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Valuation and Decision-making of Real Estate Development Project based on Real option

WANG Shuangyong

Doctor of Management

Supervisors:
PhD Leandro Luís Ferreira Pereira, Associate Professor,
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May, 2022

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Declaration

I declare that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university and that to the best of my knowledge it does not contain any material previously published or written by another person except where due reference is made in the text.

Signed:  Date: 2022.4.29

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Abstract

In view of the multi-stage, highly uncertainty and irreversibility of real estate, more literatures are based on NPV investment decisions, but traditional NPV decision-making rules are difficult measure quantitatively, is an important component of project value.

This thesis is to closely integrate the multi-stage, high uncertainty, and irreversibility of investment characteristics in real estate development, consider multiple decision-making flexibilities simultaneously, apply the real options method to scientifically evaluate the value of real estate projects, and give dynamic decision-making paths that accompany the revelation of uncertainty.

It is expected that the results of the study will not only expand the research on the application of real options method in the valuation and dynamic decision-making of real estate projects and enrich cross-study of the fields of decision science and business management, but also provide realistic guidance for investment and operational decision-making of real estate enterprises in uncertain environments.

Keywords: Real Estate; Real Options; NPV; Investment Decision
JEL: M41; G11

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Resumo

Tendo em conta as múltiplas fases, altamente incertas e irreversíveis dos investimentos em bens imóveis, a literatura atual denota que as decisões de investimento são essencialmente baseadas no VAL, mas as regras tradicionais de decisão baseadas no VAL são quantitativamente difíceis de medir, sendo esta uma importante parte da avaliação do projeto.

Esta tese visa integrar as características do investimento em imobiliário em várias fases dada a incerteza e irreversibilidade, assim como, considerar múltiplas potenciais decisões em simultâneo de forma a aplicar o método das opções reais para avaliar cientificamente o valor dos projetos imobiliários, e dar alternativas de decisão que acompanham a incerteza.

Os resultados do estudo não só expandem a investigação sobre a aplicação do método das opções reais na avaliação e tomada de decisão dinâmica de projetos imobiliários, como também enriquecem o estudo da ciência da decisão e gestão empresarial, além de fornecerem uma orientação realista para o investimento e tomada de decisão operacional de empreendimentos imobiliários em ambientes incertos.

Palavras-chave: imóveis; opções reais; valor atual líquido; decisões de investimento
JEL: M41; G11

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摘要

针对地产的多阶段、高度不确定性、投资不可逆特征，更多的文献中是以 NPV 投资决策的依据,但传统的 NPV 决策规则难以量化测度的管理决策灵活性是项目价值的重要构成。

本文紧密结合房地产开发的多阶段性、高度不确定性、投资不可逆性特征，同时考虑多种决策灵活性，运用实物期权方法来科学评估房地产项目的价值，并给出伴随不确定性揭示的动态决策路径。

预期研究结果不仅能拓展实物期权方法在地产项目价值评估和动态决策中的应用研究，丰富决策科学和企业管理领域的交叉研究，还能对不确定环境房地产企业的投资与运营决策提供现实指导。

关键词：房地产；实物期权；净现值；投资决策

JEL: M41; G11

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Chapter 1: Introduction

1.1 Background, research purpose and significance

1.1.1 Background

Since 1998, China has stopped the system of allocating welfare public housing in kind and has implemented the system of monetizing the distribution of housing. During this period, China's real estate industry has experienced the development process from being positioned as a pillar industry for driving national economic development, to being gradually removed as a stable economic growth "life-saving straw" by government in hope of cultivating new economic growth points through the strategy of economic structural transformation and upgrading.

