economic Institutions by Frank D. Graham. *Journal of Political Economy*, 53(2): 177–179.
- [11] Chen S, Zhang J, 2008, A Study on the Efficiency of Local Government Expenditure in China: 1978–2005. *China Social Science*, 2008(4): 65–78.
- [12] Besley T, Ghatak M, 2007, Reforming Public Service Delivery. *Journal of African Economies*, 16: 127–156.
- [13] Fisman R, Gatti R, 2002, Decentralization and Corruption: Evidence Across Countries. *Journal of Public Economics*, 83(3): 325–345.
- [14] Arian GG, 2004, Fiscal Decentralization: A Remedy for Corruption?. *International Tax and Public Finance*, 11(2): 175–195.
- [15] Wellisch D, Hulshorst J, 2000, A Second-Best Theory of Local Government Policy. *International Tax and Public Finance*, 7(1): 5–22.
- [16] Sun R, Gao Z, 2016, Research on the Efficiency of Medical and Health Financial Expenditure and Its Influencing Factors in Gansu Province. *Economic Research Reference*, 2016(17): 40–47.
- [17] Lin X, 2016, The Impact of Fiscal Decentralization on the Efficiency of Local Public Health Care Service Supply. *Finance and Economics*, 2016(08): 6 + 8.

- [18] Vanden EP, Tulkens H, Jamar MA, 1993, Cost efficiency in Belgian Municipalities, Core Discussion Papers.
- [19] Bardhan P, Mookherjee D, 2000, Capture and Governance at Local and National Levels. *The American Economic Review*, 90(2): 135–139.
- [20] Heinberg JD, Oates WE, 1972, The Incidence of Differential Property Taxes on Rental Housing: An Addendum. *National Tax Journal*, 25(2): 221–222.

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Estimation of Ecological Compensation Standards in the Yellow River Basin

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Abstract: It is crucial to establish a reasonable ecological compensation mechanism for the Yellow River Basin. This study uses a calculating model to estimate the value of the total cost of ecological protection in the upstream. On this basis, an apportion model is used to reach the ecological compensation standard value of each province in the midstream and downstream. The results provide a scientific reference for the ecological compensation standards in the Yellow River Basin.

Keywords: Ecological compensation; PES; Yellow River Basin

Online publication: October 21, 2022

1. Introduction

The Yellow River is the foundation and lifeblood of social and economic progress in China ^[1]. With the proposal of ecological protection and high-quality development, the establishment and improvement of the ecological benefit compensation mechanism for this basin is essential. It is necessary to consider the present stage and future of the Yellow River Basin under the environmental constraints. Various policies are emphasizing the core role of eco-compensation in the development of the Yellow River Basin and guiding the establishment of an eco-compensation mechanism for the basin.

The existing eco-compensation mechanism for the Yellow River Basin is flawed. This paper designs a model to reach the compensation value and proposes the key directions for promoting and improving the future construction of eco-compensation for the Yellow River Basin. The construction of a higher-level eco-compensation is called for in order to support the environment and usher in a better eco-service. This study reaches the exact values of the compensation, thus providing reference for the eco-compensation of the Yellow River Basin.

2. Literature review

The concept of “ecological compensation” is mostly attributed to payment for ecological services (PES), which involves the coordination of the interests of all parties through institutional arrangements and the internalization of the externality of ecosystem services. Its essence embodies the contribution of the party that destroys the ecosystem to the contributors of ecological protection ^[2, 3].

A scientific and reasonable eco-compensation standard is the key to balancing the interests of the compensation subject (usually the downstream area) and the object (usually the upstream area), which affects whether the compensation mechanism can function effectively ^[4-6]. At present, the standard accounting methods for eco-compensation in basins include the method of production service function value and measuring willingness, as well as the method of cost and expense ^[7]. The majority of scholars

believe that the key to determining the eco-compensation standard is to estimate the opportunity cost and eco-service value provided. In social practice, special attention should be paid to opportunity cost and information asymmetry. The actual implementation of ecological compensation standards should be between the opportunity cost sacrificed by ecological service providers and the benefits earned by beneficiaries ^[8-13].

There are apparent regional differences in terms of development among the provinces of the Yellow River Basin. The development quality and resource efficiency of the central cities in the east are better than those in central and western areas ^[13]. In the upstream, the ecological environment is fragile; hence, the protection and improvement of eco-services should be the main focus. In the midstream and downstream, the balance between economic and ecological development should be ensured through systems such as eco-compensation ^[14].

Lack of institutional arrangements, uncertain compensation standards, and other loopholes are emerging in the compensation practice in China ^[15-17]. Domestic scholars tend to focus on the quantification of compensation in basins, the determination of the system, and the division of the scope of protection. The majority of studies are only based on a single reach of the Yellow River Basin ^[18,19]. Therefore, this paper analyzes and constructs the game behaviors and strategies of the upstream and downstream of the transboundary watershed. Adopting the opportunity cost method to measure the loss in the upstream area and calculate the compensation amount in the midstream and downstream may provide a reference for improving the horizontal eco-compensation mechanism and promoting the improvement of the river basin ecosystem as well as the realization of the overall economic balanced development of basins.

3. Study area and data

3.1. Study area

The flow area of the Yellow River Basin accounts for about one-third of China's land area. However, the comprehensive development level of the basin is relatively subpar. The differences in characteristics, the ecological vulnerability of the basin, and over-exploitation problems are evident; the regional economic gap is widening; the ecological environment endowments, the environmental carrying capacity, and environment itself are limited, with scarce water resources. In recent years, there have been many interruptions, and the midstream is under great pressure to control the discharge of pollutants in the watershed.

The study area is based on the nine provinces of the basin. The upstream provinces included Qinghai, Gansu, Inner Mongolia, Sichuan, and Ningxia, while the midstream and downstream provinces included Shaanxi, Shanxi, Henan, and Shandong. Since the economic value of primary and secondary industries in Sichuan is higher than the average level of all the provinces in China, this study did not consider the compensation for Sichuan Province.

3.2. Data collection

The eco-compensation standard is a complex system. Based on existing studies ^[19,20], we selected several indicators to construct a model that could be used to measure the value of compensation, considering different relating factors of eco-compensation, data availability, and scientific objectivity. The values of gross national product, ecological construction and protection cost, investment in the treatment of wastes, and other data in the provinces from 2011 to 2020 are also obtained from China Statistical Yearbook and China Environmental Statistical Yearbook.

4. Materials and methods

4.1. Construction of an evaluation index system

There are different relating factors of eco-compensation. Based on scientific objectivity and data availability, we selected several indicators to construct an evaluation index system of standards of eco-compensation for the basin to measure the value of compensation.

$$R = C_t \times K_f \times K_m \times E_d \quad (1)$$

Among them, C_t is the total annual cost of ecological protection in the upstream, and K_f represents water allocation coefficients; K_m represents the water quality correction coefficient, while E_d represents the benefit distribution coefficients. Since the water quality of the Yellow River's main stream is generally good, with 90.93% of the water reaching Class III water standard, take 1 as the value of K_m .

The water allocation coefficient is the proportion of water consumed in the downstream area to the total:

$$K_f = W_d/W_t, 0 < K_f < 1 \quad (2)$$

According to the hydrological series from 1956 to 2010, adopted in the "Revision Report on Hydrological Design Achievements of the Yellow River Basin," the annual average natural runoff reaches 48.2 billion m³, of which the total water diversion in the upper streams is 13.39 billion m³; thus, $K_f = 0.278$.

4.2. Basin eco-compensation model based on opportunity cost

We selected relevant indicators to construct an evaluation system to measure the cost. Based on previous literature^[20], we calculated the cost and compensation amount of the upstream from three aspects: water quantity, water quality, and benefit distribution. We collected the data from the statistical yearbooks of various provinces. The calculation model of the annual compensation amount is as follows:

$$C_t = C_1 + C_2 \quad (3)$$

where C_t is the total annual cost of ecological protection in the upstream, C_1 is the water allocation coefficient, K_m is the water quality correction coefficient, and C_2 is the benefit distribution coefficient.

$$C_2 = (D_r - U_r) \times N_r + (D_c - U_c) \times N_c \quad (4)$$

D_r is the per capital income of farmers in the midstream and downstream; U_r is the per capital income of farmers in upstream; N_r is the agricultural population in the upstream; D_c is the per capital income of urban residents in the midstream and downstream; U_c is the per capital income of urban residents in the upstream; and N_c is the average urban resident population in the upstream.

4.3. Basin eco-compensation apportionment model

When determining the specific value of the ecological compensation amount, the economy of the compensation areas must be considered. Hence, the benefit distribution coefficient is introduced, with the following formula:

$$E_d = \frac{e^\varepsilon \times GDP_d}{(1 + e^\varepsilon) \times GDP} \quad (5)$$

where ε is the Engel coefficient of the provinces in the midstream and downstream; GDP_d is the GDP of the provinces in the midstream and downstream; and GDP is the gross national product of the year. The Engel coefficient and GDP data of the provinces in the midstream and downstream in 2011–2020 are obtained from the statistical yearbook data of each province. The corresponding benefit distribution coefficients and compensation amount are calculated according to formula (5).

5. Results analysis

The total cost of ecological protection in the upstream is calculated based on formulae (3) and (4). From **Table 1**, it can be seen that the value of the cost among upstream provinces varied from 2011 to 2020, fluctuating between 11 billion and 19.85 billion yuan; however, the values are high in each province. The cost of ecological protection is inextricably linked to the ecological and social differences between them. The mean value of the total cost reached more than 164 billion yuan.

As is indicated in **Table 2**, the values of benefit distribution coefficients of the midstream and downstream varied from 0.0160 to 0.0816. The values in Shandong and Henan are relatively high, with a mean value over 0.05, whereas the values in Shanxi and Shaanxi are below 0.03. The differences among downstream provinces indicated the different stages of economy in each province.

We calculated the compensation amounts of midstream and downstream provinces based on formula (1). It can be seen from **Table 3** that the values of compensation ranged from 229 million yuan to 1,440 million yuan. Compared with the cost paid by upstream provinces, the values of compensation are relatively low. The compensation of each province is closely linked to the economic conditions of different regions. The four compensated midstream and downstream areas are listed in the following order, from the highest to lowest ecological compensation amount to be paid: Shandong, Henan, Shaanxi, and Shanxi Province. Shandong Province has the highest GDP among them, and its amount of ecological compensation is also the highest.

Table 1. Total cost of upstream provinces (monetary unit: one hundred million yuan)

Year	Inner Mongolia	Gansu	Qinghai	Ningxia	Total
2011	336.61	959.38	220.61	180.27	1,696.88
2012	352.08	1097.40	241.67	191.68	1,882.83
2013	376.50	1243.32	288.73	218.30	2,126.86
2014	221.94	1107.04	243.89	223.80	1,796.68
2015	189.92	1142.92	279.65	252.68	1,865.16
2016	110.52	1181.02	281.41	260.14	1,733.08
2017	114.22	1239.19	255.76	267.59	1,648.31
2018	148.64	1985.07	239.57	239.57	2,115.57
2019	226.33	1451.45	267.51	269.74	1,662.37
2020	389.35	1419.53	252.60	285.44	2,346.92
Mean	246.61	1282.63	257.14	238.92	1,887.47

Table 2. Benefit distribution coefficients of the midstream and downstream

Year	Shanxi	Shandong	Henan	Shaanxi
2011	0.0227	0.0816	0.0550	0.0254
2012	0.0217	0.0798	0.0538	0.0263
2013	0.0202	0.0798	0.0533	0.0268
2014	0.0188	0.0789	0.0537	0.0270
2015	0.0172	0.0803	0.0538	0.0260
2016	0.0160	0.0787	0.0539	0.0255
2017	0.0174	0.0757	255.76	0.0258
2018	0.0174	0.0725	239.57	0.0260
2019	0.0172	0.0715	267.51	0.0261
2020	0.0176	0.0718	252.60	0.0257
Mean	0.0186	0.0771	0.0540	0.0261

Table 3. Compensation amounts of the midstream and downstream (monetary unit: one hundred million yuan)

Year	Shanxi	Shandong	Henan	Shaanxi
2011	3.24	11.62	7.83	3.62
2012	3.45	12.67	8.55	4.17
2013	3.65	14.40	9.62	4.84
2014	2.92	12.27	8.36	4.21
2015	2.67	12.48	8.37	4.04
2016	2.31	11.38	7.79	3.69
2017	2.43	10.56	7.52	3.60
2018	2.90	12.10	9.06	4.35
2019	2.29	9.51	7.24	3.48
2020	2.59	10.57	7.88	3.78
Mean	2.84	11.76	8.22	3.98

5. Conclusion

Based on the actual situation of the Yellow River Basin, an accounting model is designed for the ecological compensation quota of the Yellow River Basin from the following three aspects: water quantity, water quality, and benefit distribution. The opportunity cost method and the comprehensive cost method are used to measure the annual ecological protection of the upstream. Combined with Engel coefficient and the actual payment capacity of each region (reflected by the ratio of GDP), the compensation fees payable by the beneficiaries in the midstream and downstream are determined.

From the empirical results, the four compensated midstream and downstream areas are listed in the following order, from the highest to lowest ecological compensation amount to be paid: Shandong, Henan, Shaanxi, and Shanxi Province. The economic development level of Shandong is the highest among the 9 provinces of the Yellow River Basin, and the amount of ecological compensation it needs to pay is also the highest. The ecological compensation amount in the compensation area is moderate, in line with the local economic development and payment capacity. Comparing the calculated final compensation amount with

the opportunity cost loss value in the upstream, the compensation amount is much lower than the cost loss value, and it is not enough to make up for the cost of ecological protection.

Acknowledgments

The authors are grateful for the recommendations made by the reviewers.

Funding

This research was supported by the Inner Mongolia Natural Science Foundation Project “Research on the Transformation and Upgrading of Heavy Chemical Industry along the Yellow River Economic Belt in Inner Mongolia: Based on the Perspective of Ecological Optimization of the Yellow River Basin” (Project Number: 0406022002).

Disclosure statement

The authors declare no conflict of interest.

Author contributions

S.W. conceived the idea of the study and wrote the thesis, Y.Z. analyzed the data and wrote the paper. All authors contributed to the paper and approved the final manuscript.

References

- [1] Dong ZF, Hao CX, Qu AY et al., 2020, Orientation and Focus on Construction of the Ecological Compensation Mechanism in the Yellow River Basin. *Ecological Economy*, 36(02): 196–201.
- [2] Kong FB, 2007, Improving Ecological Compensation Mechanism of China: Theory, Practice and Research Prospects. *Issues in Agricultural Economy*, 2007(10): 50–53.
- [3] Cuperus R, Canters KJ, Piepers AAG, 1996, Ecological Compensation of the Impacts of a Road. Preliminary Method for the A50 Road Link (Eindhoven-Oss, The Netherlands). *Ecological Engineering*, 7(4): 327–349
- [4] Yang T, 2019, Analysis on the Determination and Assessment Structure of Ecological Compensation Standard. *Journal of Shaanxi University of Technology (Social Sciences)*, 37(5): 31–35.
- [5] Hu YY, 2019, Review on Ecological Compensation Standard. *Journal of Shaanxi University of Technology (Social Sciences)*, 37(5): 25–30.
- [6] Shan YH, 2021, The Study on Horizontal Transfer Payment Institutionalization Development of Ecological Compensation in the New Era: Based on the Theory of Kaldor-Hicks Efficiency. *On Economic Problems*, 2021(02): 107–116.
- [7] Liu Y, Bi J, Lv JS, 2019, Trade-Off and Synergy Relationships of Ecosystem Services and the Driving Forces: A Case Study of the Taihu Basin, Jiangsu Province. *Acta Ecologica Sinica*, 39(19): 7067–7078.
- [8] Pagiola S, Pamirez E, Gobbi J, et al., 2007, Paying for the Environmental Services of Silvopastoral Practices in Nicaragua. *Ecological Economics*, 64(2): 374–385.
- [9] Engel S, Pagiola S, Wunder S, 2008, Designing Payments for Environmental Services in Theory and Practice: An Overview of the Issues. *Ecological Economics*, 65(4): 663–674.
- [10] Munoz-Pina C, Guevara A, Torres JM, et al., 2008, Paying for the Hydrological Services of Mexico’s

Forests: Analysis, Negotiations and Results. *Ecological Economics*, 65(4): 725–736.

- [11] Takasaki Y, Barhan BL, Coomes OT, 2001, Amazonian Peasants, Rain Forest Use, and Income Generation: The Role of Wealth and Geographical Factors. *Society and Natural Resources*, 14(4): 291–308.
- [12] Ferraro PJ, 2008, Asymmetric Information and Contract Design for Environmental Services. *Ecological Economics*, 65(4): 810–821.
- [13] Newton P, Nichols ES, Endo W, et al., 2012, Consequences of Actor Level Livelihood Heterogeneity for Additionality in a Tropical Forest Payment for Environmental Services Programme with and Undifferentiated Reward Structure. *Global Environmental Change*, 22(1): 127–136.
- [14] Han L, He DD, Yang Y, 2021, Coupling Coordination Evaluation of High Quality Development and Land Use Efficiency of Urban Agglomeration – Empirical Analysis of Seven Urban Agglomerations in the Yellow River Basin. *Journal of Henan Normal University (Philosophy and Social Sciences Edition)*, 2021(01): 95–101.
- [15] Jin FJ, 2019, Coordinated Promotion Strategy of Ecological Protection and High-Quality Development in the Yellow River Basin. *Reform*, 2019(11): 33–39.
- [16] Ji PC, 2018, Speed Up to Better the River Basin Ecological Compensation Mechanism in China. *Macroeconomic Management*, 2018(10): 41–46.
- [17] Shen MH, Xie HM, 2020, Transboundary Ecological Compensation in the Xin'an River Basin and Its Institutional Arrangement of Sustainability. *China Population, Resources and Environment*, 30(09): 156–163.
- [18] Hu ZH, Liu JY, Zhong MR, et al., 2016, Interests Balance of Trans-boundary River Basin Ecological Compensation Based on Evolutionary Game Theory – Taking Lijiang Basin as a Case. *Economic Geography*, 36(06): 42–49.
- [19] Li CF, Zhang LY, Zhao GC, et al., 2014, Research on Basin Ecological Compensation Based on Evolutionary Game Theory – Taking Taihu Basin as a Case. *China Population, Resources and Environment*, 24(01): 171–176.
- [20] Qiao XN, Yang YJ, Yang DG, et al., 2012, Standards of Payments for Ecosystem Services in Watershed: Taking Weigan River Basin as an Example. *Journal of Natural Resources*, 2012(10): 1666–1676.

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Forecasting Tesla's Stock Price Using the ARIMA Model

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Abstract: The stock market is an important economic information center. The economic benefits generated by stock price prediction have attracted much attention. Although the stock market cannot be predicted accurately, the stock market's prediction of the trend of stock prices helps in grasping the operation law of the stock market and the influence mechanism on the economy. The autoregressive integrated moving average (ARIMA) model is one of the most widely accepted and used time series forecasting models. Therefore, this paper first compares the return on investment (ROI) of Apple and Tesla, revealing that the ROI of Tesla is much greater than that of Apple, and subsequently focuses on ARIMA model's prediction on the available time series data, thus concluding that the ARIMA model is better than the Naïve method in predicting the change in Tesla's stock price trend.

Keywords: Stock price forecast; ARIMA model; Naïve method; Tesla

Online publication: October 21, 2022

1. Introduction

Financial markets generally refer to markets where securities are traded, which include the stock market, bond market, foreign exchange market, and derivatives market. Financial markets can allocate resources to enterprises and entrepreneurs, create liquidity, guide the rational allocation of capital, and promote the smooth operation of the capitalist economy. Among the financial markets, the stock market is the most common financial market and an important economic information center. Stocks generate transactions that provide investors with capital gains and dividend income, measure the overall health of the economy, and play a vital role in improving social and economic performances.

Although the stock market cannot be predicted accurately, the stock market's prediction of the trend of stock prices helps in understanding the operation law of the stock market as well as the influence mechanism on the economy. Therefore, a model is needed to predict the overall trend of stock prices. The autoregressive integrated moving average (ARIMA) method is a statistical method used to analyze and build predictive models that best represent time series by modeling correlations in data. Using the ARIMA model to predict time series data is better than the Naïve method because it can predict the changing trend of stock prices more accurately. Therefore, this paper primarily studies the use of ARIMA model to predict the changing trend of Tesla's stock price and compares it with the Naïve method in this respect.

In this paper, we focus on using the Naïve method and ARIMA model to predict the existing time series data, so as to understand the changing trend and investment value of Tesla's stock price in hope that the predicted results will be conducive to investors in making optimal decisions in the future. This paper is

structured as follows: in section 2, we discuss the various applications of the ARIMA model in the stock market and the novelty of this paper in comparison; we discuss the experimental method in section 3, followed by the experimental results based on a detailed analysis of the experimental process in section 4; in Section 5, we draw our conclusion.

2. Literature review

Stock price forecast is an essential topic in finance and economics. It stimulates the interest of stock market researchers to develop better prediction models, effectively reduce the risk of stock market investment, and promote the further development of the economy and society. The ARIMA model has been applied in many studies to detect time series for predicting the changing trend of stock prices. Based on the stock data obtained from the New York Stock Exchange and the Nigerian Stock Exchange, as well as the established stock price prediction model, the results of the joint use of the two models showed that the ARIMA model has a strong short-term stock price prediction potential ^[1]. In addition, by applying the auto ARIMA model and two custom ARIMA models to Netflix's stock historical data from 2015 to 2020, the calculation results of ARIMA (1,1,33) were found to be more accurate, thus once again reflecting the potential of the ARIMA model for accurate prediction of time series data, which would help investors make decisions ^[2].

The ARIMA model can also be used with other models. For example, a support vector machine (SVM) was combined with the ARIMA model in a study to form a hybrid model that has linear and nonlinear modeling abilities to predict stock prices; the hybrid model significantly reduced the overall forecast error and better predicted the stock price of SBC Communications Inc. ^[3]. The effectiveness of several ARIMA-GARCH models in modeling and forecasting the conditional mean and weekly volatility of crude oil spot prices in 11 international markets from February 1, 1997, to March 10, 2009, has been studied ^[4]. ARIMA-intervention analysis method was used in another study to model the Chinese stock market price index, so as to evaluate the economic movement of the Chinese stock market price at different times ^[5]. This illustrates the predictable nature of the stock market and the effectiveness of the ARIMA time series model as an analysis and forecasting tool. By referring to published stock data, a study compared the performance of the artificial neural network (ANN) forecasting model with that of the traditional Box-Jenkins ARIMA model, which has been widely used for time series forecasting ^[6]. The results revealed that both the models are able to make good predictions when applied to practical problems. The DWT-ARIMA-GSXGB hybrid model was proposed in 2020 ^[7]. Through experimental comparison of 10 stock data sets, the results showed that the DWT-ARIMA-GSXGB stock price prediction model has a better approximation ability, suggesting that the fit to the opening price of the stock index is better ^[7]. This model greatly improves the performance of the single ARIMA model in stock price prediction.

It can be seen that the ARIMA model is often used to solve practical problems in the stock market. By contrast, the innovation of our study lies in that when predicting time series data. By comparing the ARIMA model with the Naïve method, we conclude that the ARIMA model can predict the overall trend of stock prices and consider the impact of seasonal factors on the forecast results.

3. Methodology: ARIMA model

The ARIMA model is one of the most popular forecasting methods, which is commonly used to analyze time series data for better understanding and forecasting ^[8,9]. In the ARIMA model, it is assumed that the future of a variable is simply a linear combination of past values and past errors, which is expressed as follows:

$$y = \theta_0 + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \cdots + \phi_p y_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - \cdots - \theta_q \varepsilon_{t-q}$$

where y_t is the actual value, ε_t is the random error at time t , ϕ_i and θ_j are coefficients, p and q are integers, which are called autoregressive polynomials and moving average polynomials, respectively. The method consists of three stages: model identification, parameter estimation, and diagnostic test. The ARIMA (0,1,1) model discussed in this paper can be expressed as follows:

$$y_t = \phi_0 + \varepsilon_t + \theta_1 \varepsilon_{t-1}$$

The existing time series data can be used by the ARIMA model to predict the stock price. Although there are some errors in the prediction results of the ARIMA model with the actual ones, it is feasible to determine the overall trend of stock price change.

4. Analysis of experimental procedure

Quantmod package was used to obtain the stock prices in R. This package uses Yahoo Finance as its source for stock prices. Using these data, we plotted a candlestick chart (**Figure 1**) from January 2, 2018, to December 30, 2021. Creating a static or interactive chart enables the visualization of stock price data. From the figure, we can intuitively see Tesla's stock price in different periods and also draw attention to the overall trend and periodicity shown by the trading volume.



Figure 1. Tesla's stock price and stock's trading volume

From the figure, we can see that there is an upward trend and seasonal pattern. In order to determine the components of the data, the data was broken down. For convenience, we used the closing price, which can be obtained by the `Cl()` function, for further analysis in this paper (in the quantmod package, the daily OHLC data, including the opening price, high price, low price, and closing price, can be obtained, among which the closing price is considered to be a useful marker for assessing changes in stock prices over time). We changed the period to monthly data, and the data was broken down into seasonal, trend, and random parts after decompose, using the `decompose` function. Through the output of the four graphs (**Figure 2**) showing the closing price data, we can see that during the study period, Tesla's stock price showed an overall upward trend (an obvious upward trend began around 2022), with repeated seasonal fluctuations (the closing price of Tesla tended to reach the highest in January, with the lowest in July); there were also irregular or random fluctuations that were not captured by trends and seasonality.

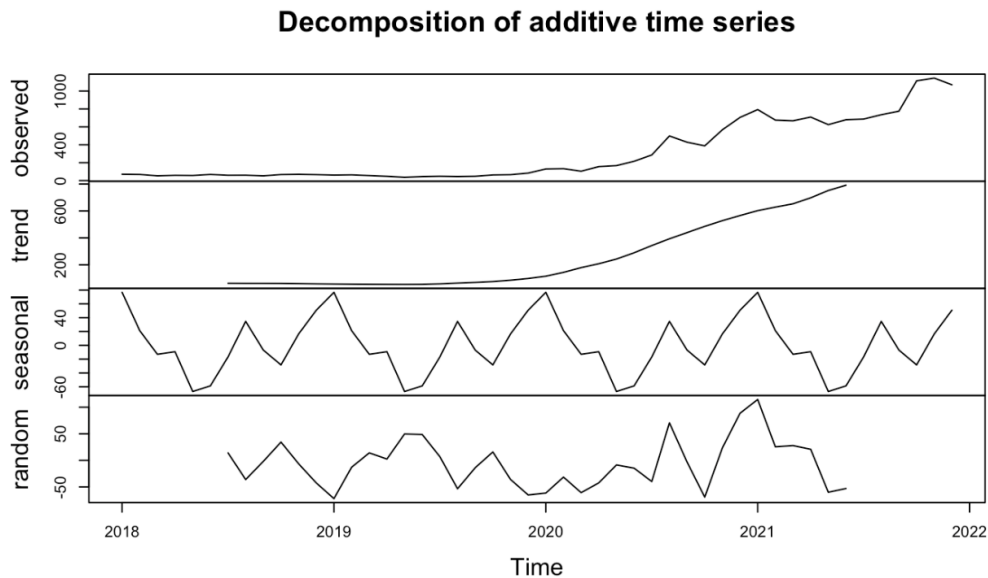


Figure 2. Raw time series data, data trends, seasonal factors, and stochastic components

In order to have a closer look at the investability of Tesla's stock, the closing price of Tesla was compared with that of Apple. As can be seen from the chart, Apple's stock price grew steadily from the beginning of 2018 to the end of 2021.

From the beginning of 2018 to that of 2020, Tesla's stock price changed in the same way as Apple's. Since then, Tesla's stock price has increased significantly, reaching almost six times that of Apple by the end of 2020.

In order to visualize the return on investment of Tesla's and Apple's stocks during this period (**Figure 3**), we used PerformanceAnalytics in R to obtain an overview of the cumulative return (top), daily return (middle), and drawdown (bottom).

From the beginning of 2018 to the end of 2021, it can be seen that both, Tesla and Apple had positive cumulative earnings. Since the beginning of 2020, Tesla's cumulative earnings increased rapidly, whereas Apple's stock price stabilized after a slight increase. The widened gap between Tesla and Apple indicates that Tesla's returns since then are far greater than Apple's. By the end of 2021, Tesla's cumulative stock return was almost four times that of Apple.

Daily Return TSLA vs AAPL 2018-2021

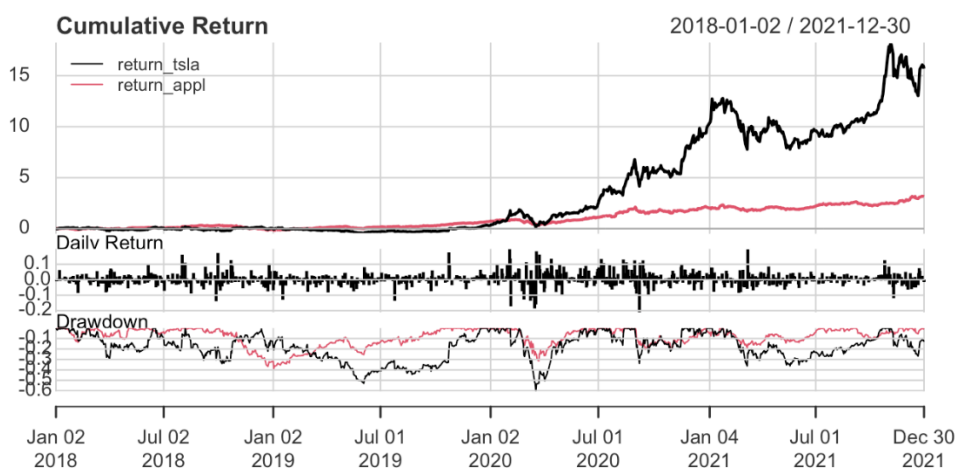


Figure 3. Cumulative return, daily return, and drawdown of Apple's and Tesla's stocks

In order to determine the investment value of Tesla's stock, we predicted the direction of the stock price based on the existing stock price data. In the following experiments, the Naïve method (**Figure 4**) and the ARIMA model were used to predict the time series data. We split the data into training data and test data in order to assess how well the model predicts the data not used in the training model. Two models were used to fit the training data and obtain the prediction results of the test data. The forecast results were plotted. Through Akaike Information Criterion (AIC), AICc (AIC with sample size correction), or Bayesian Information Criterion (BIC) with modified sample size, an ARIMA model with optimal progression can be selected. Using the R `auto-arima()` function, we obtained two kinds of ARIMA, namely non-seasonal ARIMA and seasonal ARIMA, which correspond to the prediction results of the model shown in **Figure 5** and **Figure 6**, respectively. The blue line represents the average of our predictions, while the darker and lighter areas represent 80% and 95% confidence intervals, respectively. Comparing the results with actual test data, there are differences between the two. The predicted image obtained with the Naïve method is a horizontal line, and it does not predict the upward trend of the test data. Although the ARIMA model's predication showed an upward trend, there is still a difference with the actual value of the experimental data. At the same time, the consideration of seasonal factors has insignificant impact on the prediction results.

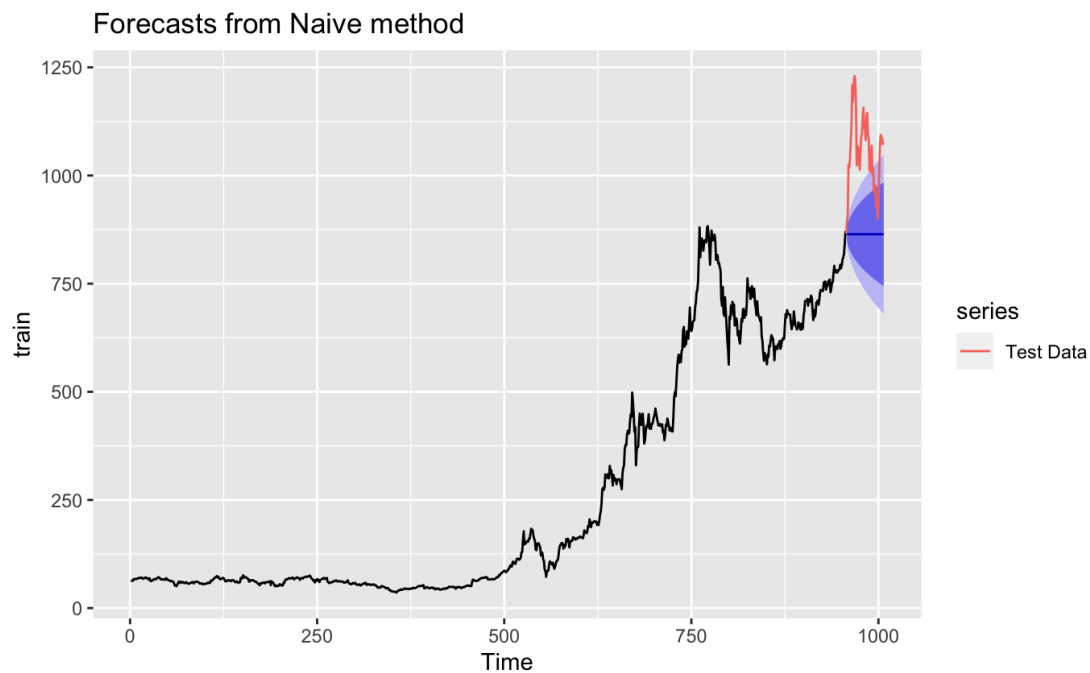


Figure 4. Naïve method

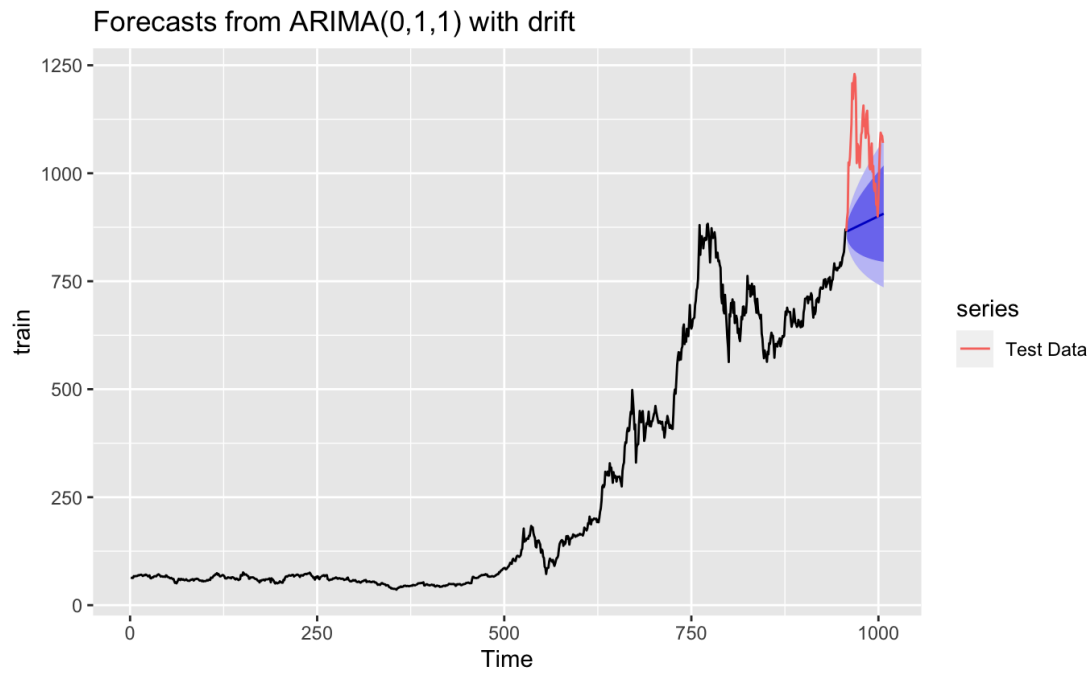


Figure 5. ARIMA (0,1,1) without seasonal trend

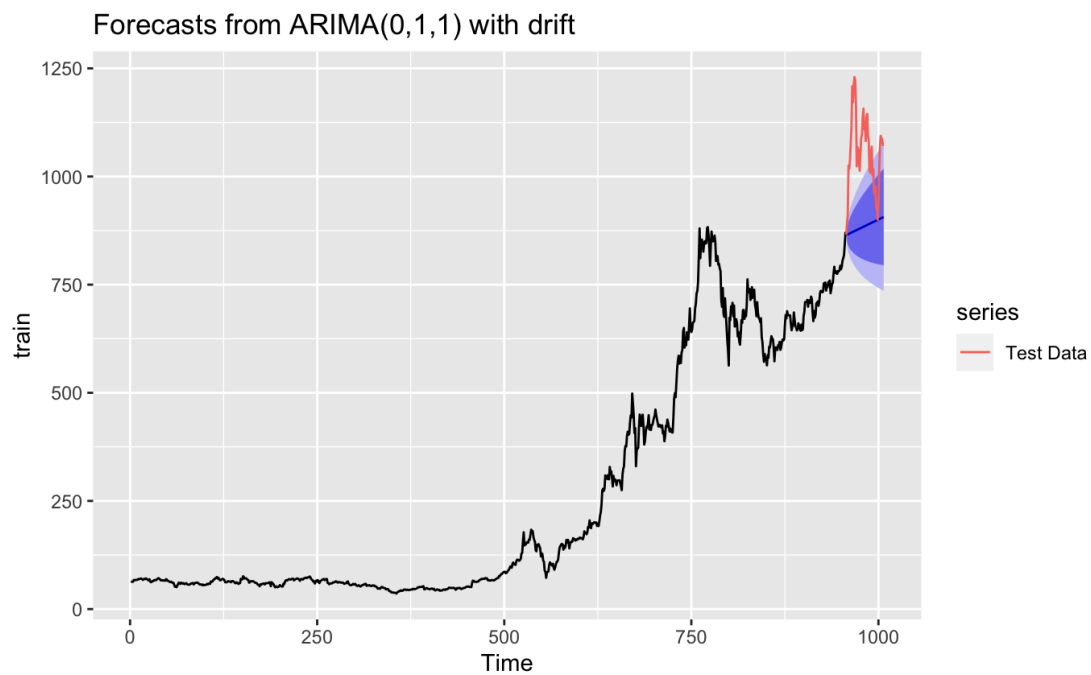


Figure 6. ARIMA (0,1,1) with seasonal trend

From **Table 1**, it can be seen that the mean error (ME) and root mean squared error (RMSE) of the ARIMA model are both, small and naive. The ME of the ARIMA model, which is 0.000282, is much smaller than that of the Naïve method. In other words, the same conclusion can be obtained: the ARIMA model is better at predicting Tesla's closing price than the Naïve method.

Table 1. Accuracy of the two approaches

	ME	RMSE
Naïve method	0.836992	13.25738
ARIMA (0,1,1)	0.000282	13.19243

5. Conclusion

This paper studies Tesla's stock price from 2018 to 2021. Through the decomposition function, we can see the upward trend, seasonal fluctuations, and irregular random fluctuations. By comparison with Apple's stock price, which has investment potential, Tesla's stock returns grew rapidly after 2020, reaching a return of four times that of Apple by the end of 2021. In order to predict the changing trend of Tesla's stock price more accurately, the Naïve method and ARIMA model were used to predict the time series data. It can be seen from the forecast results that the trend of Tesla's stock price cannot be predicted by the Naïve method, and although the ARIMA model has certain errors, it still can predict an upward trend in Tesla's stock price (whether seasonal factors are considered has little impact on the forecast results). The same conclusion can be obtained through RMSE: the ARIMA model is better at predicting Tesla's closing price than the Naïve method.

Through the above experiments, we find that by comparing with Apple's stock price and forecasting model, Tesla's stock price shows an upward trend and has certain investment value. At the same time, the prediction model can only determine the overall trend, but it cannot accurately predict the actual trend of stock prices. In recent years, deep learning has been extensively researched on. Through deep learning, time series prediction based on financial data can also be done. The structure of recurrent neural network (RNN) and long short-term memory (LSTM) models in deep learning is suitable for processing time series data^[10,11]. In the future, we will use deep learning methods to fit the data of Tesla's stock price to obtain more accurate results.

Disclosure statement

The authors declare no conflict of interest.

Author contributions

Z.T. conceived the idea of this research and investigated the relevant data. R.L. analyzed the data and process of the experiment as well as summarized the experimental results. Q.W. wrote the paper and arranged it.

References

- [1] Ariyo AA, Adewumi AO, Ayo CK, 2014, Stock Price Prediction Using the ARIMA Model. Proceedings of the 2014 UKSim-AMSS 16th International Conference on Computer Modelling and Simulation, 106–112.
- [2] Khan S, Alghulaiakh H, 2020, ARIMA Model for Accurate Time Series Stocks Forecasting. International Journal of Advanced Computer Science and Applications, 11(7): 524–528.
- [3] Pai PF, Lin CS, 2005, A Hybrid ARIMA and Support Vector Machines Model in Stock Price Forecasting. Omega, 33(6): 497–505.
- [4] Mohammadi H, Su L, 2010, International Evidence on Crude Oil Price Dynamics: Applications of ARIMA-GARCH Models. Energy Economics, 32(5): 1001–1008.

- [5] Jarrett JE, Kyper E, 2011, ARIMA Modeling with Intervention to Forecast and Analyze Chinese Stock Prices. *International Journal of Engineering Business Management*, 3(3): 53–58.
- [6] Adebisi AA, Adewumi AO, Ayo CK, 2014, Comparison of ARIMA and Artificial Neural Networks Models for Stock Price Prediction. *Journal of Applied Mathematics*, 2014: 614342.
- [7] Wang Y, Guo Y, 2020, Forecasting Method of Stock Market Volatility in Time Series Data Based on Mixed Model of ARIMA and XGBoost. *China Communications*, 17(3): 205–221.
- [8] Qin J, Tao Z, Huang S, et al., 2021, Proceedings of the 2021 IEEE 2nd International Conference on Big Data, Artificial Intelligence and Internet of Things Engineering (ICBAIE), March 26–28, 2021: Stock Price Forecast Based on ARIMA Model and BP Neural Network Model. IEEE, New Jersey, US, 426–430. <https://doi.org/10.1109/ICBAIE52039.2021.9389917>
- [9] Hu Y, Tao Z, Xing D, et al., 2020, Research on Stock Returns Forecast of the Four Major Banks Based on ARMA and GARCH Model. *Journal of Physics: Conference Series*, 1616(1): 012075.
- [10] Petnehazi G, 2018, Recurrent Neural Networks for Time Series Forecasting. ArXiv. <https://arxiv.org/abs/1901.00069>
- [11] Tang Q, Fan T, Shi R, et al., 2021, Prediction of Financial Time Series Using LSTM and Data Denoising Methods. ArXiv. <https://arxiv.org/abs/2103.03505>

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The Future of Quasi Emission Control Enterprises in a Low-Carbon Economy

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Abstract: At 9:30 a.m. on July 16, 2021, the national carbon emission trading market started operation at Shanghai Environment and Energy Exchange. On the first day, the carbon emission quota totaled 4.244 million tons, with a turnover of 210 million yuan and an average transaction price of 51.23 yuan/ton. The carbon trading price is on the rise. With the gradual maturity and improvement of conditions, there will be about 8,000 to 10,000 emission control enterprises under the eight major industries in the future, and China's carbon market will become the largest market covering greenhouse gas emissions worldwide. It can be seen that carbon trading is a "big deal." If enterprises participate well, they will form carbon assets, but if they do not participate well, they will form carbon liabilities. This paper analyzes the opportunities and challenges faced by quasi emission control enterprises under the background of low-carbon economy. This provides certain reference significance for these enterprises to actively participate in the national carbon trading market in the future.

Keywords: Low-carbon economy; Carbon trading; Carbon asset management; Quasi emission control enterprise

Online publication: October 21, 2022

1. Connotation of low-carbon economy

Driven by the concept of "low carbon" and "carbon reduction," scholars and relevant workers from all over the world continue to explore and find that the leading factor of climate change is people's dependence on fossil fuel-based energy utilization, including coal and crude oil, for economic growth. Climate change is not only an environmental problem, but also an economic challenge. Therefore, academic and political circles have begun to explore how to link low carbon with economic development.

Extensive discussions on low-carbon economy have been carried out. According to a study, the objective of low-carbon economy is to achieve social and economic development goals with less energy consumption and greenhouse gas emissions ^[1] or obtain larger economic output ^[2]. Low-carbon economy itself is a green ecological economic development mode, characterized by or based on low energy consumption, material consumption, emission, and pollution ^[3]. It is a general term for low-carbon industry, low-carbon technology, low-carbon life, and other economic forms. Similar to the aforementioned study, as discussed in another paper, the fundamental purpose of low-carbon economy is to achieve sustainable economic, social, and ecological development ^[4]. Low-carbon economy aims at sustainable development,

relying on a series of feasible measures, such as technological innovation, system optimization, industrial upgrading, and clean energy development, in order to achieve low-carbon development of energy flow and recycling of resource flow, as well as reduce high-carbon energy consumption and greenhouse gas emissions, thus solving the issue of climate warming and achieving a coordinated development in economic growth and environmental protection ^[5]. Ever since the concept of “low-carbon economy” was put forward, it has been extending to all fields of economy, technology, and society. Its connotation is also deepening and expanding.

We believe that low carbon represents the following practices: optimizing the energy consumption structure, improving energy utilization efficiency, reducing greenhouse gas emissions, and reducing conventional or local pollutants. Low-carbon economy, therefore, emphasizes the goal of achieving “economic” development, while “low carbon.” It is an organic integration of “low carbon” and “economic” development, including top-down institutional innovation and policy implementation. Low-carbon economy also includes specific emission control behaviors and ideological changes from the bottom up. It is crucial to understand that low carbon is not contradictory to economic development.

2. Definition of quasi emission control enterprises

In line with the overall arrangement of the state, the Ministry of Ecology and Environment has carried out data accounting, submission, and verification for years in power generation, petrochemical, chemical, building materials, steel, nonferrous metals, paper, aviation, *etc.*, which are all high-emission industries ^[6]. Therefore, the data accounting, submission, and verification of these high-emission industries have a relatively solid foundation. We will follow the principle of “mature one-by-one,” further expand the coverage of the carbon market, and give full play to the role of the market mechanism in controlling greenhouse gas emissions, promoting low-carbon technology innovation, and guiding climate investment and financing.

With the continuous maturity of the national carbon market and progress of emission data monitoring and verification technology, it is only a matter of time that the aforementioned key emission enterprises in petrochemical, chemical, building materials, steel, nonferrous metals, paper, aviation, and other high-emission industries will be included in the scope of emission control. These enterprises already possess the characteristics of emission control enterprises (with the same or more energy consumption and carbon emission scale). Since some restrictive factors are not included in the scope of emission control, the key emission enterprises that will be included when these restrictive factors are removed in the future are called “quasi emission control enterprises.”

3. Analysis of the current situation of quasi emission control enterprises

For quasi emission control enterprises that have not been included in the national unified carbon market, carbon trading is both, an opportunity and a challenge. SWOT analysis is used to analyze the strengths, weaknesses, opportunities, and threats of quasi emission control enterprises (**Figure 1**).