From 2000 to 2020, the annual sales amount of commercial housing increased from389.6 billion yuan to 17.36 trillion yuan (National Bureau Of Statistics [NBS], 2020), with an increase of 26.72 times and a compound annual growth rate were20.9%; The annual sales area of commercial housing rose from 186.37 million square meters (NBS, 2001c) to 1.76 billion square meters (NBS, 1999), with an increase of 9.45 times; domestic loans increased from 138.5 billion yuan (NBS, 2001b) a year to 2.6675 trillion yuan (NBS, 2020), with an increase of 19.26 times. However, sales amount, sales area, and domestic loans maintain a rising trend, while the national housing boom index shows a downward trend. Looking back, before 2016, because the real estate industry was positioned as a stabilizer of economic growth, China chose expansionary monetary policy to stimulate the real estate market. Especially in 2008, to deal with the international financial crisis, the Chinese government cut interest rates five times in a row to stimulate the development of the real estate industry. While the "4 trillion" (GOSC, 2008,) economic stimulus policy was added, and this part of the funds was mainly used for housing construction, rural infrastructure construction, railway and highway construction, so the real estate industry in China entered a "golden period". During this period, the average price of commercial housing has been rising for 29 months in a row. In 2009, the average price of commercial housing increased by 23.2%, which is the highest in history. At the same time, in 2012 and 2015, China continued to implement a loose monetary policy, which led to a sharp increase in the money supply (X. Chen & Ma, 2016). Along with the repeated reduction of statutory deposit reserve ratio and benchmark interest rate (Marley & Lou, 2015), as well as the

added incentive factor of real estate speculation motivation, China's house prices skyrocketed all the way. In view of the rapid rise of house prices, the introduction of various policies aimed at strict regulation and control makes the house prices temporarily "rest", but the rising trend has never changed. As shown in figure 1.1：

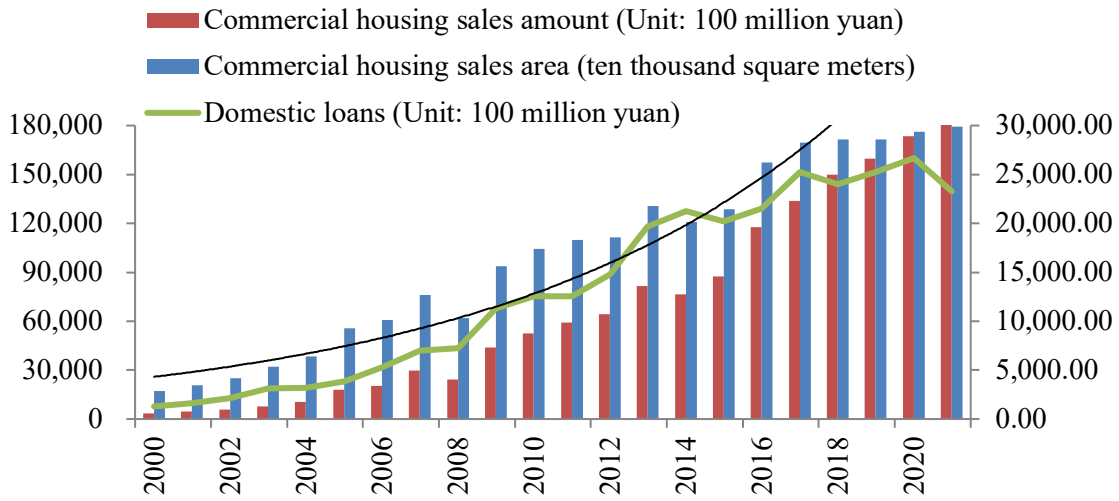

Figure 1.1 Real estate sales area, sales value, loan data

Source: NBS (2001a)

The lessons of history tell us that the American subprime mortgage crisis (H. Liu, 2013), the Japanese real estate bubble (X. Zhang & Sun, 2016), and the Hong Kong property market crash all came to an abrupt end after experiencing a series of crazy house prices. The problem of house price bubbles caused by the continued rise in house prices, and the possibility of further triggering systemic financial risks, have not only attracted high concern of many scholars, but also attracted great attention of the Chinese government. President Xi Jinping put forward work requirements in many conferences and reports in 2016 and 2017, such as "housing is for living in, not for speculation" (Xinhua News Agency, 2016) curbing real estate bubbles" (General Office of the State Council of the People's Republic of China [GOSC], 2018), "guarding the bottom line against systemic financial risk". Therefore, the impact of many policy uncertainties is very important in the process of the continuous growth and strict control of Chinese house prices, which objectively requires multi-stage investment in real estate development projects to cope with policy uncertainties.

The rising housing prices have also resulted in a significant expansion of the housing price-to-income ratio. As shown in Annexes 1.1

The direct consequence of policy uncertainty is the sharp fluctuation of house prices, which causes bad results in the operation of many real-estate company, Wanda Group, which ranks

first in commercial real estate, sold 13 cultural tourism real estate projects and 76 hotel real estate projects in 2017, amounting to 63.755 billion Yuan (Wanda Group, 2017). Country Garden Group, with annual sales of 550.8 billion yuan in 2017, suffered a multi-project collapse due to the demand for high-speed turnover of real estate development projects. Vanke Group, the No. 1 in residential real estate, shouted the slogan "Live on" in November 2018 (Liang, 2018). November 2018, Zhong Hong Group delisted due to the rising scale of overdue debts. On the surface, it seems that many real estate enterprises are thirsty for cash flow under the tight external and internal environment. However, in the depth, essentially, the occurrence of these phenomena is caused by the deep anxiety and worry of real estate enterprises in the face of various significant uncertain factors.

Due to the characteristics of capital density and fixed project location of real estate investment, once the initial investment cost of real estate is generated, there will be a certain amount of sunk cost, and the investment cost is irreversible. Any real estate enterprise, facing such huge investment amount, irreversibility after investment, and the irreversibility caused by the unique physical geographical attribute of land, fails to investment, and will inevitably bear terrible consequences.

In general, China's real estate market is in the "stimulus-tightening" cycle of the process. Real estate development projects will be subject to the changes of international environment, the requirements of domestic economic growth, the adjustment of domestic economic structure, the adjustment of fiscal policy, the adjustment of monetary policy and many other external uncertainties. In addition, with the characteristics of multi-stage development, real estate development projects have typical characteristics of uncertainty and investment irreversibility. For example, in the external environment, the uncertainty such as the international financial crisis in 2008 no longer exists, but a new uncertainty of Sino-US trade war appears. At the same time, there are new uncertainties in the internal environment, such as the transformation of economic structure and the prevention and control of air pollution. Therefore, for real estate development projects, the uncertainty of investment is continuous and dynamic.

Compared with the anxiety and worry of large real estate enterprises, small and medium-sized real estate enterprises often face the test of life and death (Shao & He, 2015). Various uncertainties including natural conditions, policy factors, market factors, in the land acquisition stage, development and construction stage, operation and sales stage of real estate projects, will have an impact on investment. Large real estate enterprises often have a large number of real estate development projects at the same time. If it is not the investment failure of a large number of real estate development projects, only the failure of a certain project has a limited impact on

large real estate enterprises as a whole. However, for small and medium-sized real estate enterprises that own only one or a few real estate development projects, it often determines their life and death whether the real estate development project with huge capital investment is successful in the end after going through three important stages of land acquisition, development and construction, operation and sales (Zeng & Qu, 2005) and hundreds of detailed nodes. As shown in figure 1.2.