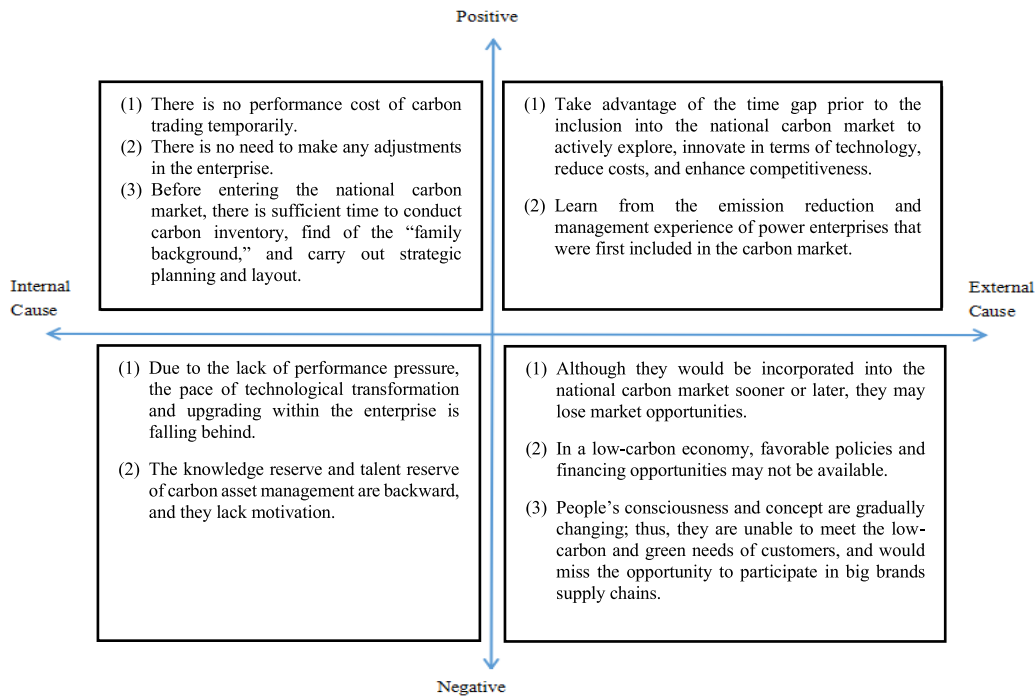


Figure 1. SWOT analysis of quasi emission control enterprises

At the initial stage of the establishment of the national carbon market, these enterprises were not covered by the trading system. The biggest advantage is that there is no contract performance cost. Contract performance cost here includes the cost of obtaining carbon emission rights with compensation, the data monitoring and verification fee paid to intermediaries, and the cost of technological transformation. Owing to these costs, the operating burden of emission control enterprises increases, whereas quasi emission control enterprises are exempted from this burden. At the same time, quasi emission control enterprises do not need to make any adjustments in the enterprise for the time being, thus remaining unchanged and coping with all kinds of changes, which may create a late-mover advantage in the process of improving the national carbon market. Before entering the national carbon market, quasi emission control enterprises have sufficient time to conduct a more detailed carbon inventory and formulate a strategic plan suitable for their own development based on the amount of carbon emissions, while taking into consideration of the current carbon price and carbon trading-related policies and regulations.

From the perspective of external environment, quasi emission control enterprises that are not included in the national carbon market should take advantage of the time gap to actively explore and find ways to minimize the cost of emission reduction, such as cooperating with new energy enterprises to carry out energy-saving technological transformation efforts, improve energy use efficiency and reduce carbon emissions, or investing in efforts to launch zero emission projects or emission reduction projects in advance, as well as using the generated emission reduction credits to fulfill the contract in the future. Since voluntary emission reduction projects often take a long time to develop, and the certification process is complicated, it is likely to miss the opportunity to redevelop them when it is really necessary. Moreover, China’s national unified carbon market has only been operational for a few decades. Although a pilot market existed in the past, it has limited coverage and inactive trading activities; additionally, previous carbon trading activities are not highly referenced, and compared with the carbon market in Europe, the maturity of the carbon market is far from enough. Therefore, the carbon trading process of power enterprises that are included in the national carbon market, carbon asset management methods, and carbon price fluctuations are valuable experiences for quasi emission control enterprises to enter the national carbon market.

It is precisely because these quasi emission control enterprises are not under any pressure to fulfil contracts that there will be some inertia created, thus affecting enterprises. One of the original purposes of establishing the carbon trading system is to drive enterprises to make efforts to reduce emissions and control greenhouse gas emissions in terms of the total amount by increasing the carbon emission costs of enterprises incorporated into the national carbon market, especially those high-energy consuming enterprises. However, quasi emission control enterprises are not under any of these pressures at the moment; hence, they may lack the motivation to be actively involved in emission reduction. When the pace of technological transformation and upgrading within enterprises fall behind, the same goes for the awareness and action of carbon asset management knowledge reserve and talent reserve.

Without doubt, the external disadvantages of quasi emission control enterprises are also evident. First of all, compared with emission control enterprises that have already been included in the national unified carbon market, quasi emission control enterprises, which would be included sooner or later, may lose market opportunity. Secondly, under the background of low-carbon economy, the state is vigorously promoting green finance and green funds and providing capital support to “green enterprises” that meet the standards; however, quasi emission control enterprises may lose such preferential policies and financing opportunities. Thirdly, the climate issue is a global issue that is relatable to every country and person. People’s consciousness and ideologies have also changed with policy advocacy. Green consumption has become a new fashion for both, enterprises and consumers. Those quasi emission control enterprises that have yet to participate in carbon trading would not be able to establish a good image, improve their soft power, or meet the low-carbon needs of consumers; they may miss the opportunity to participate in big brand supply chains.

4. Problems of quasi emission control enterprises

4.1. Lack of internal motivation and weak awareness of emission reduction

Carbon trading makes use of the market mechanism to turn carbon emission rights into assets with commodity attributes, such as scarcity, consumption, and investment, under total amount control. The effort of emission control enterprises to obtain emission space through market-oriented trading of carbon assets or exchange economic benefits through energy conservation and emission reduction through technical means would add a certain burden on their production costs and management costs. These burdens will imperceptibly drive emission control enterprises to innovate emission reduction technologies and improve their energy structure to reduce their contract performance costs. Since quasi emission control enterprises have not been included in the carbon trading system, they have no contract performance pressure for the time being, so they might fall behind in terms of core technology and knowledge reserves; additionally, they might not have the awareness or motivation to strive for internal emission reduction.

4.2. Large demand for core technology investment

In order to improve energy use efficiency and reduce greenhouse gas emissions, it is necessary to develop low-carbon technologies vigorously. This means that enterprises need to make technological transformation or introduce new energy-saving and emission control equipment, which demands large investments of additional funds and may eventually double their operating costs. This is a huge obstacle for enterprises that put interests first.

4.3. Lack of independent innovation ability

The gap between China’s low-carbon technology research and development (R&D) base and the international advanced level is estimated to be 7–10 years or more (National Technology Foresight Research Group, 2008). There are about 28,000 large and medium-sized enterprises in China, of which

only 25% have their own R&D institutions; moreover, 75% of them do not have full-time R&D personnel. In terms of enterprise technology innovation, most of China's patent applications are practical technologies, which focus on short-term economic benefits. In addition, most of the invention patents in the high-tech field come from abroad, such as radio transmission and semiconductors. Now, under the background of low-carbon economy, both, emission control enterprises and quasi emission control enterprises lack independent core low-carbon technologies. This has become a major constraint for China to achieve the dual carbon goal and develop a low-carbon economy.

5. Suggestions for the development of quasi emission control enterprises

5.1. Train the management and set up a carbon asset management department

The arrival of the brand-new low-carbon economy era has introduced some novel terms, such as carbon trading, carbon finance, carbon assets, carbon disclosure, carbon audit, *etc.*, which not only requires the update of knowledge reserves by the management, but also conceptual innovations. Quasi emission control enterprises that are not included in the national trading system should make full use of this period by conducting carbon knowledge lectures, low-carbon awareness training, and low-carbon culture construction for the management and all their employees. They should also actively introduce and encourage low-carbon researchers to serve the enterprises and constantly improve their competitiveness.

5.2. Develop and invest in China Certified Emissions Reduction (CCER) projects in advance to prepare for future performance and participation in carbon finance

CCER projects tend to have a complicated development process and a long development cycle. The time point of project development will affect the listing time of CCER, and ultimately the income of emission reduction projects. If quasi emission control enterprises invest in CCER projects in advance, the carbon assets generated based on these projects that are successfully filed can be used for future performance or financial activities, such as quota CCER replacement, carbon pledge financing, and carbon trusteeship.

5.3. Fulfill social responsibilities, actively disclose carbon information, and establish a good corporate image

At present, China is implementing a voluntary disclosure of carbon information. Quasi emission control enterprises voluntarily disclose carbon information and are constantly improving the carbon information disclosure mechanism, which may play a role in social supervision and placing constraints on the enterprise's management. On the one hand, carbon information disclosure intuitively reflects the enterprise's carbon emissions and emission reduction status, helps establish a good public image for the enterprise, breaks international green barriers, promotes international trade, and enhances the brand value and influence of the enterprise. On the other hand, carbon information disclosure guides enterprises in such a way to discover their own shortcomings and strengths in carbon management, cultivates their awareness of coordinated development for emission reduction and profits, as well as inspires initiatives for carbon planning and management.

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Zhuang G, Pan J, Zhu S, 2011, Connotation of Low Carbon Economy and Construction of Comprehensive Evaluation Index System. *Economic Dynamics*, 2011(01): 132–136.

- [2] Liu C, Feng B, 2009, The Enlightenment of Low Carbon Economy on the Construction of “Two Oriented Society” in Wuhan Urban Circle. *China Population, Resources and Environment*, 19(05): 16–21.
- [3] Bao J, Zhu F, 2009, From Creating a Low-Carbon Economy to Coping with Energy Challenges – Interpreting the Changes and Characteristics of UK Energy Policy. *Journal of Zhejiang University of Technology (Social Science Edition)*, 8(02): 148–154.
- [4] Fu Y, Ma Y, Liu Y, et al., 2008, Research on the Development Model of Low Carbon Economy. *China Population, Resources and Environment*, 2008(03): 14–19.
- [5] Wu C, 2021, Research on the Synergy Effect of China’s Low-Carbon Economic Development. *Management World*, 37(08): 105–117.
- [6] Chen J, Wang L, Xia W, et al., 2021, Exploration of Carbon Asset Management Mode Under the “Double Carbon” Goal. *China Development Observation*, 2021(16): 37–38 + 47.

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Research on Carbon Reduction Strategy of China's Industrial Chain with the Goal of Carbon Emission Peak and Carbon Neutrality

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Abstract: In order to achieve the development goals of emission peak in 2030 and carbon neutrality in 2060, carbon reduction measures should be implemented in the whole industrial chain. Based on the existing research, the basic logic of carbon reduction in the industrial chain is analyzed, and then the specific strategies for carbon reduction in the industrial chain are proposed, including: reducing the use of fossil energy and vigorously developing the new energy industry; reducing carbon through energy conservation, industrial upgrading, development of circular economy, and application of carbon capture technology; reducing carbon through low-carbon transformation of logistics industry, innovation of trading methods, and promotion of low-carbon green consumption. The external guarantee system for carbon reduction includes the introduction of relevant policies, laws and regulations, and the use of carbon emission trading mechanism.

Keywords: Carbon emission peak and carbon neutrality; Industrial chain; Carbon emission reduction; Carbon emission rights

Online publication: October 21, 2022

1. Introduction

The goal of carbon emission peak and carbon neutrality was proposed to overcome global climate change. Research shows that greenhouse gases are the cause of average temperature rise and climate change. The greenhouse gas that has the greatest impact on climate change is CO₂, which accounts for about 75% of greenhouse gases. CO₂ is mainly produced in the production and consumption of fossil energy. Since the industrial revolution, global CO₂ generated by the combustion of fossil fuels has accumulated to 2.2 trillion tons, and global average surface temperature has increased by 1.1°C, which caused problems such as the increase of pests and diseases, drought, and rise of sea level.

In order to address the climate problem, the relevant parties signed the Kyoto Protocol in 1997, which specified the types and amounts of emission reduction gases. In December 2015, the Paris agreement was signed. One of its main objectives was to “control the global average temperature rise below 2 °C higher than the pre-industrial level, and strive to limit the temperature rise below 1.5 °C higher than the pre-industrial level.” The research of the Intergovernmental Panel on climate change (IPCC) shows that to achieve this goal, the global greenhouse gas emissions need to be reduced by half before 2030 and reach net zero emissions around 2050, that is, carbon neutrality^[1-2].

Carbon neutralization has become an important goal for global climate governance^[3]. In 2021, about 130 countries and regions have established carbon neutralization time. Since the reforming and opening up, China's GDP has grown at an average annual rate of 10%, and has become the world's second largest

economy. Due to the high energy consumption and carbon emissions of leading industries, China is also the country with the largest carbon emissions in the world and also suffers the greatest impact due to global climate change. It is manifested by the rise of average temperature, the increase of extreme heat waves, floods in the south, droughts in the north, and so on. In order to promote sustainable development, reduce carbon emissions must be reduced ^[4]. This paper will discuss China's carbon reduction strategy from the perspective of the industrial chain.

2. Literature review

In October 2021, the State Council of China issued "The Guide on Fully, Accurately, and Comprehensively Implementing the New Development Concept to Achieve Carbon Emission Peak and Carbon Neutrality" and "The Action Plan for Carbon Emission Peak Before 2030", which established the top-level design of policies to reduce carbon emissions ^[5-7]. Since then, other ministries and local governments have introduced carbon reduction policies for key industries.

China's carbon emissions are still in the rising stage since fossil energy accounts for more than 85% of China's energy consumption, and the industry still dominates economic development. Hu Angang et al. believes that coping with global climate change is not only the biggest challenge for China to realize socialist modernization, but also the biggest opportunity for realizing green industrialization, urbanization and agricultural and rural modernization ^[8-9]. The goal of carbon emission peak will help promote China's high-quality development and comprehensive green transformation. Zhang Yaxin et al. proposed to strengthen the research and analysis of carbon neutralization strategies in European Union countries and learn from the advanced technologies of foreign countries, policy measures, and social transformation ^[10].

Many scholars have discussed the development mode and strategy under the background of carbon neutrality. Zou Caineng et al. proposed that carbon substitution, carbon emission reduction, carbon storage, and carbon recycling are the four main ways to achieve carbon neutralization ^[11], with carbon substitution as the backbone of carbon neutralization. Zou Caineng and He Dong studied the path of world energy transformation, and pointed out that "new energy" + "smart energy" energy system is the development trend and direction of world energy transformation ^[12]. Zhou Shuhui suggested that oil and gas enterprises accelerate business transformation and upgrading, as well as promote the coordinated development of the upstream and downstream of the new energy industry chain ^[13]. Wang Can et al. have pointed out that the technologies supporting carbon neutralization can be divided into high energy efficiency recycling technology, zero carbon energy technology, and negative emission technology. Technological development needs policy support ^[14,15].

To sum up, the carbon emission peak and carbon neutrality goal provides a direction for China's high-quality economic and social development, and will push China's economic and social development to make a comprehensive low-carbon transition. Under the background of coexistence of opportunities and challenges, the path of carbon reduction has become the focus of discussions.

3. Study on the path of carbon emission peak and carbon neutrality in China

Due to the organic nature of the economic system and the close relationship between the upstream and downstream of the industrial chain, carbon emission reduction needs systematic linkage.

3.1. Carbon emission reduction logic from the perspective of industrial chain

An important source of carbon emissions is the combustion of fossil fuels. As the production and utilization of clean energy still face technical challenges ^[16], fossil energy will still be the main source of energy supply in China for a period of time ^[17]. In order to reduce carbon emissions while economic development, on one hand, the fossil energy industry needs low-carbon transformation; on the other hand, it is necessary to

accelerate the development of new energy industry, including the production, storage, transmission, and utilization of new energy, so as to form a new production and service chain.

The production and manufacturing industry produces carbon emissions during its operation. Therefore, it is necessary to pay attention to the key industries of carbon emission such as steel and cement, and reduce carbon emissions by adopting measures such as clean energy, energy conservation, and emission reduction, and developing circular economy. The above measures can promote the low-carbon transformation of process flow, facilities and equipment in relevant industries and the low-carbon innovation of technology. In addition, low-carbon high-tech industries and digital economy have also become development hotspots.

Carbon circulation and consumption also need to be reduced, and digital technology have become effective support conditions for carbon reduction. The logistics industry can use green energy-saving facilities and equipment, and adopt modern information technology to reduce emissions. E-commerce and new retail mode can improve transaction efficiency and reduce carbon emissions through centralized distribution. The development of smart home and other products can reduce the carbon emissions of different living scenarios. The industrial chain carbon reduction logic is shown in **Figure 1**.

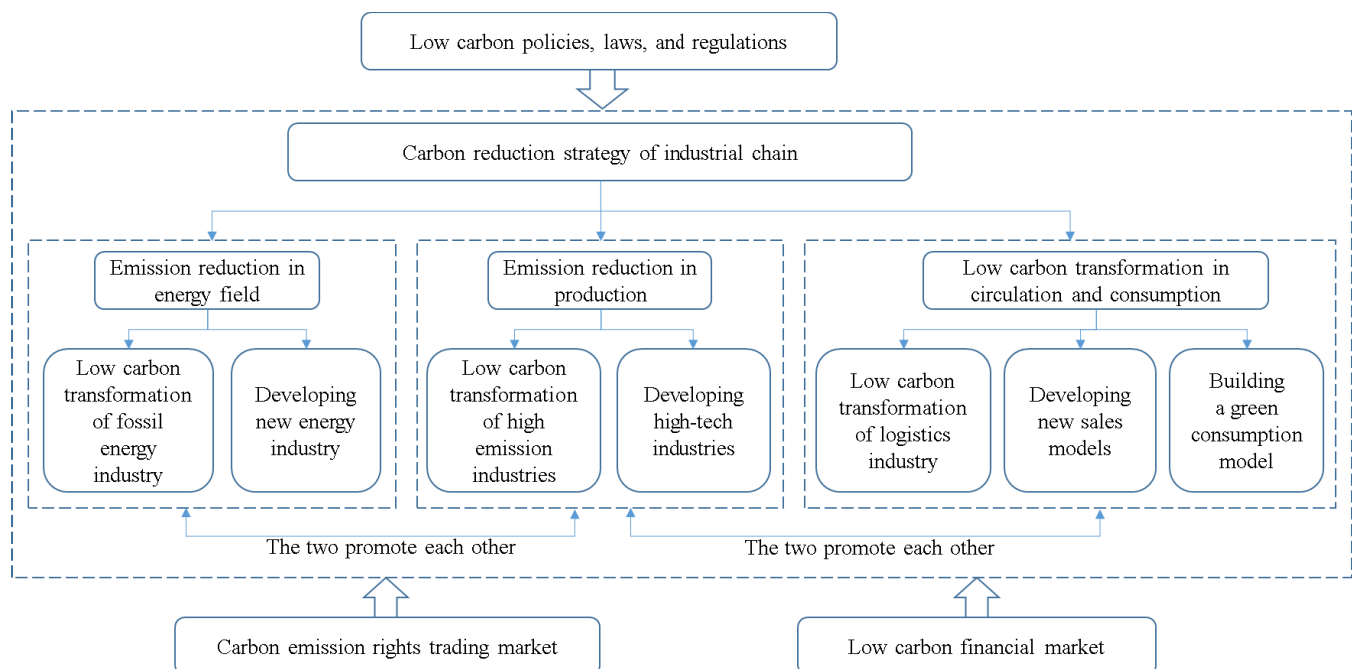


Figure 1. Carbon reduction strategy and logic diagram of the industrial chain

It should be noted that the carbon reduction measures in all links of the industrial chain cannot be separated from policy guarantees, legal constraints and financial support, and also need the help of market.

3.2. Carbon emission reduction strategy based on industrial chain

Based on the analysis above, actions of the entire industrial chain are needed to reduce carbon emissions, from adjusting the energy structure to reducing carbon emissions in production, circulation, and consumption.

3.2.1. Low carbon reform in energy supply

China's energy Low-carbon reform should start with the coal industry. Coal accounts for more than 60% of China's energy consumption. Technological innovation can promote low-carbon reform of traditional energy industries and the development of new energy industries. The goal of energy sector reform is to completely replace fossil energy with clean energy. The carbon reduction strategy of China's energy

industry is shown in **Figure 2**.

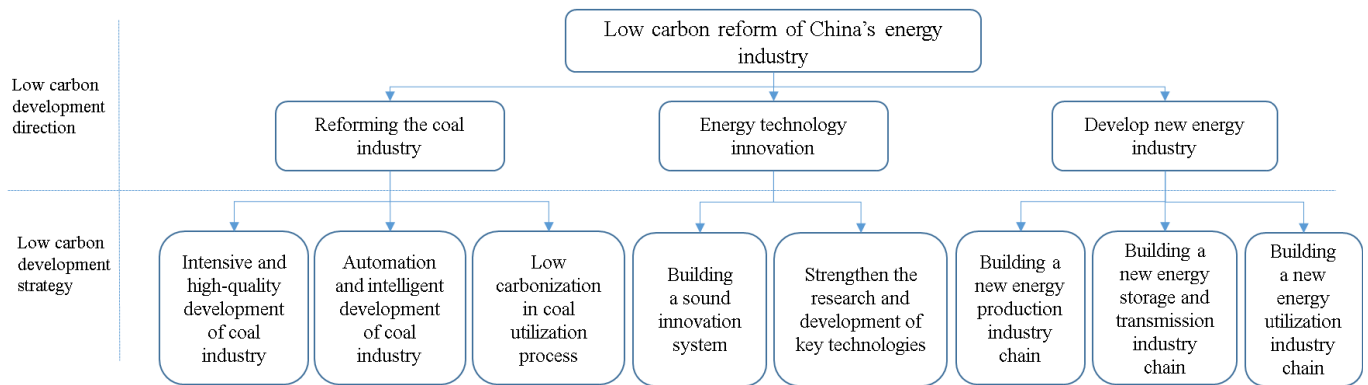


Figure 2. Carbon emission reduction strategy map of China's energy industry

The use of coal energy in the whole society must be reduced, and the production capacity must be increased. The mechanization, automation, informatization, intelligence, and green level of coal mines need to be improved. Large modern coal mines need to become the main body of coal production to build an intensive, safe, and efficient coal industry system. The efficiency of coal utilization should be improved, such as promoting the industrialization of coal deep processing, increasing the proportion of large capacity, high parameter and low pollution coal-fired power generation units in the installed capacity of thermal power, and strictly controlling the planning and construction of coal-fired power generation.

Technology is an important support to promote the low-carbon transformation and upgrading of the energy industry. An energy technology innovation system should be built. Scientific and technological innovation investment in important energy fields and emerging energy industries needs to be increased, and relevant talent teams need to be cultivated. Breakthrough technologies will be needed for safe and green mining of coal, storage and utilization of new energy, and construction of distributed energy system.

To achieve China's carbon emission peak and carbon neutrality goal, it is necessary to accelerate the development of non-fossil energy industries such as solar energy, wind energy, hydropower, nuclear energy, biomass energy, geothermal energy, and marine energy. The development of the industries mentioned involves many links such as energy production, storage, transmission, and utilization. In short, the production and application of new energy need to plan and build a complete industrial chain. The development of new energy industry will not only change the energy structure, but also optimize the industrial and employment structure as the number of relevant employees in China has reached about 4.5 million from 2010 to 2019.

3.2.2. Carbon emission reduction in production

Carbon reduction of the manufacturing industry needs to be accelerated through energy conservation and emission reduction, industrial upgrading, recycling, and other ways^[18].

According to various calculations, energy conservation and energy efficiency improvement will contribute more than 70% to China's goal of achieving the peak carbon emission in 2030. China's energy-saving and emission reduction strategy includes the modernization of equipment and management in key industries, the innovation of energy-saving technologies, and the improvement of energy utilization efficiency in key industries. Industrial upgrading and industrial structure adjustment is another important measure to reduce carbon in the manufacturing industry. Suitable carbon reduction strategies need to be formulated for different regions and industries based on development characteristics and plans to realize low-carbon transformation of manufacturing industry. The carbon reduction strategy should also be reflected in the new fixed asset investment. The circular economy strategy adopted by many countries is

also conducive to energy saving and emission reduction of manufacturing industry. In addition, it is necessary to use technical means to implement carbon capture for carbon emissions that are difficult to reduce. Some specific measures are shown in **Table 1**.

Table 1. Main strategies for carbon emission reduction in production

Main strategy	Concrete measure
Energy saving	Modernization of equipment and management in key industries Energy-saving technological innovation Promoting new energy-saving models
Industrial upgrading and industrial structure adjustment	Implementing specific optimization strategies to reduce carbon according to the characteristics of the industry Matching the new fixed asset investment with the goal of reducing energy consumption intensity, promote the development of new energy, new energy vehicles, digital economy
Developing circular economy	Using the concept of circular economy to guide regional development Developing and applying the technology of "zero" emission technology and the recycling technology Developing environmental protection industry and renewable resources industry
Carbon removal and carbon utilization technology	Adopting point source CCUs Technology Adopting biomass energy carbon capture and storage technology Adopting air carbon capture and storage technology

3.2.3. Carbon emission reduction in commodity circulation and consumption

The strategies for reducing carbon emissions in the field of commodity circulation and consumption mainly include three aspects: low-carbon logistics, electronic transactions and green consumption.

The main path of low-carbon development of the logistics industry is to promote the integration of digital technology and logistics industry. Specific carbon reduction strategies includes: Firstly, the logistics industry can use information technology support to realize the optimization of logistics schemes, transportation modes and routes, and strengthen cooperation to promote the development of multimodal transport; Second, the logistics industry can information technology to improve the level and efficiency of warehousing management, and promotes warehousing and procurement management modes such as just in time and zero inventory; thirdly, the logistics industry should build an information platform, improve the efficiency of matching logistics supply and demand, and promote centralized distribution, joint distribution and other modes to reduce costs and carbon emissions; fourthly, the logistics industry will strengthen the R & D and application of intelligent transportation related software, hardware and technology, promote driverless and unmanned distribution business, and reduce carbon emissions.

Changes in trading patterns can also reduce carbon emissions. Developing e-commerce can improve transaction efficiency and reduce carbon emissions through nearby transportation and distribution. The information provided by the e-commerce platform can also help consumers judge the carbon emission level. The Ministry of Ecology and Environment reported that online platforms can raise the awareness of the transformation of green and low-carbon and promote certain behaviors under certain conditions, which helps enterprises in reduce carbon emissions in terms of consumer demands.

Some studies show that the consumption oriented economic model reduces carbon emissions by about 35% compared with the export-oriented economic model. Reducing carbon emissions from the consumption side requires consumers to establish a low-carbon consumption concept and develop low-carbon consumption and living habits, such as buying green low-carbon products and services,

strengthening the recycling of waste materials, etc.

3.3. Build an external guarantee system conducive to carbon reduction

Carbon reduction in the industrial chain needs policy support and legal norms, as well as market guidance.

In terms of energy supply, fiscal and tax policies in the energy field need to be improved; energy prices need to be reformed to reflect energy shortages and carbon emission intensity; the government needs to increase research and development support for key technologies in the new energy industry, and accelerate the revision and formulation of energy and environment related laws and regulations to meet the strategic requirements of carbon emission peak and carbon neutrality. In terms of energy consumption, local governments need to formulate differentiated “double carbon” plans. The government will also introduce relevant policies to support energy conservation and emission reduction, industrial transformation and upgrading, circular economy development, etc., and promote and guide a low-carbon lifestyle. In order to obtain financial support, the government needs to guide and encourage financial institutions to participate in carbon emission reduction in the industrial chain ^[19], such as encouraging financial enterprises to carry out green financial business through fiscal and monetary policies, credit guarantees, risk supervision, and performance assessment. In addition, domestic and foreign experience shows that carbon emission trading is an effective tool to control carbon emissions ^[20], and the market mechanism can promote enterprise carbon reduction and drive industrial upgrading. Relevant safeguard measures are shown in **Table 2**.

Table 2. External guarantee system for carbon emission reduction in industrial chain

External guarantee system	Domain division	Examples of specific measures
Policies, laws and regulations	Energy policies and regulations	Subsidies related to new energy industry chain Supporting policies for transformation of traditional fossil energy industry Government energy price reform Financial fund for energy technology R & D
	Manufacturing policies and regulations	Regional and industrial carbon peak and carbon neutrality planning Circular Economy Promotion Law Regulations on comprehensive utilization of resources Low carbon industry promotion law Government performance appraisal system for energy conservation and emission reduction, circular economy development, new energy utilization
	Circulation and consumption policies and regulations	E-commerce low carbon development law Green logistics Promotion Law Low carbon consumption regulations
	Investment and financing policies and regulations	National Green Development Fund Government green bond Fiscal and tax policies for green development Green development monetary policy Green development risk sharing policy Green finance supervision and assessment system
	Carbon emission trading system	Accounting and reporting of total carbon emissions Allocation and payment of carbon emission quotas Regulations on punishment of illegal discharge Administrative measures for carbon emission trading

4. Conclusion

The carbon emission peak and carbon neutrality targets are of great significance to China's development in the new stage, which can promote economic transformation and upgrading and form a greener, more efficient and sustainable development model. In order to achieve this goal, carbon reduction strategies need to be implemented in energy production, circulation, consumption, and other fields from the perspective of the entire industrial chain. The main way to reduce carbon emissions is to reduce the use of fossil energy, reform energy supply, and vigorously develop the new energy industry. At the same time, we also need to reduce carbon emissions in energy consumption which can be achieved in the following ways: firstly, implement a carbon reduction strategy in the production field, including energy conservation and emission reduction, industrial upgrading, developing a circular economy, and applying carbon capture technology; Secondly, reduce carbon emissions from the circulation sector, including low-carbon transformation of the logistics industry, innovation of trade methods and promotion of low-carbon green consumption; thirdly, build an external guarantee system for carbon emission reduction in the industrial chain, including the introduction of policies and regulations to encourage and restrict carbon emission reduction in relevant industries, enterprises and individuals, and the improvement and application of the carbon emission trading mechanism.

Funding

Hubei Social Science Foundation Project "Research on the Relationship Between Rail Transit and Intensive and Sustainable Development of Large Cities" (Project number: 2020052)

Disclosure statement

The author declares no conflict of interest.

References

- [1] Intergovernmental Panel on Climate Change, 2013, Climate Change 2013: The Physical Science Basis Summary for Policy Makers, viewed July 12, 2022, <https://www.ipcc.ch/report/ar5/wg1/>
- [2] Intergovernmental Panel on Climate Change, 2020, Global Warming of 1.5°C, viewed July 15, 2022, <https://www.ipcc.ch/sr15/>
- [3] Carbon Neutrality Coalition, 2017, Plan of Action: Carbon Neutrality Coalition, viewed July 15, 2022, <https://www.carbon-neutrality.global/plan-of-action/>
- [4] He J, 2019, New Situation of Global Climate Governance and China's Countermeasures, Environmental and Economic Research, 3: 1–9
- [5] Yang G, Chang X, (eds) 2020, An Important Speech at the General Debate of the 75th Session of the United Nations (UN) General Assembly, People's Daily Overseas Edition, September 23, 2020.
- [6] The State Council, 2021, Opinions of the Central Committee of the Communist Party of China and the State Council on Fully, Accurately, and Comprehensively Implementing the New Development Concept and Doing a Good Job in Carbon Peak and Carbon Neutralization, viewed September 10., 2022, http://www.gov.cn/xinwen/2021-10/24/content_5644613.htm
- [7] The State Council, 2021, Carbon Emissions Peak Action Plan Before 2030, viewed September 10, 2022, http://www.gov.cn/zhengce/content/2021-10/26/content_5644984.htm?skinTheme=0
- [8] Hu A, 2021, China's Goal and Main Ways to Achieve Carbon Peak by 2030 Journal of Beijing University of Technology (Social Science Edition), 21(03): 1–15

- [9] Li J, 2020, Carbon Neutrality, Opportunities and Challenges for China's Development and Transformation, Xinde Marine News, viewed September 15, 2022, <https://www.xindemarinenews.com/topic/yazaishuiguanli/24908.html>
- [10] Zhang Y, Luo H, Wang C, 2021, International Trend Analysis of Carbon Neutrality Action. *Research Progress on Climate Change*, 17(01): 88–97
- [11] Zou C, He D, Jia C, et al., 2021, The Connotation and Path of World Energy Transformation and its Significance for Carbon Neutrality. *Journal of Petroleum*, 42(02): 233–247.
- [12] Zou C, Xiong B, Xue H, et al., 2021, the Position and Role of New Energy in Carbon Neutrality. *Petrol Exploration and Development*, 48(02): 480–491
- [13] Zhou S, Wang J, Liang Y, 2021, The Development of China's Natural Gas Industry in the 14th Five Year Plan Against the Background of Carbon Neutrality. *Natural Gas Industry*, 41(02): 171–182
- [14] Wang C, Zhang Y, 2020, Realization Path and Policy System of Carbon Neutrality Vision. *China's Environmental Management*, 12(06): 58–64
- [15] Zhang X, Guo S, Kong H, et al., 2021, Science and Technology Demand and Technology Path of Carbon Neutrality Vision. *China's Environmental Management*, 13(01): 65–70
- [16] The State Council, 2020, White Paper on China's Energy Development in the New Era, viewed September 17, 2022, http://www.gov.cn/zhengce/2020-12/21/content_5571916.htm
- [17] Gao J, Jiang K, Liu J, et al., 2017, Scenarios Analysis of the Coal Demand in China Based on LEAP Model. *China Coal*, 43(4): 23–27.
- [18] Liu J, Xiahou QR, Wang K, et al., 2019, Research on the Medium and Long-term Low-Carbon Development Path of China's Industrial Sector. *China Soft Science*, 2019(11): 31–41 + 54
- [19] Chai Q, Fu S, Wen XY, et al., 2019, Research on China's Funding Needs for Implementing the National Independent Contribution to Climate Change by 2030. *China's Population, Resources and Environment*, 29(4): 1–9
- [20] Mackenzie D, 2009, Making Things the Same: Gases, Emission Rights and the Politics of Carbon Markets. *Accounting, Organizations and Society*, 34(3-4): 440–455. <https://www.doi.org/10.1016/j.aos.2008.02.004>

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ARIMA and Facebook Prophet Model in Google Stock Price Prediction

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Abstract: We use the Autoregressive Integrated Moving Average (ARIMA) model and Facebook Prophet model to predict the closing stock price of Google during the COVID-19 pandemic as well as compare the accuracy of these two models' predictions. We first examine the stationarity of the dataset and use ARIMA(0,1,1) to make predictions about the stock price during the pandemic, then we train the Prophet model using the stock price before January 1, 2021, and predict the stock price after January 1, 2021, to present. We also make a comparison of the prediction graphs of the two models. The empirical results show that the ARIMA model has a better performance in predicting Google's stock price during the pandemic.

Keywords: ARIMA model; Facebook Prophet model; Stock price prediction; Financial market; Time series

Online publication: October 21, 2022

1. Introduction

Since the full-scale outbreak of COVID-19 in the middle of 2020, the financial markets have been severely hit. The world economy was subsequently affected by the spread of the pandemic, which resulted in financial markets slumping, stock prices plummeting, and worldwide companies being affected. Therefore, this time-specific series of changes has its research significance and can provide valuable references for future generations of the financial markets. We selected the closing price of GOOGL from 2007 to 2022 from Yahoo Finance for our research. We chose Alphabet Inc. as our research subject because the parent entity already has a market cap of 1.79 trillion U.S. dollars, which is over Amazon, thus making it the most valuable internet company. Moreover, the firm had over 257.6 billion in revenue in 2021, creating the highest annual net income at 76 million dollars ^[1]. Therefore, the study of Alphabet Inc. has significant implications for the financial markets. In this research, we use two models, which are the Autoregressive Integrated Moving Average (ARIMA) model and the Facebook Prophet model, to forecast the stock price during the pandemic and compare them with the actual situation in order to discover the advantages and disadvantages of the two models.

In the literature review section, we present the current research achievements of ARIMA and Facebook Prophet as well as the reason we choose these two models to predict stock price during the pandemic. In the method section, we first confirm the stationarity of the data, and then introduce the ARIMA and Facebook Prophet methods, respectively, while explaining their design principles. In the experimental analysis section, we conduct the experiments and analyze the prediction results. This includes the source of the data and its interpretations, the application of the algorithms, and the analysis of the predictions separately with graphs. We then we present a comparative analysis of the two models using errors. In the

conclusion section, we highlight the value of this research and its implications in real life.

2. Literature review

There are some literatures that emphasize on the use of the ARIMA and Facebook Prophet model. ARIMA, as an abbreviation of “Auto Regressive Integrated Moving Average,” is a class of models that interprets a given time series based on its past values, *i.e.*, its lags and lagged forecast errors, to use the equation to predict future values. Stevenson highlights the significance of the predicting method in the stock market, revealing that ARIMA models are instrumental in predicting broad market trends, but the forecasting results differ significantly from reality while using other models [2]. Jadevicius and Huston argue that ARIMA can be used to evaluate a wide range of market price changes, which can help governments and central banks to forecast the increase in national housing prices and enable investors to predict how to invest [3]. ARIMA is an effective model to forecast what we are focusing on in short-term, which is in line with the pandemic period.

Facebook Prophet is an open-source procedure for forecasting time-series data, which works best with time series that have strong seasonal effects and several seasons of historical data. Ignacio Medina *et al.* first introduced this web-based algorithm – Prophet. There are two main options, which are “train” and “predict.” Under the “train” part, Prophet builds a prediction rule based on genes by finding the optimal predictor, then the rule is applied to give the prediction of a new dataset with high accuracy [4]. Wen-Xiang Fang *et al.* used Prophet in the finance markets to forecast the stock value of Microsoft Corporation (MSF), and the empirical results showed that Prophet has certain advantages in predicting future price trends [5]. Sumedh Kaninde *et al.* also used Prophet to predict the stock price and concluded that this model can be used to predict stock prices for a long period of time with reasonable accuracy [6]. Due to its training characteristic and effectiveness in predicting future time-series data, including stock prices, we use it to predict the closing stock price of GOOGL during the COVID-19 pandemic to determine whether the model can constantly predict with high accuracy under the contingency. In addition, we also compare the prediction of ARIMA and that of Facebook Prophet.

3. Methodology

In order to ascertain reliable predictions of the closing stock price during the COVID-19 pandemic, two algorithms are used. Before performing the algorithm, we need to check the stationary of our data by applying the augmented Dickey-Fuller (ADF) test. Thereafter, we will use the ARIMA model and Facebook Prophet model to predict the stock price during the pandemic.

3.1. ARIMA

ARIMA is obtained from combining differencing with autoregressive model and moving average model, in which the integration refers to the reverse of differencing. It was first popularized by Box and Jenkins [7], and it belongs to a class of models that interprets a given time series based on its past values, *i.e.*, its lags and lagged forecast errors, to use the equation to predict future values [8].

The ARIMA model can be written as follows:

$$y'_t = c + \phi_1 y'_{t-1} + \cdots + \phi_p y'_{t-p} + \theta_1 \varepsilon_{t-1} + \cdots + \theta_q \varepsilon_{t-q} + \varepsilon_t \quad (1)$$

where y'_t is the differenced time series data, and the functions on the right contain the lagged values of y'_t , which can be used as the predictors for prediction. Any “non-seasonal” time series that exhibits a pattern and is not random white noise can be modeled with an ARIMA model. An ARIMA(p,d,q) model is characterized by three terms: p, d, and q [9].

- (1) p: The order of the autoregressive term
- (2) q: The order of the moving average term
- (3) d: The number of differences required to make the reversed time series stationary

We will use the backshift notation when building the complicated models, the equation can be written as follows ^[8]:

$$(1 - \phi_1 B - \dots - \phi_p B^p)(1 - B)^d y_t = c + (1 + \theta_1 B + \dots + \theta_q B^q) \varepsilon_t \quad (2)$$

3.2. Facebook Prophet

Facebook Prophet is a time-series data forecasting algorithm, which was developed by Facebook's data science team. It is based on an additive model, in which the nonlinear trend fits to the seasonality of the year, week, and day, along with the holiday effect ^[10].

The Prophet model can be expressed as follows:

$$y(t) = g(t) + s(t) + h(t) + \varepsilon(t) \quad (3)$$

where $y(t)$ refers to the additive regression model, $g(t)$ refers to trends, $s(t)$ refers to seasonality, which shows periodic changes, $h(t)$ refers to holiday, which reflects predictable annual abnormal days on irregular schedules, $\varepsilon(t)$ refers to error, which is typically modeled as normally distributed noise, showing information that is not included in the model ^[12]. Due to the seasonality and holiday components, Prophet is most effective for time series with strong seasonal effects and historical data of several seasons (however, we do not expect seasonal or holiday effects for stock market data).

4. Empirical analysis

The data set comprises 15 years of stock prices from 2007–2022 from Google Inc., whose ticker symbol is "GOOGL." We use the R package "Quantmod" to obtain publicly available data from Yahoo Finance. The data selected include the company's close price on Google. Moreover, we have a total of 3,946 data with no missing values. The structure of the data is shown in **Table 1**. The average closing price of Google Inc. is 41.065, and the minimum value is 6.443.

Table 1. Summary statistics

Variable	N	Mean	Std. Dev.	Min	Pctl. 25	Pctl. 50	Pctl. 75
GOOGL.Close	3945	41.065	34.853	6.442	14.515	28.065	55.84

4.1. Data analysis and processing

Figure 1 clearly shows the trend of the stock over a period of time. The volatility of the stock market can be seen clearly. Though there are peaks and troughs in the short term, we can see a clear upward trend in the long term, but it is not linear. At the same time, we can see a significant downward trend in the share price after the COVID-19 period. We want to ascertain whether a simple linear regression can capture the trend of the data and help us forecast the stock price. We assume that a simple linear regression does not capture the trend of the data.

We use date as the independent variable and stock price as the dependent variable. We obtain a goodness-of-fit of 74.4% through the linear regression model. By comparing the p-value tables, the results are found to be statistically significant since the p-value is less than 0.001, thus the original hypothesis is rejected. This means a relationship exists between the date and the stock price. The coefficient of the date

indicates that with each changing day, the closing stock price increases by \$0.02.

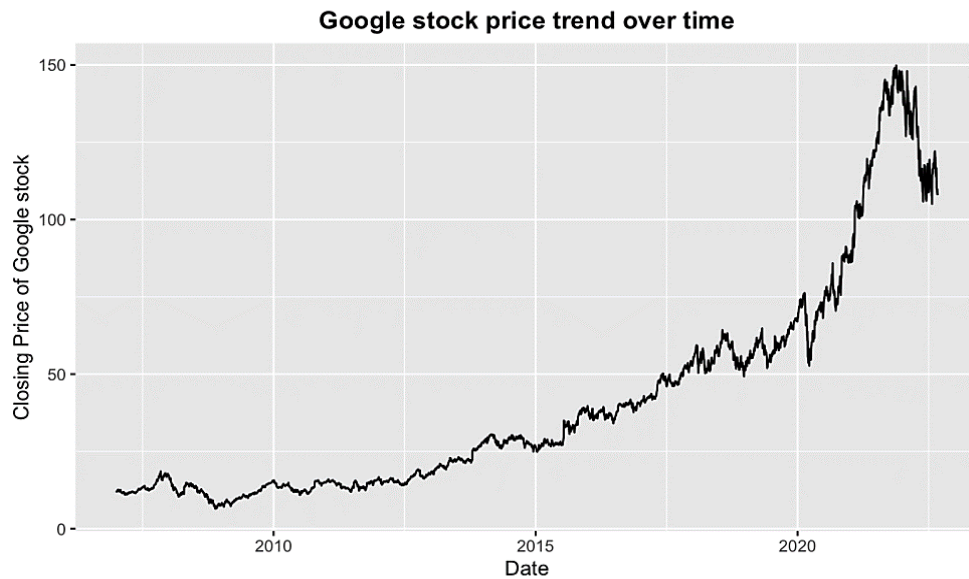


Figure 1. Google stock price trend over time

Based on **Figure 2**, we can clearly see that the time series is not stationary, *i.e.*, its variance is not constant across time. In addition, a clear positive trend indicates that there is no recovery to a constant value, thus suggesting that the time series is not stationary on average. In general, these two properties are undesirable for better and easier time-series modeling. In order to confirm that it is non-stationary, we compared the original time-series data with the transformed data. We applied log transformation and Box-Cox transformation to do so. Moreover, we used the popular log transformation method to determine the mean stationarity.

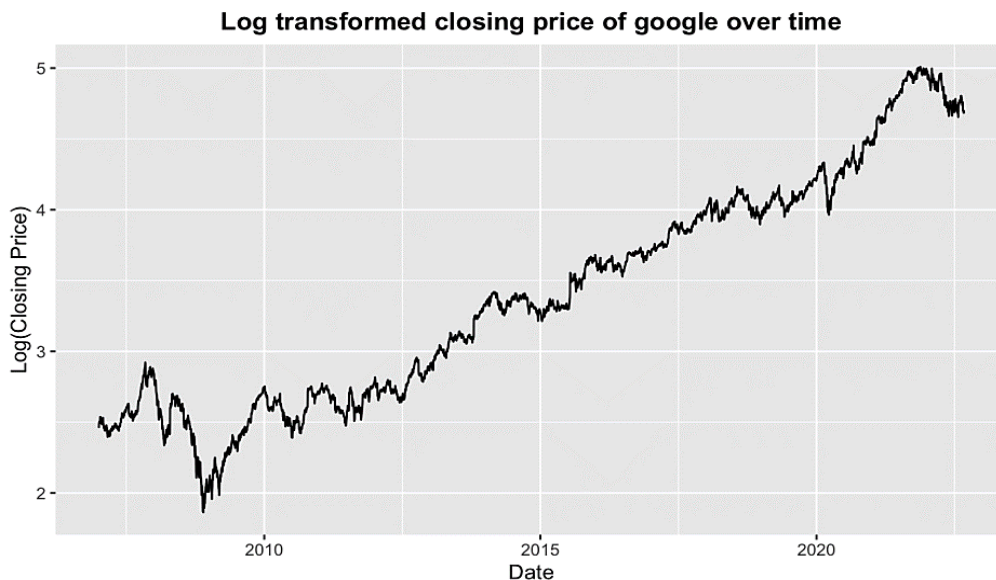


Figure 2. Log-transformed closing price of Google over time

The ADF test is a standard statistical test used to determine whether a given time series is stationary. It is one of the most commonly used statistical tests when analyzing the stationarity of a series, which is largely dependent on the presence of a unit root. The time series is non-stationary if the unit root is present.

The null hypothesis of the ADF test is as follows: the covariance of the first lag of Y is equal to 1. When the test statistic is below the critical value, we reject the null hypothesis and infer that the time series is stationary. The ADF test was performed on the original closing price, and the closing price was Box-Cox transformed. Three sets of p-values were derived from the ADF test when the lag order is 15 (**Table 2**).

Table 2. ADF test on three variables

Variable	Dickey-Fuller	p-value
GOOGL.Close	-1.68	0.715
GOOGL.log_close	-3.15	0.0967
GOOGL.bc_close	-3.33	0.647

Although the transformed p-values dropped sharply, we cannot confidently reject the null hypothesis at 95% significance level. In order to address the non-smoothness of the mean, we calculated the first-order lag of the closing price. However, we also have outliers that deviate more than most points. By running an ADF test on the first-order lagged closing price to see if we have achieved the mean stationary property, the p-value is apparently equal to 0.01 when the Dickey-Fuller is equal to -15.484, below the critical value of 0.05. This indicates that the series is now stationary.

4.2. ARIMA model

We will use Akaike information criterion (AIC) and Bayesian information criterion (BIC) to evaluate the performance of the model. According to the BIC value, the order of the best model is $c(0,1,1)$. We then bring $ARIMA(0,1,1)$ into the model.

In **Figure 3**, the dashed line represents the model's prediction, and the solid line represents the actual value. As we can observe from **Figure 3**, the dashed and solid lines have a very high degree of overlap, and $ARIMA(0, 1, 1)$ has an excellent performance in predicting stock prices. It not only predicts the overall upward trend of stock prices well, but also the upward and downward fluctuations of stock prices in the short term, except that the value of the predicted fluctuations is higher than the actual stock prices. Moreover, this model perfectly predicts the overall downward trend of stock prices after the COVID-19 pandemic.