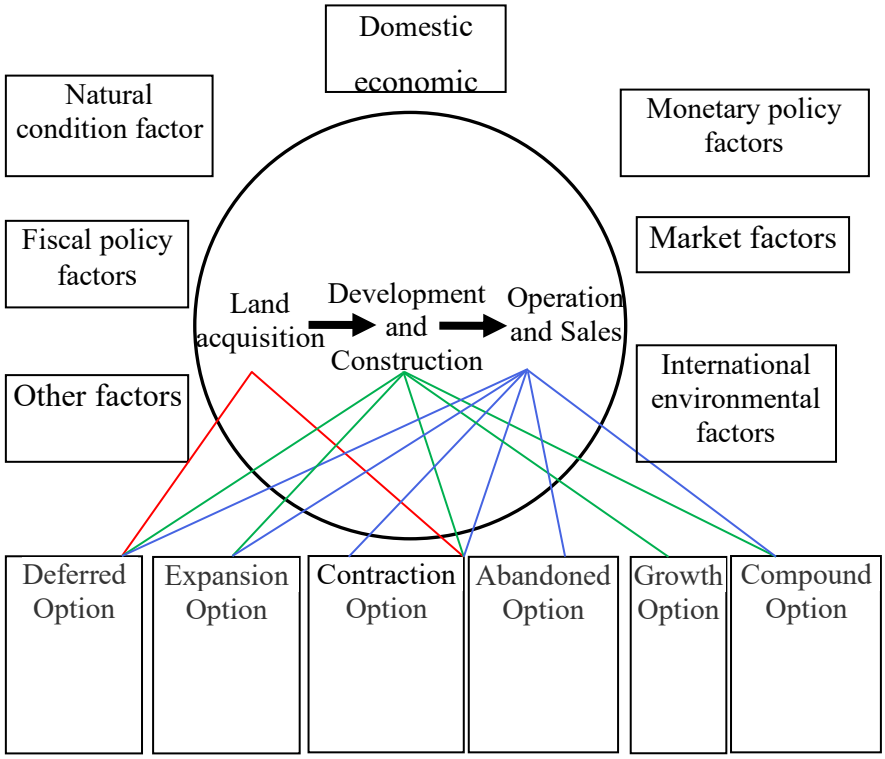

Figure 1.2 Real estate project investment multi-stage real option chart

As can be seen from the above figure, there are many forms of real options in the development and construction and sale of real estate and there are many characteristics that correspond to the characteristics that exist in real options, including the characteristics of multi-stage, uncertainty, and irreversibility. At the same time, real estate projects in different stages of the development process are faced with various uncertainties, such as international environmental factors, domestic economic factors, market factors, monetary policy factors, which endow different types of real options for real estate development projects in different stages.

(1) Land acquisition stage: This stage is the initial stage of a real estate development enterprise, where the real estate enterprise obtains land use rights through bidding, auction, and listing, and only on this basis can the real estate project be developed, constructed and sold. In an uncertain market environment, economic environment and policy environment, delayed development of land will yield more valuable information and therefore delayed development

and construction will create more value. Moreover, the greater the uncertainty, the greater the potential value. Therefore, at this stage, there are deferred options and abandoned options.

(2) Development and construction stage: China's real estate market has always been accompanied by intensive regulatory policies. In addition to the impact of market uncertainty and competition, policy uncertainty profoundly affects, the decision-making of investors. When the policy environment is good; the increase of policy uncertainty will delay investment. When the policy environment is poor, the increase of policy uncertainty will accelerate investment. Therefore, it is also necessary to use real option method to analyze and judge whether to carry out development &construction, when to carry out development &construction, and the scale of development & construction and so on at this stage. This stage mainly includes deferred options, expansion options, contraction options, multiple options overlapping compound options.

(3) Operation and sale stage: The stage d sale of real estate projects is a unique phenomenon in China. Because of the incomplete information of the real estate market in China, developers cannot obtain the accurate demand or price information. Therefore, the real estate enterprises need to find demand or price information through stage d sale, to reduce the risk of miscalculation of the market. At this stage, the real estate enterprises have the options based on the judgment of the future market. Therefore, in the sale stage, the option of deferring sale in stage s is mainly according to the market price.

1.1.2 Theoretical significance

With the increase of economic policy uncertainty after the global financial crisis in 2008 Baker et al. (2015); Morikawa (2016) believes that economic policy uncertainty is the main source of economic uncertainty. In this environment, China's real estate industry has developed rapidly in recent years, and a large amount of money has been pouring into the real estate industry, so the bubble in the real estate industry is becoming more and more obvious. At the same time, with the release of various policies restricting real estate at the national level, the environment of the real estate industry has become increasingly complex. In this case, it is risky to rely only on traditional analysis methods and the experience and intuition of decision makers to make investment judgments. Therefore, investors should consider the uncertainty of the project and the irreversibility of the investment, carry out more in-depth analysis, to fully realize the flexible value contained in the real estate project investment, and introduce the real estate project investment decision into the right track. Under this background, real option method is gradually

introduced into real estate investment decision analysis, especially in recent years, the research of real option analysis technology on real estate investment decision has greatly changed researchers' modeling habits of real estate investment decision and has become one of the important research fields of domestic and foreign scholars.

It has rich management enlightenment and practical guiding significance for the investment decision-making of real estate enterprises. The real option method helps enterprises to achieve the optimal investment time and investment scale under uncertain conditions, broadens the vision of enterprise investment, and can further improve the science and accuracy of enterprise investment decision-making. it has a certain academic significance and application prospect for the current research on enterprise investment decision under uncertain conditions.

1.1.3 Practical significance

The real estate industry has been developing rapidly in recent years, and a large amount of capital has been pouring into the real estate industry. Therefore, the bubble in the real estate industry is becoming more and more obvious. With the policies of restricting the real estate issued at the national level, the environment of the real estate industry has become increasingly complex. Under such circumstances, only relying on traditional analysis methods and decision makers' own experience and intuition to make investment judgments, the risk is huge. Therefore, investors should consider the uncertainty of the project and the irreversibility of investment, and conduct a more in-depth analysis, to fully recognize the flexible value contained in the investment of real estate project and introduce the investment decision-making of real estate projects into the right track.

It has rich management enlightenment, such as real estate enterprises salary incentives, assessment, merger and acquisition decision-making and other practical guiding significance. Real option method can help enterprise decision makers improve their thinking mode. In the case of high uncertainty and irreversible investment, if real estate enterprises want to maintain long-term and sustainable competitiveness, they must attract and retain outstanding talents. Therefore, establishing a perfect and effective salary incentive mechanism is the key to the healthy development of enterprises. Similarly, the real option method plays an important guiding role in the decision-making process of merger and acquisition of enterprises.

1.2 Research problem

In view of the multi-stage, highly uncertainty and irreversibility of real estate, more literatures

are based on NPV investment decisions, but traditional NPV decision-making rules are difficult to guide corporate decision-making practices, and the flexibility of management decision-making, which is difficult to measure quantitatively, is an important component of project value. A minority of the literature, while using the real options approach, lacks a simultaneous consideration of various decision-making flexibility such as option to expand, option to defer, and option to abandon.

Therefore, the research problem of this thesis is to closely integrate the multi-stage, high uncertainty, and irreversibility of investment characteristics in real estate development, consider multiple decision-making flexibilities simultaneously, apply the real options method to scientifically evaluate the value of real estate projects, and give dynamic decision-making paths that accompany the revelation of uncertainty. It is expected that the results of the study will not only expand the research on the application of real options method in the valuation and dynamic decision-making of real estate projects and enrich cross-study of the fields of decision science and business management, but also provide realistic guidance for investment and operational decision-making of real estate enterprises in uncertain environments.

1.3 Research questions

The questions research in this thesis include:

(1) How to abstract and refine the characteristics and types of real options in real estate, taking into account their economic characteristics and investment practices?

(2) How to simultaneously consider various real options including mutually exclusive options, multiple interacting options, use case company data to estimate key parameters, quantitatively measure the value created by decision-making flexibility, and obtain a dynamic path for real estate investment decision-making?