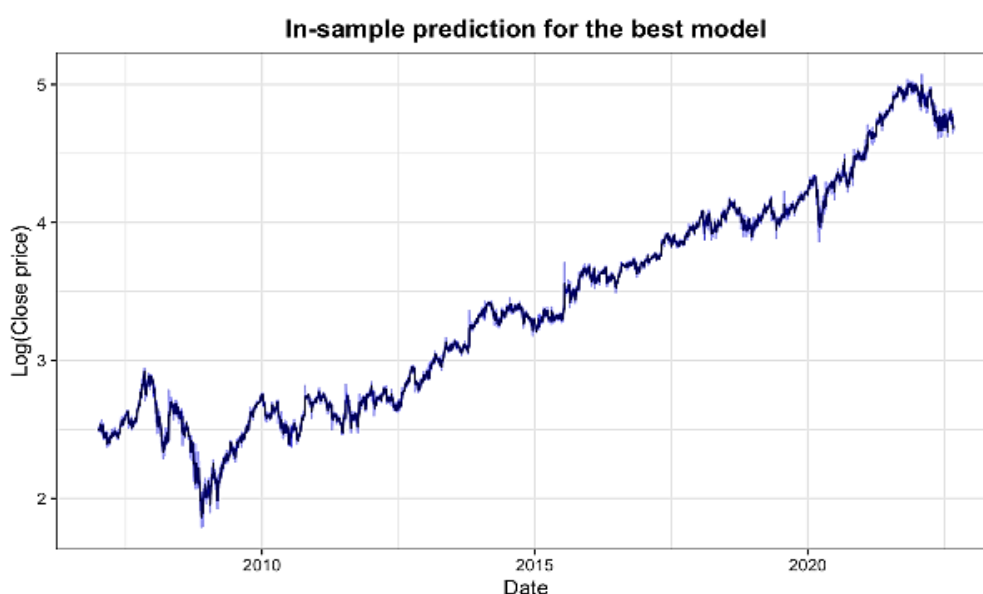


Figure 3. In-sample prediction for the best model

The root mean square error (RMSE) for the ARIMA model is 0.01842, which means that the error between the predicted value and true value is 0.01842461, signifying a relatively small error. This indicates that this model completes the prediction with a relatively high degree of accuracy. We will predict five time periods from the best model.

4.3. Facebook Prophet model

We consider the data before January 1, 2021, as the training dataset and the data from January 1, 2021, to present as the test dataset.

In **Figure 4**, the x-axis is time in years, while the y-axis is the closing price of Google, which is the target variable. The black points represent the real data, whereas the blue points represent the predicted values; the light blue area represents the 95% confidence interval. Using the dataset before January 1, 2021, the Prophet model predicts the stock closing prices with relatively high accuracy. However, when predicting short-term fluctuations, the value of the fluctuations is in fact lower than the real data. Using the dataset from January 1, 2021, to present, the model predicts a continuous upward trend in the closing stock price, which is also not consistent with the actual situation, in which the stock price shows a significant downward tendency.

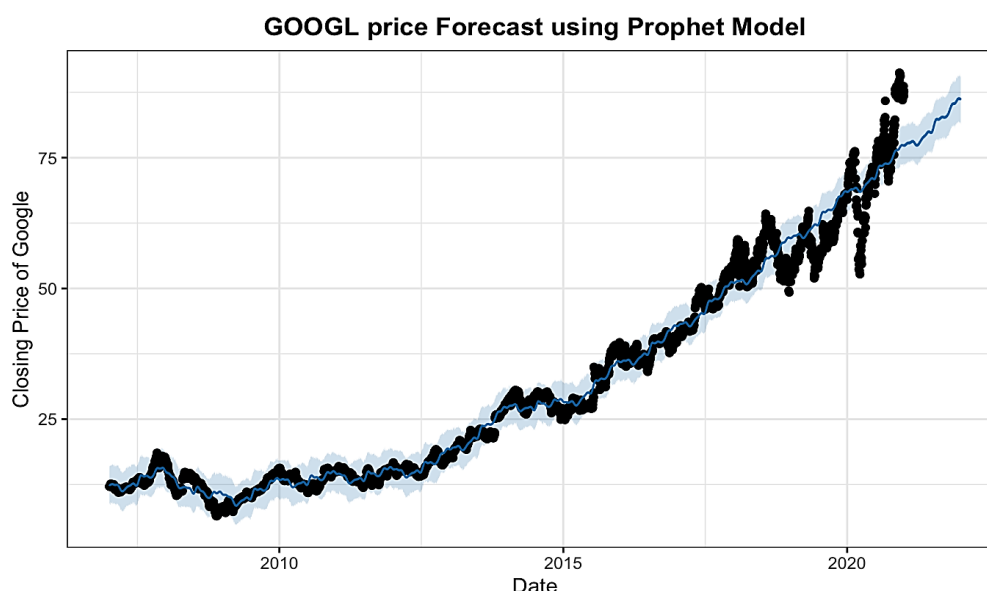


Figure 4. GOOGL price forecast using the Prophet model

4.4. Comparison between ARIMA and Facebook Prophet

There are some parameters that can be used to examine the performance of the Prophet model. We use RMSE for comparison, in which the lower the RMSE, the lesser the error. The RMSE of ARIMA and Prophet is 0.01842 and 47.56, respectively. Comparing the values, the error of the Prophet model is significantly larger than that of ARIMA. This indicates that ARIMA outperforms Prophet in terms of accuracy and overall performance when predicting Google's closing stock price. Moreover, considering the negative impact of COVID-19 on stock prices, ARIMA well predicts this situation, while Prophet derives the exact opposite trend, further validating its imperfection in predicting stock prices.

5. Conclusion

In this study, we used both the ARIMA model and the Facebook Prophet model to predict the trend of stock prices during the pandemic period. The RMSE shows that the error of the ARIMA model is less than that

of the Facebook Prophet model, indicating that the ARIMA model is more accurate than the Facebook Prophet model. This suggests that the ARIMA model will play a significant role in forecasting the trend of stock prices during a particular time series. Therefore, the ARIMA model merits further investigation.

Disclosure statement

The authors declare no conflict of interest.

Author contributions

Z.T. conceived the idea of the study and performed the experiments. S.G. and B.J. analyzed the data and wrote the paper.

References

- [1] Statista Research Department, 2022, Alphabet Inc. – Statistics and Facts, Statista, viewed September 15, 2022, <https://www.statista.com/topics/6042/alphabet-inc/#dossierKeyfigures>
- [2] Stevenson S, 2007, A Comparison of the Forecasting Ability of ARIMA Models. *Journal of Property Investment & Finance*, 25(3): 223–240. <https://www.emerald.com/insight/content/doi/10.1108/IJHM A-04-2014-0010/full/html>
- [3] Jadevicius A, Huston S, 2015, ARIMA Modelling of Lithuanian House Price Index. *International Journal of Housing Markets and Analysis*, 8(1): 135–147. <https://www.emerald.com/insight/content/doi/10.1108/IJHMA-04-2014-0010/full/html>
- [4] Medina I, Montaner D, Tarraga J, et al., 2006, Prophet, a Web-Based Tool for Class Prediction Using Microarray Data. OUP Academic. Oxford University Press, <https://academic.oup.com/bioinformatics/article/23/3/390/236076>
- [5] Fang W-X, Lan P-C, Lin W-R, et al., 2019, Combine Facebook Prophet and LSTM with BPNN Forecasting Financial Markets: The Morgan Taiwan Index. 2019 International Symposium on Intelligent Signal Processing and Communication Systems (ISPACS), <http://doi.org/10.1109/ISPACS48206.2019.8986377>
- [6] Kaninde S, Mahajan M, Janghale A, et al., 2022, Stock Price Prediction Using Facebook Prophet. *International Conference on Automation, Computing and Communication 2022 (ICACC-2022)*, ITM Web Conf, 44: 03060. <https://doi.org/10.1051/itmconf/20224403060>
- [7] Stellwagen E, Tashman L, 2013, Arima: The Models of Box and Jenkins. *Foresight: The International Journal of Applied Forecasting*, 2013(30): 28–33. <https://ideas.repec.org/a/for/ijafaa/y2013i29p28-33.html>
- [8] Hyndman RJ, Athanasopoulos G, 2018, 8.5 Non-seasonal ARIMA models, in *Forecasting: Principles and practice* (2nd Edition), OTexts, Melbourne, Australia. <https://otexts.com/fpp2/non-seasonal-arima.html>
- [9] Fattah J, Ezzine L, Aman Z, et al., 2018, Forecasting of Demand Using ARIMA Model. *International Journal of Engineering Business Management*, 2018: 10. <https://doi.org/10.1177/1847979018808673>
- [10] Forecasting at Scale, n.d., Prophet, viewed September 18, 2022, <https://facebook.github.io/prophet>

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Research on the Rural Logistics Development Model Based on Online and Offline Transactions

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Abstract: As the world's second largest economy and a traditional agricultural country, China has not yet achieved the goal of modernizing the logistics of agricultural products. The overall modernization of its logistics industry has not been achieved either. Due to the poor overall performance of its agricultural product logistics, the level of China's agricultural product logistics is still in its infancy, with high logistics costs, large losses, and low efficiency. In fact, the construction of a modern agricultural product logistics system in China is lagging behind. This has seriously affected the process of agricultural industrialization in China. Compared with its urban socio-economic development, its rural development is relatively lagging behind. The "three-rural" (including agriculture, rural area, and peasant) problem caused by the divided urban-rural structure in China has distorted the relationship between workers and peasants. This has become a global problem, affecting China's economic and social development. The core problem is the slow growth of farmers' income. The bottleneck that has been restricting their income has shifted from production to circulation. In recent years, the promulgation of a series of policies and documents has brought both, hope and challenges to the online and offline integration and development in the field of agricultural product circulation. This paper briefly outlines the characteristics and status quo of rural logistics development based on online and offline transactions, and provides some effective suggestions on how to build a new rural logistics development model based on online and offline transactions, in hope to assist the development of new rural logistics models in China. The construction provides a reference for the development of the logistics industry in China's rural areas, thereby promoting the circulation of agricultural and sideline products, and better developing China's rural economy.

Keywords: Online and offline; Rural logistics; Rural economy; Logistics system

Online publication: October 21, 2022

1. Research background

With the rapid development of the internet, business model innovations relying on the internet have emerged. The integrated online and offline development is becoming the most dynamic emerging economic form that accelerates trade flow and promotes consumption. The State Council issued the "Opinions on Promoting Offline Interaction and Accelerating the Innovation, Transformation, and Upgrading of Commercial Circulation," which puts forward specific policies for accelerating the development of online and offline interactions from four aspects: encouraging innovation, stimulating vitality, improving systems, and improving policies guide. On June 2, 2015, the Ministry of Finance promulgated the "Guiding Opinions on Promoting Comprehensive Agricultural Development and Moderate Scale Management" through the development of contract farming and cooperative business models to improve the production and operation of agricultural products and cooperatives, as well as to further improve the agricultural service scale and

informatization level. On November 17, 2015, the Ministry of Finance issued the “Guiding Opinions on Supporting the Comprehensive Development of Agricultural Advantages and Characteristic Industries and Promoting Agricultural Industrialization,” further proposing the “Internet + Agriculture” development model, while encouraging and supporting agricultural enterprises to speed up the development of advantageous and characteristic agricultural product e-commerce platforms.

2. Research significance

The logistics theory was recently introduced in China, and the understanding of the role of logistics in economy had only began in recent years. Since China’s logistics foundation is weak, and its logistics technology is relatively backward, its logistics development is slow. Especially in the vast rural areas of China, logistics is still a relatively new concept. The root cause for the slow logistics development is the lack of theoretical guidance. Logistics activities can only thrive under the guidance of the logistics theory. In order to fill the gap and develop China’s rural logistics, it is necessary to explore and study the rural logistics (or agricultural product logistics/agricultural logistics) model. This is the main purpose of this paper. Through this research, we attempt to improve the level of rural logistics research in China and strengthen the exchange and cooperation of rural logistics research at home and abroad.

3. Principles and strategies for building a rural logistics development model based on online and offline transactions

3.1. Basic principles of constructing a rural logistics development model

3.1.1. Principle of sustainability

For sustainable development, the agricultural product logistics development model should not only respect the economic laws, but also the social laws and natural laws, so as to improve people’s quality of life. China is in the middle stage of industrialization, as indicated by its large population and high agricultural production and consumption. In addition, modern agricultural product logistics started relatively late in China. Economic activities that are related to agricultural product logistics have a significant impact on the environment, resources, nature, and people’s quality of life. This would inevitably lead to excessive resource consumption and serious environmental damage. Therefore, it is necessary to consider the overall interests and long-term interests, pay attention to the environment, and construct an intensive development model that is closely related to green economic activities, such as green production, green marketing, and green consumption.

3.1.2. Principle of interest

The main goal of any system is to satisfy the interests of its members. Collaborative agricultural logistics finance, as a whole, is maintained to meet the interests of its members or customers although its participants have different interests. In addition, the biochemical characteristics of agricultural products, the dispersion of agricultural production and consumption, the information asymmetry, and the interaction of trade barriers, natural disasters, price signals, and behavior patterns contribute as risks to agricultural logistics finance. Therefore, cooperation between all parties can only exist when the financial operation of agricultural logistics offers attractive economic benefits to all participants. By achieving organizational goals through cooperation, it is then feasible to achieve the best operational outcomes and serve their own interests. This is the prerequisite for developing collaborative agricultural logistics.

3.1.3. Principle of system

The rural logistics network is an organic whole, composed of three interconnected and interacting sub-networks: logistics infrastructure network, logistics organization network, and logistics information

network. Its advantages and disadvantages are evaluated in terms of overall benefits. In order for the system to be completely balanced, the integration of rural logistics network resources must begin from the perspective of the whole, regard the logistics network as a system, and use the optimization of the overall goal of the system as the criterion to coordinate the relationship between the various sub-networks in the system. Since the distribution of rural areas in China is not concentrated, the rural logistics network must likewise have gaps in terms of the levels and modes. Therefore, the key to the integration of China's rural logistics network resources is to promote the overall development on the basis of adhering to the principle of integrity and unified planning, while determining the best plan and gradually implementing it according to regions, industries, and steps through market links, combining the rural logistics network and related industries into an effective operation, as well as providing the best logistics services at the lowest cost.

3.1.4. Principle of adaptability

The integration of rural logistics network resources should be compatible with the national, provincial, municipal, and village economic development guidelines and policies, the distribution and needs of China's rural logistics resources, and its social development. Therefore, the integration of China's rural logistics network must adapt to the characteristics of the economic operation of its rural economy and build a logistics network that can effectively meet the logistics needs of rural areas. By constructing a logistics network based on rural economic characteristics and agricultural production needs, the integration of logistics network resources cannot be established separately from the rural environment; otherwise, the expected effect will not be achieved ^[1].

3.2. Main strategies for constructing a rural development model

3.2.1. The government should actively play the guiding role

The integrated online and offline development requires time and involves various fields and parties, such as rural areas, townships, processing enterprises, and logistics enterprises. The government should play an active role in guiding and supporting, focusing on increasing farmers' income, accelerating rural development, and realizing the modernization of agriculture. The first step is to help agricultural e-commerce enterprises coordinate and solve capital problems, especially capital bottlenecks encountered in their development, as well as encourage financial institutions to provide financial services to high-quality e-commerce enterprises. The second step is to build a platform and standardize management. These can be done by establishing an e-commerce management center for agricultural products, standardizing management, charging, and other behaviors, as well as providing a healthy and standardized living environment for the integrated online and offline development of agricultural products. The third step is to coordinate relevant enterprises in carrying out necessary resource integration in a complementary and win-win manner. On the one hand, enterprises such as those developing supply bases, logistics companies, farmers' cooperatives, as well as supply and marketing cooperatives can be integrated to establish large-scale, specialized and standardized joint-stock cooperative enterprise groups so as to create market competitiveness; on the other hand, integrating the existing resources and resources of third-party logistics enterprises under construction to form a logistics system with wider coverage and better distribution methods would help reduce costs and improve efficiency; at the same time, it is necessary to speed up the resource integration of physical retailers. Enterprise groups should also be encouraged to integrate with brick-and-mortar retailers through acquisitions, share purchases, *etc.*, and provide them with support in the form of big data, high-quality supply, fast payment, and overall distribution, so as to realize the deep integration of brick-and-mortar retailers and the internet. Complementary advantages and rapid development would be achieved through the online and offline integration ^[2].

3.2.2. Strengthen the construction of logistics informatization

In order to develop an online and offline agricultural product logistics model, it is necessary to strengthen the construction of informatization, build an agricultural product circulation information system, eliminate information asymmetry in the circulation process, and reduce the sales cost of agricultural products as well as consumers' time cost. The first step is to improve the construction of the network platform, build an online network system for agricultural product transactions in various regions, effectively integrate the decentralized online agricultural product transaction platforms, and form a network platform covering various regions and equipped with various functions, such as inquiry, ordering, payment, distribution, and those that allow consumers to provide feedback and evaluation. Secondly, it is important to establish a traceability system for agricultural product information, monitor and track the production, transaction, and transportation of agricultural products in real time, collect relevant information, process comprehensively, analyze effectively, establish a mechanism for agricultural product sales information updates, and provide information to consumers. Having such systems would provide convenient network query services, realize the virtualization, informatization, and efficiency of the transaction process, as well as improve transaction efficiency. Combined with the internet of things, agricultural product information processing and data management can be improved through radio frequency identification, video monitoring, photothermal induction, and other measures. This would also ensure that the quality of agricultural products from supply to sale is controllable and improve consumer satisfaction. In addition, supporting cold chain storage facilities and equipment (such as cold storage) should be set up at important nodes (such as distribution points, physical stores, *etc.*) to ensure that a cold chain exists throughout the process.

3.2.3. Ensure good integrated online and offline development planning

At this stage, the main reason for the loss of most agricultural e-commerce products is unclear product positioning. In the early days of our business, we often hope to build a customer base quickly and achieve greater transaction volumes through rich product categories. However, various relatively large supply systems will directly increase management costs, making it difficult for the company to achieve profitability in the short term and overloading its operations. Therefore, reasonable commodity positioning is the key to the integrated online and offline development of e-commerce for agricultural products. First of all, we must start with a single variety, plan scientifically, implement overall planning, and make steady progress. Based on the consumption habits of consumers when in face with products, agriculture e-commerce enterprises should first consider agricultural products with regional characteristics, then cultivate consumers' sense of identity, and improve consumer satisfaction. When there is a fixed customer base for a product, then a second product should be launched in due course. Second, it is necessary to combine online and offline integration with regional characteristics. In the development of e-commerce enterprises, it is necessary to use a grading model according to the consumption characteristics of the community residents while extending the e-commerce platform to the community. This would ensure a reasonable positioning and differentiated treatment. Through the establishment of a community e-commerce platform, the organic combination of online transactions, offline experience, and community distribution can be achieved, thereby improving the coverage and adaptability of the e-commerce platform.

3.2.4. Supervise the transaction process

Compared with tangible market transactions, the protection of rights is a major problem that plagues online and offline e-commerce transactions for agricultural products. The e-commerce trading platform is a virtual trading environment. When disputes arise between buyers and sellers, there must be a mechanism for resolving disputes. This requires relevant government departments to establish and improve the relevant

laws and regulations as soon as possible, as well as strengthen the supervision of online and offline e-commerce transactions, improve the e-commerce transaction environment, and ensure smooth transactions. In the early stage of foreign e-commerce development, there are many issues, such as account security problems, information leakage, and problems pertaining to integrity ^[3]. With supervision and the improvement of relevant laws and regulations, the construction of foreign e-commerce trading platforms has matured. China should learn from these foreign experiences in managing e-commerce transactions so as to ensure that the implementation of e-commerce transactions for agricultural products would run smoothly.

3.2.5. Improve the logistics infrastructure for agricultural products

The construction of logistics parks is a necessary means and an effective way to improve the construction of rural logistics infrastructure. The government should lead the construction of rural logistics parks and provide financial, technical, and human resources support for agricultural product logistics. The characteristics of both, urban and rural areas should be considered when building a professional logistics distribution center, and various infrastructures should also be built in the logistics distribution center. Other logistics companies should be encouraged to develop logistics parks of a certain scale, mainly in the suburbs, where few people come and go, the traffic is not as crowded as in cities, and their impact on urban traffic is minimal. These logistics parks would naturally attract many logistics enterprises to join its big family, thus relieving the city's congestion and traffic pressure. At the same time, with the continuous development of the real estate market, urban land is becoming more compact and prices are rising, but large areas of rural land resources have not been developed. Establishing logistics parks in rural areas would not only solve large-scale warehousing needs, but also ease the pressure on the price of land that can be purchased by logistics companies. Furthermore, building logistics parks in rural areas can ease the ecological balance between urban and rural areas.

3.2.6. Increase talent training

Due to the late start of China's logistics industry, there is a lack of training for logistics talents. Therefore, in the actual operation process, problems such as low-quality logistics personnel, poor service quality, and customer complaints may arise. This is a problem we need to solve urgently. In context of the actual situation, it is necessary to encourage employees in the logistics industry to take up courses on logistics management and improve the training courses offered by logistics enterprises. In addition, the government should encourage logistics industry associations to cooperate with private educational institutions, improve the logistics industry training mechanism, and establish logistics-related professional certificates. It is also important to strengthen exchanges and cooperation, as well as cultivate outstanding agricultural product logistics and distribution talents. With the rapid development of rural e-commerce, the agricultural product logistics industry will become a new interest of growth in the future. Many enterprises have problems such as backward information technology, asymmetrical information, and insufficient experience of the delivery staff. Therefore, enterprises must be able to communicate, cooperate, and learn from each other. In addition, the state should introduce advanced educational resources from developed countries, carry out education and training on agricultural product logistics and distribution, as well as improve the overall quality of the employees. At the same time, the state should introduce more excellent talents into the logistics industry, so that their advanced concepts and management methods may penetrate into the industry, thereby improving the quality of the entire logistics service ^[4].

3.2.7. Increase capital operation and support

In order to meet the huge capital demand for the development of rural logistics, it is necessary to develop

financing channels and make joint contributions to provide capital support for the operation of rural logistics. The government should fund large-scale logistics hubs and construction projects, such as highways, railways, ports, and airports, whereas medium-sized construction projects, such as regional logistics centers, distribution centers, and storage centers, can be jointly funded by the government and private capital. It is possible to attract investments for small-scale logistics infrastructure construction, such as rural logistics centers, transfer stations, trade centers, *etc.*, depending on who invests and who benefits; otherwise, joint investment in the form of shareholding cooperation can also be made, which allows the flow of private capital into the field of rural logistics. A certain feedback mechanism can be adopted by the government to give preferential treatment in terms of land use tax, business tax, and industrial and commercial tax. Enterprises and individuals who actively participate in the construction of rural logistics networks may relax loan restrictions on logistics enterprises that are committed to developing the rural logistics markets and providing subsidies. In addition, it would be beneficial to further promote the opening-up of rural logistics, relax investment restrictions, attract foreign investment in rural logistics, relax financing and foreign investment conditions, encourage foreign logistics companies to expand their markets in the vast rural areas, and welcome foreign logistics based on the principle of equal opportunities. Enterprises should be involved in the investment and operation of rural logistics warehousing, transportation, processing, freight forwarding, and other projects.

4. Conclusion

Since the rural areas in China adopt a decentralized operation model, their agricultural production scale is small. In addition, due to the lack of information on market supply and demand, the cost bore by the farmers for finding customers is extremely high. This affects the effective circulation of agricultural products. The online and offline transaction mode can help solve this problem, improve the development level of China's rural logistics, and alleviate the problems faced by these rural areas. At present, the online and offline rural logistics model can develop well, and it is committed to the organic integration of online and offline resources, which has become the main direction of agricultural e-commerce. Although agricultural product e-commerce is developing rapidly, there are some challenges to the construction of the logistics model. For instance, due to the agricultural product distribution characteristics and the undeveloped rural logistics network, the logistics cost of agricultural products remains high, and there are difficulties in controlling food safety. In order to solve this problem, the government and relevant industries must attach importance to this concern and work together to make full use of technology, education, management, and other means to provide a suitable platform and space for the optimization of rural logistics models, so as to improve the quality of life of Chinese farmers, and thus to promote the sustainable development of China's rural economy.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Yichang Logistics Industry Development Center, 2021, Accelerate the Improvement of Rural Logistics Network System to Help Yichang National Logistics Hub Construction, viewed July 15, 2022, <http://wlj.yichang.gov.cn/content-54039-951457-1.html>
- [2] Li X, Peng S, 2021, Research on the Development of Rural Logistics Under the Strategy of Rural Revitalization. *Logistics Engineering and Management*, 43(2): 10–12.
- [3] Xiao J, 2021, Research on the Development of Rural Logistics Industry Under the Background of

Rural Revitalization. Jiangsu Science and Technology Information, 38(4): 29–32.

- [4] Ma Q, He H, Wang X, 2021, Research on the Causes and Countermeasures of Rural E-Commerce Logistics Blockage Based on DEMATEL/ISM Integrated Model. Science and Technology Innovation and Productivity, 2021(2): 57–59 + 65.

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Research on the “New University” Management System from the Perspective of Finance

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Abstract: Since the release of the “Outline of the National Medium- and Long-Term Education Reform and Development Plan (2010–2020),” “new universities” have garnered widespread attention. The system and mechanism of these “new universities” are different from those of traditional universities. They have their own ways of running schools, management systems, and personnel training methods, all of which bring a different kind of pressure to government management. Looking from a financial perspective, this is also the key research subject of finance and financial personnel. We put forward implementation suggestions for the construction of the “new university” management system based on the experience summed up in the work and contribute to the country’s higher education.

Keywords: Local government; New university; Management system; Financial affairs

Online publication: October 21, 2022

1. Introduction

Eric Ashby, a famous British higher education expert and the former Vice-Chancellor of Cambridge University, once pointed out that any particular university is the product of its heredity and environment. He believes that from a genetic point of view, it is expressed as a common understanding of the “meaning of university” among university educators, but from an environmental point of view, it is the political system and the system itself that fund and support the university^[1]. Since the release of the “Outline of the National Medium- and Long-Term Education Reform and Development Plan (2010–2020),” many “new universities” have emerged in China. What is a “new university”? “New university” refers not to the “new” in terms of time, but to the “new” with Chinese characteristics, differing from the educational philosophy, management system, and talent training methods of existing universities. The “new university” management system comprises the manager and the managed, that is, the government and the university. Beginning from the relationship between the two, this paper explores how to better improve the management system from the perspective of financial affairs.

2. Characteristics of China’s “new universities”

At present, there is no official statistics on “new universities.” For preliminary analysis, this article selects the “new universities” that have been established following the release of “Outline (2010–2020)” (Table 1).

Table 1. Representatives of “new universities” established after the release of “Outline (2010-2020)”

School	Nature of running a school	School category	School location	Year of establishment
Southern University of Science and Technology	State-run	Science and engineering	Shenzhen	2012
Shanghai New York University	Sino-foreign cooperative education	Comprehensive	Shanghai	2012
Shanghai University of Science and Technology	State-run	Science and engineering	Shanghai	2013
Chinese University of Hong Kong (Shenzhen)	Regional cooperation (Mainland and Hong Kong, Macao and Taiwan)	State-run	Shenzhen	2014
Westlake University	Private	Science and engineering	Hangzhou	2018

According to **Table 1**, it can be concluded that the “new universities” have the following characteristics: in terms of the nature of running schools, they are not only funded by the government, but also by social forces and cooperation; from the perspective of school category, they are mainly under the category of science and technology, but some are also considered comprehensive schools; in terms of school location, there is a trend of development from old first-tier cities to new first-tier cities.

3. Current situation of China’s “new universities” management system

When it comes to the management system, the main bodies are the government and the “new universities.” The relationship between the government and these universities has been in discussion for a long time, but no clear consensus has been reached so far. We will discuss the the status quo and problems in this section.

3.1. Status quo of government management

3.1.1. Decentralization of functions and increased pressure on local government management

Article 39 of the “Outline (2010–2020)” clearly states, “In order to implement and expand the school’s autonomy in running schools, the government and its departments should sort out service awareness, improve management methods and supervision mechanisms, reduce and standardize school administrative approval items, as well as ensure that schools fully exercise their autonomy in running schools and assume corresponding responsibilities in accordance with the law.” This is to emphasize the transformation of government functions, reduce the administrative burden of colleges and universities, and protect their autonomy. As can be seen from **Table 1**, “new universities” tend to develop from established first-tier cities to new first-tier cities. In the process of promoting the construction of the rule of law in China, government agencies have streamlined administration and delegated powers, and the responsibility of managing “new universities” falls more on the local government.

3.1.2. Local government lacks strong management agency

Most of the “new universities” are units under provincial administration. For those jointly built by provinces and cities, compared with provincial capital cities and municipalities directly under the central government, the functional organizations managed by local governments are not the top-echelon. They are lacking in strength and are incapable of overall planning and guidance. The phenomenon of “a small horse drawing a big cart” is particularly prominent. This inevitably leads to the lack of functions of the local government in the overall guidance and management of higher education. At the same time, the local government lacks top-level guidance for local higher education and has unclear higher education goals, which easily lead to

arbitrary financial funding, poor policy orientation, and weak security capabilities. Therefore, the local government is constantly being criticized by the society and schools.

3.1.3. Performance accountability mechanism for financial funds

From the perspective of financial fund management, in order to make effective use and control of financial funds, local governments often use performance management methods to set grades and classifications for college qualifications, rank, and evaluation, in order to measure the size of investment in different colleges and universities. Theoreticians contend that the current government performance management model has weakened the autonomous legal standing of higher education, rendering it incapable of independent innovation and self-regulation, through the impact of its primary stage effect on higher education and the overtly administrative nature of higher education reform. It is even more of a shackle to the fledgling “new universities” that still require the blessing of the government.

3.2. Current situation of the “new university”

3.2.1. The majority of the fundings of “new universities” come from government financial appropriations

Since there is no official budget and final account disclosure platform for cooperative-run and private colleges and universities, the proportion of fiscal appropriation revenue and expenditure in the current year’s revenue and expenditure based on the final account report of public colleges and universities is used to analyze the dependence on the government.

It can be seen from **Table 2** that most of the revenue sources of the “new universities” that have been established in recent years come from financial appropriations.

Table 2. The proportion of fiscal appropriation revenue and expenditure in the current year's revenue and expenditure in the final accounts report of some colleges and universities

School	Founding year	Report year	Income		Expenditure	
			Amount (billion yuan)	Proportion	Amount (billion yuan)	Proportion
Southern University of Science and Technology	2012	2019	3.961	89.67%	3.335	93.97%
Shenzhen University	1983	2019	4.703	70.92%	4.601	76.49%
Shanghai University of Science and Technology	2013	2019	2.278	90.61%	2.153	90.12%
Shanghai Jiaotong University	1896	2019	3.429	24.82%	3.396	27.45%
Zhejiang University	1897	2020	3.600	25.58%	3.650	28.37%
Nanjing University	1902	2020	2.140	39.67%	2.146	43.31%

3.2.2. The “self-hematopoietic capability” of “new universities” needs to be strengthened

According to **Table 2**, traditional colleges and universities with considerable scale have been running for many years, and most of the school’s financial revenues and expenditures can break-even or even have surpluses; some domestic colleges and universities have strong “hematopoietic capabilities,” which has laid a solid foundation for their subsequent development. For newly established “new universities,” in order to stand out from the many “211,” “985,” and “double first-class” universities, it is necessary to focus on innovating school-running orientation, mechanism and system, talent training, teaching staff construction,

discipline development, as well as other aspects. The quality of running a school influences the growth of a university and depends on the level of the teaching staff to a large extent. In order to attract high-quality teachers, in addition to the positioning, philosophy, and prospects of the school itself, salary is also a factor that cannot be overlooked. Compared with traditional colleges and universities, the total expenditure of “new universities” are larger, and the proportion of personnel expenditure to the total expenditure is relatively higher when the level of factors or standards other than salary remains unchanged. Without government financial support, it would be challenging to overcome the financial difficulties in the growth period.

3.2.3. “New universities” need to be “de-administrative”

Since the release of the “Outline (2010–2020),” de-administration and autonomy in running schools have become topics of debate for the reform and independent running of colleges and universities. This is not unique to “new universities,” but rather common to all colleges and universities. Chinese higher education has strong administrative dependency. This characteristic is directly related to the continuous improvement of comprehensive national strength and the overall management of the country in terms of social affairs. In the construction of the main body of higher education, universities have inevitably turned into vassals of the state and lost their independence and autonomy as academic organizations as a result of the state’s political power, comprehensive control, and strong integration of universities in various ways ^[2]. For a long time, colleges and universities have developed the habit of relying on government procedures and resources; having also psychological dependence on the government, it has been extremely difficult for colleges and universities to return ^[3]. This is especially true for universities that are transforming into “new universities.”

4. Suggestions for the construction of China’s “new university” management system

From the perspective of the relationship between the two, several strategies related to the management system itself are proposed.

4.1. Government

4.1.1. Construction of management system and supervision means

The system is the foundation and guarantee of any management, and the premise of perfecting the construction of the system is by perfecting laws and regulations. “New universities” include a variety of school-running properties. Compared with public universities with relatively complete laws, regulations, and systems, the construction of cooperative education and private “new universities” is relatively backward. Taking cooperative education as an example, it is currently only supported by the “Regulations of the People’s Republic of China on Chinese-Foreign Cooperation in Running Schools” and “Measures for the Implementation of Regulations of the People’s Republic of China on Chinese-Foreign Cooperation in Running Schools,” which belongs to the administrative rules and regulations. The legal effect is relatively low. In the field of cooperative education, a high-level law is needed to carry out the top-level design, and the local government needs to study the implementation details.

By strengthening institutional construction, local governments can set up permanent institutions for higher education management directly under the responsibility of the main leaders of the local government and strengthen the overall planning ability of colleges and universities in the region, so that they can better implement “policies” based on “schools.” The first is to strengthen the top-level design and strategic planning for the high-quality development of higher education, formulate relevant supporting policies for the development of different types of universities, adhere to the goal orientation, and clarify the investment. The second is to open-up multi-department coordination management channels, build efficient information upload and release channels, and run the overall management and coordination work in colleges and

universities more smoothly. The third is to guide and motivate different types of colleges and universities to focus on major problems that need to be solved in various areas, including discipline construction, scientific research, talent introduction, achievement transformation, and social services; as well as encourage and guide the same type of colleges and universities to carry out healthy competition in relevant aspects and improve the level of running schools.

4.1.2. Carry out the transformation and upgrading of local industries well, and lay the foundation for the integration of production, education, and research

According to the “2021 Employment Report for College Graduates,” which embodies a survey of 2021 graduates, released by 58.com, old first-tier cities, including Beijing, Shanghai, Guangzhou, and Shenzhen, are still the first-choice cities for graduates, and they are also well-known for employment of graduates. In local cities, including new first-tier cities, the local employment rate of graduates is low, and in some places, the employment rate of graduates with degrees or above remains in single digits. The low local employment rate is largely due to the insufficient integration of local production, teaching, and research. The inconsistency of integration goals is one of the factors contributing to the insufficient integration. Colleges and universities tend to pursue talent training and social benefits, while enterprises (research institutes) tend to focus on economic benefits and ways to enhance their competitiveness. The value pursuit between the two is clearly different, thus indicating that the integration of the two parties would definitely not work out spontaneously. Therefore, there must be some intervention through certain administrative means ^[4].

Local governments can transform and upgrade local industries based on local characteristics, guide policy formulation through industrial development, and direct the discipline construction of colleges and universities. Under the background that “new universities” are gradually moving closer to new first-tier cities, the upgrading of local industries is extremely urgent. At present, the growth of industries is guided by policies. The industry that needs the government’s support would be developed under a series of policies. The traditional talent training model is driven by industrial development, that is to say, which industry develops better and implements the relevant professional setting and configuration of the talent training plan. However, talent training is a cycle, whereas the industrial transformation and upgrading of talent demand is immediate. This proves that there is a lag in the traditional talent training model. Therefore, education must move forward with the specific industry for talent training, and industrial development should in turn guide policies ^[5]. It is still necessary to transform the functions of local governments, reduce the management of educational needs, implement the service function of “new universities” and social connections well, and guide these universities in such a way that they can enhance their own “hematopoietic capabilities” and improve their capital operation capabilities.

4.1.3. Consider a variety of supervision methods and make full use of the power of social supervision

It has long been understood that the Chinese government has always played the role of a “paddler,” steering social development through coercive or restrictive means, and concentrating power to make decisions on social management, instead of social service work. As a result of this kind of thinking, higher education now has led a single governing body, and administrative means are mainly used for supervision. In 2016, the Ministry of Finance issued the “Operational Regulations for the Disclosure of Local Budgets and Final Accounts” to promote the legalization, democratization, and scientificization of grassroots budget management as well as to protect the public’s right to know, participate, and supervise the financial budget. However, due to the lack of local governments, the supervision of the management of cooperative schools and private colleges and universities has not received much attention. The local government can further enrich the supervision subjects by enhancing the information transparency and feedback of different types of colleges and universities in “new universities,” encourage colleges and universities to establish a sense

of self-regulation, as well as exert the power of social supervision.

In this way, government compulsory supervision, social supervision, and self-regulation can play their respective regulatory roles from different fields and perspectives, rely on and influence each other, and jointly build a comprehensive and multi-angle three-dimensional regulatory framework on how to promote the sustainable development of education and continuously improve the standardization of running schools as well as the quality of education [6].

4.2. “New university”

4.2.1. Strengthen the awareness of the main responsibility of “new universities”

According to several analyses, the proportion of China’s higher education financial expenditure in gross domestic product (GDP) and its index of public expenditure per student in higher education (that is, the ratio of per student expenditure to per capita GDP) are comparable to those of the United States, Britain, France, Germany, and Japan. Compared with other major economic countries, the Chinese government’s financial investment in higher education is more prominent as reflected not only in the higher proportion of higher education financial expenditure to total financial expenditure, but also in the higher public expenditure index per student [7]. Although the Chinese government’s efforts in financial investment in higher education are evident to all, the actual development of most colleges and universities is not as expected. It is absurd to attribute the poor development to the lack of investment from the government. The operation capacity of colleges and universities and the main body’s sense of responsibility may be the reasons for it. “New universities” must rely on government support in the early stages of establishment and transformation, but after they have stabilized, they must adhere to the principle of “setting expenditure by revenue” and “setting expenditure by means,” improve the efficiency of the use of funds and combine it with the construction of the internal control system, strengthen the awareness of capital risk control and the system of power checks and balances, as well as improve the performance management mechanism. It is worth noting that due to the establishment of a new management system for public institutions, the majority of “new universities” have canceled the institutional designation; additionally, the employment mechanism has become more market-oriented, and it is now more difficult to control personnel expenses. Attention should be paid to whether the proportion of personnel expenses is too high, resulting in an imbalance in the expenditure structure, which affects the level of education.

4.2.2. Establish a sense of local service

According to the “Zhuzhou Consensus,” issued by the first International Forum on Industry-Education Integration Development Strategy in April 2014, and the “Chengdu Consensus,” issued by the National Joint Conference of Newly-Built Undergraduate Universities in October 2016, the integration of regional industrial development serves the local and industrial economy and societal development. Facing the needs of local social and economic development, the “new university” should discard the idea of running a closed school and use it to undertake social responsibilities and actively participate in the construction of the society. Compared with traditional research-oriented universities that emphasize the “combination of teaching and scientific research,” “new universities” focus on the cooperation of production, education, and research [8]. At the 2014 symposium between teachers and students of Peking University, it was mentioned that a world-class university must have Chinese characteristics. Therefore, “new universities” must rely on industrial upgrading, serve the locality and industrial development, while considering their own conditions, break the concept of “one acre and three parts of land,” and transform the development model of blindly imitating and borrowing. It is necessary to be orientated towards innovation, integrate education, industry, and research with local economic development, emphasize the qualities of service areas, seek to become quasi-demand oriented and first-class oriented, and pursue development with traits that would create a new

impetus.

4.2.3. Guide the diversification of capital investment and expand the autonomy of running schools

Burton Clarke analyzed the transformational entrepreneurial practices of universities that have had government funding curtailed, such as Twente, Warwick, Strathclyde, Chalmers, and Makerere. In order to survive and develop, it is necessary to face the changing needs of the external environment and internal development with a proactive attitude, strive to seek diversified sources of funding, and actively strive for as much autonomy as possible^[8]. Compared with traditional research universities, “new universities” have more output and opportunities to socialize. This advantage should be used to garner social resource support, guide the use of social funds for the development of higher education, reduce their own financial pressure, and gain more autonomy in running schools. For example, a “new university” of the cooperative education type can make full use of the resources from both parties to establish an educational foundation, improve the donation mechanism, and broaden the sources of funding.

5. Conclusion

China’s “new university” needs to deal with the management between its heredity and environment, its internal logic and social needs, and run it well while taking into consideration of the local area. The objective of the “new university” is to pursue excellence in its different types, each exhibiting its strengths and characteristics. Building a “new university” in the local area is a challenge to the local area and colleges and universities. It needs to be viewed with a new attitude that embodies innovation, openness, and tolerance. Daring to be the first in innovation will always be accompanied by thorns on the road. It is the responsibility of both parties to optimize the management system, jointly raise the flag of “new university,” and contribute more to China’s higher education.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Ashby E, 1983, *University Education in the Age of Advanced Technology*, People’s Education Press, Beijing.
- [2] Jiang D, Wang J, 2014, *University Governance in the Construction of Modern National Architecture: A Holistic Study of the Historical Evolution and Practical Logic of Chinese University Governance*. *Higher Education Research*, 2014(1): 23–31.
- [3] Cheng T, Chen D, 2015, Independence or Reliance: “Provincial and Ministry Co-construction” Universities in Dilemma. *Higher Education Research*, 2015(5): 29–36.
- [4] Fu C, Tu Q, 2018, Research on the Strategy of Promoting the Integration of Industry, Teaching and Research in Higher Vocational Colleges – Taking Zhejiang Jiaotong Vocational and Technical College as an Example. *Journal of Zhejiang Jiaotong Vocational and Technical College*, 19(3): 99–102.
- [5] Wang J, 2015, Conception of Talent Matching in Vocational Education Based on Industry 4.0. *Chinese Vocational Association’s 2015 Outstanding Scientific Research Achievements Award-winning Proceedings (Volume 2)*.
- [6] Zhu M, 2020, *Research on Problems and Countermeasures of Government Supervision of Sino-Foreign Cooperative Education in Higher Education*, dissertation, University of Electronic Science and Technology of China.

- [7] Tang Y, 2019, Adequacy, Balance and Convergence of Higher Education Finance in my Country. Heilongjiang Higher Education Research, 37(10): 71–74.
- [8] Gu Y, 2018, The New Characteristics and New Forms of China's New Universities. China Higher Education Review, 9(01): 129–143.

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Predicting Google's Stock Price with LSTM Model

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Abstract: Stock market has a profound impact on the market economy, Hence, the prediction of future movement of stocks is of great significance to investors. Therefore, an efficient prediction system can solve this problem to a great extent. In this paper, we used the stock price of Google Inc. as a prediction object, selected 3810 adjusted closing prices, and used long short-term memory (LSTM) method to predict the future price trend of the stock. We built a three-layer LSTM model and divided the entire data into a test set and a training set according to the ratio of 8 to 2. The final results show that while the LSTM model can predict the stock trend of Google Inc. very well, it cannot predict the specific price accurately.

Keywords: Google; Stock prediction; LSTM model; Stock trend

Online publication: October 21, 2022

1. Introduction

Google is far ahead in global search. It is so eminent that foreign consumers use “Google search” to describe the Internet to retrieve information rather than “online search”, and only the world’s most valuable brands can use their own names in place of product or service’s names. Google also benefits from scale advantages and network effects. The more users use Google’s ecosystem of services, the more the company can learn from its data, and thus its ability to leverage artificial intelligence grows exponentially over time. Network effects provide Google with an additional source of sustained competitive advantage. The more videos are uploaded to YouTube, the more viewers are drawn to the platform. Larger audiences also provide an incentive for creators to keep producing more and better contents. In this case, creators and viewers gravitate to the leading video platform, creating a self-sustaining virtuous cycle for the business. From a fundamental point of view, it’s not an exaggeration to say that Google is one of the most competitive companies in the world, and these mentioned advantages enable the company to continue to create value for investors over the long term. Its remarkable revenue growth, superior profitability and high stock evaluation all lays the solid foundation for stock prediction on Google.

Stock price predictions are theoretically possible. However, it is impossible to pinpoint all of the elements that may influence stock prices and how they will affect stocks. This is because the forecasting model should be able to handle nonlinear problems because the stock prediction is highly nonlinear. Nevertheless, it is suitable to use the recurrent neural network (RNN) to predict since the stock has the characteristics of time series ^[1]. Although the RNN models allows the persistence of information, however, the general RNN model is weak to describe the time series data with long memory. For example, considering the time series is too long, the phenomenon of gradient dissipation and gradient explosion makes RNN training exceedingly difficult. The long short-term memory (LSTM) model proposed by

Hochreiter and Schmid Huber is modified on the basis of the RNN structure, thereby, solving the problem that the RNN model cannot describe the long memory of time series^[2].

The rest of the paper is arranged as follows: Section 2 is primarily intended to make a literature review; Section 3 describes the methodology of predicting stocks; Section 4 includes the elucidation of models as well as the analysis of the experimental results; Lastly, the paper ends with concluding remarks and relevant future perspectives in Section 5.

2. Literature review

Time series analysis predicts the future values of the series based on data through the analysis of data sets^[3]. Scholars have previously confirmed the feasibility and effectiveness of time series models in financial markets. The autoregressive–moving-average (ARMA) model and the autoregressive integrated moving average (ARIMA) model based on the ARMA model are important methods for studying time series^[4,5], and are adapted for short-term forecasting^[6,7]. However, there are still some problems with time series models, real-world systems are usually nonlinear and time series data are mostly unstable. Therefore, the combination of artificial neural network model (ANN) and support vector machine (SVM) is the most used method, resulting in better prediction accuracy than traditional methods^[8]. ANN cannot capture sequence information in the input data required to process sequence data and gradient explosion or disappearance^[9] while SVM can solve multi-dimensional and nonlinear problems and avoid neural network structure selection and local minimum point problems to a certain extent^[10].

The use of machine learning methods to forecast the stock market has been extensively studied in literatures. Google Trends and an improved population-based sine and cosine algorithm (ISCA) have both been used by some researchers to enhance the performance of the optimized artificial neural network (ANN), leading to the conclusion that Google Trends data can aid in more precise stock price direction prediction^[11].

This paper adopts the LSTM model, which can pass data to each layer, which ensures the existence of short-term memory while training long-term memory. Moreover, LSTM also solves the vanishing gradient problem encountered by recurrent networks when dealing with long data sequences^[12].

3. Methodology

Hochreiter and Schmidhuber first suggested the LSTM in 1997, and it later gained enormous popularity, especially for use in solving issues involving time series prediction^[12]. With the addition of three memory modules: input gate, output gate, and forget gate —LSTM primarily addresses the gradient disappearance issue that is common in classical RNN^[13]. These three doors and a memory unit together form a memory block (the specific structure of the memory block is shown in **Figure 1**). The upper line inside the square is called the cell state and is used to control the transfer of information to the next moment^[14].

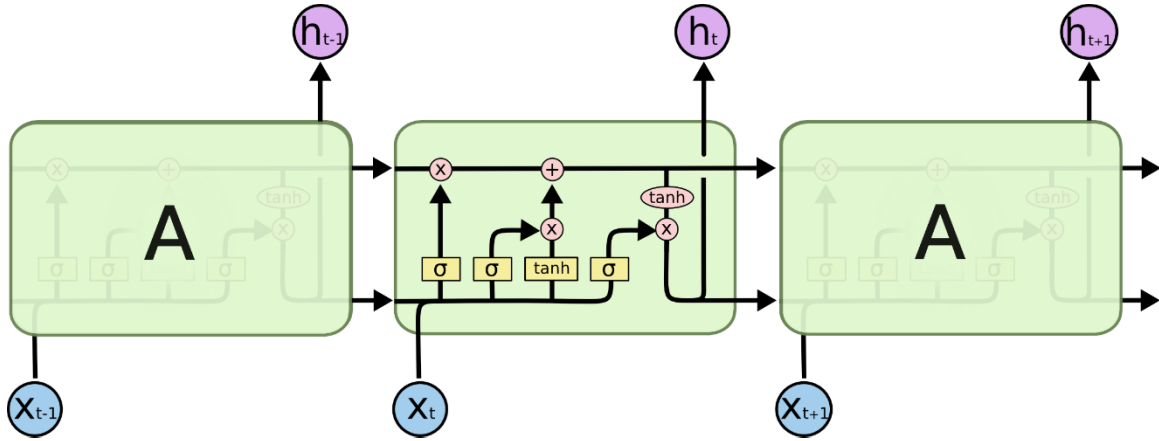


Figure 1. An LSTM's repeating module with four interconnected layers

In **Figure 1**, we can see that LSTM can add or remove information to the cell state, governed by structures called gates. Gates, which consist of a sigmoid neural network layer followed by a pointwise multiplication operation, are used to selectively let information through. The sigmoid layer outputs a number between 0 and 1, describing how much of each component should pass, and the larger the value, the more it will pass^[15].

- (1) The forget gate controls what information can pass through the sigmoid and will pass or partially pass according to the output of the previous moment, to achieve the effect of selective filtering.

$$F_t = \sigma(\omega_f * [h_{t-1}, x_t] + b_f)$$

- (2) An “input gate” layer that determines the values that will be used to update through sigmoid is added to a tanh layer used to generate new candidate values, and the candidate values are obtained to generate new information that needs to be updated (discard unnecessary information, add new information).

$$C_t = f_t * C_{t-1} + i_t * \tilde{C}_t$$

- (3) The last step is to get an initial output through the sigmoid layer, use tanh to scale the value between -1 and 1, and then multiply the output obtained by the sigmoid pair by pair to get the output of the model.

$$\begin{aligned} o_t &= \sigma(w_o[h_{t-1}, x_t] + b_o) \\ h_t &= O_t * \tanh(C_t) \end{aligned}$$

4. Empirical analysis

This paper used Google stock data for the last 20 years, with data on open, close, high, low, adjusted close and trading volume. The Google stock data is from Yahoo Finance and records 3,810 records from August 19, 2004, to October 4, 2019. In this research, we used the adjusted closing price as the final price of Google Inc.’s daily stock.

4.1. Data preprocessing

We used the data before January 1, 2019, as the training set of the data, and the data after January 1, 2019, as the validation set of the data. After we have dealt with the irrelevant features of the training set, the data is uniformly normalized to reduce the influence of too large dimensional gaps. After confirming the data

training set, it was then divided with a ratio of 60:1, and then converted to an array with NumPy to complete the data preprocessing.

4.2. Modeling

We selected TensorFlow as the deep learning framework for this modeling. When modeling the LSTM model, we set up a 3-layer network. The first layer was the LSTM layer (dimension; 60), and the second layer was the LSTM layer (dimension; 80), the third layer was the LSTM layer (dimension; 120), the dropout layer (dropout=0.2, used to prevent overfitting) was sandwiched between the three LSTM layers, and the fourth layer was the fully connected layer (The neuron number was 1, which was used to predict the future 1 Google stock price), the Adam optimizer was used to estimate the parameters, the learning rate adopted the LR decay method, and the maximum number of iterations was set to 50 times, and the mean square error regression loss was calculated to minimize the loss, until driven to 0.

4.3. Visualization

From the **Figure 2**, we can get a line chart with figsize= (14:5) as the ratio, time as the horizontal axis, and price as the vertical axis. The blue line shows the anticipated Google stock price, while the red line shows the actual Google stock price. The price mainly fluctuates around 1000-1200, and the duration is about 200 days.

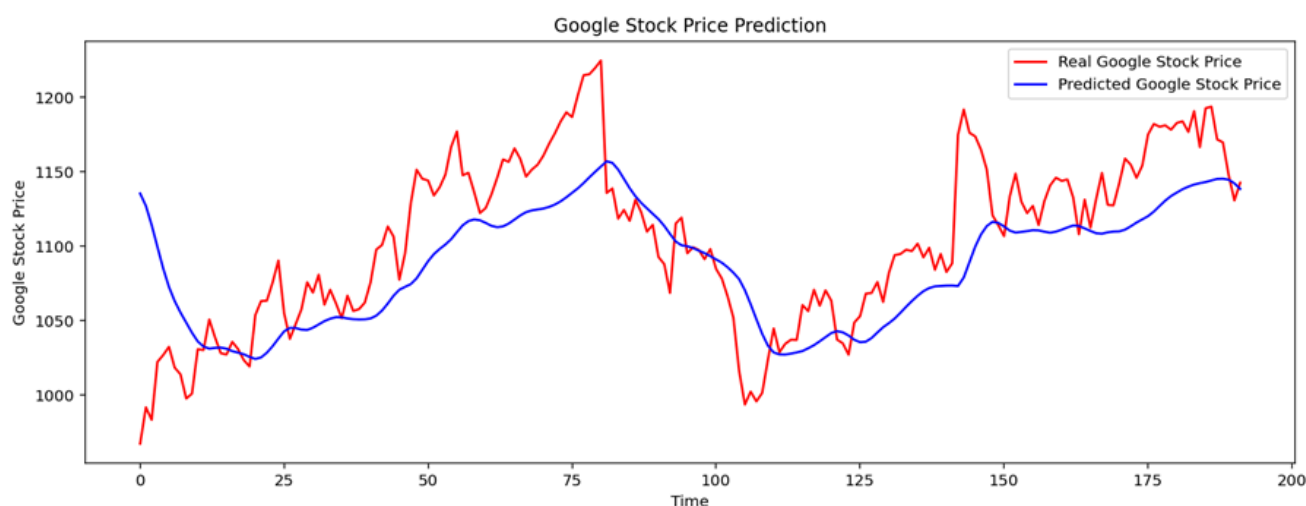


Figure 2. Google stock price prediction

5. Conclusion

In this paper, we used the LSTM recurrent neural networks to extract feature value and analyze the stock data. The LSTM deep learning model we used this time, which combines the attention mechanism with depth and uses the gradient descent method to achieve a faster speed approximation, had better performance than the previous ARIMA, ANN and SVM models, and based on the algorithm, it solved the problems of easily falling into local extreme values and slow convergence speed. In general, the overall trend of image prediction is basically consistent with the actual trend, and it is also suitable for predicting long-term trends. Although there will be delayed prediction due to the time difference and small changes that cannot be noticed in a short period of time, the upward or downward trend progressively starts to match as time goes on, and the coincidence degree in the later stage is greatly enhanced.

While the accuracy rate was not very satisfactory, we found that it can still be improved, especially if the correct threshold was set to effectively exclude very low or very high yield sequences. This is useful

when selecting stocks for analysis. Additionally, we have taken into account fewer learning characteristics and have not taken into account the subjective impact of political policies, business trade conditions, or even social climate, which will be the direction we quantify in the future. Instead, the image fit can be improved by adding more learned features and optimizing the neural network weight matrix. Finally, based on our comparison of different neural networks and optimization algorithms, better models should be designed to improve prediction accuracy in the future.

Disclosure statement

The author declares no conflict of interest.

Author contributions

Z.T. conceived the idea of the study. Y.L. wrote the introduction and integrated various parts of the paper. T.Z. analyzed the data and wrote the rest of the paper.

References

- [1] Li S, Li W, Cook C, et al., 2018, Independently Recurrent Neural Network (IndRNN): Building a Longer and Deeper RNN. *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, 5457-5466
- [2] Staudemeyer RC, Morris ER, 2019, Understanding LSTM: A Tutorial into Long Short-term Memory Recurrent Neural Networks.
- [3] Mondal P, Shit L, Goswami S, 2014, Study of Effectiveness of Time Series Modeling (ARIMA) in Forecasting Stock Prices. *International Journal of Computer Science, Engineering and Applications*, 4(2): 13.
- [4] Chen S, Lan X, Hu Y, et al., 2014, The Time Series Forecasting: From the Aspect of Network.
- [5] Yuan Q, Shi Y, Hu G, et al., (eds) 2020, Computer Applications in Industry and Engineering. *Proceedings of 32nd International Conference on Computer Applications in Industry and Engineering*.
- [6] Ariyo AA, Adewumi AO, Ayo CK, 2016, Stock Price Prediction Using the ARIMA Model. *Proceedings of 2014 UKSim-AMSS 16th International Conference on Computer Modelling and Simulation*, 106–112.
- [7] Zhang G, Patuwo BE, Hu MY, Forecasting with Artificial Neural Networks: The State of the Art. *International Journal of Forecasting*, 14(1): 35–62.
- [8] Vui CS, Soon GK, On CK, et al., 2013, A Review of Stock Market Prediction with Artificial Neural Network (ANN). *Proceedings of IEEE International Conference on Control System, Computing and Engineering*, 477-482, <https://www.doi.org/10.1109/ICCSCE.2013.6720012>
- [9] Liang X, Ge Z, Sun L, et al., 2019, LSTM with Wavelet Transform-Based Data Preprocessing for Stock Price Prediction. *Mathematical Problems in Engineering*.
- [10] Sands TM, Tayal D, Morris ME, et al., 2015, Robust Stock Value Prediction Using Support Vector Machines with Particle Swarm Optimization. *Proceedings of IEEE Congress on Evolutionary Computation (CEC)*. IEEE, 3327-3331.
- [11] Hu H, Tang L, Zhang S, et al., 2018, Predicting the Direction of Stock Markets Using Optimized Neural Networks with Google Trends. *Neurocomputing*, 285: 188-195.
- [12] Hochreiter S, Schmidhuber J, 1997, Long Short-term Memory. *Neural Comput.*, 9(8): 1735–1780.

<http://dx.doi.org/10.1162/neco.1997.9.8.1735>

- [13] Ma Q, 2020, Comparison of ARIMA, ANN and LSTM for Stock Price Prediction. E3S Web of Conferences, 218: 01026.
- [14] Lu W, Li J, Li Y, et al., 2020, A CNN-LSTM-based Model to Forecast Stock Prices. Complexity, 2020: 6622927
- [15] Ghosh A, Bose S, Maji G, et al., 2019, Stock Price Prediction Using LSTM on Indian Share Market. Proceedings of 32nd International Conference on Computer Applications in Industry and Engineering, 101–110.

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Analysis of Human Resource Development and Management in Regional Economic Development

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Abstract: At present, China's economic growth model has gradually shifted from high-speed growth to high-quality development. Under the era of digital economy, a steady and sustainable economic development has become the main goal of the country's development. The practice of modern economic development has shown that human resource is not only the premise of regional economic development, but also one of the important sources of regional economic growth. The coordinated development of human resource and economy is not only an inevitable requirement for high-quality development, but also the first task to assume to solve the imbalance in regional economic development. Based on the interaction mechanism of human resource development and management and regional economic development, this paper selects data from the 2021 China Statistical Yearbook, takes the 2011–2020 national population census data as samples, analyzes the current status and existing problems of human resource development and management in China's regional economic development from three dimensions (human resource quantity, quality, and structure), as well as explores the path of human resource development and management in regional economic development, such as increasing investment and improving the quality of human resource, allocating human resource in a reasonable manner and improving the human resource structure, allocating talents in different regions in a balanced manner, coordinating the shortage and saturation of talents, *etc.*, so as to promote a balanced development between regional economic development and human resource development and management.

Keywords: Human resource development; Human resource management; Regional economy

Online publication: October 21, 2022

1. Introduction

A coordinated development between human resource and economy is the fundamental requirement for development. Examining the relationship between the two and rationally developing regional human resource are essential for realizing the harmonious development of society and economy. As the first resource, talent has become an impetus for promoting the high-quality development of regional economy^[1]. At present, the geographical differences in the development and management of human resources in China are still pronounced. Rapidly developing cities such as Beijing and Shanghai attach great importance to the absorption and training of talents, while the northwest region, which is relatively backward in economic development, still has weak awareness of talents, insufficient human resource development, and poor of human resource management. As of 2020, the country's population has reached 1,412.12 million, of which primary and junior high school diplomas comprise the majority. The low human resource quality incites a need for improvement. How to carry out human resource development and management effectively and scientifically, improve the quality of human resource continuously, allocate the human resource

structure rationally, promote the coordinated development of human resource development and management and regional economic development, as well as achieve regional integrated development is a topic worth discussing.

2. Connotation of human resource development and management

The concept of “human resource development” was first proposed by an American scholar, Nadler, who pointed out that human resources should be investigated, analyzed, planned, and adjusted based on the existing human resources of enterprises or organizations, according to the development-strategy goal of the organization and the change of the organization structure, so as to improve the organization’s human resource management level, improve the efficiency of human resources management, and promote the rapid progress and development of the organization ^[2,3].

“Human resource management” involves carrying out rational and scientific development and utilization through the analysis of the human resource management content, setting a programmed and institutionalized management mechanism, realizing the optimal allocation of human resources, and gradually improving the management effect of human resources ^[4].

In short, the objective of human resource development and management is to optimize and integrate the existing human resources within the organization, so that the potential human resources can be developed and utilized to the greatest extent, and various internal elements can be optimized and integrated to maximize the value of the organization ^[5]. The human resource development and management system covers three aspects: human resource quantity, human resource quality, and human resource structure.

3. Relationship between human resource development and management and regional economic development

In the 1960s, Theodore Schultz proposed the theory of “human capital.” He studied the relationship between human capital investment and economic development, and revealed the role of human quality in economic development from the perspective of economics. It opened the prelude to the research on the relationship between modern human resources and economic development ^[6].

3.1. Internal mechanism of human resource development and management to promote regional economic development

The growth of human capital is the impetus for economic growth, and human resources have always been at the core of economic development. With the continuous development of regional economy, human resource development has been gaining intensity, and economic growth has become more dependent on human resources. The impact of talent development on regional economic development is now more prominent ^[7]. The driving mechanism of human resource development and management on regional economic development is reflected in the following three aspects: first, regions with higher accumulation of human capital have higher production capacity and innovation ability; an improvement in the average human capital level promotes the physical capital and research and development level, which is conducive to regional economic growth ^[8]; second, human resource development and management is realized through various means, such as education investment, employee training, and medical and health investment; education investment can improve the workers’ basic ability, enhance their cultural and scientific levels in the learning process, as well as promote their cognitive, creative, and judgment abilities, thereby improving their intellectual level overall; human resource training, on the other hand, promotes the absorption and dissemination of knowledge by human resources, improves the level of science and technology, as well as enhances the professional skills of human resources, thereby improving production capacity and efficiency, which in turn would increase economic returns ^[9]; third, based on the driving force of the first two elements

such as talents and innovation, human resource development and management is conducive to improving the quality of regional talents rather than the quantity, applying the ability factors such as intelligence and physical strength to practical work, giving full play to the comprehensive quality of human resources, reducing brain drain, optimizing regional talent structure, improving talent competitiveness, and eventually driving the transformation, optimization, and upgrading of regional economic growth ^[10]. In addition, improving the scientific and technological innovation level of market subjects and promoting industrial structure adjustments are conducive to realizing economic transformation, promoting the reasonable allocation of regional economic resources, as well as promoting sustainable regional economic growth ^[11].

3.2. Feedback effect of regional economic development on human resource development and management

On the one hand, the adjustment of industrial structure in the process of regional economic development affects the cost, structure, and level of human resource development and management. With the rapid development of regional economy and the continuous adjustment of industrial structure, new industrial clusters are formed. In order to stabilize their market position, market participants will increase the human resource development and management cost, expand the scale of talent introduction, and absorb and cultivate more high-level talents. High-quality human capital will improve the employment structure, further promote the development of regional economy, form a cluster-type effect, and create a good social and economic cycle, thereby ensuring long-term development of both, regional economy and human resources ^[12,13]. On the other hand, China has gone through different stages of economic development: “agriculturalization → industrialization → informatization → knowledge-based → digitalization.” It has achieved high-quality regional economic development, and its human resources have shifted from labor-intensive to knowledge-based, and now to meeting the needs of talents in the digital age. This verifies that the economic base determines the superstructure. At present, there is a higher demand for social talents as a result of regional economic development. This increasing demand promotes the continuous optimization and upgrading of the human resource development and management system, as well as the structural improvement of the regional, professional, and talent markets. High-quality human capital accumulation and increments have been achieved, and there is a steady momentum in regional economic development; additionally, the regional development gap has been narrowed ^[14].

4. Current situation of human resource development and management in regional economic development

4.1. Status quo of human resource quantity

Population is the basis of human resource. The scale and trend of population change are reflected in the population size, its natural growth rate, and its changes. According to **Table 1**, in the past ten years, the total population has been increasing year by year, but the natural growth rate of the population has fluctuated. This is due to the significant decrease in birth rates based on the data analysis of the National Bureau of Statistics. In addition, according to the data from 2021 China Statistical Yearbook, the proportion of urban population has increased significantly, whereas the rural population has decreased year by year in the past ten years.

Table 1. National population and natural growth rate from 2010 to 2020

Year	National population (10,000 people)	Natural growth rate (%)
2011	134,916	6.13
2012	135,922	7.43
2013	136,726	5.90
2014	137,646	6.71
2015	138,326	4.93
2016	139,232	6.53
2017	140,011	5.58
2018	140,541	3.78
2019	141,008	3.32
2020	141,212	1.45

Source: China Statistical Yearbook 2021

According to **Table 2**, the distribution of human resources in China has gradually transitioned from teenagers to young people in the seven national censuses. People aged 15–64 make up the majority of the national population size, and the scale of human resources has greatly expanded. However, the proportion of the elderly population has seen a significant increase in 2020, with a difference of only 4.45% from the proportion of population aged 0–14 in that year. The issue of aging human resources will become more prominent. With the decline in the natural growth rate of China’s population and the accelerated aging of the population, the total employment volume continues to decline, and the existing labor resources are in short supply.

Table 2. Proportion of population of each age group in the seven national censuses (unit: %)

Year	0–14 years old	15–64 years old	More than 65 years old
1953	36.28	59.31	4.41
1964	40.69	55.75	3.56
1982	33.59	61.50	4.91
1990	27.69	66.74	5.57
2000	22.89	70.15	6.96
2010	16.60	74.53	8.87
2020	17.95	68.55	13.50

Source: China Statistical Yearbook 2021

4.2. Status quo of human resource quality

Education is the basis for the systematic development of human resources. It is also considered to be the key indicator for measuring the quality of human resources. It can be seen from **Table 3** and **Table 4** that the education level of the national population has generally improved. In the 1960s, the population with primary school education ranked first, while the population with junior college education and above was the least. In the 21st century, the situation improved, and in 2020, the population with college education and above increased. The downward trend in the number of illiterates is evident, from 233.27 million in 1964 to 37.75 million in 2020. The illiteracy rate has been decreasing year by year. Especially since 2000, the illiteracy rate has dropped to single digits, with only 2.67% in 2010, indicating that the quality of human resources in China has improved to a certain extent. However, on the whole, as of 2020, the supply of high-

level talents and high-skilled talents in terms of education level remains at a low level. The apparent gap in supply and demand has resulted in the failure of meeting the needs of high-quality economic development. According to the 2021 China Statistical Yearbook, there are also clear regional differences in the quality of human resources in China, and the level of education reveals a specific characteristic: “high in the east and low in the west.”

Table 3. Level of education per 100,000 people in the seven national censuses (unit: person)

Year	College and above	High school and secondary school	Junior high school	Primary school
1953	/	/	/	/
1964	416	1,319	4,680	28,330
1982	615	6,779	17,892	35,237
1990	1,422	8,039	23,344	37,057
2000	3,611	11,146	33,961	35,701
2010	8,930	14,032	38,788	26,779
2020	15,467	15,088	34,507	24,767

Source: China Statistical Yearbook 2021

Table 4. Illiterate population and illiteracy rate in the seven national censuses

Year	Illiterate population (10,000 people)	Illiteracy rate
1953	/	/
1964	23,327	33.58%
1982	22,996	22.81%
1990	18,003	15.88%
2000	8,507	6.72%
2010	5,466	4.08%
2020	3,775	2.67%

Source: China Statistical Yearbook 2021

4.3. Current situation of human resource structure

Since 2012, the national economic development has shown a “three-two-one” structure, *i.e.*, the tertiary industry has the largest GDP, followed by the secondary industry, with the primary industry having the lowest GDP. By 2020, the primary industry’s GDP was 7,775.41 billion yuan, the secondary industry’s GDP was 3,845.53 billion yuan, and the tertiary industry’s GDP was 5,539.68 billion yuan. Economic development and human resources are complementary to each other. The industrial layout of human resources reflects the power source of regional economic development. It is also related to the optimization and upgrading of the industrial structure. According to **Table 5**, from 2016 to 2020, there was a shift in the employment structure of China’s human resources industry from the primary industry to the tertiary industry; however, the employment structure in the secondary industry remained the same. In recent years, the employment of the tertiary industry ranked first. From the perspective of human resource structure, the adjustment of industrial structure changes the human resource structure by affecting the employment structure. The industrial structure adjustment and economic transformation and upgrading have led to an imbalance in employment structure. The coexistence of labor shortage and unemployment has become increasingly prominent. The gap between human resource supply and demand must be narrowed, and the human resource structure requires further optimization ^[15].

Table 5. Employment structure of human resources industry from 2016 to 2020 (unit: ten thousand people)

Year	Primary industry	Secondary industry	Tertiary industry
2016	20,908	22,295	33,042
2017	20,295	21,762	34,001
2018	19,515	21,356	34,911
2019	18,652	21,234	35,561
2020	17,715	21,543	35,806

Source: China Statistical Yearbook 2021

4.4. Regional heterogeneity in the coordination between human resource development and management and economic development

Based on the analysis of the quantity, quality, and structure of human resources, and taking into account of the 2021 China Statistical Yearbook data, it can be seen that from a regional perspective, the unbalanced education level and economic development have led to large regional differences in terms of the quantity, structure, and quality of human resources in China ^[16,17]. In view of the geographical advantages and policy support, high-level talents and high-skilled talents are mainly concentrated in core industries and economically developed eastern, central, and first- and second-tier cities. In the western region, due to the relatively backward education level, poor policy support, and slow industrial development, the attraction to talents is weak, resulting in structural imbalance and resource shortage in terms of human resource quality and quantity between regions. In addition, due to the acceleration of urbanization, the main labor force is concentrated in cities, which makes the development of poverty-stricken areas more challenging. As a result, the pace of economic development declines rather than increases ^[18].

5. Path exploration of human resource development and management in regional economic development

5.1. Increase investment and improve the quality of human resources

By analyzing the internal mechanism of human resource development and management to promote regional economic development, it can be seen that human resource development and management is realized through various methods, such as education investment, employee training, and medical and health investment, all of which would help promote regional economic growth. As of 2020, the total number of people over the age of six in China was 1,315,347,565. Among them, those with primary school education accounted for 26.41%, junior high school education accounted for 37.03%, regular high school education accounted for 16.13%, junior college education accounted for 8.54%, and university education accounted for 37.03%, with undergraduates accounting for 7.16%, and postgraduate degrees accounting for 0.82%; the remaining 3.91% were those who had never attended school. This shows that the overall quality of human resources is not high.

Therefore, first of all, the government should promote the development and increase the investment in education, in order to improve the education level of human resources, set a solid foundation for basic education, and prioritize the education problems in remote and poor rural areas ^[19]. Second, vocational training should be taken as another means to improve the quality of human resources. In today's era of digital economy, the accelerated development of science and technology and the acceleration of information updating accentuate the importance of continuing education and training ^[20].

5.2. Reasonably allocate human resources and improve the structure of human resources

The rationality of the human resource structure is also one of the influencing factors of regional economic

development. According to the analysis above, in the 2020 GDP, the primary industry accounted for 7.65%, the secondary industry accounted for 37.82%, and the tertiary industry accounted for 54.53%. In the employment structure of the human resources industry in 2020, the employment in the primary industry, secondary industry, and tertiary industry accounted for 23.6%, 28.7%, and 47.7%, respectively. Both the GDP and the industrial employment structure show a “three -two-one” structure. This shows that economic development and human resources are complementary to each other. Therefore, first of all, it is necessary to allocate human resources in a reasonable manner, actively develop the tertiary industry, give full play to the advantages of the tertiary industry, and vigorously develop emerging service industries to adapt to the growth of digital economy. Secondly, it is necessary to plan the distribution of talents rationally in the three major industries and attach importance to professional and technical personnel.

5.3. Balance the allocation of talents in various regions to effectively coordinate the shortage and saturation of talents

According to the 2021 China Statistical Yearbook, there are clear regional differences in terms of the human resource quality in China. Talents with higher education levels are concentrated in Beijing and Shanghai, while those in Hainan, Tibet, and other regions have lower education levels. Considering the current situation of economic development and human resources in the eastern, central, and western regions of China, the following measures should be taken in order to narrow the regional gap and alleviate regional heterogeneity: first, the state should vigorously support the economic development and human resource development in the western region, beginning with employment, people’s livelihood, market, and other aspects, along with the development status of remote areas in the west by introducing more generous talent policies, so as to promote long-term and stable economic development in the western region; from a long-term perspective, it is necessary to coordinate the current situation of talent shortage in different regions, prevent talent gathering and “hometown plot,” and maximize the talent “reservoir” resources by implementing the “limited post” system in some areas with relatively saturated human resources, so as to indirectly promote more excellent talents to flow into the western region, balance the allocation of human resources, and realize the simultaneous development of economic development and talent development management ^[21].

Disclosure statement

The author declares no conflict of interest.

References

- [1] Mijiti M, Seyiti J, Zhang Y, 2020, The Time-Space Differentiation of the Coordinated Development of Regional Economic Development and Human Resources Development: The Case of Provinces and Cities Along the Silk Road Economic Belt. *Economic Perspective*, 2020(05): 64–73.
- [2] Dai D, 2021, Analysis of Human Resource Development and Regional Economic Development. *Business News*, 2021(34): 179–181.
- [3] Ge F, 2018, Research on the Influence of Human Resource Development on My Country’s Regional Economic Development. *Southern Entrepreneur*, 2018(04): 85–86.
- [4] Guo Y, 2021, Analysis of Human Resource Management and Regional Economic Development. *Business Exhibition Economy*, 2021(15): 109–111.
- [5] Gong X, 2018, Analysis of the Relationship Between Human Resource Management and Regional Economic Development. *Science and Technology Economic Market*, 2018(12): 108–109.

- [6] Schults W, 1961, Investment in Human Capital. *American Economic Review*, 1961(3): 1–17.
- [7] Shan L, Song G, 2016, The Spatiotemporal Coupling Analysis of Regional Human Resources Development and Economic Development – Taking the Bohai Rim Region as an Example. *Demographic Journal*, 38(04): 103–112. <http://doi.org/10.16405/j.cnki.1004-129X.2016.04.012>
- [8] Abel JR, Deitz R, 2011, The Role of Colleges and Universities in Building Local Human Capital. *Current Issues in Economics and Finance*, 17(6): 1–7.
- [9] Wang G, 2018, Research on the Impact of Human Resources in the Northern Region on Regional Economic Development, dissertation, Jilin University.
- [10] Lu J, 2022, Exploration of Human Resource Management to Promote Economic Development. *Business Observation*, 2022(21): 29–32.
- [11] Du R, 2019, Research on the Influence of Human Resource Development on Regional Economic Development and Effective Countermeasures: Inner Mongolia Autonomous Region as an Example. *Inner Mongolia Science and Technology and Economy*, 2019(08): 3–4 + 9.
- [12] Zhao K, 2020, On the Relationship Between Human Resource Management and Regional Economic Development. *Value Engineering*, 39(03): 4–6. <http://doi.org/10.14018/j.cnki.cn13-1085/n.2020.03.002>
- [13] Zhang C, 2019, Research on the Relationship Between Human Resource Management and Regional Economic Development. *Shanxi Agricultural Economics*, 2019(07): 36.
- [14] <http://doi.org/10.16675/j.cnki.cn14-1065/f.2019.07.020>
- [15] Zhang Y, 2017, Analysis of the Relationship Between Human Resource Development and Regional Economic Development. *Management Observation*, 2017(31): 91–92.
- [16] Yao J, 2021, Research on the Influence of Human Resource Development on Regional Economic Development and Effective Countermeasures – Taking Guangdong Province’s Talent Team Construction to Promote Regional Economic Development as an Example. *Business News*, 2021(22): 194–196.
- [17] Huang X, Huang L, 2021, Human Resource Development and Management in Regional Economic Development. *Business Exhibition Economy*, 2021(22): 130–132.
- [18] Deng H, 2021, Talking About the Impact and Countermeasures of Human Resource Development on Regional Economic Development. *Finance and Economics*, 2021(36): 186–187. <http://doi.org/10.19887/j.cnki.cn11-4098/f.2021.36.092>
- [19] Miao Y, 2020, Talking About the Status Quo and Innovation of Human Resources Development in Regional Economic Development. *Human Resources*, 2020(04): 139.
- [20] Zaoreguli Abula, 2021, Research on the Coupling and Coordination of Human Resource Development and Regional Economic Development in Xinjiang, dissertation, Xinjiang Normal University, <http://doi.org/10.27432/d.cnki.gxsfu.2021.000580>
- [21] Ding X, 2020, Research on the Impact of Human Resources Development on Regional Economic Development and Countermeasures. *Industry and Technology Forum*, 19(14): 87–88.
- [22] Zhao L, 2022, On Human Resource Management in Regional Economic Development. *China Market*, 2022(09): 33–34. <http://doi.org/10.13939/j.cnki.zgsc.2022.09.033>

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Wavelet Analysis of Bitcoin Price and Twitter-Based Economic Uncertainty Index

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Abstract: In this paper, we analyze the time-series graphs of Bitcoin price and Twitter-based economic uncertainty index over the past two years and use a wavelet coherence graph to determine their relationship. We found a causal relationship between Bitcoin (BTC) and Twitter-based economic uncertainty (TEU) index in different frequency bands, which would help predict Bitcoin price movements in the future. Our study provides reference to academics and investors.

Keywords: Wavelet; Bitcoin; Twitter; Time series

Online publication: October 21, 2022

1. Introduction

Digital currencies have developed rapidly in this era. Bitcoin plays an increasingly prominent role in the economy. Hence, the development of digital economy has had a certain impact on Bitcoin ^[1]. As a result, there are fluctuations in the economic environment, be it small or large. From the beginning of the 21st century, digital currency began playing a huge role in the market, and Bitcoin, which is one of the most popular kinds of digital currency, was introduced in 2008 ^[2]. The currency has been used since 2009, and it can be transferred through the bitcoin network. In the year 2021, the price of each bitcoin rose to 68,000 dollars.

On March 24, 2021, following the announcement by Tesla that bitcoin would be accepted for vehicle purchases, Bitcoin price soared; on May 13, Musk tweeted that Bitcoin mining is a waste of energy, and therefore stopped accepting bitcoin as payment. The tweet sent Bitcoin plummeting, with nearly 300,000 people exploding their holdings in 24 hours. With Musk's help, Bitcoin hit a three-month high in a week. On August 23, Bitcoin rose above \$50,000 in sub-market trading and pre-European trading, breaking that threshold for the first time in three months. Bitcoin hit a high of \$64,000 in April, and then nearly halved in mid-to-late May. Since late July, Bitcoin has gradually regained its upward momentum, breaking the technical levels of \$47,000 and \$48,000 in a row.

Twitter is a software that was invented in the United States in 2006. Twitter users are spread across the globe, with as many as 396.5 million people using Twitter in 2021 ^[3]. The Twitter-based economic uncertainty (TEU) index consists of the total number of daily English-language tweets containing both "uncertainty" terms as well as "economy" terms. A large group of data are concluded into the index to determine the economic relationship ^[4]. We construct daily, weekly, and monthly Twitter-based economic uncertainty (TEU) indicators from 2011 onwards according to the counts of tweets about "economy" and "uncertainty" ^[5].

In this article, our exploration embodies the relationship between Bitcoin and Twitter-based economic uncertainty index. First, we discuss the relationship and research background between Bitcoin and Twitter in blockchain technology and introduce the relationship between Bitcoin and Twitter-based economic uncertainty index. We then analyze the characteristics of Bitcoin and Twitter to prepare for the experimental analysis that follows. The third section is a discussion of our research method. We use Bitcoin price change and the change of uncertainty index for analysis. We also use R data for analysis, and two graphs that reveal the relationship between TEU-ENG and Bitcoin are shown. The fourth section embodies the experimental analysis. Based on the time-series graphs, we first perform a simple data analysis of the data components and data sources. Subsequently, we describe the relationship between Bitcoin and Twitter-based economic uncertainty by analyzing the wavelet correlation between the two based on the graph's information.

2. Bitcoin price, social media, and wavelet coherence

In recent years, Bitcoin's price volatility has garnered widespread attention from both academic researchers and investors. Many studies are currently trying to find a way to predict volatility. Roy *et al.* [6] proposed the use of time series to predict the price of Bitcoin. They collected the daily market capitalization, trading volume, and opening and closing prices of Bitcoin from July 2013 to August 2017, and applied the processed data to the autoregressive integrated moving average (ARIMA) model, autoregressive (AR) model, and moving average (MA) model to predict the price of Bitcoin for the next 10 consecutive days. In another study, Karalevicius *et al.* [7] used sentiment analysis to predict price movements. They used various Bitcoin-related news portals to conduct sentiment analysis experiments and data preprocessing and fed the data into a sentiment analyzer. They used a lexicon-based approach to observe how sentiment changes over time.

Some academics have found a potential interaction between social media discussions and bitcoin prices. According to Mai *et al.* [8], the majority of users, as the silent majority, contribute little, while a small group of highly active users contribute the most and are more influential sources of information. They also mentioned that in-depth discussions carried out on internet forums can paint a more comprehensive picture of participants and are therefore more likely to trigger final adoption or purchase decisions. A study based on Twitter sentiment, collecting a total of 92,550 tweets over 60 days, found a strong correlation between Bitcoin percentage change and Twitter sentiment [9].

Time and frequency are important for studying Bitcoin price dynamics; wavelet coherence can be used to locate correlations between sequences and evolutions in time and across scales. In Kristoufek's study [10], a wavelet coherence analysis of Bitcoin price and some possible drivers was conducted separately; the correlation and lead-lag relationship between them were evident. In Phillips and Grose's study, the use of wavelets showed consistency between cryptocurrencies and online factors among different cryptocurrencies [11]. These previous studies fully demonstrate the practical significance of wavelet analysis.

3. Data and methodology

The data used in this study comprises Bitcoin (BTC) and Twitter-based economic uncertainty index (TEU-ENG). We sourced the data on BTC from Yahoo Finance and gathered information about TEU-ENG from the Economic Policy Uncertainty website. The period of collected data is from January 1, 2020, to June 1, 2022, yielding 883 valid pieces of data. We chose this period because we want to reduce the interference of the COVID-19 pandemic on this study.

The wavelet coherence

Time series was used when analyzing BTC and TEU separately. In order to analyze the correlation between BTC and TEU, we took into account of widely implemented methods, thus wavelet coherence was used.

According to Torrence and Compo ^[12], the cross-wavelet transform can be represented by two-time series $a(t)$ and $b(t)$ as follows:

$$N_{ab}(p, q) = N_a(p, q)N_b^*(p, q) \quad (1)$$

In the formula, $N_a(p, q)$ and $N_b(p, q)$ are the two continuous transformations of $a(t)$ and $b(t)$, p is the position index, q is the measure, and the asterisk (*) represents the composite conjugate. As for the equation of the coefficient of adjusted wavelet coherence, Torrence and Webster ^[13] stated that:

$$W^2(p, q) = \frac{|M(M^{-1}N_{ab}(p, q)|^2)}{M(M^{-1}|N_a(p, q)|^2)M(M^{-1}|N_b(p, q)|^2)} \quad (2)$$

M is the smoothing mechanism, and $0 \leq W^2(p, q) \leq 1$. This interval is the squared range of wavelet coherence coefficients. Close to 1 indicates high correlation, whereas close to zero indicates a lack of correlation.

4. Empirical analysis

We analyze the time-series graph of Bitcoin price, as shown in **Figure 1**.

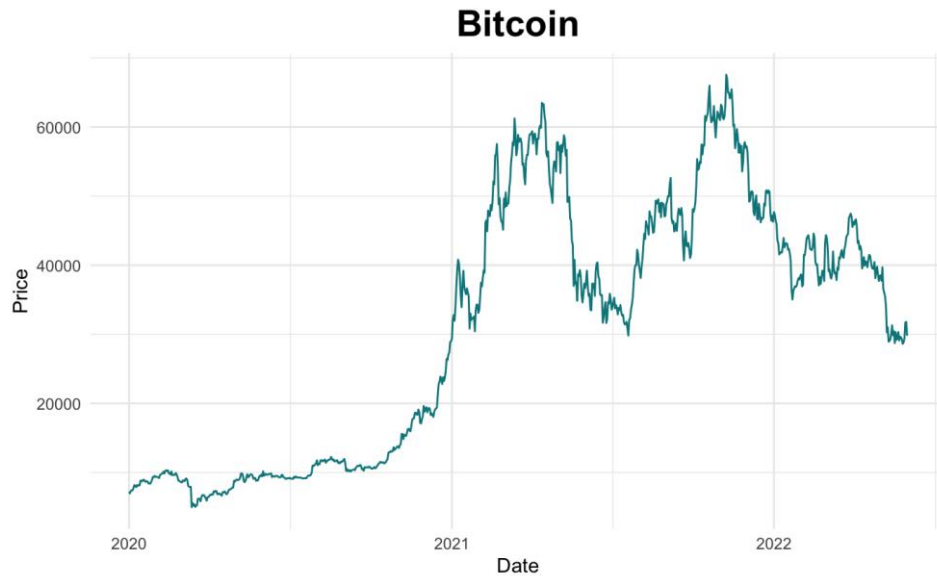


Figure 1. Bitcoin price from January 1, 2020, to June 1, 2022

The analyzed period began with a value of approximately \$7,200 per bitcoin and ended at approximately \$30,000. That price has more than quadrupled in less than 30 months. Moreover, there were two periods in 2021 when Bitcoin traded above \$60,000.

We analyze the time-series graph of Twitter-based economic uncertainty index, as shown in **Figure 2**.

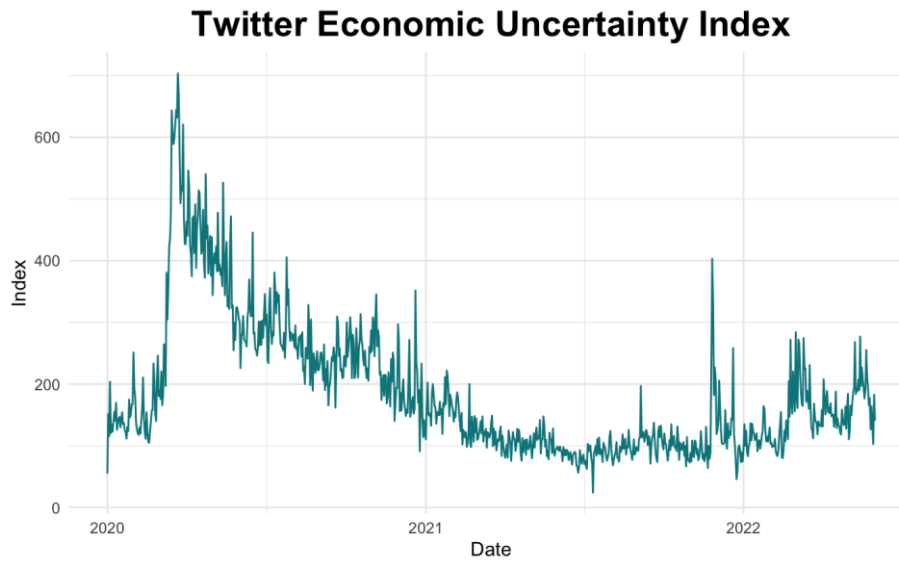


Figure 2. Twitter-based economic uncertainty index

We use TEU-ENG data, which consist of all tweets in English. The TEU-ENG index increased sharply in March 2020, and the peak index was close to 650, just as COVID-19 was raging around the world. Thereafter, the overall trend of the index dropped.

The wavelet coherence between BTC and TEU is shown in **Figure 3**.

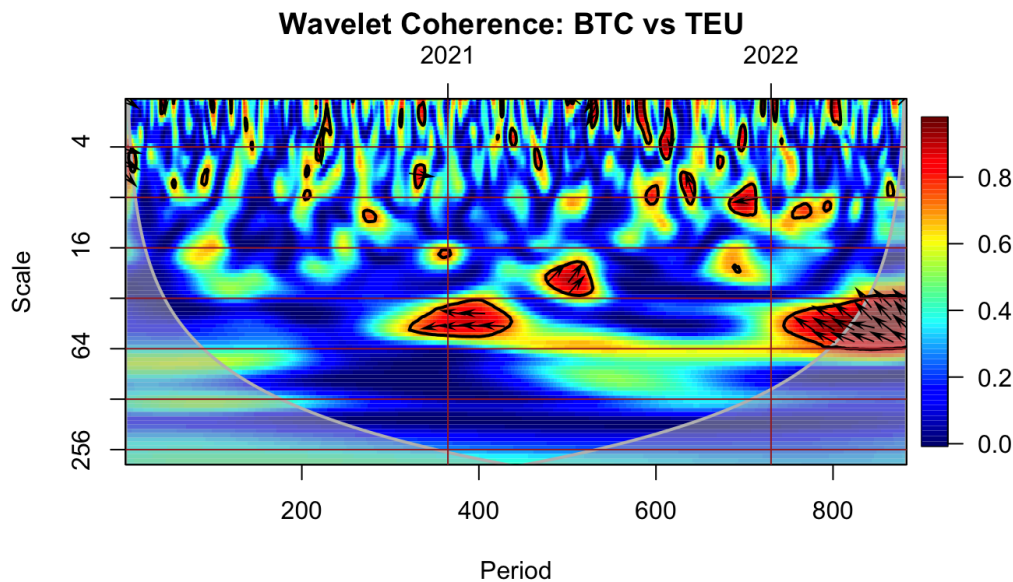


Figure 3. Wavelet coherence: BTC versus TEU

There are some prominent warm areas in the graph, which are located in the first half of 2021 and 2022. They indicate strong dependency over the 16–64 days frequency bands for the corresponding sample period. For the larger red island in 2022, the arrow points upward and to the left, indicating that BTC guides the rise of TEU and is negatively correlated with TEU. The conflict between Ukraine and Russia in 2022 exacerbated this change and affected the volatility of the crypto market. In 2021, two hot red zones can be seen, indicating strong dependence between two variables. For the red island over the 32–64 days frequency

bands, the arrows point upwards-left and downwards-left, suggesting that BTC and TEU affect each other and are negatively correlated. For the other smaller island, the arrow points upwards and to the right, indicating that TEU is leading BTC during this period, and the two are positively correlated. In February 2021, Tesla's CEO Elon Musk revealed Tesla's \$1.5 billion investment in Bitcoin. This revelation prompted a short-term surge in demand for bitcoin. There are many smaller red areas in the 0–16 frequency bands, and their arrows point differently. BTC and TEU have mutually bidirectional causality in the low-frequency segment. Briefly, BTC and TEU show bidirectional causality in the low-frequency interval from 0–64 days, but there is no dependence between them in the high-frequency interval (64–256 days).

5. Conclusion

In this study, we collect the daily data of BTC and TEU in the recent two years, analyze the time-series graphs, and use a wavelet coherence graph to analyze the interactive guided-lag interactions in the time-frequency domain. We conclude that BTC and TEU show bidirectional causality in the frequency interval from 0–64 days, with no dependence between them in the high-frequency interval (64–256 days). We also found that geopolitical conflicts, such as the Russia-Ukraine war in 2022, also affect Bitcoin's price volatility. These findings are useful for predicting Bitcoin price trend.

Acknowledgements

Many thanks to Ms. Liu Tong for her help in revising and embellishing the experimental analysis as well as the methodological aspects of this paper.

Disclosure statement

The authors declare no conflict of interest.

Author contributions

Z.T. conceived the idea of the study. W.Y. wrote the abstract, literature review, data and methodology, empirical analysis, and conclusion.

References

- [1] Trautman LJ, 2014, Virtual Currencies; Bitcoin & What Now After Liberty Reserve, Silk Road, and Mt. Gox?. *Richmond Journal of Law and Technology*, 20(4): 1–108.
- [2] Vigna P, Casey M, 2016, *The Age of Cryptocurrency: How Bitcoin and the Blockchain Are Challenging the Global Economic Order*, Picador/St. Martin's Press, New York.
- [3] Dean B, 2021, How Many People Use Twitter in 2021? [New Twitter Stats], Backlinko, viewed September 15, 2022, <https://backlinko.com/twitter-users>
- [4] Lee K, Choi E, Kim M, 2022, Twitter-Based Chinese Economic Policy Uncertainty, viewed May 27, 2022, <http://dx.doi.org/10.2139/ssrn.4121891>
- [5] Baker SR, Bloom N, Davis SJ, et al., 2021, Twitter-Derived Measures of Economic Uncertainty, viewed June 15, 2022, http://policyuncertainty.com/media/Twitter_Uncertainty_5_13_2021.pdf
- [6] Roy S, Nanjiba S, Chakrabarty A, 2018, Bitcoin Price Forecasting Using Time Series Analysis. 2018 21st International Conference of Computer and Information Technology (ICCIT), 1–5.
- [7] Karalevicius V, Degrande N, De Weerd J, 2018, Using Sentiment Analysis to Predict Interday Bitcoin

- Price Movements. *Journal of Risk Finance*, 19(1): 56–75. <https://doi.org/10.1108/JRF-06-2017-0092>
- [8] Mai F, Shan Z, Bai Q, et al., 2018, How Does Social Media Impact Bitcoin Value? A Test of the Silent Majority Hypothesis. *Journal of Management Information Systems*, 35(1): 19–52.
- [9] Sharif A, Aloui C, Yarovaya L, 2020, COVID-19 Pandemic, Oil Prices, Stock Market, Geopolitical Risk and Policy Uncertainty Nexus in the US Economy: Fresh Evidence from the Wavelet-Based Approach. *International Review of Financial Analysis*, 70: 101496.
- [10] Kristoufek L, 2015, What are the Main Drivers of the Bitcoin Price? Evidence from Wavelet Coherence Analysis. *PloS One*, 10(4): e0123923.
- [11] Phillips RC, Gorse D, 2018, Cryptocurrency Price Drivers: Wavelet Coherence Analysis Revisited. *PloS One*, 13(4): e0195200.
- [12] Torrence C, Compo GP, 1998, A Practical Guide to Wavelet Analysis. *Bulletin of the American Meteorological Society*, 79(1): 61–78.
- [13] Torrence C, Webster PJ, 1998, The Annual Cycle of Persistence in the El Niño/Southern Oscillation. *Quarterly Journal of the Royal Meteorological Society*, 124(550): 1985–2004.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Effect of Digital Economy Development on Rural-Urban Income Disparity: Evidence from China

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Abstract: Promoting income equality between urban and rural residents is one of the main goals of China's social progress and economic development. It is also a necessary means to achieve "common prosperity." Digital economy can effectively promote economic development, the adjustment of industry structure and industry upgrading, as well as increase the disposable income of urban and rural residents, which is theoretically beneficial to rural-urban income disparity. An empirical analysis is conducted based on the data of 30 provinces, municipalities, and autonomous regions in China from 2013 to 2020. The findings demonstrate that the growth of digital economy helps lessen rural-urban income disparity and has a significant effect in East China and North China.

Keywords: Digital economy; Income disparity; Regional heterogeneity; Rural-urban development divide

Online publication: October 21, 2022

1. Introduction

China's economy is in a period of transition, and digital economy has become a new source of growth for the nation. According to China's officials, digital economy has now made a considerable contribution to China's economic expansion, accounting for more than 60% of gross domestic product (GDP) with a scale exceeding RMB 45 trillion. However, the insufficient and imbalanced development between urban and rural areas is still prominent, with a significant gap in their development and income distribution. China's 14th Five-Year Plan and the Long-Range Objectives Through the Year 2035 clearly states that "the growth of per capita disposable income will keep pace with GDP growth, and there will be a significant improvement in the distribution structure." This is one of the main goals of China's social and economic development in this period. Therefore, promoting balanced economic growth between urban and rural regions and narrowing the rural-urban income gap have become pressing issues to be solved. It is of practical significance to study the role of digital economy, as the impetus for socio-economic development in the new era, in boosting income and reducing the rural-urban income disparity.

2. Literature review

There has been many academic research on how digital economy influences urban-rural income disparity. According to Chen Wen and Wu Ying, a "U-shaped" relation exists between digital economy development and income disparity, *i.e.*, rural-urban income disparity lessens at the early stage of development, but with further development, the inequality exacerbates, giving rise to the urban-rural digital divide phenomenon^[1]. Wang Jun and Xiao Huatang argue that the effect of digital economy on rural-urban income disparity is regionally heterogeneous, with a lessening effect in the central and western regions, an increasing effect in

the eastern region, and no significant effect in the northeastern region ^[2]. According to Chen Xinxin and Duan Bo, digital economy significantly narrows the rural-urban income gap in East and Central China through agglomeration economies, but the western region fails to promote the agglomeration of production factors and cross-regional mobility, thereby widening the rural-urban gap ^[3]. Liu Jun argues that the advancement of digital economy makes a direct contribution to promoting income equality and facilitating labor mobility, which indirectly leads to better income distribution ^[4]. It can be seen that there are still disagreements among academics about the mechanism and effect of digital economy on rural-urban income disparity, thus requiring further analysis of regional heterogeneity.

In addition, evaluating the level of digital development in a region is also an issue that needs to be discussed and studied. Nowadays, most of the current indexes are constructed by research institutions and scholars themselves. For instance, China Digital Economy Development Index and The Peking University Digital Financial Inclusion Index of China were constructed by China Electronics Information Industry Development Institute and the Institute of Digital Finance of Peking University, respectively. These indexes are based on sufficient data and are credible, but on the one hand, it is difficult to obtain the data for these indexes, and they cannot be compared with each other. Hence, many scholars tend to construct their own indexes. For example, Bai Peiwen and Yu Li measured the level of digital economy development of each city from four aspects: digital products users, digital enterprises, digital platforms, and digital output ^[5]; Li Xiaozhong and Li Junyu constructed a different index, which includes digital foundation, application capability, industrial support, and development capability ^[6]. The significant variation in the constructed indexes used to measure the level of digital economy development affects the research conclusions to a certain extent.

The vast exploration of the connection between digital economy development and urban and rural citizens' income by scholars has an important reference value for this paper. This paper selects 12 measurement indicators, constructs a measurement index for determining the level of digital economy development, and studies the effect of digital economy on the income disparity between rural and urban citizens from theoretical and empirical perspectives.

3. Theoretical analysis

3.1. Digital economy can lessen rural-urban income disparity

The purpose of reducing the income gap is to increase the growth rate of rural residents' disposable income ^[7]. The influence mechanisms of digital economy on the rural residents' per capita disposable income can be summarized in several points.

Firstly, the main source of income for rural residents is agricultural production. Digital economy can improve the efficiency of agricultural production, thus driving their income growth. The construction of digital infrastructure is conducive to the efficient dissemination of information and reducing the time cost for rural residents to obtain information. On the one hand, rural residents can gain immediate access to practical information through the internet and learn about advanced agricultural production techniques, crop varieties, and cultivation methods, thus guiding their farming activity and improving productivity; on the other hand, rural residents can learn scientific and cultural knowledge through the internet at a lower cost and improve their education level, which in turn improves the quality of the rural workforce.

Secondly, the growth of digital economy has eliminated barriers to employment and boosted job opportunities, drawing talents to rural regions, boosting human capital, and improving rural revitalization. For example, internet enterprises have moved to the countryside, supported rural development, and participated in rural revitalization initiatives, thus creating more job prospects, significant income, and insurance, all of which are beneficial in attracting young people back to the village.

Thirdly, the growth of digital inclusive finance has had a knock-on effect on rural residents' income. Digital inclusive finance has increased the coverage of conventional financial goods and financial services, while lowering the cost of access for people in rural areas. Rural residents can, on the one hand, increase their property income level by investing and borrowing money, and on the other hand, purchase digital insurance services to safeguard themselves against unforeseen hazards, thus ensuring financial security. Digital inclusive finance benefits the agricultural sector as it increases efficiency and lowers financing costs. This helps the rural communities that rely on funding to grow their business and gain better economic benefits.

3.2. The effect of digital economy on rural-urban income disparity varies by area

The expansion of digital economy is mainly evaluated by the levels of digital economy infrastructure, digital industry development, and industrial integration^[8]. Generally speaking, regions with rapid economic growth have relatively good infrastructure, high urbanization rate, and an industrial structure that is dominated by tertiary industries with high marginal returns. This gives them a certain geographical advantage in developing digital economy. In addition, most digital technology research institutes and leading digital industry enterprises are located in first-tier urban areas^[9], rendering these regions a natural technological advantage in developing digital economy. An empirical analysis of regional heterogeneity is also presented in this paper.

4. Empirical analysis

4.1. Data sources

In our study, we selected data from 30 provinces in China from 2013 to 2020. We did not consider Tibet, Hong Kong, Macau, and Taiwan because the data for these areas were missing or found unsuitable for comparison with other areas. The data were mainly obtained from the National Bureau of Statistics of China and the statistical yearbooks of each province; the data related to digital finance were obtained from The Peking University Digital Financial Inclusion Index of China (2013–2020), which was compiled by the Institute of Digital Finance of Peking University.

4.2. Empirical model

According to the above theoretical analysis, we establish the following empirical model (1):

$$Theil_{i,t} = \alpha_0 + \alpha_1 Dig_{i,t} + \alpha_2 Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \quad (1)$$

$$Theil_{i,t} = \sum_{i=1}^2 \left(\frac{y_{i,t}}{y_t} \right) \times \ln \left[\left(\frac{y_{i,t}}{y_t} \right) / \left(\frac{x_{i,t}}{x_t} \right) \right] \quad (2)$$

Theil is the predicted variable, which represents rural-urban income disparity. We used formula (2) to calculate the Theil index for different years in each region, where y_t is the per capita disposable income of all provincial residents in year t , x_t is the total resident population of a province at the end of the year in year t ; when $i = 1$, the above variable indicates urban areas, but when $i = 2$, it indicates rural areas.

The explanatory variable is digital economy development index (Dig). For the selection of individual indicators, we have made extensive reference to various studies conducted by Grishchenko^[9], Choi Changkyu and Yi Myung Hoon^[10], Benlagha and Hemrit^[11], Elena Toader *et al.*^[12], Song Xiaoling^[13], Zhang Xun *et al.*^[14], Zhang Xun, Wan Guanghua, and Wu Haitao (2021)^[15], Jing Wenjun and Sun Baowen^[16], Xu Xianchun and Zhang Meihui^[17], as well as Johannes Bauer^[18]. We then decided on the following

12 indicators from three dimensions and constructed a digital economy indicator system, containing one primary indicator, three secondary indicators, and 12 specific indicators (as shown in **Table 1**). Based on this indicator system, the entropy evaluation method (EEM) was used to calculate our index.

Table 1. Digital economy development indicators

Primary indicator	Secondary indicators	Specific indicators
Level of digital economy development	Development of the infrastructure of digital economy	Cable density
		Mobile phone penetration rate
		Number of ports connected to internet broadband
		Number of users connected to internet broadband
	Level of development of the digital industry	Software business revenue
		Research and development (R&D) expenditure of industrial enterprises
		Revenue generation per new product for industrial enterprises
		Total telecommunications services per capita
	Level of digital transformation of the industry	The Peking University Digital Financial Inclusion Index of China
		Levels of online mobile payments
		Number of websites per 100 companies
		Average e-commerce sales of companies
		Average e-commerce purchases of companies

$Z_{i,t}$ is the group of control variables, which include economic development (Eco, the GDP per capita of each province in each year and logarithmically processed); industrial structure (Is, the ratio of the value of the tertiary sector to the value-added of the primary and secondary sectors); the educational level of the population (Edu, the average number of years of education of the population in the provincial regions); the structure of fiscal expenditure (Fes, the ratio of social security and employment expenditure, health expenditure, as well as agriculture, forestry and water affairs expenditure to the local general budget expenditure); and the age structure of the population (As, the ratio of the number of retired people and children to the number of the working-age population in each province).

μ_i denotes the regional fixed effect, δ_t denotes the time fixed effect, and $\varepsilon_{i,t}$ denotes the random error term.

The descriptive statistics for the explanatory variables, core explanatory variables, and control variables are shown in **Table 2**.

Table 2. Descriptive statistics

Name of variable	Sample size	Mean	Standard deviation	Minimum	Maximum
Theil (<i>Theil</i>)	240	0.132	0.061	0.016	0.290
Digital economy development level index (Dig)	240	0.101	0.090	0.007	0.496
Economic development (Eco)	240	10.868	0.412	9.997	12.009
Industrial structure (Is)	240	1.137	0.725	0.530	5.147
The educational level of the population (Edu)	240	9.530	1.175	7.474	13.438
Structure of fiscal expenditure (Fes)	240	0.330	0.056	0.180	0.489
Population age structure (As)	240	37.199	6.213	22.700	51.120

4.3. Empirical results

4.3.1. Results of the benchmark model

In **Table 3**, columns (1)–(4) are the regression results of the pooled ordinary least squares (OLS), fixed effects model, two-way fixed effects model, and random effects model, respectively, on which the Breusch-Pagan Lagrange multiplier (BP-LM) test and Hausman test were conducted. The results show that it is more reasonable to use the fixed effects model to regress the sample. In addition, a joint significance test of the time dummy variable was also conducted, in which the results show that the time effect needs to be controlled. Therefore model (3) is the optimal model.

Table 3. Results of benchmark model

	(1)	(2)	(3)	(4)
Dig	0.0676	-0.143***	-0.1479***	-0.115***
Eco	-0.0569**	0.0714***	0.0305	0.0545***
Edu	-0.0121***	-0.00150	-0.00513	-0.00132
Is	0.00884	-0.000699	-0.0101	-0.0119**
Fes	0.319**	0.0669**	-0.0202	0.150***
As	0.288**	0.0613**	0.0125	0.126***
cons	0.635**	-0.656***	-0.137	-0.516***
Regional fixed effect	No	Yes	Yes	No
Time fixed effect	No	No	Yes	No
Sample size	240	240	240	240

Note: *** $P < 0.01$, ** $P < 0.05$, and * $P < 0.10$

According to the findings of the two-way fixed effects model, the coefficient of the digital economy development index (Dig) is significantly negative at the 1% level, with an estimated value of -0.148, proving that there is an inverse relationship between digital economy development and rural-urban income disparity in China. This is in line with the theoretical analysis where the development of digital economy helps lessen income inequality.

4.3.2. Analysis of regional heterogeneity

Referring to the classification often used by scholars when collecting regional data^{[19][20]}, China's provinces can be divided into six regions: North China, East China, Northeast China, Central and South China, Southwest China, and Northwest China. Regression analysis was conducted using a two-way fixed effects model by region, and the results are shown in **Table 4**.

Table 4. Empirical analysis of regional heterogeneity

	(1) North China	(2) East China	(3) Northeast China	(4) Central and South China	(5) Southwest China	(6) Northwest China
Dig	-0.184***	-0.115***	-0.255	0.0528**	0.0298	-0.228
Eco	-0.00147	0.0139	0.0286	0.0834	0.238*	-0.0197
Edu	-0.0135**	-0.00357	0.00876	-0.000874	-0.0284**	0.00724*
Is	0.00524	-0.0120	-0.0277**	0.0305	0.0492	0.0177**

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	(1) North China	(2) East China	(3) Northeast China	(4) Central and South China	(5) Southwest China	(6) Northwest China
Fes	-0.0732	-0.0398	-0.129**	-0.0587	0.0628	0.158***
As	0.0579	-0.0160	-0.127	0.206***	0.0273	0.136**
cons	0.248	0.00830	-0.196	-0.839	-2.123*	0.206
Sample size	40	56	24	48	32	40

Note: *** $P < 0.01$, ** $P < 0.05$, and * $P < 0.10$

The impact of digital economy expansion on the income of urban and rural populations varies across different regions. In North China and East China, the development of digital economy is conducive to narrowing the urban-rural income gap, which is in line with the results obtained from the benchmark model. In Northeast, Northwest, and Southwest China, the effect of digital economy development on rural-urban income disparity is insignificant, probably because these three regions are at a disadvantage in terms of digital economy infrastructure, digital industry development, talent pool, resource endowment, and regional economic development compared to the former two regions. On the other hand, in Central and South China, digital economy development widens the urban-rural income gap. This indicates that a “digital divide” has emerged in this region.

4.3.3. Robustness test

We winsorized the predicted variable, Dig, at 1%, and then conducted regression by the two-way fixed effects model. As shown in **Table 5**, column (2), the coefficient of the predicted variable was still significantly negative, with a coefficient of -0.1480. Since the level of digital economy development in Beijing and Shanghai is significantly higher than other provinces, municipalities, and autonomous regions in the original data, we repeated the regression on the panel data after excluding the samples from these two places. The results are shown in **Table 5**, column (3), in which the coefficient of the predicted variable, Dig, was still significantly negative, with a coefficient of -0.151. This indicates that the results of the empirical analysis are robust.

Table 5. Robustness test results

	(1)	(2)	(3)
Dig	-0.1479***	-0.1480***	-0.151***
Eco	0.0305	0.0294	0.0260
Edu	-0.00513	-0.00506	-0.00118
Is	-0.0101	-0.00991	-0.0190
Fes	-0.0202	-0.0226	-0.0253
As	0.0125	0.0115	0.0343
cons	-0.137	-0.125	-0.119
Regional fixed effect	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes
Sample size	240	240	224

Note: *** $P < 0.01$, ** $P < 0.05$, and * $P < 0.10$

5. Conclusion

This study provides an empirical analysis using the data from 30 provinces and other provincial areas in China between 2013 and 2020 and concludes the following: firstly, digital economy helps in promoting rural-urban income equality in China; secondly, the effect of digital economy on the rural-urban income disparity in China is regionally heterogeneous, significantly bridging the income gap in East, North, and Northeast China.

Acknowledgements

We would like to express our sincere thanks firstly to our tutor, Lina Wang, who encouraged us and gave a lot of guidance and advice. We are also grateful to all of our friends and classmates who helped with the writing of this manuscript.

Funding

The work was supported by the 2022 College Students' Innovation and Entrepreneurship Training Program of School of Economics and Management, North China University of Technology "Research on the Impact of the Digital Economy on the Income of Urban and Rural Residents" (Project Number: 108051360022XN413).

Disclosure statement

The authors declare no conflict of interest.

Author contributions

S.Z. conceived the idea for the study; Y.D. collected and analyzed the data as well as wrote the paper.

References

- [1] Chen W, Wu Y, 2021, Digital Economy's Development, Digital Divide and the Income Gap Between Urban and Rural Residents. *South China Journal of Economics*, 2021(11): 1–17.
- [2] Wang J, Xiao H, 2021, Has the Development of Digital Economy Narrowed the Income Gap Between Urban and Rural Residents?. *Reform of Economic System*, 2021(06): 56–61.
- [3] Chen X, Duan B, 2022, Has the Digital Economy Narrowed the Gap Between Urban and Rural Areas? – Empirical Test Based on Mediating Effect Model. *World Regional Studies*, 31(2): 280–291.
- [4] Liu J, Yang Y, Zhang S, 2020, Research on the Measurement and Driving Factors of China's Digital Economy. *Shanghai Journal of Economics*, 2020(06): 81–96.
- [5] Bai P, Yu L, 2021, Digital Economy Development and Firms' Markup: Theoretical Mechanisms and Empirical Facts. *China Industrial Economics*, 2021(11): 59–77.
- [6] Li X, Li J, 2022, Research on the Influence of Digital Economy Development on Urban-Rural Income Gap. *Journal of Agrotechnical Economics*, 2022(02): 77–93.
- [7] Mu T, Diao L, Huo P, 2021, Digital Economy and Inclusive Growth of Urban and Rural Areas: An Analysis from the Perspective of Digital Skills. *Chinese Review of Financial Studies*, 13(04): 36–57 + 124–125.
- [8] Zhao T, Zhang Z, Liang S, 2020, Digital Economy, Entrepreneurship, and High-Quality Economic Development: Empirical Evidence from Urban China. *Journal of Management World*, 36(10): 65–76.

- [9] Grishchenko N, 2020, The Gap Not Only Closes: Resistance and Reverse Shifts in the Digital Divide in Russia. *Telecommunications Policy*, 44(8): 102004.
- [10] Choi C, Yi MH, 2009, The Effect of the Internet on Economic Growth: Evidence from Cross-Country Panel Data. *Economics Letters*, 105(1): 39–41.
- [11] Benlagha N, Hemrit W, 2020, Internet Use and Insurance Growth: Evidence from a Panel of OECD Countries. *Technology in Society*, 62: 101289.
- [12] Toader E, Firtescu BN, Roman A, et al., 2018, Impact of Information and Communication Technology Infrastructure on Economic Growth: An Empirical Assessment for the EU Countries. *Sustainability*, 10(10): 3750–3750.
- [13] Song X, 2017, Empirical Analysis of Digital Inclusive Finance Bridging the Urban-rural Residents' Income Gap. *Finance & Economics*, 2017(06): 14–25.
- [14] Zhang X, Wan G, Zhang J, et al., 2019, Digital Economy, Financial Inclusion, and Inclusive Growth. *Economic Research Journal*, 54(08): 71–86.
- [15] Zhang X, Wan G, Wu H, 2021, Narrowing the Digital Divide: The Development of Digital Finance with Chinese Characteristics. *Social Sciences in China*, 2021(08): 35–51 + 204–205.
- [16] Jing W, Sun B, 2019, Digital Economy Promotes High-Quality Economic Development: A Theoretical Analysis Framework. *Economist*, 2019(02): 66–73.
- [17] Xu X, Zhang M, 2020, Research on the Scale Measurement of China's Digital Economy – Based on the Perspective of International Comparison. *China Industrial Economics*, 2020(05): 23–41.
- [18] Bauer JM, 2018, The Internet and Income Inequality: Socio-Economic Challenges in a Hyperconnected Society. *Telecommunications Policy*, 42(4): 333–343.
- [19] Chen C, 2018, Research on the Dynamic Transformation of High-Quality Economic Development in New Era. *Shanghai Journal of Economics*, 2018(05): 16–24 + 41.
- [20] Zhang X, Jiao Y, 2017, A Preliminary Study of China's Digital Economy Development Index and Its Application. *Zhejiang Social Sciences*, 2017(04): 32–40 + 157.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Marketing Analytics Case Study: Hotel Catalonia Barcelona Plaza

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Abstract: Imagine a scenario where Hotel Catalonia Barcelona Plaza approached a consulting company, seeking to understand its customers and improve its performance. The hotel provided its room booking records from 2015 to 2017 to the consulting company, while the consulting company collected tweets about the hotel, its customer reviews from Booking.com, and the reviews of other hotels in Barcelona. With all the data collected, the consulting company conducted an analysis to help the client hotel understand its customers and performance, and subsequently provided corresponding recommendations based on the findings.

Keywords: Marketing analytics; Luxury marketing; Tourism marketing

Online publication: October 21, 2022

1. Executive summary

1.1. Company background information

Hotel Catalonia Barcelona Plaza is ideally located in Plaza España. The hotel provides optimum comfort to its customers with newly renovated magnificent rooms and stunning views. In order to meet the various demands of its customers, it has complete facilities for fitting, business, and leisure purposes. Notably, it has an outdoor swimming pool on its terrace and gymnasium for those who wish to stay in shape. Additionally, the hotel has 11 meeting rooms for business meetings and corporate events on its premise. In terms of food and feast, customers are able to enjoy the impeccable food and services offered by its two restaurants: a café and a garden marquee for parties and celebrations.

1.2. Assumptions and tasks

This report is based on the hotel's data from 2015 to 2017, aiming to explore its business potential and improvements without the influence of the COVID-19 pandemic. In order to achieve this, a comprehensive analysis is conducted to understand the consumers of this hotel and investigate the profiles of existing target audience (TA). Thereafter, the performance of the hotel is evaluated from different aspects, including strategic positioning compared with main competitors. A review analysis utilizing sentiment data and topic modelling is also discussed in this report. Finally, feasible recommendations are proposed from both, strategic and tactical levels to help Catalonia Barcelona Plaza bolster its established status and develop into new markets.

1.3. Insights

The consumer segments that the client hotel served in the past three years consist of business people,

couples, and getaway families, amongst which business people and couples have made the largest contributions. Taking into account of the communication messages delivered specifically to business people on the official website, the target consumers of the client hotel can be defined as follows: corporate road warriors as the core audience, family getaway-oriented travelers as halo audience 1, and romantic trip-oriented couples as halo audience 2.

The client hotel and its main rivals each have their own niche in the hotel industry, thus creating a delicate equilibrium. However, in order to increase its market share, the client hotel may target a profitable and prospective market segment, namely solo tourists, without significantly disrupting the equilibrium.

Reviews have revealed a slight rise in customer dissatisfaction with the client hotel over the past three years. The customers are mainly dissatisfied with the facilities and environment in the rooms, bathrooms, bar, breakfast, and staff services; however, many are pleased with the client hotel's location and view.

1.4. Recommendations

- (1) Develop varying strategies for four different consumer segments.
- (2) Improve the quality of offerings and provide personalized services.

2. Consumer understanding

Figure 1 shows that the client hotel often receives reservations from 2 adults, followed by 1 adult, and 3–4 adults or above. In terms of nationality, tourists from France, Germany, and Britain account for the top three reservations out of all nations (**Figure 2**).

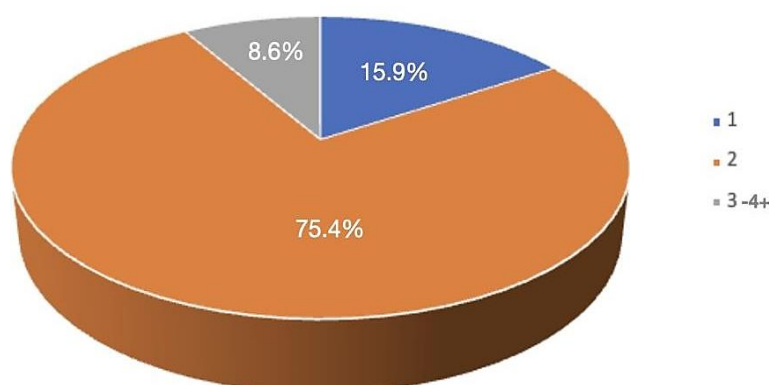


Figure 1. Proportion of reservations by the number of adults

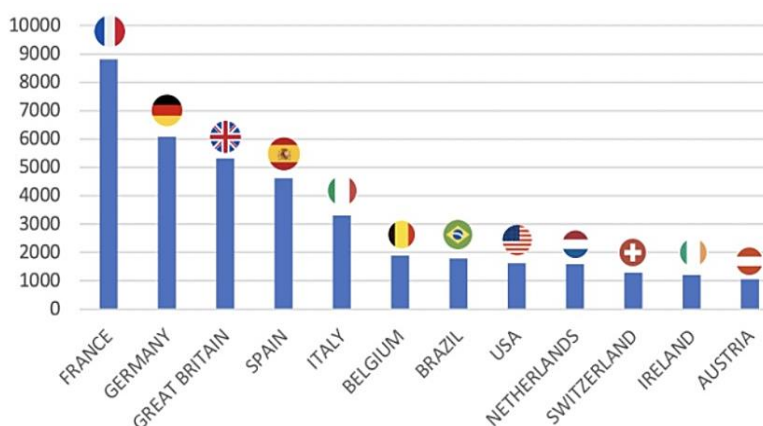


Figure 2. Number of reservations by country of origin

By classifying the guests by the number of adults who made reservations and checked in, there are three categories as shown in **Figure 3**: category one (1 adult); category two (2 adults), and category three (2–4+ adults). These three categories can be further subdivided based on the number of children and babies each booking relates to. For instance, category one (1 adult) can be divided into “1 adult with 0 children or babies” or “1 adult with 1–2 children.” To be precise, they are two groups: “business people” and “one parent with children or babies.” In terms of their contributions to the client hotel, the aforementioned “business people” contributed 15.4% of the total reservations from 2015 to 2017, whereas the reservations made by “one parent with children or babies above” were 0.5% of the total.


Customer Segmentation 			
1 adult	0 children or babies	business people	15.4% ★
	1–2+ children or babies	one parent with children or babies	0.5%
2 adults	0 children or babies	couples	67.4% ★
		business people with colleagues	
	1–2+ children or babies	getaway families	↑ 8.0%
3~4+ adults	0 children or babies	business people with multiple colleagues	8.4%
	1–2+ children or babies	getaway families	↑ 0.20%

Figure 3. Customer segmentation

Insights

Therefore, the consumer segments that the client hotel have served in the past three years mainly consist of business people, couples, and getaway families, amongst which business people and couples have made the largest contributions. Taking into account of the communication messages seen on the official website of the hotel, their focus is on business aspects to attract business people, as shown in **Figure 4**. Hence, the existing target audiences of the client hotel can be defined as follows: corporate road warriors or business people as the core audience, followed by family getaway-oriented travelers and romantic trip-oriented couples as the two types of halo audiences (**Figure 5**).

WHY GO?

This imposing hotel Catalonia Barcelona Plaza is situated in Plaza España, next to the Fira de Barcelona facilities and Montjuic. It has 347 rooms and the guests can enjoy excellent connections with every means of public transport. It has its own parking facilities and offers ideal accommodation for business trips or short breaks. The panoramic terrace and most of the rooms have unbeatable views. The gardened marquee which is located in the central courtyard creates an ideal atmosphere for cocktails and dinner parties. We also offer you our 11 meeting rooms, where you can organise business meetings, conventions and family celebrations and free wifi. The hotel has 2 restaurants: Filigrana, specializing in market cuisine and grilled; and the Japanese restaurant Kurai. It also has a cafeteria, the Gourmet Corner, with a daily menu; 11 meeting rooms, free Wi-Fi, a car park in the building and excellent connections with all public transport. Hotel Barcelona-003967

Figure 4. Communication messages on the official website that focus on attracting business people



Figure 5. Existing target audiences of the client hotel

Accordingly, the representative of each target audience can be defined (**Figure 6**). Kévin, from France, represents corporate road warriors, the Schmidt family from Germany represents family getaway-oriented travelers, and Lily and Jack, from Britain, represent romantic trip-oriented couples.

Corporate road warriors



Kévin

Geographic characteristics	French
Psychographic characteristics	<ul style="list-style-type: none"> • Personality: positive, proactive, adaptive and willing to embrace challenges • Lifestyle and value: dress well and keen on fashion; quality-concerned, less price-sensitive; prefer to “chill” after working hours; focus on self-improvement
Demographic characteristics	<ul style="list-style-type: none"> • Age: 30 years old • Occupation: international trade • Income: generally well-paid • Education: MBA • Family and household: single

Family getaway-oriented travellers



The Schmidt's

Geographic characteristics	German
Psychographic characteristics of parents	<ul style="list-style-type: none"> • Personality: family and children come first • Lifestyle and value: keen on comfortable experience and value family togetherness
Demographic characteristics of parents	<ul style="list-style-type: none"> • Age: 35 years old • Occupation: white collar • Income: generally well-paid • Family and household: 2 children (10 months and 3 years old)

Romantic trip-oriented couples



Lily and Jack

Geographic characteristics	British
Psychographic characteristics	<ul style="list-style-type: none"> • Personality: caring and sweet to each other • Lifestyle and value: dress well and keen on fashion; not keen on travelling but rather spending time together in the hotel; expecting to celebrate their one-year anniversary
Demographic characteristics	<ul style="list-style-type: none"> • Age: 25 years old • Occupation: 3-year working experience • Income: not well-off but spend generously on this romantic trip • Education: bachelors • Family and household: a year into this romantic relationship

Figure 6. Profiles of representative target audiences

3. Performance evaluation

In this section, the performance of the client hotel is evaluated, focusing on two key factors: strategic positioning assisted by competitive profile matrix, and its customer reviews investigated by sentiment analysis and topic modelling.

Insights

- (1) The client hotel and its primary competitors each have their own niche position in the hotel industry, thus creating a delicate equilibrium. However, in order to grow its market share, the client hotel may develop a profitable and promising market segment, namely solo travelers, without disturbing the equilibrium to a large extent.
- (2) There has been a slight increase in customer dissatisfaction with the client hotel, as reflected in reviews over the past three years. The customers are dissatisfied with the facilities and environment in the rooms, bathrooms, and bar, staff services, as well as the breakfast provided; however, many are pleased with the staff, location, and view of the client hotel.

As a renowned destination for visitors with leisure purposes and the world's top city for workcations ^[1], Barcelona is packed with hotels, in which fierce competitions exist between them. As shown in **Figure 7** ^[2], among all the cities around the globe, Barcelona ranks 13th in the ranking of "Cities with the Most Hotels." Consequently, in order to distinguish themselves from these hotels, a solid positioning strategy would be crucial to delivering precise messages to the right consumer segments and ultimately providing a return on investment ^[3].

CITIES WITH THE MOST HOTELS (INCLUDING HOSTELS)

Rank - Total - City, Country - Hotel rooms/B&Bs&Inns/Specialty

- 4169 - Beijing, China - 3505/426/238
- 3127 - Rome, Italy - 1279/1567/281
- 2756 - Shanghai, China - 2485/169/102
- 1984 - Paris, France - 1847/59/78
- 1793 - London, England - 1065/381/347
- 1611 - Guangzhou, China - 1558/22/31
- 1330 - Marrakech, Morocco - 422/806/102
- 1280 - Hangzhou, China - 1155/67/58
- 1227 - Shenzhen, China - 1178/38/11
- 1218 - Chengdu, China - 1074/77/67
- 1139 - Istanbul, Turkey - 706/299/134
- 1101 - Prague, Czech Republic - 667/187/247
- 1081 - Barcelona, Spain - 547/162/372

Figure 7. Ranking of cities with the most hotels

Having gathered information from the client hotel's official website, a complete picture of its positioning is illustrated in **Figure 8**. It claims to be an ideal accommodation for business trips and short breaks, and it emphasizes a high price-facility ratio to target primarily corporate road warriors.



Figure 8. Details of the client hotel (offerings, TA, communication highlights)

Based on the location of the client hotel on Google Maps, the hotel cluster surrounding Catalonia Square, which is the heart and center of Barcelona, could be identified. Eight hotels in this cluster are marked by blue locators in **Figure 9**.

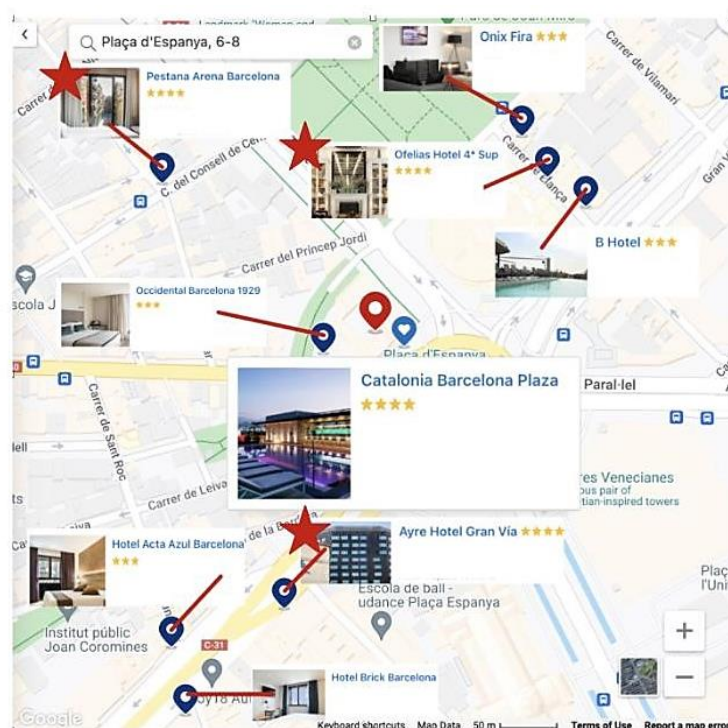


Figure 9. Hotel cluster around Catalonia Square on Google Maps

In order to determine the client hotel's main competitors, the competitive profile matrix is employed. This matrix, as shown in **Figure 10**, is used to further determine the main competitors of the client hotel, thus narrowing down the company's main rivals and comparing them based on the industry's key competitive criteria ^[4]. This may help the client hotel better understand its external environment and its competitors ^[5]. The intuition of this matrix is to first define the possible criteria, and then assign each dimension a weighting and rate the hotels according to their actual competitiveness. By filtering and gathering average review ratings and the total number of received reviews from the given data (**Figure 11**), the 8 hotels can be compared to the client hotel in the matrix. Taking Ayre Hotel Gran Via as an example, the hotel may receive 1 in the first dimension ("star rating compared with us") since it has the same star rating as the client hotel. In terms of review rating, it is comparable to the client hotel; hence, it is given 1 as well in the dimension "review rating compared with us." Likewise, the dimensions of "proximity to us" and "popularity compared with us" can be scored. From the results, it is clear that Ayre Hotel Gran Via, Pestana Arena Barcelona, and Ofelias Hotel 4* Sup are the top three key competitors, as indicated by red stars in **Figure 9**.

Criteria	Weight	Ayre Hotel Gran Via ★★★★★	Occidental Barcelona 1929 ★★	Pestana Arena Barcelona ★★★★★	Ofelias Hotel 4* Sup ★★★★★	Onix Fira ★★	B Hotel ★★	Hotel Acta Azul Barcelona ★★	Hotel Brick Barcelona
Star Rating Compared with us	0.40	1	0	1	1	0	0	0	0
Review Rating Compared with us	0.25	1	1	1	1	0	1	0	1
Proximity to us	0.20	0	1	0	0	0	0	0	0
Popularity Compared with us	0.15	1	0	0	0	0	0	0	0
Total Score	1.00	0.80	0.45	0.65	0.65	0.00	0.25	0.00	0.25

Figure 10. Competitive profile matrix


hotel name	average review rating	total number of reviews received (popularity)
Ayre Hotel Gran V a	8.8	6883
Occidental Barcelona 1929	9.3	1015
Prestana Arena Barcelona	8.5	1252
Ofelias Hotel 4 Sup	8.6	729
Onix Fira	7.8	1951
B Hotel	8.7	1773
Hotel Acta Azul Barcelona	8.1	2110
Hotel Brick barcelona	9	1348
Catalonia Barcelona Plaza	8.6	2969

Figure 11. Average review rating and total number of reviews received

Similarly, the profiles of the aforementioned main competitors are analyzed below.

- (1) Pestana Arena Barcelona: a boutique hotel in the center of Barcelona that caters to travelers who are concern about the price-value ratio.

PESTANA ARENA BARCELONA



PRICE: 70-133 Euros

PRODUCT HIGHLIGHTS

- gym, sauna and Turkish bath
- meals at the Lorenzo restaurant and bar
- terrace during the summer
- huge LCD TV

PROPOSITION


A BOUTIQUE HOTEL IN THE CENTER OF BARCELONA

TA


Travellers who concern price-value ratio

Communication highlight

1. Awards and certifications




TRIPADVISOR
Travellers' Choice 2021




BARCELONA HOTELS ASSOCIATION
Official Member


2. Promotions to get discounts



SPRING PROMOTION
Up to 25% off!
Book yourself a special stay this Spring!



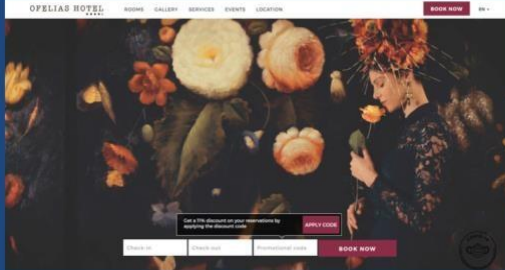
EASTER OFFER
Because family holidays are sweeter!
Take advantage of the Easter Offer and celebrate life with joy!



SUMMER OFFER
Book your summer stay with 25% off!
While you focus on your holiday, we'll take care of your comfort.

- (2) Ofelias Hotel: a hotel that provides a harmonious stay in an environment dominated by beauty and sensuality, serving solo travelers who expect to enjoy individual hours.

OFELIAS HOTEL



PRICE: 173-371 Euros

PRODUCT HIGHLIGHTS

- Solarium-swimming pool
- Chill out area
- Massage service in room
- Smoke free hotel
- Solar panels: a large part of the hotel's energy is renewable
- Outsourced restauration service
- Rooms for holding any personal or corporate event

PROPOSITION


a harmonious stay in an environment dominated by sensuality and beauty.

TA


Solo travellers who want to enjoy "ME" time

Communication highlight

1. Enjoy individual moments



2. Dominated by breathtaking sensuality and beauty



LILIUM LUXURY | BUCANVILLIA SUPERIOR TERRACE | ROSEMARY DOUBLE COMFORT | GARDINIA DON COMFORT

Ofelias' rooms combine a simply elegance with a flawless design made by the interior designer Lázaro Rosa-Violan, offering you a magic stay in Barcelona.

AYRE HOTEL GRAN VÍA BARCELONA

AYRE HOTELS

HOTELS & DESTINATIONS

OFFERS

MEETINGS & EVENTS

HOTEL

ROOMS

SERVICES

AYRE HOTEL GRAN VÍA BARCELONA

PRICE: 165-356 Euros

PRODUCT HIGHLIGHTS

- Location advantage: very close to the Barcelona's Exhibition Centre, Fira de Barcelona
- 3 meeting rooms that can accommodate both corporate events and private parties.
- taste authentic signature cuisine in a relaxed and peaceful environment, with an exquisite and personalized treatment.

PROPOSITION


The ideal accommodation for business people, families and young couples.

TA

Mainly business people, and then families and young couples


Communication highlight

1. Sites and activities designed for business people



BUSINESS CENTER


We know how important it is to be able to make progress with your work when you are away from home. Ayre Hotel Gran Vía has everything you need.



BAR


After a long day, enjoy a pleasant after-work drink in our cafeteria cum bar. Relax and savor delicious and refreshing cocktails: Bloody Mary, Manhattan, Martini, Caipirinha, Daiquiri, Pilsa Colada, Margarita... Disconnect from the urban frenzy and feel the cosmopolitan nature of Barcelona!

2. Welcome different groups of people with various demands



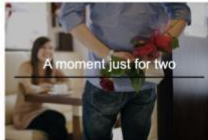
More time to enjoy

LONG WEEKEND



Up to 20% off!

ADVANCE BOOKING



A moment just for two

ROMANTIC GETAWAY

The diagram is a 2x2 matrix with the following axes and labels:

- Vertical Axis (Leisure purposes):**
 - Top: Togetherness
 - Bottom: Individual
- Horizontal Axis (Business orientation):**
 - Left: High price-value ratio
 - Right: Luxury & Premium

The quadrants contain the following hotel images and labels:

- Top-Left (Togetherness, High price-value ratio):** PESTANA ARENA BARCELONA. Price: 76,133 Euros.
- Top-Right (Togetherness, Luxury & Premium):** OFELIAS HOTEL. Price: 175,971 Euro.
- Bottom-Left (Individual, High price-value ratio):** CATALONIA BARCELONA PLAZA. Price: 100,000 Euros.
- Bottom-Right (Individual, Luxury & Premium):** AYRE HOTEL GRAN VIA BARCELONA. Price: 700,000 Euros.

Red lines connect the hotel images to their respective positions on the axes. Blue lines connect the hotel images to their respective positions on the axes.

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The second part of performance evaluation employs sentiment analysis and topic modelling. Based on the given sentiment data of the client hotel, the yearly aggregate strength of reviews can be calculated by summing up the aggregate strength of positive and negative reviews per year (**Figure 13**).

year	review type	sum of positive sentiment strength	sum of negative sentiment strength	aggregate strength of posi/nega review
2015	positive review	466	-200	266
	negative review	220	-269	-49
2016	positive review	1359	-602	757
	negative review	747	-877	-130
2017	positive review	482	-226	256
	negative review	254	-288	-34
year		average sentiment strength of the year	aggregate sentiment strength of the year	number of reviews
	2015	1.192	217	182
	2016	1.142	627	549
	2017	1.110	222	200

Figure 13. Sentiment strength analysis

The client hotel's performance can be evaluated by the changes in average sentiment strength over the past three years. **Figure 14** shows a decline in the hotel's average sentiment strength from 2015 to 2017, indicating that the customers' affection for the client hotel as reflected in reviews is waning.

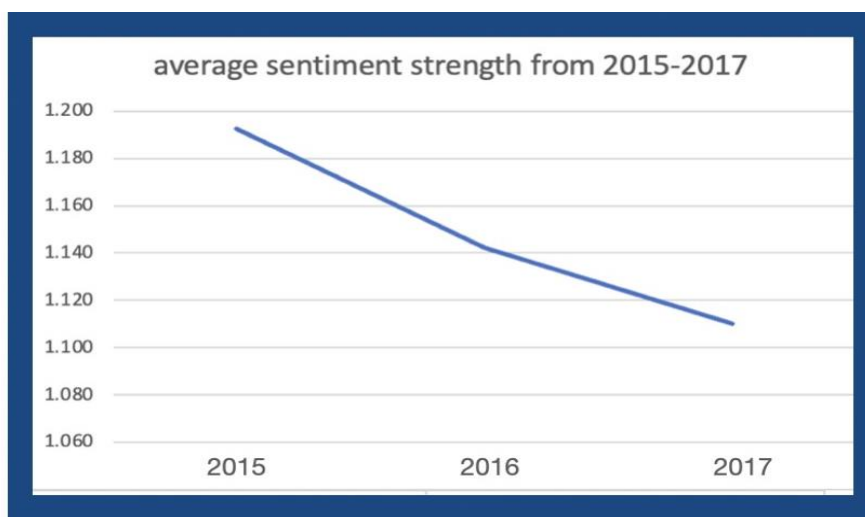


Figure 14. Average sentiment strength from 2015 to 2017

In this case, the client hotel should be more cautious about their offerings and deal with the dissatisfaction of customers as indicated in their reviews. By visualizing both, positive and negative reviews from topic modelling, word clouds are generated to show the prominent topics among customers. In terms of negative reviews, the most discussed topics among customers are room, bathroom, bar, breakfast, staff, reception, *etc.*, whereas in terms of positive reviews, guests tend to praise the staff, location, and view of the client hotel (**Figure 15** and **Figure 16**).



Figure 15. Visualization of positive reviews on the client hotel via topic modelling



Figure 16. Visualization of negative reviews on the client hotel via topic modelling

4. Recommendations

4.1. Develop varying strategies for different segments

Firstly, based on customer understanding, it is clear that the target audiences of the client hotel are mainly business people, followed by couples and families. According to strategic positioning analysis, there are blue oceans for the client hotel to explore, namely solo travelers. This market segment is anticipated to have significant business prospects. According to a survey by Klook in 2019 ^[7], 76% of the 21,000 people polled globally disclosed that they have traveled alone or are contemplating it. Furthermore, the data obtained from Google Trends have revealed that the number of people traveling alone has grown by 761.15% and many people are continuously seeking for solo travel opportunities. Therefore, the client hotel can consider developing this promising market for business expansion. Accordingly, different strategies for different target audiences are formulated.

On the tactical level, the client hotel can launch an integrated marketing campaign. This is a form of communication strategy that combines multiple channels to assure the consistency of messages delivered to the target audiences [8]. For instance, the message that the client hotel can impart is as follows: “We are

a hotel that welcomes all groups of people, and anyone may make themselves at home here, regardless of who they are.” This message can possibly resonate with potential consumers from the four expected target audiences, thus making them feel welcomed. Moreover, as shown in the visualization of positive reviews, the hotel’s location and view are among the most highly discussed topics. More specifically, they are the competitive advantages that should be emphasized in communications. This integrated marketing communications (IMC) campaign can highlight that fact that the hotel is a center-located hotel with spectacular views that is ideal for business trips, romantic dates, family holidays, or personal getaways.

After deciding on the planned message, it is necessary to DO and CONFIRM, as asserted by Cai and Hobson [9] in their integrated branding approach. This is a strategy that companies can employ to stand out in competition and develop long-term sustainable competitiveness (**Figure 17**).

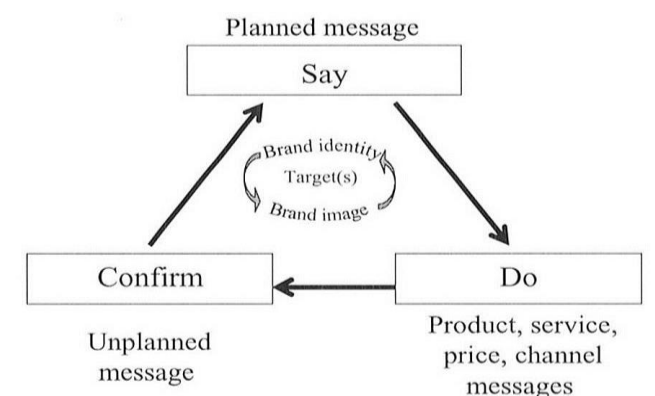


Figure 17. Concept of brand message integrity

Sequentially, in the DO and CONFIRM stages, the client hotel should follow the practical steps in **Figure 18**. Companies are expected to fulfill the promises in their planned message during the DO stage. In the CONFIRM stage, they should be able to manage the unplanned messages, including the word-of-mouth of guests and the reports about the hotel by the media, in order to enhance the planned brand image and ensure message integrity.

Notably, solo travelers are the segment that receives a generally higher level of education, with more than 80% of them having a university education or above (**Figure 19**). They have high regard for self-improvement and their interests in addition to meeting like-minded individuals (**Figure 20**). Therefore, to attract these group of people, special offerings related to self-development and quality social activities might be effective.

Although the aforementioned strategic positioning refreshment and tactical practices may help the client hotel expand into new markets and enlarge its market share, there are potential challenges to contemplate on. For example, if the positioning refreshment exercise is poorly executed, it might result in confusing positioning, and there would be a jumble of conflicting messages and perceptions in the target markets ^[10]. On the flip side, good practice may yield substantial returns and largely leverage company capabilities. Pink Lemonade, for example, has transitioned from a creative agency to an IMC service provider, which turns out to be a huge success in scaling up, given the growing number of client brands and advertising awards ^[11].

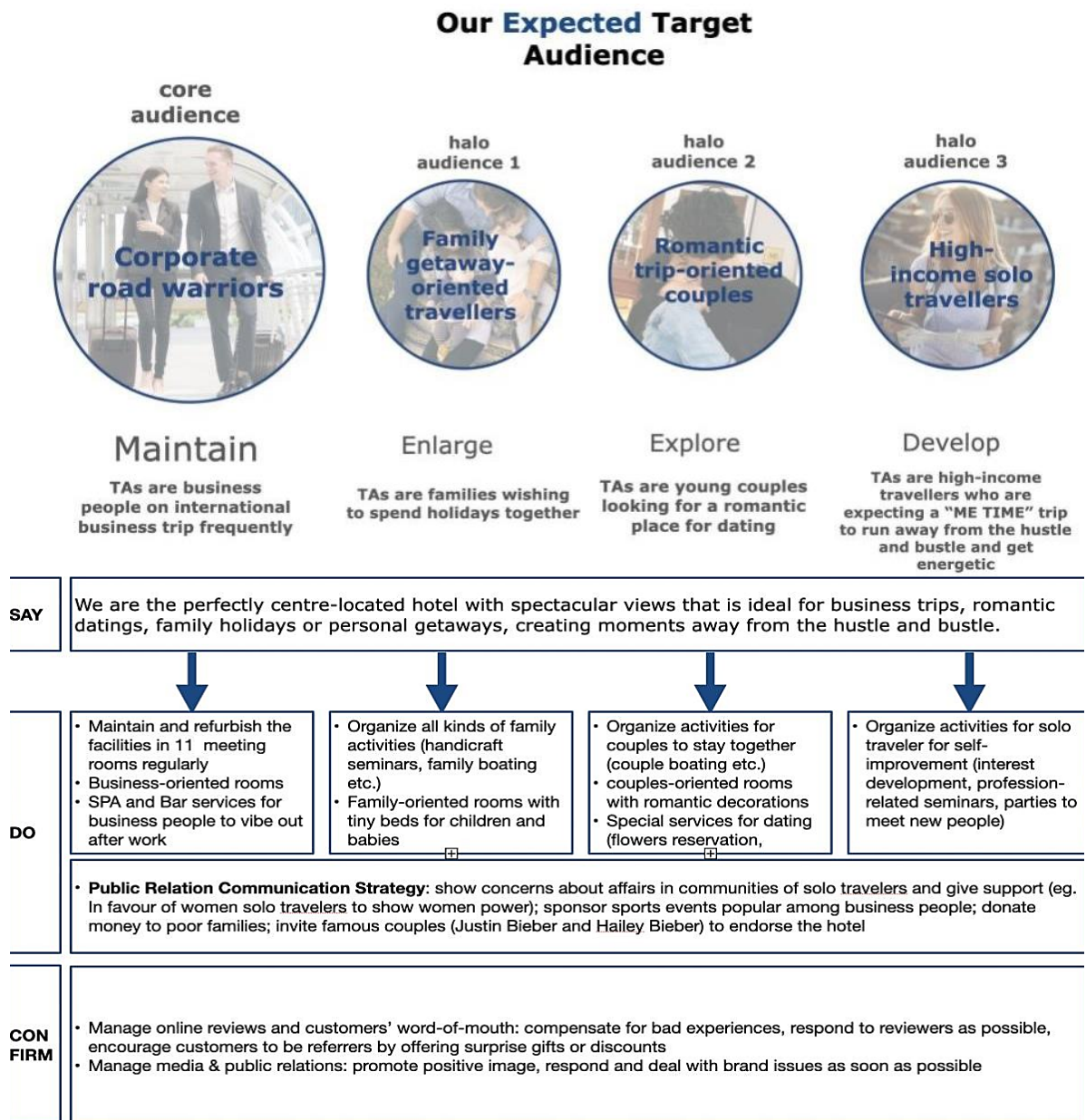


Figure 18. Strategic direction and practical steps to follow

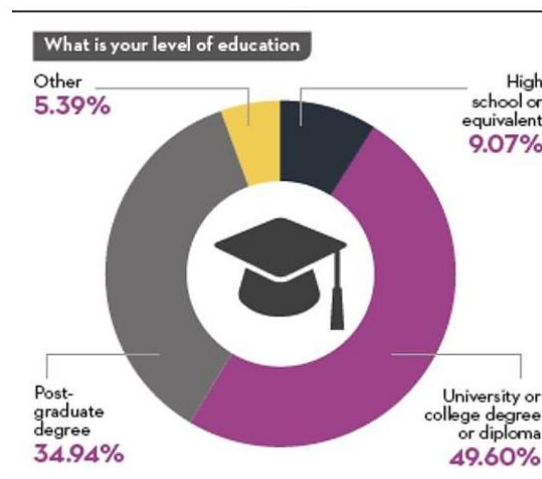


Figure 19. Education background of solo travelers



Figure 20. Reasons why travelers choose to travel alone

4.2. Improve the quality of offerings and provide personalized services

As can be seen in the word cloud for negative reviews, issues pertaining to rooms, bathrooms, breakfast, bar, staff, and reception are often raised by customers. Having delved into these, the causes of such negative reviews have been found to be associated with tangible offerings (physical environment) and intangible offerings (staff services) (Figure 21).

Hence, the client hotel should address the two issues accordingly. For tangible offerings, many reviewers have reported that the environment in the rooms and bathrooms is unpleasant due to the lack of housekeeping. Besides that, the facilities provided are not satisfactory; for example, some mirrors in the bathrooms are broken, and there are instances where taps are missing. Moreover, limited options, “uncozy” environment, and average food quality are all perceived as unfavorable aspects of breakfast. A considerable number of guests have also complained that the bar’s menu is overpriced. In a nutshell, the client hotel must improve its environment and refurbish its facilities as a whole as well as make minor modifications to its breakfast and bar offerings.

In terms of intangible services, the quality of the staff requires further improvement. Based on the dimensions for evaluating service quality (Figure 22) by Parasuraman *et al.* ^[12], the services provide by the client hotel’s staff lack responsiveness, empathy, reliability, and assurance.

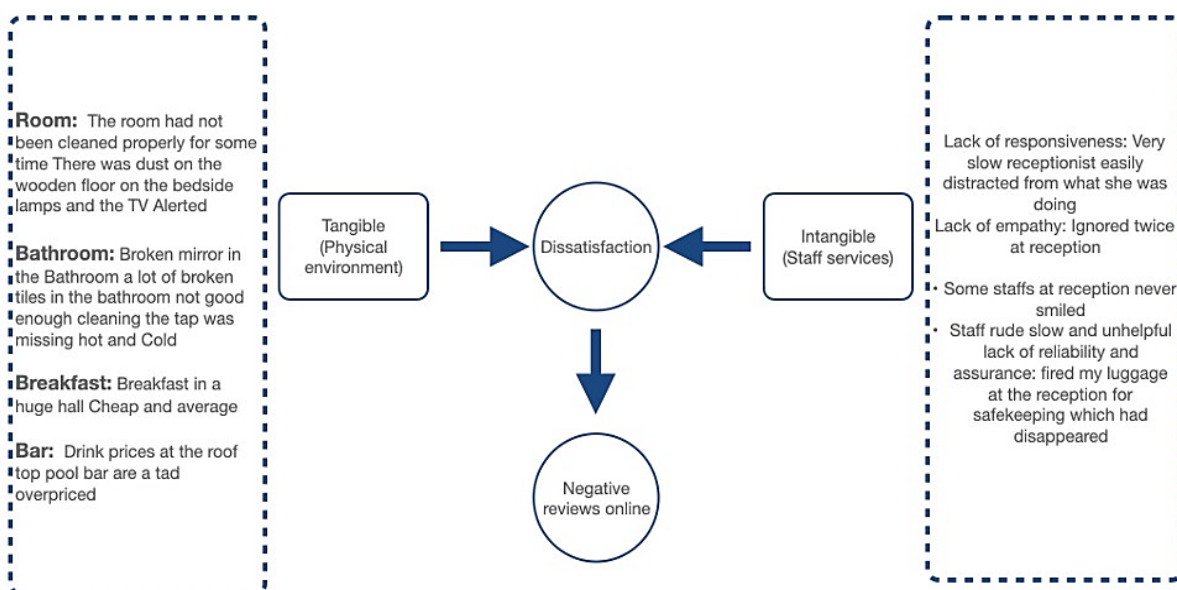


Figure 21. Causes of customer dissatisfaction with the client hotel

[illegible]

"we asked if we could do breakfast on terrace on Sunday 1 11 15 but was told it was not enough notice we was disappointed as it was my wife's 50th birthday so i wanted to surprise her"

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If the client hotel had known the customer's expectation in advance, this review could have been avoided. **Figure 25** depicts a service blueprint that the hotel can refer to for improvement. It is a useful tool for businesses to coordinate complex services by bridging the gap between different employees and identifying potential problems along the process ^[13]. In short, the client hotel must not only improve the overall quality of its offerings, but also design personalized services in order to win its guests' devotion.

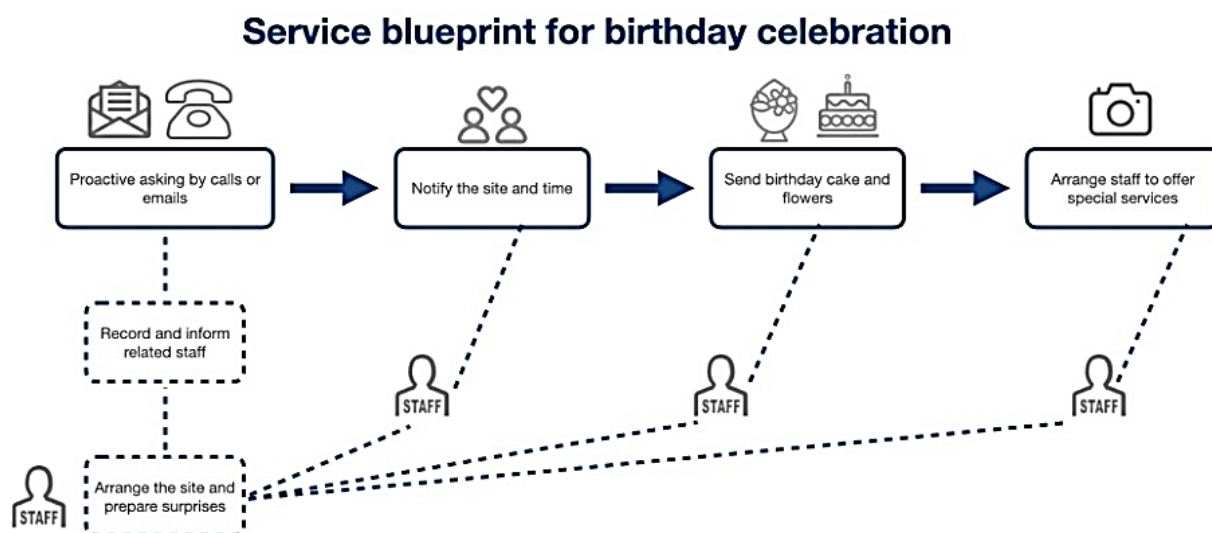


Figure 25. Service blueprint

5. Conclusion

Firstly, the client hotel mainly caters to business people, followed by couples and getaway families. Another niche market – solo travelers – can be further developed by the client hotel to expand its market share. Secondly, the client hotel has encountered a slight rise in customer dissatisfaction. Given the analysis of consumer understanding and performance evaluation, the recommendations of developing varying strategies towards different segments and offering improvements in directions of greater quality and personalization should be taken into consideration but conditional on the budget constraints so as to ensure future success.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Lopez A, 2022, Top Cities for Remote Working Trips Worldwide 2021, viewed April 22, 2022, www.statista.com/statistics/1277710/top-cities-for-remote-workingtrips-worldwide/
- [2] Wade R, 2011, 90 Cities with the Most Hotels around the World, viewed April 22, 2022, www.priceoftravel.com/cities-with-most-hotels
- [3] Christiansen L, 2020, Building an Understanding of Business Operations, viewed April 22, 2022, <https://altametrics.com/business-operations.html>
- [4] Dipanwita B, 2015, Competitive Profile Matrix: A Theoretical Review, viewed April 22, 2022, https://www.researchgate.net/publication/308706961_Competitive_Profile_Matrix_A_Theoretical_R_eview

- [5] Mahmood Sohel S, Atiqur Rahman AM, Uddin MA, 2014, Competitive Profile Matrix (CPM) as a Competitors' Analysis Tool: A Theoretical Perspective. *International Journal of Human Potential Development*, 3(1): 40–47.
- [6] Chiang IP, Lin CY, Wang KM, 2008, Building Online Brand Perceptual Map. *Cyberpsychol Behav*, 11(5): 607–610.
- [7] Klook Travel, 2019, viewed April 22, 2022, www.klook.com/newsroom/content/6388?n=0
- [8] Dietrich G, Livingston G, 2012, *Marketing in the Round: How to Develop an Integrated Marketing Campaign in the Digital Era*, Que Publishing, Seattle.
- [9] Cai LA, Perry Hobson JS, 2004, Making Hotel Brands Work in a Competitive Environment. *Journal of Vacation Marketing*, 10(3): 197–208.
- [10] Alberto, 2021, The Risk of Repositioning a Brand, viewed April 22, 2022, <https://www.marketingtraslasalmenas.com/en/2021/04/09/brand-repositioning-is-not-kids-game/>
- [11] ISB University, 2021, Pink Lemonade: Time to Refresh the Firm's Positioning, viewed April 22, 2022, <https://www.isb.edu/en/research-thought-leadership/research-centres-institutes/centre-for-learning-and-management-practice/management-rethink/management-rethink-volume-2-issue-1/pink-lemonade--time-to--refresh-the-firm-s-positioning.html>
- [12] Parasuraman A, Zeithaml VA, Berry LL, 1985, A Conceptual Model of Service Quality and Its Implications for Future Research. *Journal of Marketing*, 49(4): 41–50. <https://doi.org/10.1177/002224298504900403>
- [13] Gibbons S, 2017, Service Blueprints: Definition, viewed April 22, 2022, <https://www.nngroup.com/articles/service-blueprints-definition/>

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Prediction of Amazon's Stock Price Based on ARIMA, XGBoost, and LSTM Models

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Abstract: Finding the best model to predict the trend of stock prices is an issue that has always garnered attention, and it is also closely related to investors' investment dynamics. Even the commonly used autoregressive integrated moving average (ARIMA), extreme gradient boosting (XGBoost), and long short-term memory (LSTM) have their own advantages and disadvantages. We use mean squared error (MSE) to judge the most suitable model for predicting Amazon's stock price from many aspects and find that LSTM is the model with the best fitting effect and the closest to the real curve. However, the LSTM model still needs to improve in terms of performance so as to reduce the bias. We anticipate the discovery of more models that are apt for predicting stocks in the future.

Keywords: Amazon; ARIMA; XGBoost; LSTM

Online publication: October 21, 2022

1. Introduction

Stocks are indeed fascinating. According to Asness, "A stock, also known as equity, is a security that represents the ownership of a fraction of the issuing corporation ^[1]." The ups and downs of stocks reflect the operations of the capital market. However, there is a misconception that the stock market is the capital market. In addition, the rise and fall of the stock market do not equate with the rise and fall of the real economy. This misunderstanding leads to the idea that the capital market can function better when stocks rise and real enterprises can receive sufficient support to develop. In fact, the stock market is only a part of the capital market; that is to say, the role of the stock market cannot be exaggerated or overlooked. After all, it is the most active part of the capital market. The economic dynamism of the market is boosted when the most dynamic forces come into play. The sharp rise in the stock market proves that the status of the capital market in the financial market is constantly rising.

Besides, the stock market is in a constant change on a daily basis, and the ups and downs of stocks affect the investors. The answer to which why people choose to invest in stocks is as follows: "Stocks offer investors the greatest potential for growth (capital appreciation) over the long haul ^[2]." It is precisely because of the high rate of return that investors increase their investment in stocks. There are different benefits when investing in different stocks, and different investment groups have different definitions of stock returns. Only by being careful in each step of the investment can the investor expect a high return.

Analytically speaking, Amazon's distinct position in the international market is quite representative. The ever-increasing penetration rate of the internet has resulted in an ever-increasing demand for e-commerce. As an early developing e-commerce company, Amazon occupies a dominant position in the

global e-commerce market. Amazon has achieved a monopoly in the industry, and it is often the choice of companies that wish to publish and sell products online. Amazon has received many positive and negative reviews. Some people think that Amazon is a great place to shop online; it has everything one could possibly need; the price is reasonable, and there is quality to the items sold; Amazon is the perfect place to shop online! However, some people think that Amazon has poor ethics in the sense that the goods received do not conform to the advertised ones. The different experiences of shoppers and the comments made on public platforms can affect a company's image, which in turn affects the company's stock.

We first use the most non-complex Fourier transform and average autoregression to observe the basic information of Amazon's stock, followed by autoregressive integrated moving average (ARIMA), extreme gradient boosting (XGBoost), and long short-term memory (LSTM) to estimate the stock. The objective is to determine the best model for predicting Amazon's stock price. We discuss our point of view in two parts: the first part is a review of literature, in which we find the best model by reviewing some relevant information and looking for models that study the stock market for comparison; the second part focuses on describing the experimental results through continuous analysis and comparison of data, concluding and indicating the expectations of the future stock market.

2. Literature review

In order to find the most suitable model to predict Amazon's stock price, we use moving average (MA) and Fourier transform to observe, followed by ARIMA, LSTM, and XGBoost to predict. In 1998, Ho and Xie^[3] studied the approach to repairable system reliability forecasting based on ARIMA. They concluded that the ARIMA model is an alternative that provides satisfactory results for forecasting. In 2019, there was a global outbreak of the coronavirus (COVID-19); Benvenuto *et al.*^[4] used a simple econometric model – ARIMA – to forecast the spread of COVID-19 and the trend of COVID-19's incidence and prevalence. Zhang^[5] proposed an approach that combined both ARIMA and artificial neural network (ANN) models to improve data accuracy, taking advantage of the unique strength of ARIMA and ANN models in linear and nonlinear modeling. Contreras^[6] used ARIMA to predict the next-day electricity prices for maximum benefits. Ariyo^[7] presented the extensive process of the stock price predictive model by using the ARIMA model to analyze the New York Stock Exchange (NYSE) and Nigeria Stock Exchange (NSE); the results showed that the ARIMA model has a strong potential for short-term forecast. Smagulova^[8] investigated an emerging topic that uses a memristor circuit to achieve the hardware acceleration of LSTM because LSTM is a recurrent neural network with a state memory and multilayer cell structure. Gers^[9] focused on LSTM because it has a shorter time lag than RNNs on tasks, making it an accurate measurement or generation of time intervals. Graves^[10] studied the TIMIT speech corpus with bidirectional and unidirectional LSTM networks and found that LSTM outperforms RNNs. Chen^[11] forecasted China's stock returns using the LSTM model, improving its accuracy from 14.3% to 27.2%, and reflecting the potential of the LSTM model for stock price prediction. Fu^[12] used the LSTM and gated recurrent units (GRU) neural network (NN) method to forecast real-time traffic flow and control traffic. As for the XGBoost model, Liao^[13] constructed a dynamic weighting multi-factor stock selection strategy established on the XGBoost model. He used the XGboost machine learning method to forecast the information coefficient (IC) of components, revealing that the XGBoost model is useful for IC coefficient prediction. Basak^[14] used two algorithms, random forests and gradient boosted decision trees, to facilitate the connection of the concerning – whether the stock price will change with respect to the existing price n days earlier. Kumar^[15] used data from Yahoo Finance and several algorithms based on seasonal (S)ARIMA and XGBoost to estimate the value. Gumelar^[16] experimented with about 25 companies to forecast the closing price by using two highly accurate analyses, LSTM and XGBoost, and found that XGBoost has a 99% prediction accuracy. In this study, we use Fourier transform and MA to observe the basic information of Amazon,

followed by ARIMA, LSTM, and XGBoost to estimate the stock price, aiming to determine the most suitable model for predicting Amazon's stock price.

3. Method

3.1. Autoregressive integrated moving average

The ARIMA model was introduced by Box and Jenkins in 1970^[7]. It is one of the most popular methods used for prediction. Also known as the Box-Jenkins method, the ARIMA model consists of a set of activities for identifying, estimating, and diagnosing ARIMA models using time series data. The ARIMA model has shown to be effective for accurate short-term prediction. Its performance in short-term prediction outperforms complex structural models. In the ARIMA model, the value of a variable in the future is a linear combination of past values and past errors, expressed as follows:

$$Y_t = \phi_0 + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \dots + \phi_p Y_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - \dots - \theta_q \varepsilon_{t-q} \quad (1)$$

where Y_t is the actual value and ε_t is the random error at t ; ϕ_i and θ_j are the coefficients, while p and q are integers that are often referred to as autoregressive and moving average, respectively.

3.2. Long short-term memory

At time t , x_t is the input data of the LSTM cell, h_{t-1} is the output of the LSTM cell at the previous moment, c_t is the value of the memory cell, and h_t is the output of the LSTM cell. The calculation process of the LSTM unit can be divided into several steps^[17].

(1) First, calculate the value of the candidate memory cell \tilde{c}_t ; W_c is the weight matrix, and b_c is the bias.

$$\tilde{c}_t = \tanh(W_c \cdot [h_{t-1}, x_t] + b_c) \quad (2)$$

(2) Calculate the value of the input gate i_t ; the input gate controls the update of the current input data to the state value of the memory cell, σ is the sigmoid function, W_i is the weight matrix, and b_i is the bias.

$$i_t = \sigma(W_i \cdot [h_{t-1}, x_t] + b_i) \quad (3)$$

(3) Calculate the value of the forget gate f_t ; the forget gate controls the update of the historical data to the state value of the memory cell, W_f is the weight matrix, and b_f is the bias.

$$f_t = \sigma(W_f \cdot [h_{t-1}, x_t] + b_f) \quad (4)$$

(4) Calculate the value of the current moment memory cell c_t ; c_{t-1} is the state value of the last LSTM unit.

$$c_t = f_t * c_{t-1} + i_t * \tilde{c}_t \quad (5)$$

where $*$ represents the dot product. The update of memory cell depends on the state value of the last cell and the candidate cell, and it is controlled by the input gate and forget gate.

(5) Calculate the value of the output gate o_t ; the output gate controls the output of the state value of the memory cell, W_o is the weight matrix, and b_o is the bias.

$$o_t = \sigma(W_o \cdot [h_{t-1}, x_t] + b_o) \quad (6)$$

(6) Finally, calculate the output of the LSTM unit h_t .

$$h_t = o_t * \tanh c_t \quad (7)$$

Benefitting from the three control gates and memory cell, LSTM store, read, reset, and update long time information easily. It is important to note that the dimensions of the output can be controlled by setting the dimensions of the weight matrix due to the sharing mechanism of the LSTM internal parameters. LSTM establishes a long time-delay between input and feedback. The gradient will neither explode nor disappear because the internal state of the memory cell in this architecture maintains a continuous error flow ^[18].

3.3. Extreme gradient boosting

The XGBoost algorithm is based on gradient boosting decision tree (GBDT) ^[19]. Compared with GBDT, the advantage of XGBoost is that it supports linear classifiers and performs Taylor expansion for the cost function by introducing a second derivative to ensure more accurate results. There principles of XGBoost are discussed below.

The XGBoost model uses additive training method to optimize the objective function, which means the optimization process of the latter step relies on the result of its previous step. The t -th objective function of the model can be expressed as follows:

$$obj^{(t)} = \sum_{i=1}^n l(y_i, \hat{y}_i^{t-1} + f_t(x_i)) + \Omega(f_t) + constant \quad (8)$$

where l represents the loss term of the t -th round, $constant$ represents a constant term, and Ω is the regularization term of the model, shown as follows:

$$\Omega(f_t) = Y \cdot T_t + \lambda \frac{1}{2} \sum_{j=1}^T w_j^2 \quad (9)$$

where both Y and λ are customization parameters. Generally, the larger these two values are, the simpler the structure of the tree is, and the overfitting problem can be solved effectively. Performing a second-order Taylor expansion on (8), the process is given by

$$obj^{(t)} = \sum_{i=1}^n \left[l(y_i, \hat{y}_i^{t-1}) + g_i f_i(x_i) + \frac{1}{2} h_i f_i^2(x_i) \right] + \Omega(f_t) + constant \quad (10)$$

where g is the first derivative, and h is the second derivative. They can be described as follows:

$$g_i = \partial_{\hat{y}_i^{t-1}} l(y_i, \hat{y}_i^{t-1}) \quad (11)$$

$$h_i = \partial_{\hat{y}_i^{t-1}}^2 l(y_i, \hat{y}_i^{t-1}) \quad (12)$$

Substitute (9), (11), and (12) into (10), and take the derivative. Then, solutions can be obtained from (13) and (14) as follows:

$$w_j^* = -\frac{\sum g_i}{\sum h_i + \lambda} \quad (13)$$

$$obj^* = -\frac{1}{2} \sum_{j=1}^T \frac{(\sum g_i)^2}{\sum h_i + \lambda} + \gamma \cdot T \quad (14)$$

where obj^* represents the score of loss function; the smaller the score, the better the structure of the tree. w_j^* refers to the solution of weights.

4. Experiment and analysis

With the goal of finding the best model for predicting Amazon's stock price, MA and Fourier transform were first applied to observe the basic information of Amazon.

We extracted yearly historical Amazon stock price from 2010 to 2019 from Yahoo Finance, including its open price, high price, low price, closing price, *etc.* Then, we selected its closing price and drew a broken line chart to observe its rising and falling trends. In **Figure 1**, we can see that the closing price of Amazon's stock remained at about 250 USD and gradually rose with small fluctuations from 2010 to 2013. Amazon's "online retail" has achieved success at that time, and its profit growth and valuation have continued to improve since then. Since 2014, its closing price has seen a rapid increase, reaching nearly 1,000 USD in 2018, but with significant fluctuations. In less than a year from 2018, the closing price of Amazon's stock jumped from less than 1,000 USD to about 2,000 USD; it then fell sharply to about 1,500 USD in 2019 after reaching a peak. Amazon is the largest online e-commerce company in the United States. With the increase in demand for online shopping in the United States and the good e-commerce shopping experience provided by Amazon, the development of its e-commerce scale still maintains a relatively high growth. Additionally, its business scale continues to expand; this is one of the main reasons for the rise of its stock price. Taking April 20, 2016, as the boundary, the data is divided into two subsets: training and test datasets (**Figure 1**).

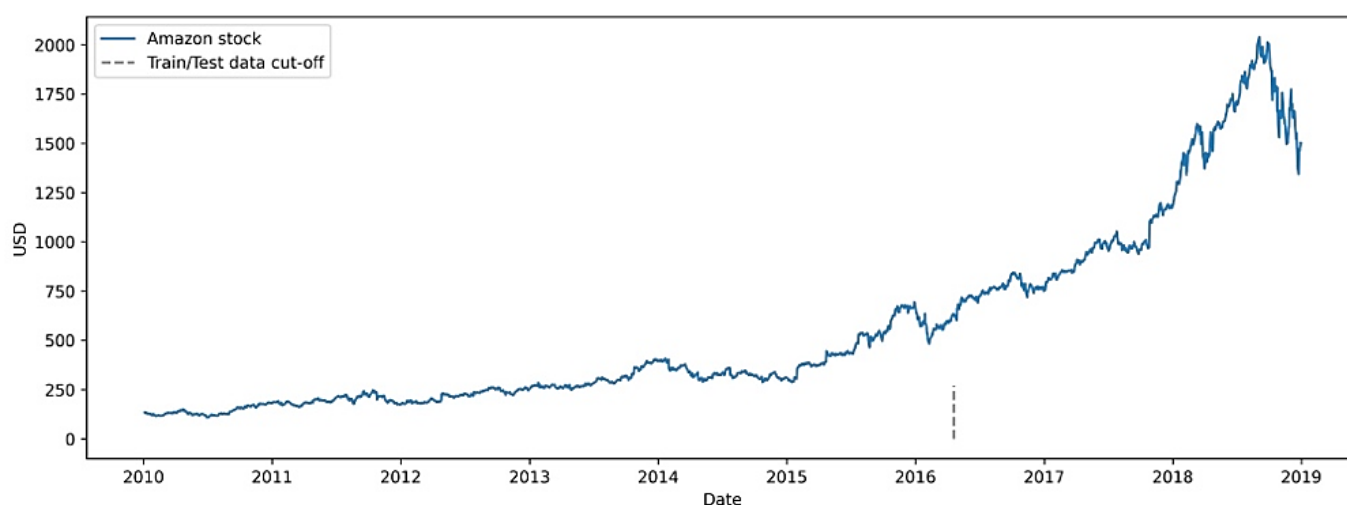


Figure 1. Amazon's stock price

MA7, MA21, Closing Price, Upper Band, and Lower Band are used as technical indicators for stock forecasting from 1850 to 2250, as shown in **Figure 2**. We set two moving averages with different calculation days, 7 days and 21 days, to understand the overall operating trend of the stock price from different periods. From **Figure 2**, we can see that the trend of MA7 and MA21 is consistent with the Closing Price, staggered with it many times, and fluctuates between the Upper Band and Lower Band. From 1970 to around 2200, the Closing Price, MA7, and MA21 increased significantly, but decreased after reaching a peak in 2200.

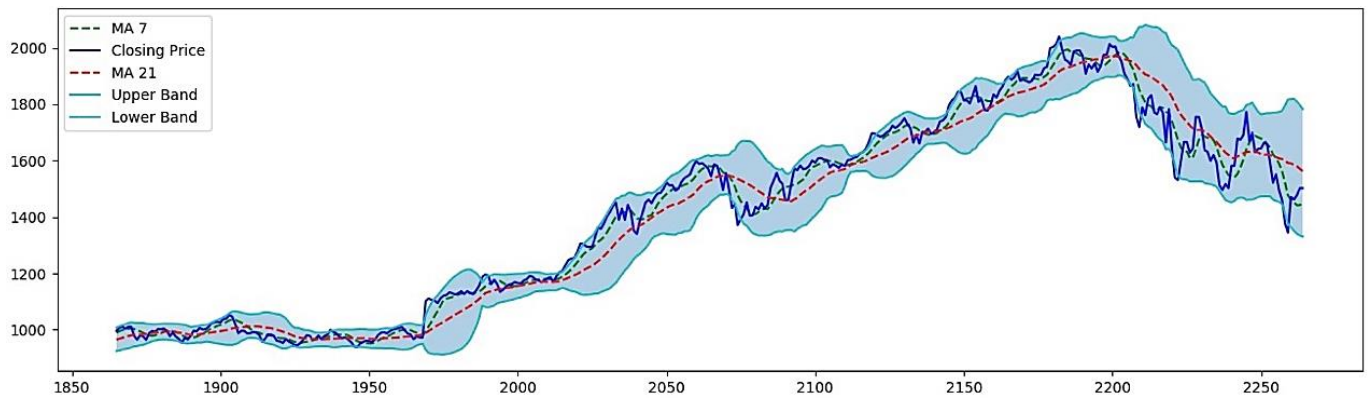


Figure 2. Technical indicators for Amazon – last 400 days

Using momentum and moving average convergence/divergence (MACD), we measured the rate of change of Amazon's stock price during this period and reflected it directly in **Figure 3**. Two green horizontal dotted lines are marked in **Figure 3** at positions 15 and -15. It can be seen that the trend of Momentum is stable, fluctuating up and down around the green horizontal dotted line at 15. Momentum can be seen to be slightly lower than the green horizontal dotted line at 15 between 1850–2050. It then overlaps with the green horizontal dotted line at 15 between 2050. After 2110, Momentum can be seen to be slightly above the green horizontal dotted line at 15 before overlapping the line again around 2210. It can be seen that MACD (green dash-dotted line) fluctuates greatly between the green horizontal dotted line at 15 and -15 in 1850–1970, with a relatively stable trend. The majority of MACD are above the green horizontal dotted line at 15 in 1970–2200, resulting in several rises with large fluctuations, but there is a lower trend from 2200–2260.

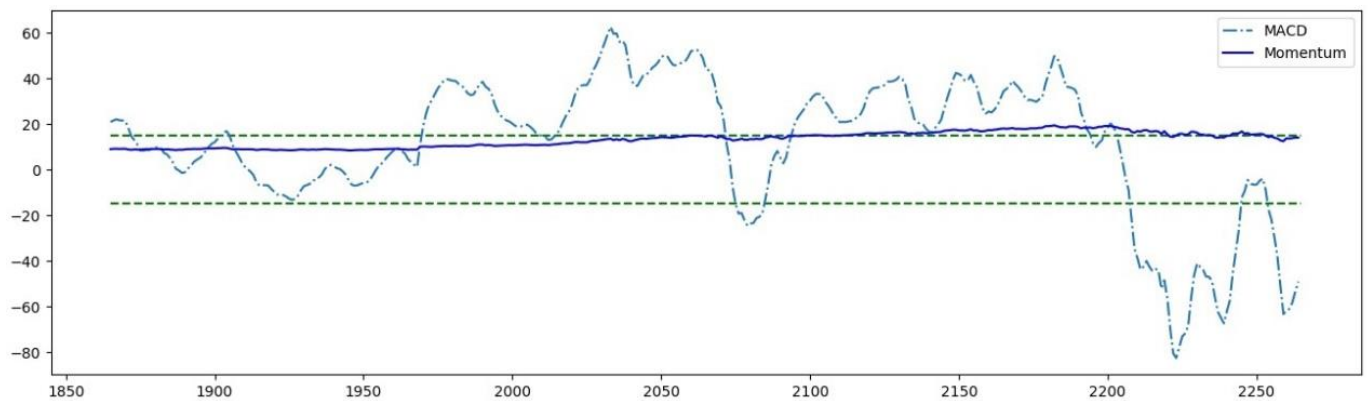


Figure 3. MACD

Historical stock price is a large number of noisy data. Stock price changes on a daily basis, and not every indicator can be used to predict the stock market. Therefore, we use Fourier transform to remove the noise in the original data. In order to see the denoising effect from an intuitive perspective, we collected 2,000 days of Amazon's daily closing price data, as shown by the purple curve in **Figure 4**.

We then use Fourier transform with 3, 6, 9, and 100 components and compare the curve with the real price, as shown in **Figure 4**. With the increase of components, we can see that the curve, after noise filtering, is more consistent with the real data trend, such as the Fourier transform with 100 components represented by the red curve.

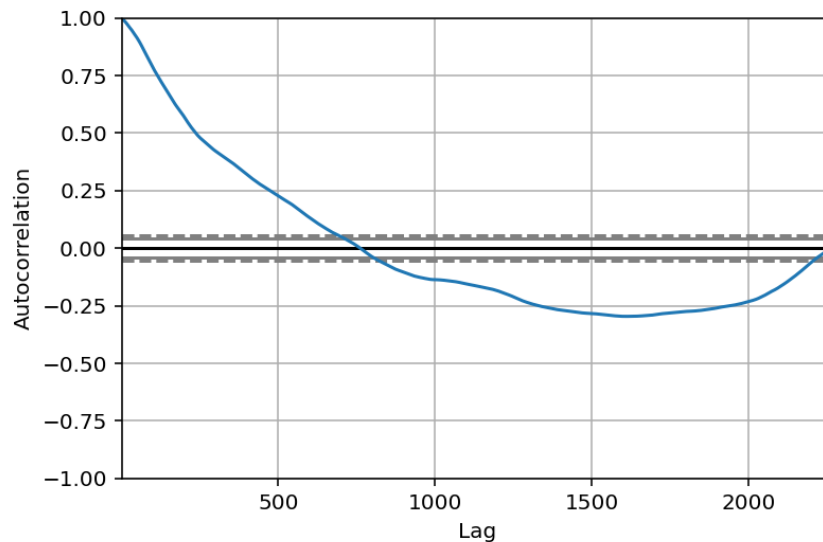


Figure 4. Amazon's (closing) stock price and Fourier transforms

In the experiment, we use three prediction methods: ARIMA, XGBoost, and LSTM. By comparing the MSE obtained, we can judge the accuracy of the model in predicting Amazon's stock price.

We match ARIMA to the entire dataset and check the residuals. Built in Panda, according to its autocorrelation diagram, as shown in **Figure 5**, we can see a positive correlation with the first 500–700 lags and a negative correlation with the first 700–2000 lags. Therefore, a good starting point for the model parameter AR can be 5. Here, ARIMA(5,1,0) model is applied. This sets the lag value to 5 for AR, utilizes a difference order of 1 to make the time series stationary, and uses a MA model of 0. When fitting the model, it provides a lot of debugging information about the fitting of the linear regression model. Turn it off by setting the DISP parameter to 0.

Briefly, we fit the ARIMA(5, 1, 0) model, with conditional sum-of-squares (CSS) as the fitting method, and Akaike information criterion (AIC) and Bayesian information criterion (BIC) as the model parameters.

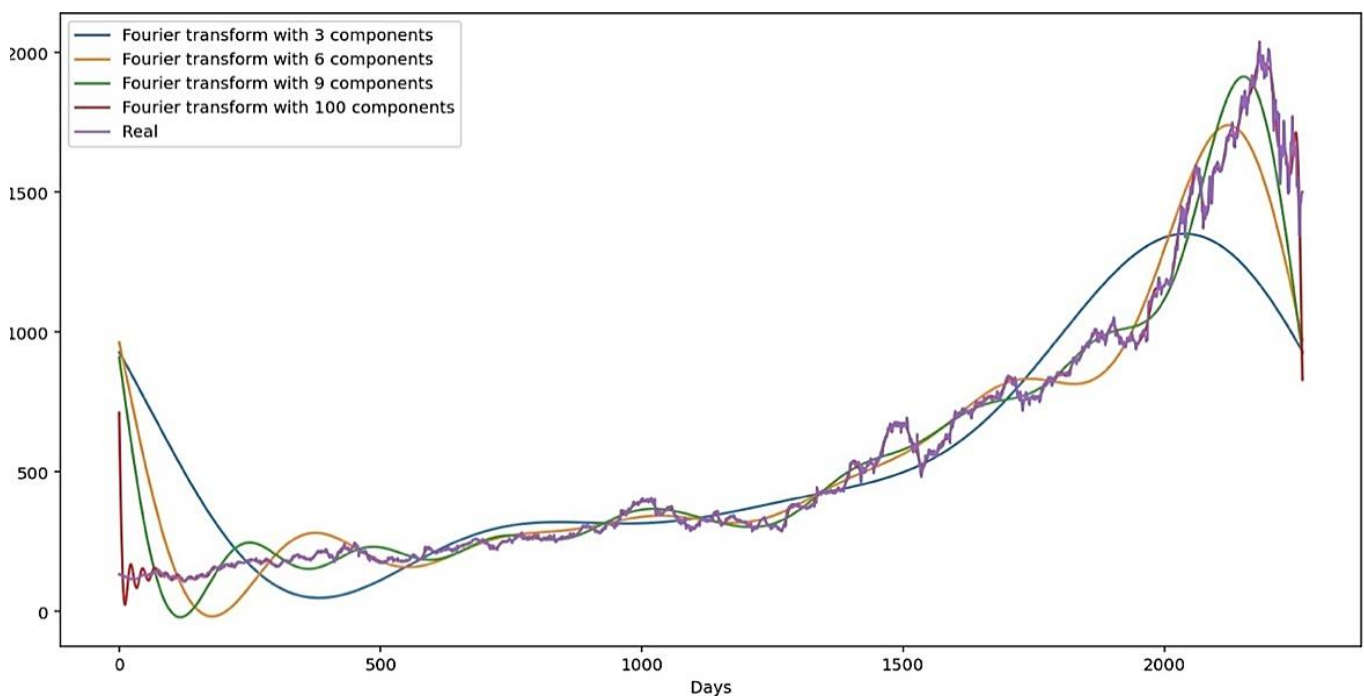


Figure 5. Autocorrelation of Amazon's closing stock price

The algorithm forecasts the expected value (\hat{y}), adds \hat{y} to the prediction data structure, and then adds the actual value to the test set for model refining and re-fitting. Eventually, having built the prediction and history data structures, the final output test MSE value is 557.865. Compared with the actual price, the predicted line chart of Amazon's stock price is drawn, as shown in **Figure 6**. We can see that the predicted value of the model is close to the actual value, and the model fitting effect is good.

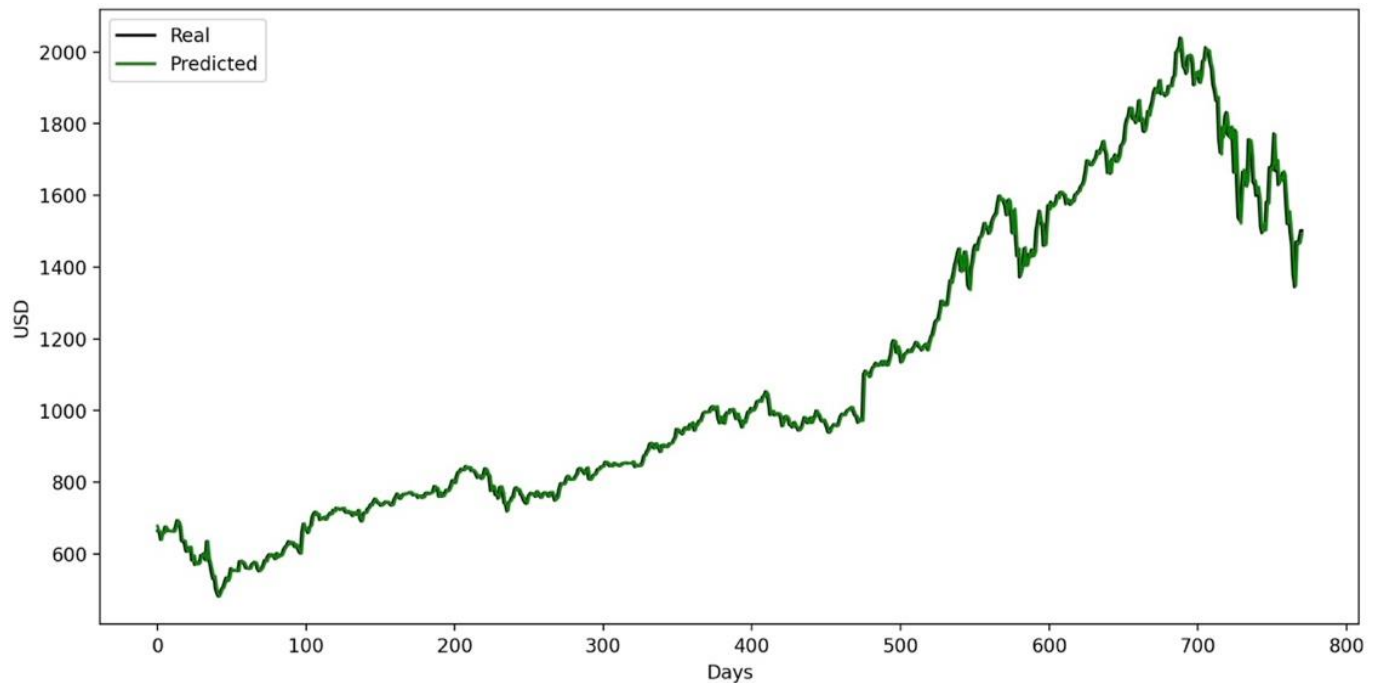


Figure 6. ARIMA model on Amazon's stock

In order to evaluate the model performance accurately, the data is divided into a training set and a validation set. By calculating the training set and the validation set, the data respective are obtained. The XGBoost parameters are as follows: $\gamma = 0.0$, $n_estimators = 200$, $base_score = 0.7$, $colsample_bytree = 1$, and $learning_rate = 0.05$. We then obtain the root mean squared error (RMSE) of the training set and validation set, respectively. With the increasing number of iterations, the RMSE of the training set gradually approaches 0, while the RMSE of the validation set gradually approaches 600.

We applied a stacked LSTM model. The loss of the model training process (on the training set) is continuously optimized as the training process advances. The initial optimization and loss decrease rapidly, and then gradually stabilize. From the running results of the code, the MSE of the training set reduced to 0.0524, while that of the verification set reduced to 0.0514, as shown in **Table 1**.

Table 1. MSE in LSTM model

Epochs	MSE training/validation
10	0.0614 / 0.0598
30	0.0591 / 0.0586
60	0.0569 / 0.0560
80	0.0546 / 0.0533
97	0.0524 / 0.0523
99	0.0529 / 0.0514

By observing the MSE, we can see the performance of the LSTM model. Compared with the training set, the effect on the test set is slightly biased, but the overall trend is still well predicted.

Three prediction methods are used in total, and the MSE obtained is summarized in **Table 2**. It is evident that MSE is much smaller than ARIMA and XGBoost when the LSTM model is used to predict Amazon's stock price. It is clear that the LSTM model has obvious advantages in meeting our demand for forecasting Amazon's stock price.

Table 2. MSE of three models

Model	MSE
ARIMA	557.865
XGBoost	360,000
LSTM	0.0514

5. Conclusion

By looking at Amazon's stock using a simple data model and comparing the three models, the following conclusions can be drawn.

First of all, the stock trends and closing price curves of MA7 and MA21 learned in two-calculation days are basically the same. Secondly, using the stock change rate observed by Momentum and MACD, it is found that Momentum tends to be stable but MACD has several large fluctuations. Third, after denoising with Fourier transform, with the increase of components, the denoised curve is more consistent with the curve of the real data. By comparing the three models – ARIMA, XGBoost, and LSTM – the MSE is obtained to judge the stock price accuracy. The final comparison shows that LSTM is the best model for predicting Amazon's stock price. In order to evaluate the MSE model performance, we split the data into a training set and a validation set. When using the LSTM model to predict Amazon's stock price, MSE is much smaller than ARIMA and XGBoost.

When looking at the performance of the LSTM model, although the impact on the test set is slightly skewed compared to the training set, the overall trend is still very predictable. In the future, this model can be further studied, which would be a good research direction for predicting stock prices and understanding the stock market.

Disclosure statement

The authors declare no conflict of interest.

Author contributions

Z.Z. conceived the idea of the study, and K.H. performed the experiments.

References

- [1] Asness CS, Frazzini A, Pedersen LH, 2012, Leverage Aversion and Risk Parity. *Financial Analysts Journal*, 68(1): 47–59.
- [2] Qin J, Tao Z, Huang S, et al., 2021, Stock Price Forecast Based on ARIMA Model and BP Neural Network Model. 2021 IEEE 2nd International Conference on Big Data, Artificial Intelligence and Internet of Things Engineering (ICBAIE), IEEE, 426–430.
- [3] Ho SL, Xie M, 1998, The Use of ARIMA Models for Reliability Forecasting and Analysis. *Computers &*

Industrial Engineering, 35(1–2): 213–216.

- [4] Benvenuto D, Giovanetti M, Vassallo L, et al., 2020, Application of the ARIMA Model on the COVID-2019 Epidemic Dataset. *Data in Brief*, 29: 105340.
- [5] Zhang GP, 2003, Time Series Forecasting Using a Hybrid ARIMA and Neural Network Model. *Neurocomputing*, 50: 159–175.
- [6] Contreras J, Espinola R, Nogales FJ, et al., 2003, ARIMA Models to Predict Next-Day Electricity Prices. *IEEE Transactions on Power Systems*, 18(3): 1014–1020.
- [7] Ariyo AA, Adewumi AO, Ayo CK, 2014, Stock Price Prediction Using the ARIMA Model. 2014 UKSim-AMSS 16th International Conference on Computer Modelling and Simulation, IEEE, 106–112.
- [8] Smagulova K, James AP, 2019, A Survey on LSTM Memristive Neural Network Architectures and Applications. *The European Physical Journal Special Topics*, 228(10): 2313–2324.
- [9] Gers FA, Schraudolph NN, Schmidhuber J, 2002, Learning Precise Timing with LSTM Recurrent Networks. *Journal of Machine Learning Research*, 3: 115–143.
- [10] Graves A, Fernandez S, Schmidhuber J, 2005, Bidirectional LSTM Networks for Improved Phoneme Classification and Recognition. *International Conference on Artificial Neural Networks*, Springer, 799–804.
- [11] Chen K, Zhou Y, Dai F, 2015, A LSTM-Based Method for Stock Returns Prediction: A Case Study of China Stock Market. 2015 IEEE International Conference on Big Data (Big Data), IEEE, 2823–2824.
- [12] Fu R, Zhang Z, Li L, 2016, Using LSTM and GRU Neural Network Methods for Traffic Flow Prediction. 2016 31st Youth Academic Annual Conference of Chinese Association of Automation (YAC), IEEE, 324–328.
- [13] Liao J, Zhang R, 2018, Dynamic Weighting Multi Factor Stock Selection Strategy Based on XGBoost Machine Learning Algorithm. 2018 IEEE International Conference of Safety Produce Informatization (IICSPI), IEEE, 868–872.
- [14] Basak S, Kar S, Saha S, et al., 2019, Predicting the Direction of Stock Market Prices Using Tree-Based Classifiers. *The North American Journal of Economics and Finance*, 47: 552–567.
- [15] Kumar DS, Thiruvarangan BC, Vishnu A, et al., 2022, Analysis and Prediction of Stock Price Using Hybridization of SARIMA and XGBoost. 2022 International Conference on Communication, Computing and Internet of Things (IC3IoT), IEEE, 1–4.
- [16] Gumelar AB, Setyorini H, Adi DP, et al., 2020, Boosting the Accuracy of Stock Market Prediction using XGBoost and Long Short-Term Memory. 2020 International Seminar on Application for Technology of Information and Communication (iSemantic), IEEE, 609–613.
- [17] Cao J, Li Z, Li J, 2019, Financial Time Series Forecasting Model Based on CEEMDAN and LSTM. *Physica A: Statistical Mechanics and Its Applications*, 519: 127–139.
- [18] Jiang H, He Z, Ye G, et al., 2020, Network Intrusion Detection Based on PSO-XGBoost Model. *IEEE Access*, 8: 58392–58401.
- [19] Ma X, Sha J, Wang D, et al., 2018, Study on a Prediction of P2P Network Loan Default Based on the Machine Learning LightGBM and XGBoost Algorithms According to Different High Dimensional Data Cleaning. *Electron Commerce Res Appl*, 31: 24–39.

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Exploring Apple's Stock Price Volatility Using Five GARCH Models

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Abstract: The financial market is the core of national economic development, and stocks play an important role in the financial market. Analyzing stock prices has become the focus of investors, analysts, and people in related fields. This paper evaluates the volatility of Apple Inc. (AAPL) returns using five generalized autoregressive conditional heteroskedasticity (GARCH) models: sGARCH with constant mean, GARCH with sstd, GJR-GARCH, AR(1) GJR-GARCH, and GJR-GARCH in mean. The distribution of AAPL's closing price and earnings data was analyzed, and skewed student t-distribution (sstd) and normal distribution (norm) were used to further compare the data distribution of the five models and capture the shape, skewness, and loglikelihood in Model 4 – AR(1) GJR-GARCH. Through further analysis, the results showed that Model 4, AR(1) GJR-GARCH, is the optimal model to describe the volatility of the return series of AAPL. The analysis of the research process is both, a process of exploration and reflection. By analyzing the stock price of AAPL, we reflect on the shortcomings of previous analysis methods, clarify the purpose of the experiment, and identify the optimal analysis model.

Keywords: Financial market; Stock price; Volatility; GARCH model

Online publication: October 21, 2022

1. Introduction

The stock market plays an important role in finance. In recent years, the rapid development of the stock market has concerned everyone related. It is imperative for investors and analysts to pay attention to the stock market because the fluctuation of stock prices directly affect income. In addition, the stock market also improves the flow of funds, helps solve financing problems, and provides more convenience for investors. Demircuc-Kunt and Levine emphasized that the international integrated stock market can disperse risks and promote economic growth ^[1]. The financial market of every country has a close relationship with the financial system of the United States. Taking Apple Inc., a large and successful modern company, as an example, the stock price changes of Apple Inc. reflect the development of the company and its partner companies. Investors and market participants will always pay attention to the stock fluctuations of Apple Inc., and the investment results are closely related to the stock market changes. Since the volatility of the stock is unclear, it is necessary to use relevant data analysis technology to calculate and analyze its model to present intuitive and understandable data to its investors and market participants. Therefore, it is necessary to apply statistics, modeling, and other technologies to it.

This paper comprises five sections. The first section is the introduction, which includes the background and reasons for the research. The second section is a literature review, where we discuss the contributions made by scientists in the past to our research field and the shortcomings in the analysis of stock price data in recent years. The third section describes our research methods. The fourth section is a detailed analysis and discussion of the experimental results. The last section concludes the paper. We were able to achieve the aim of the experiment and reach a deeper conclusion.

2. Literature review

Apple Inc. has been regarded as the most innovative technology company in the world over the past three decades ^[2]. In 2007, the stock price of Apple Inc. reached 200 dollars ^[3]. As of June 2015, Apple Inc. had been the largest listed company by market capitalization. In the past, many scholars have made many contributions to predicting stock prices. Mohan and Mullapudi studied deep learning models by gathering large sets of time series data and analyzing them to improve the accuracy of stock prices ^[4]. In order to obtain a better result on forecasting, Jeong took Apple's stock as a sample by using autoregressive integrated moving average (ARIMA) and seasonal autoregressive integrated moving average with exogenous regressors (SARIMAX) models ^[5]. Kim and Jun used a method that compared different time series models to determine the best time series model for predicting Apple's stock, and they concluded that the most appropriate one is IN-ARCH ^[6]. Silvennoinen and Teräsvirta also used a similar method; when surveying the MARCH, they made different generalized autoregressive conditional heteroskedasticity (GARCH) models that fit the same data and compared the result ^[7]. Ding and Zhang studied using Open Information Extraction (Open IE) techniques to withdraw the structured events from online data ^[8].

Recently, many scholars have taken an interest in GARCH comparison field study. Sharma *et al.* investigated five major emerging countries' volatility of financial markets by using univariate volatility models covering GARCH 1, 1, Exponential Generalized Autoregressive Conditional Heteroscedasticity (E-GARCH 1, 1) and Threshold Generalized Autoregressive Conditional Heteroscedasticity (T-GARCH-1, 1) models; they found that GARCH (1, 1) model is superior to nonlinear GARCH models on predicting volatility ^[9]. The study filled the gap on the choice of forecasting market volatility by linear versus nonlinear models. Ampountolas evaluated various traditional time series forecasting performance models for daily hotel demand at multiple horizons, achieved a stable forecast by comparing the different time series models, and eventually chose a suitable one to predict the daily hotel demand ^[10]. Fałdziński *et al.* took the forecasting performance of GARCH-type models and support vector regression (SVR) for futures contracts of selected energy commodities into comparison and found that SVR has a lower forecast error ^[11]. Several researchers modelled cryptocurrencies volatility by using GARCH models and carried out a comparison based on normal and student's t-error distribution ^[12]. The study not only identified the high volatility of cryptocurrency price volatility, but also obtained a better GARCH fitting model using an efficient measurement error distribution technique. Lee and Lee considered score vector and residual as the basis of cumulative sum (CUSUM) tests; they compared their performance and found that the standardized residual-based CUSUM is generally better than the other tests ^[13]. Their study is of great importance in internal risk modeling and regulatory oversight; it even strengthens the confidence in global precious metal investments. Even with the numerous achievements presented by previous researchers, there are still existing gaps. This study aimed to identify the most appropriate models among the time series models that can forecast volatility. Hence, we used the data of Apple Inc. for design comparison of GJRARCH and sGARCH models.

3. Method

3.1. GJR-GARCH

Letting $\delta = 2$ yields the Glosten-Jagannathan-Runkle GARCH (GJRGARCH) model, which attempts to address volatility clustering in the innovation process.

When $\delta = 2$ and $0 \leq \gamma_i < 1$,

$$\sigma_t^2 = \omega + \sum_{i=1}^p \alpha_i (|\varepsilon_{t-i}| - \gamma_i \varepsilon_{t-i})^2 + \sum_{j=1}^q \beta_j \sigma_{t-j}^2 \quad (1)$$

$$= \omega + \sum_{i=1}^p \alpha_i (|\varepsilon_{t-i}|^2 + \gamma_i^2 \varepsilon_{t-i}^2 - 2\gamma_i |\varepsilon_{t-i}| \varepsilon_{t-i}) + \sum_{j=1}^q \beta_j \sigma_{t-j}^2 \quad (2)$$

$$\sigma_t^2 = \begin{cases} \omega + \sum_{i=1}^p \alpha_i^2 (1 + \gamma_i)^2 \varepsilon_{t-i}^2 + \sum_{j=1}^q \beta_j \sigma_{t-j}^2, & \varepsilon_{t-i} < 0 \\ \omega + \sum_{i=1}^p \alpha_i^2 (1 - \gamma_i)^2 \varepsilon_{t-i}^2 + \sum_{j=1}^q \beta_j \sigma_{t-j}^2, & \varepsilon_{t-i} > 0 \end{cases} \quad (3)$$

$$\sigma_t^2 = \omega + \sum_{i=1}^p \alpha_i (1 - \gamma_i)^2 \varepsilon_{t-i}^2 + \sum_{i=1}^p \alpha_i \{(1 + \gamma_i)^2 - (1 - \gamma_i)^2\} S_i^- \varepsilon_{t-i}^2 + \sum_{j=1}^q \beta_j \sigma_{t-j}^2 \quad (4)$$

$$\sigma_t^2 = \omega + \sum_{i=1}^p \alpha_i (1 - \gamma_i)^2 \varepsilon_{t-i}^2 + \sum_{j=1}^q \beta_j \sigma_{t-j}^2 + \sum_{i=1}^p 4\alpha_i \gamma_i S_i^- \varepsilon_{t-i}^2 \quad (5)$$

where

$$S_i^- = \begin{cases} 1 & \text{if } \varepsilon_{t-i} < 0 \\ 0 & \text{if } \varepsilon_{t-i} \geq 0 \end{cases}$$

Also, define

$$\alpha_i^* = \alpha_i (1 - \gamma_i)^2 \text{ and } \gamma_i^* = 4\alpha_i \gamma_i \quad (6)$$

then,

$$\sigma_t^2 = \omega + \sum_{i=1}^p \alpha_i^* \varepsilon_{t-i}^2 + \sum_{j=1}^q \beta_j \sigma_{t-j}^2 + \sum_{i=1}^p \gamma_i^* S_i^- \varepsilon_{t-i}^2 \quad (7)$$

This is the GJR-GARCH model ^[14].

However, when $-1 \leq \gamma_i < 0$, then recall equation (1).

$$\alpha_t^2 = \omega + \sum_{i=1}^p \alpha_i (|\varepsilon_{t-i}| - \gamma_i \varepsilon_{t-i})^2 + \sum_{j=1}^q \beta_j \sigma_{t-j}^2 \quad (8)$$

$$\alpha_t^2 = \begin{cases} \omega + \sum_{i=1}^p \alpha_i^2 (1 - \gamma_i)^2 \varepsilon_{t-i}^2 + \sum_{j=1}^q \beta_j \sigma_{t-j}^2, & \varepsilon_{t-i} > 0 \\ \omega + \sum_{i=1}^p \alpha_i^2 (1 + \gamma_i)^2 \varepsilon_{t-i}^2 + \sum_{j=1}^q \beta_j \sigma_{t-j}^2, & \varepsilon_{t-i} < 0 \end{cases} \quad (9)$$

$$\begin{aligned} \alpha_t^2 = & \omega + \sum_{i=1}^p \alpha_i (1 + \gamma_i)^2 \varepsilon_{t-i}^2 + \sum_{j=1}^q \beta_j \sigma_{t-j}^2 + \sum_{i=1}^p \alpha_i \{(1 + \gamma_i)^2 - (1 - \gamma_i)^2\} S_i^+ \varepsilon_{t-i}^2 \\ & + \sum_{i=1}^p \alpha_i \{1 + \gamma_i^2 - 2\gamma_i - 1 - \gamma_i^2 - 2\gamma_i\} S_i^+ \varepsilon_{t-i}^2 \end{aligned} \quad (10)$$

where

$$S_i^+ = \begin{cases} 1 & \text{if } \varepsilon_{t-i} > 0 \\ 0 & \text{if } \varepsilon_{t-i} \leq 0 \end{cases}$$

Also, define

$$\alpha_i^* = \alpha_i (1 + \gamma_i)^2 \text{ and } \gamma_i^* = -4\alpha_i \gamma_i \quad (11)$$

then,

$$\alpha_t^2 = \omega + \sum_{i=1}^p \alpha_i^* \varepsilon_{t-i}^2 + \sum_{j=1}^q \beta_j \sigma_{t-j}^2 + \sum_{i=1}^p \gamma_i^* S_i^+ \varepsilon_{t-i}^2 \quad (12)$$

This allows positive shocks to have a stronger effect on volatility than negative shocks ^[15]. However, when $p = q = 1$, the GJGARCH(1,1) model will be written as follows:

$$\alpha_t^2 = \omega + \alpha \varepsilon_t^2 + \gamma S_1 \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \quad (13)$$

3.2. sGARCH

Standard Generalized AutoRegressive Conditional Heteroskedasticity (sGARCH) has a moving average (MA) part and an autoregressive (AR) part, which are mergers by GARCH, an extension of the ARCH model.

Define the GARCH (p,q) model as follows:

$$X_t = \sigma_t \varepsilon_t \quad (14)$$

$$\sigma_t^2 = \omega + \sum_{i=1}^p \alpha_i x_{t-1}^2 + \sum_{j=1}^q \beta_j \sigma_{t-j}^2 \quad (15)$$

where $\omega > 0, \alpha_i > 0, \beta_j > 0, \sum_{i=1}^p \alpha_i + \sum_{j=1}^q \beta_j < 1$. ϵ_t is a separate but identical sequence. For ease of processing, the order of all GARCH models used will be limited to one.

The standard GARCH model ^[16], represented as sGARCH(1,1), is given as follows:

$$\sigma_t^2 = \omega + \alpha_1 \epsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 \quad (16)$$

4. Empirical analysis

Figure 1 shows the closing price of Apple Inc. (AAPL) from January 2, 2008, to April 11, 2022. The fluctuations of the closing price and the turnover volume are clearly indicated in **Figure 1**. The closing price of AAPL showed an upward trend and tended to 165.75, fluctuating up and down. From 2008 to 2018, the closing price showed a relatively low value and a steady upward trend. In 2012, due to some factors, the closing price fell following a rise. From 2014 to the beginning of 2016, it still showed an upward trend, but after that, it began to fluctuate. There was an overall upward trend until 2018. In 2018, it began to rise rapidly, reaching nearly 170, and finally tending to 165.75. From 2020 to 2021, the closing price fluctuated significantly due to the impact of the COVID-19 pandemic, but it still showed an overall upward trend.

The trading volume of Apple Inc. is shown at the bottom of the figure. The trading volume in 2008 was high, but since 2016, the trading volume has been very low, from the initial 3,000 to several hundred(s). With the change in the stock's closing price, the trading volume also changes. Therefore, the trading volume showed a downward trend.



Figure 1. Closing price of Apple Inc. (AAPL)

Figure 2A shows AAPL's histogram of return, while **Figure 2B** shows AAPL.Close of Returns from January 2, 2008, to April 11, 2022. As can be seen from **Figure 2A**, the frequency decreases from 0.00 to positive and negative, respectively; the maximum positive return frequency and maximum negative return frequency can reach up to 1,500 and 1,000, respectively. The positive returns were greater than the negative returns, indicating that the company is profitable and ideal.

Figure 2B shows the curve of distribution density, the changing trend of the data set, and the normal distribution curve. As can be seen from **Figure 2B**, the highest values of the blue bar chart and the green curve appear on the right side of the 0.00 returns, which again suggest that AAPL is profitable. The red curve is a normal distribution curve. Compared with the red curve, the green curve is more consistent with the density of the data set distribution and is also approximately symmetrical.

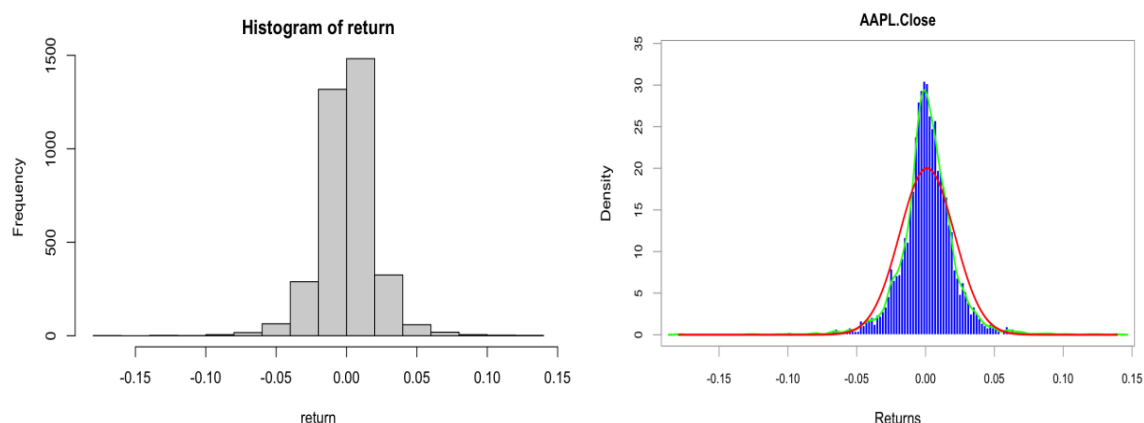


Figure 2. Histogram of return and AAPL close

Figure 3 shows the frequency range of return fluctuation around 0.00 from January 2, 2008, to April 11, 2022. Based on **Figure 3**, there was a maximum fluctuation in 2008, with a fluctuation range of nearly 0.3. The reason for that was the financial crisis, which brought a huge impact not only on the world economy, but also on Apple Inc. After that, the income fluctuation saw a gradual decrease, in which the fluctuation range was around 0.15. Until the middle of 2012, due to the influence of some factors, the fluctuation range slightly increased to 0.2, then gradually decreased and fluctuated in a small range. In 2020, the frequency of income fluctuation increased again. Although the range of fluctuation was small compared with that of 2008, it was the largest one in recent years. Affected by COVID-19, the world economy has been in turmoil and recession, ensuing a great fluctuation in the company's return frequency. Until 2022, Apple Inc.'s earnings fluctuated slightly, but the last was -0.0255.

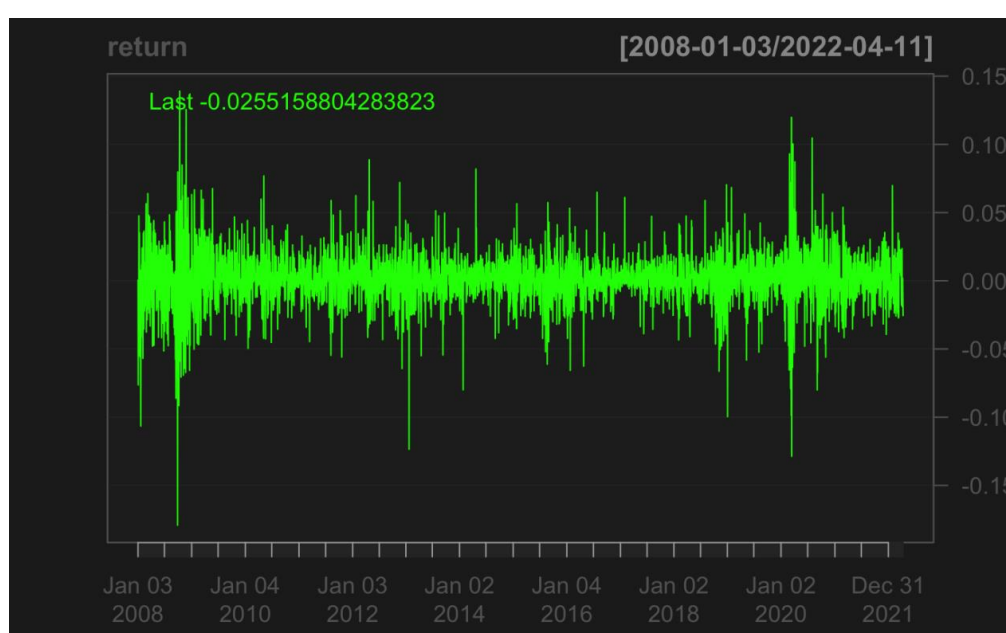


Figure 3. Returns of AAPL

Figure 4 shows Apple Inc.'s yearly rolling volatility from January 2, 2008, to April 11, 2022. It reflects the average fluctuation degree of AAPL price within one year. As can be seen in **Figure 4**, the rolling volatility showed a downward trend since 2008; thereafter, there was a sharp drop below 0.3 in 2009. These were the result of the financial crisis in 2008, in which the global economy was affected, and international trade declined. From 2010 to 2013, there was little volatility, and there was an overall upward trend, rising to above 0.3. However, at the beginning of 2014, the rolling volatility dropped again, and the decline was smaller than that in 2018, maintaining between 0.2 and 0.3. Until January 2017, the volatility dropped to 0.2, but it subsequently rose to more than 0.2 at the beginning of 2018, reaching more than 0.3 in 2019. However, the outbreak of the novel coronavirus has brought another great impact on the world economy. Therefore, as shown in the figure, we can see the significant fluctuations at the end of 2020, ranging from about 0.45 to 0.25.



Figure 4. Apple Inc.'s yearly rolling volatility

Table 1 shows the results of the maximum likelihood estimate (MLE) of sGARCH with constant mean, GARCH with sstd, GJR-GARCH, AR(1) GJR-GARCH, and GJR-GARCH in mean models for Apple Inc.'s returns. Model 1 uses normal distribution (norm), whereas Models 2, 3, 4, and 5 use skewed student t-distribution (sstd). From **Table 1**, the loglikelihood value (9605.649) is the maximum for Model 4 – AR(1) GJR-GARCH. When the skew is greater than 0, it indicates that the shape of the model distribution is right biased; when the skew is equal to 0, it indicates a normal distribution. When the shape is greater than 3, it indicates a spike, but when the shape is equal to 3, it indicates a normal distribution. The shape (5.448357) is the maximum and the skew (1.002632) is relatively low for Model 4 – AR(1) GJR-GARCH. These results indicate that Model 4, AR(1) GJR-GARCH, is the optimal model to describe the volatility of the return series of Apple Inc.

Table 1. Results of the maximum likelihood estimate (MLE) of sGARCH with constant mean, GARCH with sstd, GJR-GARCH, AR(1) GJR-GARCH, and GJR-GARCH in mean

Model	sGARCH with constant mean	GARCH with sstd	GJR-GARCH	AR(1) GJR- GARCH	GJR-GARCH in mean
ω	0.000015**	0.000008	0.000011***	0.000011***	0.000011***
α	0.111926***	0.101071***	0.034580***	0.033869***	0.034613***
β	0.848943***	0.882488***	0.863740***	0.863450***	0.863350***
γ	--	--	0.156976***	0.158980***	0.157047***
Skew	--	1.008920	1.002508	1.002632	1.002682
Shape	--	5.018493	5.423806	5.448357	5.425795
Loglikelihood	9425.7	9575.31	9605.39	9605.649	9605.395

Note: *The value of PR is less than 0.1; **the value of PR is less than 0.05; ***the value of PR is less than 0.01

5. Conclusion

We studied the volatility of AAPL's returns from January 2, 2018 to April 11, 2022. The results of the statistical properties revealed that the return of AAPL is leptokurtic and rightward. Five different GARCH type models (sGARCH with constant mean, GARCH with sstd, GJR-GARCH, AR(1) GJR-GARCH, and GJR-GARCH in mean) were compared, in which the AR(1) GJR-GARCH model was identified to be the most appropriate model for estimating the time-varying volatility in AAPL's returns. To account for the skewness and shape in AAPL's returns for the years under study, normal distribution (norm) and skewed student t-distribution (sstd) were used to capture the loglikelihood in the five GARCH models. The skewed student t-distribution (sstd) performed better in capturing the shape and skewness in the return series distribution. Hence, the AR(1) GJR-GARCH model is considered the optimal model for modeling and estimating the volatility in AAPL's returns. The results of this study are useful for investors and market players in investment decision-making and analysis of stock price fluctuations.

Acknowledgments

Thanks to several anonymous classmates for their help.

Disclosure statement

The authors declare no conflict of interest.

Author contributions

Z.T. conceived the idea of the study and supervised the writing of the paper; S.F. analyzed the data and summarized the paper; K.H. collected the data and wrote the method; and J.L. wrote the introduction.

References

- [1] Demirguc-Kunt A, Levine R, 1999, Stock Market Development and Financial Intermediaries. Stylized Facts. World Bank Economic Review, 10(2): 291–321.
- [2] Finkle TA, Mallin ML, 2010, Steve Jobs and Apple, Inc. Journal of the International Academy for Case Studies, 16(7): 31.
- [3] Ahmar A, 2016, Predicting Movement of Stock of Apple Inc. Using Sutte Indicator. Proceedings of

the 3rd AISTSSE Trends in Science and Science Education, 35–38.

- [4] Mohan S, Mullapudi S, Sammeta S, et al., 2019, Stock Price Prediction Using News Sentiment Analysis. Proceedings of the 2019 IEEE Fifth International Conference on Big Data Computing Service and Applications (BigDataService), 205–208.
- [5] Jeong J, 2022, Predicting Apple Stock Price Using News Headlines and Other Features with Classical Time Series Models, Supervised Models, and Machine Learning Models, dissertation, UCLA.
- [6] Kim JM, Jun S, 2017, Integer-Valued GARCH Processes for Apple Technology Analysis. *Industrial Management & Data Systems*, 117(10): 2381–2399.
- [7] Silvennoinen A, Terasvirta T, 2009, Multivariate GARCH Models, in *Handbook of Financial Time Series*, Springer, Berlin, Heidelberg, 201–229.
- [8] Ding X, Zhang Y, Liu T, et al., 2014, Using Structured Events to Predict Stock Price Movement: An Empirical Investigation. Proceedings of the 2014 Conference on Empirical Methods in Natural Language Processing (EMNLP), 1415–1425.
- [9] Sharma S, Aggarwal V, Yadav MP, 2021, Comparison of Linear and Nonlinear GARCH Models for Forecasting Volatility of Select Emerging Countries. *Journal of Advances in Management Research*, 18(4): 526–547.
- [10] Ampountolas A, 2021, Modeling and Forecasting Daily Hotel Demand: A Comparison Based on SARIMAX, Neural Networks, and GARCH Models. *Forecasting*, 3(3): 580–595.
- [11] Fałdzinski M, Fiszeder P, Orzeszko W, 2020, Forecasting Volatility of Energy Commodities: Comparison of GARCH Models with Support Vector Regression. *Energies*, 14(1): 6.
- [12] Salamat S, Lixia N, Naseem S, et al., 2020, Modeling Cryptocurrencies Volatility Using GARCH Models: A Comparison Based on Normal and Student's T-Error Distribution. *Entrepreneurship and Sustainability Issues*, 7(3): 1580–1596.
- [13] Lee Y, Lee S, 2019, CUSUM Test for General Nonlinear Integer-Valued GARCH Models: Comparison Study. *Annals of the Institute of Statistical Mathematics*, 71(5): 1033–1057.
- [14] Emenogu NG, Adenomon MO, Nweze NO, 2020, On the Volatility of Daily Stock Returns of Total Nigeria Plc: Evidence from GARCH Models, Value-at-Risk and Backtesting. *Financial Innovation*, 6(1): 1–25.
- [15] Rossi E, 2004, Lecture Notes on GARCH Models, University of Pavia.
- [16] Bollerslev T, 1986, Generalized Autoregressive Conditional Heteroskedasticity. *J Econometrics*, 31: 307–327.

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Economic Opportunities of Qingdao Winery as a New Ecotourism Destination

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Abstract: The consumer psychology of consumers is constantly changing. Under the abundant material life, the emotional and personalized needs of consumers for products are highly valued. Winery tourism is a new ecotourism project. Its high-end and fashionable characteristics do not only meet consumers' demand for personalized tourism, but also their pursuit for high-quality and fashionable leisure ways; thus, it has broad development prospects. At present, Qingdao winery tourism has begun to take shape, but in it faces problems in its development, especially in terms of resource integration and brand development. Therefore, taking the development of Qingdao winery tourism as an example, this paper puts forward several development countermeasures and policy objectives as well as provides a scientific analysis basis for the development of Qingdao winery tourism.

Keywords: Emerging ecotourism; Qingdao winery; Tourism product development

Online publication: October 26, 2022

1. Introduction

In August 2015, the International Wine and Spirits Exhibition (IWES) declared at the International Wine Expo that the world wine development has officially entered the "Chinese era." Based on the in-depth understanding of wine culture, wine tourism projects, which support the increasing number of wine tourism tourists, are well-recognized by local tourists. The the ultimate goal of leisure tourism is realized via the integration of modern lifestyle and wine culture ^[1]. Many local wine enterprises have integrated their own enterprise development with the tourism industry to form new leisure tourism products so as to cater to consumers and uphold a more dominant role in the tourism market. Considering the geographical location, climate conditions, and geological structure of Qingdao, this city has many suitable grape growth zones. Qingdao has developed into a wine industry base on this land. With its development of nearly 40 years, Qingdao's wine production and sales have always been in the forefront of China. Fully utilizing Qingdao winery tourism resources and further promoting the development of Qingdao's tourism industry have become urgent issues that its winery tourism must face ^[2].

2. A comprehensive analysis of the development potential of Qingdao winery tourism resources

We have conducted an in-depth analysis of Qingdao winery tourism resources. The research shows that Qingdao winery has rich resources and great tourism value. In order to carry out a detailed investigation on Qingdao winery tourism resource market, a questionnaire survey was conducted. The questionnaire included the demographic variables of Qingdao winery tourism market and tourists' acceptance of Qingdao wine and winery tourism ^[3].

2.1. Analysis of variance

Variance analysis and independent sample t-test were used to test whether there were significant differences among different demographic groups (age, gender, occupation, education, and income) in strategy formulation, strategy implementation, and strategy evaluation. According to the statistical results (**Table 1**), all P values were greater than 0.05, indicating that there was no significant difference between the different demographic groups in the three regions ^[4].

Table 1. Variance analysis and independent samples t-tests for different demographic groups in strategy formulation, strategy implementation, and strategy evaluation

Variables	Groups	Strategy formulation	Strategy implementation	Strategy evaluation
Age	Under 23 years old	3.02 ± 1.03	3.09 ± 1.13	3.12 ± 0.91
	23–30 years old	2.75 ± 1.07	2.93 ± 1.12	2.92 ± 0.94
	31–40 years old	2.77 ± 1.18	3.00 ± 1.16	2.91 ± 0.98
	41–50 years	2.91 ± 1.12	2.74 ± 1.10	2.92 ± 0.98
	More than 50 years old	2.99 ± 1.02	2.81 ± 1.08	2.99 ± 0.94
	F	0.742	1.045	0.348
	P	0.564	0.384	0.846
Gender	Male	2.86 ± 1.11	2.85 ± 1.11	2.93 ± 0.95
	Female	2.87 ± 1.10	2.91 ± 1.14	2.97 ± 0.97
	T	-0.081	-0.556	-0.363
	P	0.936	0.578	0.716
Occupation	Businessman	2.83 ± 1.10	2.75 ± 1.14	2.86 ± 1.00
	Student	2.83 ± 1.12	2.98 ± 1.08	2.87 ± 0.95
	Teacher	2.91 ± 1.18	2.89 ± 1.16	2.95 ± 1.00
	Government agency staff	2.83 ± 0.99	2.86 ± 1.05	2.95 ± 0.84
	Other	2.92 ± 1.14	3.01 ± 1.13	3.05 ± 0.95
	F	0.146	0.768	0.592
	P	0.965	0.547	0.669
Education	Below junior high school	2.65 ± 1.02	2.51 ± 0.87	2.62 ± 0.83
	High school/vocational school/technical school/vocational school	2.83 ± 0.89	2.71 ± 1.08	2.85 ± 0.79
	College	2.93 ± 1.05	2.77 ± 1.10	2.92 ± 0.94
	Undergraduate	2.89 ± 1.17	2.96 ± 1.14	3.00 ± 1.00
	Graduate and above	2.84 ± 1.10	2.94 ± 1.16	2.97 ± 0.96
	F	0.257	1.09	0.72
	P	0.906	0.361	0.578
Income	Below 2,000 RMB (n = 43)	2.55 ± 1.04	2.68 ± 0.99	2.76 ± 0.87
	2,000–4,000 RMB (n = 55)	2.93 ± 1.07	2.85 ± 1.15	3.00 ± 0.94
	4,000–6,000 RMB (n = 103)	2.89 ± 1.15	2.94 ± 1.16	2.95 ± 1.04
	6,000–10,000 RMB (n = 77)	2.89 ± 1.14	2.90 ± 1.11	3.01 ± 0.95
	10,000 RMB or more (n = 81)	2.95 ± 1.06	2.90 ± 1.14	2.95 ± 0.91
	F	1.054	0.433	0.523
	P	0.379	0.785	0.719

Through the cross analysis of the survey data, several conclusions can be drawn

- (1) Different regions have different levels of acceptance toward Qingdao winery tourism. The farther away from Qingdao, the lesser the understanding and attention to the winery tourism, the lower the regional economic level, and the lower the awareness of the winery tourism. Therefore, Qingdao winery tourism mainly attracts local tourists and tourists from surrounding economically developed areas ^[5].
- (2) Among the surveyed tourists, the attention, understanding, and intention of different genders to Qingdao winery tourism are basically the same.
- (3) Tourists of different ages have different perceptions and attitudes toward Qingdao winery tourism. Generally speaking, tourists of all ages attach great importance to castle tourism and have certain tourism intentions. In contrast, younger tourists, under the age of 20, have less understanding and attention to castle tourism. This shows that younger people have lesser understanding of wine and castle tourism as well as poorer knowledge of castle tourism ^[6].
- (4) The level of education has a great impact on Qingdao winery tourism. As seen from the survey data, the higher the education level of the respondents, the more they know about wine, and the higher their acceptance towards winery tourism.
- (5) Different occupations have different levels of acceptance toward Qingdao winery tourism. Based on the occupational variable, educators, civil servants, and business conference personnel, who are highly educated, rich in knowledge, and stable in terms of income, tend to pursue a leisure cultural atmosphere during their spare time since they have holidays, paid holidays, and leisure time ^[7]. This is the reason they can accept the high-level culture of winery tourism. Students, especially college students, are willing to participate as long as their economic conditions permit.
- (6) The income level has a great impact on Qingdao winery tourism. Based on the income level of the interviewees, the higher the income level of tourists, the higher the recognition and participation in winery tourism. These data indicate that the leisure winery tourism has been accepted by most tourists, but it has not yet been popularized in mass tourism ^[8].
High-end users are still the main target of the winery tourism.

3. Suggestions for the economic development of Qingdao winery as a new eco-tourism destination

3.1. Pay attention to the development of Qingdao's wine culture and leisure services

First, it may be beneficial to build a local cultural platform in Qingdao. Wine culture includes wine planting, production, wine tasting, etiquette, and other aspects. It not only covers the physical characteristics of wine itself, but also the intangible spiritual connotation formed by wine tasting. It helps visitors understand the origin and development of Qingdao's wine culture by means of promotional videos, graphic advertisements, documentaries, and field visits ^[9]. In order to further promote the integrated development of Qingdao's wine culture and leisure services, it is necessary to integrate the local cultural characteristics of Qingdao with the wine culture in restaurants, bars, interior decoration, service personnel clothing, and etiquette. Through the integrated development of wine culture and the local leisure service industry, the local cultural characteristics can be formed to meet the personalized needs of tourists for tourism products. At the same time, it enhances the added value of wine tourism products and helps shape the brand characteristics of Qingdao's wine culture tourism to a certain extent. Second, emphasizing the development of wine science and technology tourism products may be advantageous. Wine science and technology tourism refers to various science and technology tourism resources in wineries and agricultural parks that can meet the needs of tourists, increase their knowledge, broaden their vision, and enrich their experience. Wine technology tourism is a form of winery tourism. Many wineries in Qingdao are now focusing on wine technology tourism. For example, Qingdao Huadong winery combines traditional brewing technology with modern advanced brewing technology to form a brewing process that integrates viewing and application; the

products formed are significant for the wine tourism industry ^[10]. The containers used by the distillery are oak barrels and stainless steel cans. The fermentation process varies for different materials, thus forming a personalized acidification process, which is different through different processes.

3.2. Strengthen the international brand construction of wine real estate tourism

First, enhance the image of wine producing areas. In wine tourism planning, it is very important to create and improve the image of the origin of wines. Other than that, Qingdao should integrate wine culture resources, strengthen wine culture management, implement origin protection policy, standardize and protect the wine brewing process and planting technologies, conduct wine quality inspection in strict accordance with the requirements, and increase the cultural connotation of winery tourism. Second, transform Qingdao into an international wine brand city. In the construction of international wine brand cities that radiate wine culture ^[11], famous directors can be invited to shoot documentaries and films related to wine culture, increase publicity, and improve the popularity and reputation of Qingdao so as to ensure the quality of work. Third, create the image symbol of Qingdao's wine culture tourism. Qingdao's unique geographical location has formed various local cultures with local characteristics since ancient times and through its development, such as marine culture, fairytale culture, and wine culture. These local cultural characteristics can be integrated and developed, thus making them more prominent. Fourthly, establish the tourism brand marketing model of Qingdao distillery. Through the marketing of tourism products related to wine culture, it would be beneficial to further expand the scope of publicity and promotion of tourism projects ^[12]. By expanding marketing channels, both, consumers and tourists may better understand Qingdao winery tourism projects. This would in turn increase the popularity of Qingdao's tourism projects and provide an impetus for the development of Qingdao winery tourism. Network marketing is a popular marketing method. The establishment of network marketing for Qingdao winery tourism has an important impact on the development of the latter. In marketing tourism products, advertising wine tourism products in mass media, such as radio, television, and paper media, is the best way to expand the popularity of tourism products. At the same time, cultural activity marketing can be adopted to attract tourists. By holding wine culture festivals and shooting films or television dramas, it is feasible to increase the popularity of Qingdao winery as a tourist destination.

3.3. Innovative design of wine tourism projects

The innovative design of tourism projects is the key to attracting tourists' attention. Tourism projects include tourism activities in the winery based on grape planting, production, and processing, with a tourism plan. This type of tourism project may include visiting vineyards, grape production processes, and wine cellars ^[12]. Experiential tourism projects, on the other hand, can promote the enthusiasm of tourists, enrich the itinerary, and improve the return visit rate. These projects include agricultural planting experience, do-it-yourself (DIY) fruit wine making, food experience, *etc.* Holiday tourism projects include planning for various festivals, which is a good way to attract people to the winery and increase its influence and popularity. For instance, during spring, the festival of "Love Connects Arbor Day" can be carried out; similarly, wine and grape carnivals can be held during summer, while a romantic golden autumn wedding festival can be held during autumn; in winter, the thematic festival of "Farewell to Old Age" can be held. Other than that, cultural tourism projects, which are considered an integral part of the winery, should be carried out. Wine culture museum, wine tasting competition, and special cultural programs are instances of these projects.

3.4. Strengthen the guarantee of wine tourism industry development

The first is to strengthen insurance policy guarantee. Qingdao has vigorously promoted its wine tourism,

shaped its city's brand characteristics, enhanced its tourism competitive advantages, and promoted the upgrading of its wine industry structure. The government and relevant departments of Qingdao should pay more attention to the development of its wine tourism, provide support through policies ^[13] and funds, establish an open economic system and build an industrial park, promote the wine industry to venture internationally and participate in international markets, encourage international cultural exchanges, form an international wine brand city, improve its international reputation and influence, as well as promote the innovation and development of the modern service industry, while relying on East China Sea Economic New Area and the Long Island Leisure. The second is to strengthen institutional guarantee. The development of Qingdao's wine tourism needs not only the joint efforts of tourism enterprises and wine enterprises, but also the strong support of various government departments. Therefore, under the new development situation of Qingdao's grape tourism, a special management department, the Wine Bureau, has been established, along with a wine association that cooperates with Qingdao's municipal government to jointly manage and serve the wine industry ^[14]. In the development of wine tourism, it is also necessary to strengthen the cooperation with other departments and organizations, especially transportation and logistics, environmental protection, land management, and other departments, so as to provide support and convenience for the industry as well as promote the healthy and harmonious development of wine tourism. In addition, it is necessary to form an industrial chain monitoring mechanism for the wine industry. This mechanism should be jointly established by Qingdao's local and national wine monitoring center and its processing technology research and development center to provide guarantee for the healthy development of the industry. The third is to strengthen personnel training guarantee. With the continuous development of Qingdao's wine industry, the demand for talents is increasing. Universities in Qingdao have strengthened the training of wine-related professionals ^[15]. Colleges and universities in Qingdao are also offering wine-related majors to promote the wine culture and provide a large number of professionals for the industry. As Qingdao's wine culture has remarkable characteristics and a relatively mature development, local colleges and universities in Qingdao have successively developed courses related to wine and wine culture. These elective courses or compulsory courses provide students with opportunities to understand wine culture and stimulate their interest in wine. In order to strengthen talent training in Qingdao's professional colleges and higher vocational colleges, professionals and practitioners with a good grasp of wine culture should be recruited, along with professional wine lecturers, so as to provide guarantee for the cultivation of wine professionals ^[16].

4. Conclusion

Winery tourism is a distinguished tourism project that has garnered widespread attention in recent years. The emergence and development of winery tourism have promoted the development of the wine industry and tourism. At the same time, it enriches tourism resources and meets the personalized tourism needs of tourists. Winery tourism will become the leading project of wine tourism ^[17]. Qingdao has a unique planting environment for grapes and is known as the seventh largest grape coast in the world. Its climate and soil are ideal for grape planting. The design of Qingdao winery tourism route reflects the features of international grape and wine cities, forming a route with the main wineries as the main body, integrating grape planting, wine culture, and the natural scenery of the winery ^[18]. Although Qingdao winery tourism has made outstanding achievements, there are still some problems. Qingdao winery tourism should seize the opportunity to establish special development plans, strengthen measures to protect the origin, and formulate comprehensive development strategies, such as improving the overall image of the winery, exploring the cultural connotation of the winery, forming a wine culture with Chinese characteristics, and developing wine tourism products with personality at a unique level ^[19]. Through the continuous improvement of its service system, the construction of the tourism infrastructure and public service platform,

the strengthening of the cultivation of winery tourism professionals, the introduction of a series of measures to promote the diversified development of the winery tourism, and the formation of distinctive and diversified winery tourism products would eventually improve the reputation of Qingdao winery.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Chen LS, 2016, Research on Tourists' Cognition and Participation Behavior of Wine Culture Tourism, *Journal of Agronomy*, 6(6): 73–77.
- [2] Chen WJ, 2012, Chinese Grape and Wine in the Decade After China's Entry into WTO. *Chinese and Foreign Grapes and Wine*, 2(2): 69–71.
- [3] Chen Y, 2010, Analysis on the Development Strategy of Wine Enterprises in China. *Modern Economic Information*, 7(7): 160.
- [4] Chen YY, 2015, Analysis and Development Enlightenment of Foreign Wine Culture Tourism Model. *Industry Watch*, 3(3): 45–49.
- [5] Guo YM, 2010, Study on Tourism Development Model of Wineries in China. *Travel World*, 6(6): 29–33.
- [6] Huang GR, 2010, Research on Tourism Development Under the Background of Experience Economy, Nanchang University.
- [7] Han S, 2014, Study on Wine Leisure Tourism Development at the Eastern Foot of Helan Mountain. *Tourism Economy*, 3(3): 203–205.
- [8] Yuan J, Morrison AM, Cai LA, et al., 2008, A Model of Wine Tourist Behavior. *International Journal of Tourism Research*, 9(9): 93–97.
- [9] Bruwer J, Saliba A, Miller B, 2011, Consumer Behavior and Sensory Preference Differences Implications for Wine Product Marketing. *Journal of Consumer Marketing*, 10(10): 52–59.
- [10] Lin QQ, 2009, Enlightenment of Foreign Wine Tourism on the Development of Tea Tourism in China. *Tropical Geography*, 29(3): 290–291.
- [11] Li LJ, 2013, On the Development of Wine Culture Tourism Resources. *Business Economy*, 11(11): 60–63.
- [12] Li JM, 2012, The First Year of Modern Chinese Wine. *Wine Business*, 6(6): 9–11.
- [13] Liang XH, 2010, Analysis on the Types of Wine Culture Tourism Resources in China. *Winemaking Technology*, 10(10): 103–106.
- [14] Li WR, 2010, Shanxi Leisure Tourism Product Development Research, Shanxi University of Finance and Economics.
- [15] Gomez M, Molina A, 2011, Denomination of Origin Effects on Brand Equity. *International Journal of Tourism Research*, 1(1): 58–73.
- [16] Ma J, 2014, Research on Wine Tourism Development Strategy from the Perspective of Experience Economy. *Economic Development Research*, 1(2): 219–222.
- [17] Sun YX, 2014, Research on Kaifeng Leisure Tourism Product Development Based on RMP Model, Guangxi University.

- [18] Tian Y, 2011, On the Development of Chinese Wine Manors from the Perspective of French Wine Manors. *Abstracts of Chinese Horticulture*, 8(8): 172–173.
- [19] Tang HL, 2013, Study on the Innovative Development Model and Ideas of Ningxia Wine Winery. *Journal of Anhui Agricultural Sciences*, 4(18): 7939–7941.

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Impact of Two-Way FDI on the Industrial Structure in Shandong Province Under the Background of “New and Old Kinetic Energy Conversion”

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Abstract: This paper uses the panel data of 17 cities in Shandong Province from 2003 to 2018 to construct a panel model to empirically study the impact of foreign direct investment (FDI) on the industrial structure. The results show that two-way investment, financial industry development, and policy variables have significant roles in promoting the advancement of the industrial structure in the province. In the future implementation of the “Going Global” strategy in Shandong Province, the cooperation between two-way investment and the financial industry should be strengthened, the level of regional financial development should be improved, and the impact of two-way investment on the optimization and upgrading of the industrial structure should be reinforced.

Keywords: New and old kinetic energy conversion; Foreign direct investment; Industrial structure transformation

Online publication: October 26, 2022

1. Introduction

In recent years, the economy of Shandong Province in China has encountered many problems, such as overcapacity and irrational industrial distribution. Therefore, realizing the resurgence of Shandong's economy through enterprises “going global” is the focus of research. This paper believes that the development of enterprises in the province by “going global” stimulates the macroeconomic variables in the province ^[1]. Optimizing cross-border investment is one of the keys to new and old kinetic energy conversion, which can promote the transformation and upgrading of industries in the province, improve technological development capabilities, and identify new economic growth points ^[2].

2. Literature review

In recent years, the effect foreign direct investment (FDI) on the economy of our home country has become a trending topic among local economists. By learning from well-known foreign companies and imitating them, Chinese companies will be able to form good demonstration and competitive effects on other domestic companies; at the same time, there will be a strong upstream and downstream industry linkage effect. The transmission of supply and demand chains will create momentum for upstream and downstream industries as well as promote the development of upstream and downstream enterprises and industries ^[3]. Jianqing Yang and Zhilin Zhou analyzed the impact of outward (O)FDI in eastern, central, and western

China on the upgrading of local industries; the analysis showed that the OFDI in China has a significant positive impact on the upgrading of local industries^[4]. According to the results of the regional analysis, the promotion effect in eastern China is the most significant, while the effect in both central and western regions is not significant. Dongkun Li and Min Deng analyzed the relationship between China's provincial OFDI, spatial spillover, and industrial structure upgrading. In their research, the spatial panel Dubin model was used to carry out empirical analysis. The results showed that local OFDI not only improves the level of local industrial structure rationalization, but also significantly promotes the improvement of the level of industrial structure rationalization in neighboring areas, especially critical provinces through spatial spillover effects^[5].

3. Model setting

3.1. Selection of theoretical model

According to the international research and development (R&D) spillover model, proposed by Coe and Helpman, imports and OFDI can absorb advanced technologies and R&D elements, and they are important carriers for the international transfer of technological resources, thereby promoting the technological progress of the home country and the transformation and upgrading of the home country's industries. The formula is as follows^[6]:

$$IS = \alpha + \beta_1 S_t^d + \beta_2 S_t^{im} + \beta_3 S_t^{ofdi} + \varepsilon_t \quad (1)$$

where IS represents the level of the industrial structure development of the home country, S^d represents the technology spillover benefit brought about by the capital of the home country, S^{im} represents the reverse technology spillover brought about by imports, and S^{ofdi} represents the reverse technology spillover brought about by OFDI^[7].

Model (1) is integrated and modified as follows: (1) in order to determine the spillover benefit of domestic capital to the industrial structure, domestic capital is divided into FDI and domestic fixed asset investment for consideration; (2) in order to prevent the omission of important variables, which would lead to deviations in the regression results, this paper adds the financial industry development level (FD) and the R&D level (RD) of enterprises above designated size as the control variables^[8]; (3) in consideration of the impact of the “new and old kinetic energy conversion” macro policy on the industrial structure of Shandong Province, this paper uses “new and old kinetic energy conversion” as a dummy variable to explain the policy's intervention in the industrial structure. The model is as follows:

$$\begin{aligned} HIS_{i,t} = & \alpha + \beta_1 \ln GDP_{i,t} + \beta_2 \ln FAI_{i,t} + \beta_3 \ln IFDI_{i,t} + \beta_4 \ln OFDI_{i,t} \\ & + \beta_5 \ln IM_{i,t} + \beta_6 FD_{i,t} + \beta_7 \ln RD_{i,t} + \beta_8 \mathbf{Dum} + \varepsilon_{i,t} \end{aligned} \quad (2)$$

where HIS refers to high-level industrial structure, GDP refers to gross domestic product (GDP) per capita, FAI refers to fixed asset investment, $IFDI$ refers to foreign direct investment, $OFDI$ refers to outward foreign direct investment, IM is the amount of imports^[9], FD represents the level of financial industry development, and RD represents the enterprise's technology R&D level.

3.2. Variable selection and description

The basic data in this paper are derived from the 2003–2018 “Shandong Province Statistical Yearbook,” “Shandong Province National Economic and Social Development Statistical Bulletin,” and the municipal statistical yearbooks of 17 cities in Shandong Province^[10].

The dependent variable is high-level industrial structure (HIS). In the process of upgrading the industrial structure, the added value of the service industry is significantly higher than that of the agriculture industry ^[11]. Therefore, the degree of advanced industrialization in a region is indicated by the proportion of the total social production of the service industry in that region. The details are shown in formula (3).

$$HIS = Y_3 / Y_2 \quad (3)$$

The independent variables include foreign direct investment (IFDI), social fixed asset investment (FAI), amount of imports (IM), and per capita GDP (GDP), which are all calculated using U.S. dollar as the currency unit of each city's historical flow. For outward foreign direct investment (OFDI), the stock of each city that has been calculated in U.S. dollars since 2003 is used.

With regard to financial industry development level (FD), this study uses “the proportion of non-state-owned sector loan balance to GDP” to indicate the improvement in the efficiency of financial development. With regard to enterprise technology R&D level (RD), the R&D investment per capita of each city is used to express the technology R&D level ^[12]. This study uses the “new and old kinetic energy conversion” policy as a dummy variable (Dum). Before the policy is implemented (2003–2015), the value is set to “0,” but after the policy is implemented (2016–2018), the value is set to “1.”

4. Empirical analysis

In order to test the stability of the data, this paper uses LLC in the same root case and ADF-Fisher, PP-Fisher, and IPS in different root cases to perform unit root tests at the same time. The results show that some variables passed the significance test, but some failed. After the first-order difference, all variables passed the significance test. In order to determine whether there is a long-term stable relationship between the original variables ^[13], this paper uses the Kao test, proving that there is a long-term stable cointegration relationship between the variables. Due to the limitation of the layout, the test results will not be shown here.

Table 1. Regression results

Variable	Model 1	Model 2
	Fixed effect	Fixed effect
LnGDP	0.039 (1.388)	
LnIFDI	0.039*** (3.160)	0.043*** (3.595)
LnOFDI	0.012*** (3.160)	0.008*** (3.216)
LnFAI	0.111** (2.478)	0.058** (2.478)
LnIM	-0.021** (-2.096)	-0.025** (-2.597)
FD	0.189*** (4.259)	0.207*** (4.882)
LnRD	6.5E-07*** (5.064)	6.28E-07*** (4.899)
Dum	0.139*** (9.497)	0.139*** (9.474)
Fixed effect	Cross-section	Cross-section
Adjusted R ² value	0.937	0.930
Hausman test value	22.555** (0.004)	25.042*** (0.000)
F-value	153.112*** (0.000)	159.091*** (0.000)
n	272	272

Note: (...) refers to the t value, but in Hausman test and F-test, (...) refers to the P-value; *, **, and *** indicate significant at the level of 10%, 5%, and 1%

According to the regression results (**Table 1**), the explanatory variables IFDI, OFDI, FAI, FD, and RD in the model have a significant positive impact on the advancement of the industrial structure, implying that increasing foreign direct investment, outward foreign direct investment, fixed asset investment, financial loan ratio, and scientific research investment can promote the industrialization of Shandong Province. Since 1990, attracting investment has been an effective driving force that boosted the economy of Shandong Province and improved the distribution of Shandong's industries. Since 2001, the Chinese government has implemented the "Going Global" policy^[14]. Shandong Province responded to the call, and batches of powerful emerging companies have stepped out of the country and are on the international stage. It is precisely because these companies have absorbed the advanced technology and learned advanced management models abroad, a reverse technology spillover effect has taken place, outdated domestic sunset industries have been eliminated, the transformation of new and old kinetic energy has been realized, and the development of advanced industries in Shandong Province has been promoted. It is worth noting that the rise of the financial industry has accelerated the pace of industrial upgrading in Shandong Province, indicating that in the upgrading process, it is not only necessary to encourage physical enterprises to "bring in" and "go global," but also to optimize the allocation of capital in the financial industry^[15].

5. Policy recommendations

- (1) We should attach great importance to the impact of foreign investment and the use of foreign capital on industrial structure, continue to encourage and guide companies with international competitiveness to "go global," and cultivate enterprises with certain competitiveness and brand value on the international stage. While focusing on quantity, we should also focus on quality and enhance the independent innovation capabilities of enterprises. At the same time, various preferential policies should be introduced to attract powerful foreign companies to invest and compete with domestic companies; however, their focus must be transformed from the original "quantity-centered" to "quality-centered."
- (2) Not only should we expand the scale of domestic and foreign financial markets, but the efficiency of financial markets should also be improved, and better financial services should be provided for overseas investment by enterprises. The financial industry should not only be a catalyst for the optimization and upgrading of the industrial structure of overseas investment, but also further reform the differentiated regional financial development strategy and focus on supporting independent innovative enterprises to "go global," so as to promote domestic industrial upgrading and technological progress.

Funding

The paper is the phased result of the general project "Analysis of the Impact of Shandong Province's Two-Way Investment on the Transformation and Upgrading of Industrial Structure under the Background of 'High-Quality Development'" and the 2020 Shandong Province Key R&D Program (Soft Science Project) (Project Number: 2020RKB01339).

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Zhang W, Zhang N, 2017, The Path Selection of My Country's New and Old Kinetic Energy Conversion Guided by the Supply-Side Structural Reform. *Dongyue Lun*, 38(12): 93–101.
- [2] Yin Z, Li D, 2015, The Mechanism of China's Foreign Direct Investment on Domestic Industrial

- Upgrading: A Discussion Based on Different Investment Motives. *Journal of Northern University for Nationalities*, 2015(1): 37–41.
- [3] Yang J, Zhou Z, 2013, An Empirical Analysis of the Impact of My Country's Foreign Direct Investment on Domestic Industrial Upgrading. *Economic Geography*, 2013(33): 120–124.
 - [4] Li D, Deng M, 2016, China's Provincial OFDI, Spatial Spillover and Industrial Structure Upgrading. *International Trade Issues*, 2016(1): 13.
 - [5] Coe DT, Helpman E, 1995, International R&D Spillovers. *European Economic Review*, 39(5): 859–887.
 - [6] Li F, 2016, The Home Country Industrial Upgrading Effect of Foreign Direct Investment – An Empirical Analysis from China's Inter-Provincial Panel Data. *International Trade Issues*, 2016(6): 124–134.
 - [7] Liu L, Hao K, 2022, Research on the Technology Spillover Effect of China's Service Industry OFDI on Host Country. *Foreign Trade and Economic Cooperation*, 2022(3):15–18.
 - [8] Wu D, Chen F, 2015, Financial Development, FDI and Economic Growth: An Empirical Study Based on Guangzhou Data. *Enterprise Management and Reform*, 2015(13): 75 + 97.
 - [9] Wang S, Wei X, Zhao L, 2016, FDI, Environmental Regulation and Advancement of Industrial Structure. *Journal of Capital University of Economics and Business*, 2016(6): 28–34.
 - [10] Gan CH, Zheng RG, Yu DF, 2011, An Empirical Study on the Effects of Industrial Structure on Economic Growth and Fluctuations in China. *Economic Research Journal*, 5: 4–16.
 - [11] Lv M, You M, 2013, The Effects of Industrial Structure Changing on Transformation of the Economic Growth Mode in South Korea: An Empirical Study Based on the Perspective of Energy Consumption and Carbon Emission. *World Econ Study*, 7: 73–80.
 - [12] Jia J, Yin L, 2015, The Spatial Effect of Public Expenditures on Industrial Structure Upgrading. *Journal of Finance and Economic*, 2015: 41(9): 18–28.
 - [13] Zhang L, 2016, Chinese Bidirectional FDI, Financial Development and Industrial Structure Optimization. *World Economy Studies*, 10: 111–124.
 - [14] Pu W, Yi Q, 2015, Research on the Impact of OFDI on China's Industrial Structure Upgrading. *Macroeconomic Research*, 2015(10): 54–61.
 - [15] Wang S, Hu Z, 2013, A Study on the Productive Efficiency Effect of Bidirectional FDI in Service Industry: Panel Model Estimation Based on Human Capital. *Journal of Finance and Economic*, 39(11): 91–102.

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Research on the Relationship Between Macroeconomic Indicators and Stock Market Value

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Abstract: The article first addresses the following questions: “Why does gross domestic product (GDP) rises, but the stock market value falls?”; “Among the macroeconomic factors, which factor has a greater impact on the promotion of investment value in the securities market?”. With these questions in mind, we put forward a hypothesis emphasizing on the impact of macroeconomic factors on the value of the stock market based on existing research and used the regression method to verify this hypothesis. The following conclusions were drawn: (1) variables that have a positive nonlinear relationship with stock market value include balance of payments surplus, rising GDP level, M1, the whole society’s fixed asset investment, and national per capita disposable income; (2) variables that have a negative nonlinear relationship with stock market value include deposit, loan interest rate, new RMB loan amount, consumer price index (CPI), and producer price index; (3) deposit reserve ratio has an S-shaped curve relationship with stock market value; (4) exchange rate has an inverted U-shaped curve relationship with stock market value.

Keywords: Macroeconomic indicators; Stock market value; Relationship

Online publication: October 26, 2022

1. Introduction

In Liaoning Smart Economy Competition, we analyzed relationship between China’s gross domestic product (GDP) and stock market value, and found that in 2000–2006 and 2007–2008, there was a rise in GDP but a fall in the stock market value. According to the theory of investment analysis, the GDP and stock market value should be in the same direction. Among the macroeconomic factors, which factor has a greater impact on the promotion of investment value in the securities market? With doubts and paradoxes, we attempt to verify these problems through empirical analysis to better guide investment practices.

The analysis of the fundamentals of securities investment is more common in textbooks. On May 19, 2022, a keyword search based on titles was carried out using the keyword “securities investment fundamentals” on China Knowledge Network. After excluding 5 articles that have less relevant content, six articles remained from a total of 11 articles. These six articles focus on the analysis of the fundamentals of securities investment^[1,2]. Another keyword search based on full text was also carried out using the same keyword “securities investment fundamentals,” with a total of 25,030 articles found. The top 500 articles with the highest correlation were selected as the research sample. CiteSpace was used for literature review. The studies could be divided into five types, in which volatility research is one of them. Volatility research began in 2003, and from 2013 to 2016, it focused on quantitative investment, teaching reform, experimental

teaching, and stocks. However, the 2021 volatility research focuses on applications. From careful reading of the content, the majority are theoretical research, with relatively few research on solving practical problems. Research has suggested that GDP and share price movements should be consistent over time; however, existing research does not explain why GDP rises while stock prices fall.

2. Construction of research models and formulation of research hypotheses

Based on existing studies, the independent variable is the investment value of the securities market (expressed by the annual closing price of the Shanghai Composite Index), while the dependent variable is the balance of payments, GDP, M1, fixed asset investment, deposit reserve ratio, national per capita disposable income, one-year deposit interest rate, short-term loan interest rate of 6 months to 1 year, new RMB loans, CPI, producer price index, and exchange rate. Based on existing research, we propose several hypotheses ^[3].

- (1) *Hypothesis 1:* The balance of payments surplus will lead to an increase in stock market value. The balance of payments is a systematic record of all transactions between residents of a country and non-residents in a given period of time. It has a deficit and a surplus. The latter occurs when revenues exceed expenditures, while a deficit occurs when expenditures exceed revenues. When the balance of payments is in surplus, the prosperity of industries that provide export products is high, the profits of enterprises are good, the income of the public is greatly improved, and the price of the securities market can rise steadily. When there is a deficit in the balance of payments, a country's export of goods is inhibited, and the efficiency of enterprises that provide these products is inevitably affected. The securities issued by listed companies will be snubbed by investors in the market, and the listed companies associated with these enterprises would face difficulties in performing, resulting in the fall of stock market prices. If a country has a long-term deficit in its income and expenditure, its foreign exchange reserves will decrease, along with its capacity to use foreign exchange to purchase imported raw materials, equipment, and technology. As a result, there would be a decline in economic growth rate, the entire national economy would be affected by the balance of payments deficit, and the performance of the securities market would be unsatisfactory.
- (2) *Hypothesis 2:* The rise in GDP will cause the stock market value to rise. GDP is the most basic indicator of the overall macroeconomic performance. The macroeconomic environment is the most basic factor of a company's management, survival, and development. The stock market value is bound to rise when the trend of macroeconomic operation improves and the overall profit level of enterprises rises.
- (3) *Hypothesis 3:* The increase in M1 will lead to a rise in stock market value. A significant money-making effect of the stock market would encourage investors to move other investment funds such as fixed deposits into the stock market, which benefit less, thereby increasing the overall M1. On the contrary, if the stock market does not make money, the money will be moved out of the stock market into other fixed assets, thus reducing the overall M1.
- (4) *Hypothesis 4:* Under the condition of moderate investment scale and reasonable structure of investment, the whole society's fixed asset investment will cause the stock market value to rise. Fixed asset investment is the primary index used to measure the scale of investment. The formation of new productive capacity through investment in fixed assets is an indispensable means for expanding reproduction and promoting economic development. It is an important condition for promoting technological progress and the basis for establishing a rational production structure and distribution of productive forces. The scale and structure of fixed asset investment are not only related to the current state in service of the society, but also to future economic development prospects and structure. Securities investment is the future investment, so the analysis of fixed asset investment is of significance to making correct decisions in securities investment.

- (5) *Hypothesis 5*: The increase in reserve ratio will lead to a decline in stock market value. Statutory deposit reserve ratio refers to the proportion of the total deposits of financial institutions to ensure the withdrawal of deposits and the settlement of funds. The higher the ratio, the less money the banks can borrow from deposits, thus reducing the money supply.
- (6) *Hypothesis 6*: As national per capita disposable income increases, the stock market value rises. The increase in people's income will directly lead to the rise of stock market prices, and the increase in investment demand and consumption expenditure will affect the total social demand. The social aggregate demand in turn stimulates investment demand, so that enterprises expand the scale of production and increase corporate profits. This increase in profits will stimulate the enthusiasm of enterprises to expand their production scale and further improve the total profits, thereby promoting an increase in stock prices. Bond prices will also increase because of active market demand, improved business environment, increased profitability, and reduced debt service risk.
- (7) *Hypothesis 7a*: When deposit rate falls, the stock market value rises; when deposit rate rises, the stock market value falls.
- (8) *Hypothesis 7b*: The stock market value rises when the lending rate falls; when the lending rate rises, the stock market value falls.
- (9) *Hypothesis 8*: As the new RMB loan amount increases, the stock market value will rise. New loans are used to reflect the situation of China's financial institutions to enterprises and residents in relation to the increase in amount of RMB loans issued based on statistical data released by the People's Bank of China to the public on a regular basis ^[4]. The increase in loans means that monetary policy has begun to ease, which is conducive to the circulation of money. The flow of money in the stock market will be large; hence, the new money will push the domestic stock market up ^[5].
- (10) *Hypothesis 9*: A stable CPI will lead to an increase in stock market value. CPI is a lagging data, but it is often an important indicator of market economic activity and government monetary policy. Among stable CPI, full employment, and GDP growth, CPI stability is the most important socio-economic goal.
- (11) *Hypothesis 10*: Producer price index and stock market capitalization have an inverted U-shaped relationship ^[6]. Producer price index is an index used to measure the average change in a manufacturer's ex-factory price. It is one of the several price indices collected and collated by the Statistical Office. If the producer price index is inches higher than expected, it indicates inflation risk. Producer prices may also indicate the risk of deflation. The fluctuation of the overall price level first appears in the production field, then spreads to the downstream industry through the industrial chain, and eventually affects consumer goods.
- (12) *Hypothesis 11*: In the presence of trade surplus, the exchange rate declines, while the stock market value rises. Exchange rate is the price expressed in one currency for another. A rise in exchange rate denotes the conversion of 1 unit of foreign currency into an increase in the local currency. When the exchange rate drops, the currency appreciates, and it is advantageous to import, thus raising the stock prices of import enterprises.

3. Correlation analysis and causal analysis

3.1. Correlation analysis

Using SPSS, the results from Pearson correlation analysis of 13 variables, such as the Shanghai Stock Exchange (SSE) Index and GDP, show that the Shanghai Index and the international balance of payments, M1, national currency issue, fixed asset investment, and deposit reserve ratio are significantly positively correlated. The Shanghai Composite Index is negatively correlated with one-year deposit interest rate, short-term loan interest rate, and new RMB loans.

3.2. Linear relationship analysis

Stepwise multiple regression analysis of the model was performed using SPSS 21.0. The results show that GDP has a significant impact on the Shanghai Index, in which the coefficient of regression is 0.612. Other variables have no significant impact on the Shanghai Composite Index.

3.3. Nonlinear analysis

Shanghai Index represents the dependent variable Y, whereas the independent variable X is represented by balance of payments (BOP), GDP, M1, fixed asset investment, deposit reserve ratio, national disposable income, one-year deposit interest rate, short-term loan interest rate of 6 months to 1 year, new RMB loans, and CPI. Only significant nonlinear relationships and the best fitting degree are listed from the nonlinear analysis of the independent variables and the Shanghai Index [7].

The quadratic relationship between BOP and SSE Index is significant, and the fitting degree is the best: $Y = 715.135 + 1.395 * 105X - 1.186 * 1013X^2$.

Between GDP and SSE Index, S function is significant, and the fitting degree is the best: $\ln(Y) = 7.955 - 56629.157/X$.

Between M1 and SSE Index, S function is significant, and the fitting degree is the best: $\ln(Y) = 7.853 - 21471.053/X$.

Between fixed asset investment and SSE Index, S function is significant, and the results are as follows: $\ln(Y) = 7.832 - 14233.782/X$

The cubic function of deposit reserve ratio and SSE Index is significant, and the fitting degree is the best: $Y = 14294.071 - 3530.427X + 286.123X^2 - 6.928X^3$.

Between national per capita disposable income and Shanghai Composite Index, the logistic function is significant: $\ln(1/Y) = X$.

Between the one-year deposit interest rate and SSE Index, the log function is significant, and the fitting degree is the best: $\ln(1/Y) = 1.217X$.

Between short-term loan interest rate of 6 months to 1 year and the Shanghai Index, the log function is significant, and the fitting degree is the best: $Y = 5755.054 - 2070.266\log(0.521X)$.

The quadratic function between new RMB loans and SSE Index is significant and has the best fitting: $Y = -7985.775 + 354.721X^8 - 2.849X^8$.

Between CPI and SSE Index, the exponential function is remarkable, and the fitting degree is the best, where $\ln(Y) = 498352.533 - 0.055X$.

Between producer price index and Shanghai Index, the logistic regression is significant, and the results are as follows: $\ln(1/Y) = 2.060*106 + 1.057X$.

Between exchange rate (100 USD against RMB) and the Shanghai Composite Index, the cubic function is significant, and the results are as follows: $Y = -13030.990 + 0.98X^2 - 9.245 * 105X^3$.






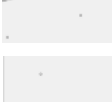
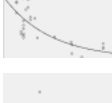
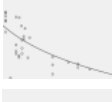



4. Conclusion

Through quantitative analysis (**Table 1**), the relationships between different macroeconomic indicators and the stock market value are described below.

- (1) Variables that have a positive non-linear relationship with the stock market value include balance of payments surplus, rising GDP level, M1, the whole society's fixed asset investment, and national per capita disposable income.
- (2) Variables that have a negative nonlinear relationship with the stock market value include deposit, loan interest rate, new RMB loan amount, CPI, and producer price index.
- (3) The variable that has an S-shaped curve relationship with the stock market value is deposit reserve ratio.

- (4) The variable that has an inverted U-shaped curve relationship with the stock market value is exchange rate.

Table 1. Verification of the relationships in the hypotheses

Hypothesis	Diagram	Verified
<i>Hypothesis 1:</i> The balance of payments surplus will lead to an increase in the stock market value.		Yes
<i>Hypothesis 2:</i> A rise in GDP will cause the stock market value to rise.		Yes
<i>Hypothesis 3:</i> The increase of M1 will lead to the rise of stock market value.		Yes
<i>Hypothesis 4:</i> Under the condition of moderate investment scale and reasonable structure of investment, the whole society's fixed asset investment will cause the market value of the stock market to rise.		Yes
<i>Hypothesis 5:</i> The increase in reserve ratio will lead to a decline in the stock market value.		Partially verified
<i>Hypothesis 6:</i> As the national per capita disposable income increases, the stock market value increases.		Yes
<i>Hypothesis 7a:</i> When the deposit rate falls, the stock market value rises; when the deposit rate rises, the stock market value falls.		Yes
<i>Hypothesis 7b:</i> The stock market value rises when the lending rate falls; when the lending rate rises, the stock market value falls.		Yes
<i>Hypothesis 8:</i> As the new RMB loan amount increases, the stock market value rises.		Partially verified
<i>Hypothesis 9:</i> A stable CPI will lead to a rise in stock market value.		Yes
<i>Hypothesis 10:</i> Producer price index and stock market capitalization present an inverted U-shaped relationship.		No
<i>Hypothesis 11:</i> In the presence of trade surplus, the exchange rate declines, and the stock market value rises.		Partially verified

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Li M, et al., 2006, Application of Cluster Analysis in Securities Investment Analysis. *Journal of Liaoning Normal University*, 6: 145–146.
- [2] Zhang J, 2019, Securities Investment Fundamentals Analysis. *Economic Practice*, 9: 110.
- [3] The New York Stock Exchange, Cambridge University Press, Cambridge.
- [4] What Does the New RMB Loan Mean? What Is the Significance of Releasing New RMB Loan Data?, 2020, viewed May 15, 2022, <http://www.southmoney.com/waihui/waihuizhishi/202006/5925148.html>
- [5] How Will the Increase in Renminbi Lending Affect the Stock Market?, n.d., viewed May 15, 2022, <https://zhidao.baidu.com/question/548468155.html>
- [6] Zhang Q, Jiang G, 2006, Basic Analysis and Technical Analysis of Security Investment. *Cooperative Economy and Technology*, 9: 47–48.
- [7] National Bureau of Statistics, 2021, *State Statistical Yearbook*.

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The Impact of Project Portfolio Management on Enterprise Strategic Objectives

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Abstract: In today's era, with the increase in the number of enterprise innovations, enterprises must adopt project portfolio management for various innovations, select alternative projects from the perspective of enterprise strategy. This paper primarily explores the use of project portfolio management in enterprise project management, hoping to improve the quality of enterprise project management and the utilization efficiency of project portfolio management in enterprise project management.

Keywords: Project portfolio management; Enterprise strategic objectives; Development strategy

Online publication: October 26, 2022

1. Introduction

Project portfolio management is a comprehensive management idea. It begins from the company's strategic objectives and carries out comprehensive evaluation of each project on this basis. The introduction of project portfolio management in the formulation of strategic objectives not only realizes the efficient allocation of resources, but also promotes the continuous and stable operation of the entire project, while maximizing the benefits. Project portfolio management first appeared in the field of computing and extended to the field of finance over time ^[1]. In recent years, with the emergence of various concepts, including industrial integration and global cooperation, the concept of project portfolio management has also penetrated into all facets of enterprise development. Under the direction of this concept, enterprises may acquire fresh ideas for development, gradually move closer to comprehensive management from single project management, and maximize the benefits of organizational objectives ^[2].

2. Advantages of project portfolio management

Project portfolio management has many advantages. First, it focuses on the overall benefits of enterprises. The fundamental purpose of an enterprise is to make profits. In the previous management concept, enterprise managers often focus on the implementation of specific projects rather than making long-term development plans. This separates the project from the overall development of the enterprise, which is not conducive to the sustainable development of the enterprise. The application of project portfolio management prevents the aforementioned situation, draws the attention of managers to each project of the enterprise to achieve a good fit between the project objectives and the enterprise's overall development objectives, and promotes the overall economic benefits of the enterprise ^[3].

Second, it improves the realizability of organizational goals. When formulating the project objectives, it is necessary for the project objectives to be in line with the actual situation. The application of project

portfolio management further refines enterprise management objectives, decentralizes management tasks, realizes top-down management, deals with the development risks from the root, and promotes a sound and rapid development ^[4].

3. Specific strategies to achieve the enterprise's strategic objectives from the perspective of project portfolio management

3.1. Strengthen personnel training and establish a good awareness of project portfolio management

Project portfolio management has become a general trend for enterprise development. In order to further improve the enterprise economy and achieve long-term development, enterprises should pay attention to the role of project portfolio management in the internal structure of enterprises, clarify the relationship between projects and enterprises, strengthen the training of managers to enhance their professional skills, ascertain the quality of work and projects, and establish a good awareness of project portfolio management in project management. Enterprises should begin from the following aspects: first, adjust the traditional personnel training structure, establish a hierarchical training mode based on the characteristics of project portfolio management and the ability and literacy of group managers, invite professionals of relevant fields to serve as instructors for them, record the actual learning of managers, and adjust the corresponding training programs and incentive policies to ensure learning and improve their project management awareness and ability ^[5]; second, formulate a capacity development blueprint based on enterprise development ^[5], raise awareness of the novel concept, encourage enterprise managers to weigh the current project management and project portfolio management, link the actual work content with project management, simplify and split the project management concept, and ensure that the training is consistent with the current work content of managers ^[6].

3.2. Improve the supervision system and adhere to the working principle of “quality first”

Compared with general management, project portfolio management involves many departments and various contents. Its system content needs to be determined in consideration of various contents. In order to further improve the supervision system and ensure the quality of the project, managers should start from each link of the project, improve the existing supervision system, and arrange corresponding supervisors for each stage to monitor the progress in real time. Moreover, managers should also report to the corresponding departments for treatment in case of emergencies, so as to ensure the overall quality of the project and improve the directivity of their management work ^[7]. Incentive policies should also be formulated based on the original supervision system; regular assessments on the work attitude and performance of managers should be carried out; and material rewards should be given accordingly, so as to further improve their work enthusiasm.

3.3. Build a scientific personnel distribution system and give full play to the effect of project portfolio management

In order to give full play to the effect of project portfolio management, we should build a scientific personnel distribution system based on the actual situation and implement it. First of all, the person-in-charge of the enterprise should improve their professional ability, learn professional managerial knowledge, make overall planning from the perspective of the overall development of the enterprise, and be highly consistent with the strategic objectives of the enterprise. At the same time, enterprises should strengthen the training of managers and grass-roots employees, improve their work ability, and establish a high-quality management team and work team on this basis to ensure a scientific and effective management process. Each enterprise should also formulate a practical employment mechanism, in which candidates are assessed prior to recruitment, improve the threshold of talent recruitment, and attract more high-quality talents. In

addition, the enterprise project manager should work closely with the senior management to ensure that all projects are in close cooperation, evaluate the utilization of resources, formulate a scientific resource allocation system, and effectively coordinate the relationship among financial, human, and material resources. Enterprise personnel can also gain more knowledge from project management and multiply benefits through knowledge sharing ^[8].

3.4. Establish a scientific evaluation system to improve work quality

Establishing an evaluation mechanism would allow for the effective evaluation of the relationship between enterprise project objectives and overall planning, thus enabling enterprises to develop in an established direction. To a certain extent, the project selection, priority determination, and effect guarantee in enterprise project management are inseparable from the project portfolio management evaluation mechanism. Therefore, in the process of enterprise development, it is necessary to establish a scientific evaluation system, which includes risk evaluation. This evaluation lists the relevant risks, including the risk of on-time project completion, the risk of multi-organization management, technical risk, project action risk, cost control risk, *etc.* Furthermore, it is also necessary to set weights in accordance with the actual situation to avoid risks. Enterprises should focus on quality and ensure good quality control. The quality of an enterprise should be evaluated from the pre-combination, combination and post-combination stages, so that the relevant personnel may come to understand the dynamic development process of the enterprise prior to making scientific decisions. In the process of project evaluation, we should begin with the commercial value and project budget to determine the action levels of the project (these levels mainly include “start,” “start after confirmation,” “need to be confirmed after research,” “will not start in the short term,” and “will not start in the long term”), locate the level based on the actual situation, and formulate scientific development objectives on this basis to optimize the effect of the project portfolio ^[9].

3.5. Relying on information technology to achieve overall consideration

Information technology plays an important role in improving the efficiency of project portfolio management. In this era, various technologies have emerged, such as big data and cloud computing. Introducing these technologies into project portfolio management allows us to fully utilize their advantages and improve the overall management effect. For example, big data can be utilized to collect project information. From that, the enterprise would be able to carry out analysis from both horizontal and vertical perspective to formulate optimization strategies. All enterprise personnel should also be proactive in communication, share information via internet platforms, analyze the advantages and disadvantages of projects, and adjust the implementation sequence and process of the combined project.

4. Project portfolio management considerations in enterprise project management objectives

4.1. Align portfolio management with the enterprise’s strategic objectives to improve the scientificity of project portfolio

Project portfolio management must be aligned with the enterprise’s strategic objectives to achieve the best results. In this context, project portfolio management can also provide continuous support for enterprise development. In the process of applying project portfolio management, enterprises should clarify their own management objectives with long-term development in mind and formulate practical development plans. In this way, they can enhance the enterprises’ core competitiveness. At the same time, senior managers should have a thorough understanding of the strategies and play the role of participants. In this way, they would be able to coordinate the external and internal environments and put forward enterprise development strategies that are viewed from a higher perspective. Compared with ordinary employees, senior managers have rich management experience; they are able to analyze the risks in the development process accurately

and subsequently deal with these risks. At the same time, the relevant managers should also optimize the operation state of the portfolio project to ensure that the enterprise operates normally ^[10].

4.2. Implement the people-oriented concept and strengthen the collection and adoption of employees' opinions

The majority of enterprises have recognized the importance of project portfolio management and applied these management methods to enterprise development. This effort has accelerated the pace of enterprise economic development to a certain extent. In the process of implementing project portfolio management, relevant enterprise managers also focus on analyzing the risks and listing various ambiguous factors. On this basis, the enterprise project cost and the development risks have reduced. In the actual development process, there are many factors that must be considered. It is necessary to consider the suggestions of employees and formulate a project management method to maximize benefits. This would stimulate the work enthusiasm of grass-roots employees and promote a steady overall development of the enterprise.

5. Conclusion

Project portfolio management focuses on the overall benefits of enterprises. It improves the realizability of organizational objectives and enhances the effectiveness of enterprise project management. In the actual development process, enterprises must determine the project implementation standards, the compatibility between the overall objectives and phased objectives, the application of various resources, and its income, so as to allocate resources reasonably, reduce its development cost, and improve its development efficiency.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Nielsen K, 2021, Agile Portfolio Management: A Guide to the Methodology and Its Successful Implementation “Knowledge That Sets You Apart”, Productivity Press, New York.
- [2] Mensi W, Nekhili R, Vo XV, et al., 2021, Quantile Dependencies Between Precious and Industrial Metals Futures and Portfolio Management. *Resources Policy*, 73: 102230.
- [3] Mensi W, Rehman MU, Vo XV, 2021, Dynamic Frequency Relationships and Volatility Spillovers in Natural Gas, Crude Oil, Gas Oil, Gasoline, and Heating Oil Markets: Implications for Portfolio Management. *Resources Policy*, 73: 102172.
- [4] Yang Z, 2021, Research on Optimization of Multi Project Portfolio Management of Huake Company, dissertation, Yanshan University.
- [5] Chereddy KKK, Cleveland S, 2021, Implementing Project Portfolio Management at Pharmaceutical Manufacturing Facilities. *International Journal of Public and Private Perspectives on Healthcare, Culture, and the Environment (IJPPHCE)*, 5(2): 36–48.
- [6] Wu LH, Wu L, Shi J, et al., 2021, Project Portfolio Selection Considering Uncertainty: Stochastic Dominance-Based Fuzzy Ranking. *International Journal of Fuzzy Systems*, 23(7): 2048–2066.
- [7] Wang J, 2020, Research on Project Portfolio Management of Enterprise Chemical New Material Product Development, dissertation, University of Electronic Science and Technology. <http://doi.org/10.27005/d.cnki.gdzku.2020.002940>
- [8] Wang X, 2019, Research on Strategy Oriented Portfolio Management in IT Enterprises, dissertation,

Beijing Jiaotong University. <http://doi.org/10.26944/d.cnki.gbfju.2019.001730>

- [9] Yu T, 2018, Research on Optimization of Project Portfolio Management in G Company, dissertation, South China University of Technology.
- [10] Li Y, 2018, Project Portfolio Management Model Based on Diversification Strategy and Its Application, dissertation, Hebei University of Technology. <http://doi.org/10.27105/d.cnki.ghbgu.2018.001417>

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Toshiba and Luckin Coffee: A Study of the Reasons for Committing Financial Fraud

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Abstract: Financial fraud, which has become a global issue, is a subject of discussion, surpassing time. Financial fraud significantly undermines investors' confidence and affects the health of capital markets. Hence, it is valuable to explore the reasons for committing financial fraud and propose solutions to this issue. This paper focuses on two financial fraud cases in recent years, Toshiba in 2015 and Luckin Coffee in 2020, analyzes and compares the reasons for the financial fraud in terms of pressure and opportunity factors, as well as proposes comprehensive suggestions for dealing with the corporate financial fraud issue.

Keywords: Financial fraud; Corporate case studies; Fraud triangle theory

Online publication: October 27, 2022

1. Introduction

With the progress of the 21st century, many public companies have become more aware and technically sophisticated in their fraudulent practices, and as a result, there is an intensification of financial fraud. Enron became the largest bankruptcy in American history after it was exposed to financial fraud. Subsequently, WorldCom and Vanke collapsed due to financial fraud. Prior to these cases, the founder of the Association of Certified Fraud Examiners (ACFE) Albrecht proposed that financial fraud is created by the three elements based on the fraud triangle theory: pressure, opportunity, and rationalization ^[1]. Pressure comes from operational performance and the need to raise capital for initial public offering (IPO), which is also the motivation for a company to act; opportunity comes from the lack of internal control, auditing, and regulatory institutions, which are the conditions for financial fraud to materialize; rationalization, which is subjective, is beyond the scope of this paper.

2. A brief overview of Toshiba and Luckin financial fraud cases

On July 20, 2015, the investigation report released by the investigation committee revealed that Toshiba's financial fraud lasted for seven years, with a false profit of about 151.8 billion yen, accounting for nearly one-third of Toshiba's pre-tax profit. Toshiba achieved the goal of falsely increasing profits and covering up its losses by arbitrarily estimating the percentage of project completion, delaying the recognition of costs and losses, exaggerating inventory value, as well as falsely increasing accounting revenue and other items. All three presidents successively participated in the fraud, which covered a wide range of businesses, involving almost all businesses of the company. Following Toshiba, which falsified its finances in 2015, the case of Luckin, an emerging company that falsified its finances in 2020, is more dramatic. On January 31, 2020, a well-known agency, Muddy Water, claimed that it had received an 89-page anonymous short

report, pointing out the fraud of Luckin Coffee. Then, on April 2, 2020, its share price plummeted by 80% after Luckin coffee admitted a false transaction of RMB 2.2 billion. On June 29, 2020, Luckin was delisted from NASDAQ under pressure.

3. Pressure perspective

When analyzing the financial fraud cases from the perspective of pressure factors, the common denominator is that both companies were under pressure to deliver operational results in a market filled with competition. The market downturn and industry systemic risks have led Toshiba to take desperate measures to whitewash its financial reports. The global personal computer (PC) industry has experienced sluggish growth in recent years, with its market nearly saturated and consumer demand declining. The external environment has seen a significant change. However, Toshiba's management did not fully consider these changes and continue to set high profit targets, putting the top management of each division under massive pressure. Coupled with the 2011 nuclear leak that hit Toshiba's nuclear energy business hard, Toshiba's management failed to make timely adjustments to achieve these targets. In order to meet the unrealistic profit targets, the divisions had to find ways to falsify financial reports. For instance, Toshiba's PC division attempted to gain temporary revenue at the end of the quarter by "plugging distribution channels" [2]. Due to market competition, Toshiba's core competencies have declined. Toshiba was known for its production of white goods and electronic products. However, as technology has become more advanced and competitors in the industry are pushing the boundaries, Toshiba had not been able to hold on to its position as the industry leader in its areas of strength. In 2012, Lenovo had a 29% market share, overtaking Toshiba at 12% and becoming the top PC brand in Japan. At the same time, due to Toshiba's blind business expansion, significant resources were consumed in non-core areas, such as sensors and white light-emitting diodes (LEDs). Its core competencies could no longer support the company's growth, thus further contributing to Toshiba's whitewashing of its financial statements. Toshiba did not consider the adaptation of its internal decision-making to the external environment when setting its strategic objectives and specific business objectives, resulting in poor business outcomes and the use of an illegal measure – financial fraud.

Luckin's pressure also came from the need for considerable business data. Luckin was considerably under more pressure than Toshiba because it had to go public. In terms of its business model, it is inherently flawed. As a newly established company, Luckin chose to frantically increase the number of shops and occupy the market at low prices. According to Luckin's financial report, by the end of 2019, there were 5,200 shops within two years, giving away more than 30.03 million cups of coffee for free or at low prices every month. This consumed a large amount of capital, incurring a net loss of 3.16 billion. With the beverage market already in an oversaturated state, becoming an exclusive brand requires not only a lot of money, but also time to gain favor from customers. Unfortunately, before its financial fraud scandal, Luckin did not have good customer stickiness, and at that time, customers were highly price sensitive. Luckin's public reports showed that after becoming a trading customer, the retention rate of new customers dropped to 35% or lower in the second month, showing a low customer retention rate. This is due to Luckin's marketing approach, which entails offering significant discounts to draw in marginal customers without benefiting its core customers [3]. Over time, the number of core customers decline, the same customers are repeatedly stimulated over a certain period of time, and Luckin Coffee continues to operate in a mode where it needs to attract customers with discounts, making it difficult to get out of the rut. Therefore, its sales volume and earnings are unable to grow, which is a fatal flaw for sales. In terms of its strategic objectives, Luckin wanted more financing for working capital and needed to meet the conditions for NASDAQ listing at the expense of inflating revenue by skipping orders. From inception to IPO, it took only 17 months for Luckin Coffee to successfully go public with a market value of US\$4.25 billion, setting a record for the fastest IPO in the world. In terms of motivation, Luckin's flawed business model was under pressure to

grow under competitive market competition, resulting in insufficient cash flow. The pressure factor was the incentive for Luckin to falsify its finances to continue to operate and go public so as to receive more investment, resulting in the scandal and crisis.

4. Opportunity perspective

In addition to the pressure factor as the motivation, the common opportunity factor of the two financial fraud cases is defective internal control. Toshiba had always been regarded as a model of corporate governance in Japan ^[4]. Its corporate governance structure appeared to be sound and balanced, but the various bodies did not perform their respective roles; moreover, the internal supervisory system and independent outside directors were virtually non-existent. With centralized corporate decision-making and a lack of accountability in management, President Atsushi Nishida served as Toshiba's global president and the company's director. Furthermore, two of Toshiba's external supervisory members were former diplomats and lacked professionalism ^[5]. In other words, the supervisory committee was only a mere formality that provided the opportunity for committing financial fraud rather than performing the supervisory role. Toshiba's fraudulent internal controls were in fact weaknesses in corporate governance, including an inadequate governance structure and an insufficient segregation of incompatible duties of independent outside directors. These factors are critical components of fraud opportunity.

The lack of maturity in the internal control system at Luckin provided the opportunity for financial fraud. According to a report submitted by Luckin, the financial fraud was led by a team headed by Liu Jian, the company's chief operating officer (COO), and the activities of the operation were not known to the financial department. This reflects the lack of communication among departments, the poor risk perception of the internal control department, and the wrong motivation of the company's senior management. Therefore, it is impossible for Luckin to avoid risks in a timely manner. In addition, due to the lack of contingency plans, Luckin's public relations department failed to deal with and take prompt measures following the scandal. As a result, Luckin was very passive in the face of the scandal. Other than that, there are also problems in the control structure. Executives of listed companies usually have information advantage, thus having a good grasp of the company's growth. In possession of this advantage, executives tend to play a role in financial fraud. An important clue of financial fraud is the change in the lifestyles of these executives ^[6]. Based on the publicly disclosed information in the annual report, the two major shareholders of Luckin were the company's senior executives, holding most of the shares of the company and more than 50% of the voting rights; that is to say, the overall decision-making and execution rights of the company were all in the hands of these two senior executives. The corporate governance problem was that ownership and control cannot be separated, thus making the company vulnerable to individualism in strategic planning, decision making, and execution, which can result in a significant increase in internal and external risks. The internal factors are reflected by the high relevance of shareholders' and executives' interests, the unreasonable control structure, the inability of internal controllers to perceive risks and control them promptly, as well as the lack of maturity of the public relations department. These factors have led to financial fraud problems, including false transactions and cost manipulation, the exposure of the company's unethical trading practices, and the worsening of the incident.

In terms of opportunity factors, there are differences between the two companies. Toshiba inherited a traditional Japanese corporate culture that makes its employees hesitant to defy their superiors. Additionally, it has been in a long-term partnership with an external accounting firm. Since Luckin is a Chinese company listed in the United States, cross-border regulation is more challenging. At Toshiba, the corporate culture was such that the employees must not question the authorities. Toshiba's internal auditors had identified the flaws in Toshiba's internal audit at the beginning of the period, but due to the extreme concentration of power at the top, there was a dysfunctional internal audit function ^[7]. Moreover, when Toshiba's top

management set unrealistic profit targets in pursuit of profit, the employees did not question the decision due to the corporate culture established in the company. In order to meet the unreasonable expectations, the corporate management adopted inappropriate accounting practices, which laid the groundwork for the company's operations. In addition, Toshiba's external auditing firm did not provide adequate oversight. As the auditor had been serving in partnership with Toshiba for a long period of time, it was possible for the accounting firm to condone the company's financial fraud for its benefit; the firm's appointment system was flawed^[8]. The other opportunity factors include Toshiba's arbitrary leadership style due to the Japanese corporate culture and the failure of the external audit firm in performing its due diligence; the external audit firm condoned the financial fraud, rather than basing itself on public interest.

A poor regulatory system also provides opportunities for financial fraud. It is worth mentioning that Luckin, whose main business and assets are in China, chose to be listed on NASDAQ because its financing is in overseas capital markets and its investors are all over the world. Therefore, there are problems such as overlapping supervision and a lack of access to some cross-border regulatory information. In addition, an inadequate regulatory system for listed companies also exists. In the United States, only 7% of all financial frauds are detected by the Securities and Exchange Commission^[9]. It can be seen that the flaws in the regulatory system and the difficulty of supervision due to cross-border listing had given Luckin the opportunity to commit financial fraud as a condition.

5. Conclusion

After sorting out the pressure and opportunity factors of Toshiba and Luckin, the business needs under market competition and internal control are common factors of financial fraud. Given the fierce market competition, companies tend to commit financial fraud in violation of the law when the profits from legitimate operations do not satisfy their targets to ensure that their operating figures are substantial, specifically, Toshiba to retain its market position and Luckin to attract investment by going to IPO. The concentration of the company's control power reduces the opportunity to circumvent faulty decisions. The deficiencies in internal control weaken the risk prevention function, resulting in the company's insensitivity to the occurrence of financial fraud. Along with the company's financial fraud similarities, the decadent corporate culture has fostered an environment conducive to counterfeiting. The failure of external audits to remain impartial and objective as well as the inadequacy of the market regulatory system for listed companies lead to the collapse of the external defense line against fraud. When combined with the analysis of fraud data over the years, the average years of 2000–2004 and 2011–2014 are considered high incidence periods of financial fraud, indicating that corporations have a stronger motivation for fraud in the economic downturn^[10]. With the impact of the new crown pneumonia and the generally sluggish economic performance of international markets, the number of corporate financial fraud cases will continue to trend upwards, thus warranting caution. In conclusion, enterprises should draw experience and lessons from financial scandals, clarify their strategic position, innovate development ideas, improve their corporate governance mechanisms, earnestly carry out internal supervision, strengthen the development of enterprise management culture, improve the external audit system, and actively prevent the occurrence of financial fraud. The market should continue to improve the relevant laws and regulations as well as the penalty system for financial fraud, increase the penalty for company violations, truly deter violation acts, protect the legitimate rights and interests of investors, improve investors' confidence, and ensure a more rational and healthy development of the securities and capital markets.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Albrecht WS, Romeny MB, 1986, Red-Flagging Management Fraud: A Validation. *Advances in Accounting*, 1986(03): 23–33.
- [2] Kirk S, 2015, Toshiba Accounting Scandal Could Speed Corporate Changes. *USA Today*, 2015(01): 4–5.
- [3] Cao Q, 2020, Empirical Study on Financial Fraud of Luckin Coffee. 2020 2nd International Conference on Economic Management and Model Engineering (ICEMME), 906–910.
- [4] Caplan D, Dutta S, Marcinko D, 2019, Unmasking the Fraud at Toshiba. *Issues in Accounting Education*, 34(3): 41–57.
- [5] Kang D, Bang J, 2015, Japan-Korea Relations: Sorry Seems the Hardest Work. *Comparative Connections*, 17(2): 133–145.
- [6] Cottrell DM, Albrecht WS, 1994, Recognizing the Symptoms of Employee Fraud. *Healthcare Financial Management*, 48(5): 18–22.
- [7] Erbuga G, 2019, Yes, But Was It A Real Audit? The Toshiba Case. *Internal Auditing & Risk Management*, 1(53): 89–102.
- [8] Cheng J, 2020, Analysis of Market Failure Theories Based on Toshiba’s Business Ethic Issue: Earnings Overstatement Scandal. *American Journal of Industrial and Business Management*, 10(1): 160–166.
- [9] Yu X, 2011, Corporate Lobbying and Fraud Detection. *Journal of Financial and Quantitative Analysis*, 46(06): 1865–1891.
- [10] Kagias P, Cheliatsidou A, Garefalakis A, et al., 2021, The Fraud Triangle – An Alternative Approach. *Journal of Financial Crime*, 29(3): 908–924.

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[2] Gamelin F.X., Baquet G., Berthoin S., et al. Effect of high intensity intermittent training on heart rate variability in prepubescent children. *European Journal of Applied Physiology*, 2009, 105: 731–738.

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[3] Jackson D., Firtko A., Edenborough M. Personal resilience as a strategy for surviving and thriving in the face of workplace adversity: a literature review. *Journal of Advanced Nursing*, 2009, 60(1): 1–9,

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[4] Hargreave M., Jensen A., Nielsen T.S.S., et al. Maternal use of fertility drugs and risk of cancer in children—A nationwide population-based cohort study in Denmark. *International Journal of Cancer*, 2015, 136(8): 1931–1939.

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[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.

Book with more than three authors

[6] Davis M., Charles L., Curry M.J., et al. Challenging spatial norms. 2013, Routledge, London.

Chapter or Article in Book

[7] Knowles M.S. Independent study. In Using learning contracts. 1986, Jossey-Bass, San Francisco, 89–96.

Others

Proceedings of meetings and symposiums, conference papers

[8] Chang S.S., Liaw L. and Ruppenhofer J. (eds). Proceedings of the twenty-fifth annual meeting of the Berkeley Linguistics Society, February 12–15, 1999: general session and parasession on loan word phenomena. 2000, Berkeley Linguistics Society, Berkeley.

Conference proceedings (from electronic database)

[9] Bukowski R.M. Prognostic factors for survival in metastatic renal cell carcinoma: update 2008. Innovations and challenges in renal cancer: proceedings of the third Cambridge conference. Cancer, 2009, 115 (10): 2273, viewed 19 May 2009, Academic OneFile database.

Online Document with author names

[10] Este J., Warren C., Connor L., et al. Life in the clickstream: the future of journalism, Media Entertainment and Arts Alliance, 2008. viewed 27 May 2009, http://www.alliance.org.au/documents/foj_report_final.pdf

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[11] Developing an argument n.d., viewed March 30 2009, http://web.princeton.edu/sites/writing/Writing_Center/WCWritingResources.htm

Thesis/Dissertation

[12] Gale L. The relationship between leadership and employee empowerment for successful total quality management. 2000, University of Western Sydney.

Standard

[13] Standards Australia Online. Glass in buildings: selection and installation. AS 1288–2006. 2006, SAI Global database.

Government Report

[14] National Commission of Audit. Report to the Commonwealth Government, Australian Government Publishing Service, 1996, Canberra.

Government report (online)

[15] Department of Health and Ageing. Ageing and aged care in Australia, 2008, viewed 10 November 2008, <http://www.health.gov.au/internet/main/publishing.nsf/Content/ageing>

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[16] Guide to agricultural meteorological practices. 2nd edn, Secretariat of the World Meteorological Organization, 2010, Geneva.

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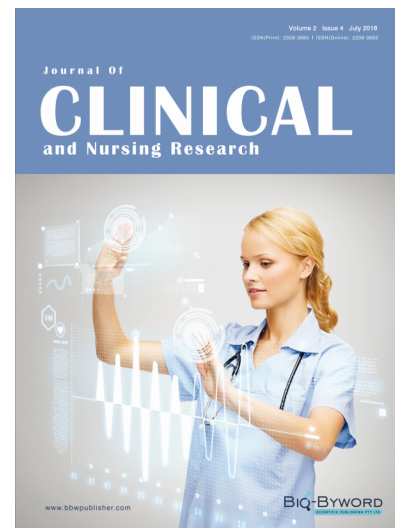
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