1.4 Technical approach

The technical approach followed in this thesis is presented in Figure 1.3:

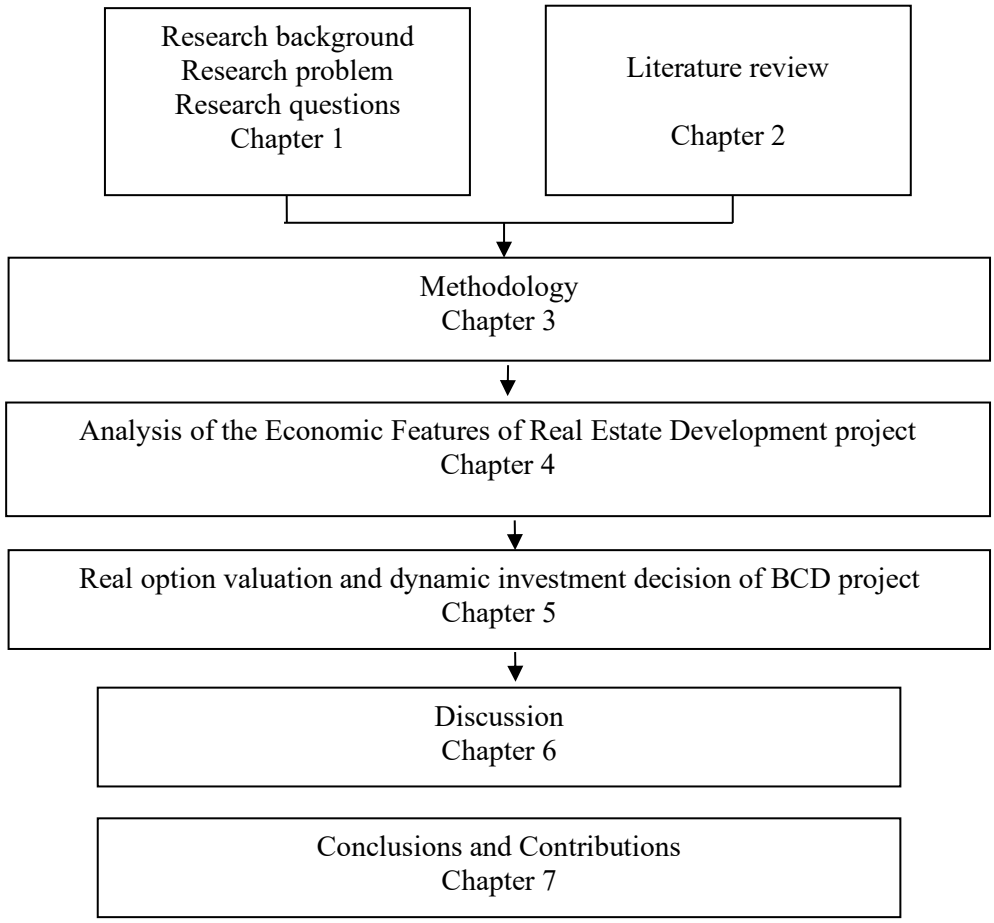

Figure 1.3 Technical approach

Chapter 2: Literature review

2.1 Basic concept

2.1.1 Definition of real estate

The real estate refers to the land that can be developed, the buildings fixed on the land and the various rights and interests attached to the buildings, which can exist in three forms including land, buildings and buildings and land in one (Mba Debase, 2021). Therefore, the real estate is not only an objective material form but also the combination of various rights and interests. According to specific regulations of the Regulations for the Implementation of the Land Management law of the People's Republic of China (GOSC, 2021), all land ownership in China belongs to the nation, and the land usage right of enterprises and individuals is only for 40 years or 70 years without the ownership of land (GOSC, 2021). Therefore, the concept of real estate in China should be interpreted as the land usage right for a limited period rather than the traditional sense of ownership of land. Some countries call the real estate immovable property or property (Agliardi, 2001), which includes four meanings as follows:

(1) The real estate takes land and buildings as the material form of its existence, yet it differs from other assets in that it is an abstract and special form of asset in the economic category as well as the symbol of wealth.

(2) Real estate, as a special kind of asset to be abstracted, manifests its tenure relations differently in different situations. Its tenure relationships can be both transferred and inherited, mortgaged and divided.

(3) The real estate acquires its rights and interests through the transfer of property rights, thus giving rise to various commercial practices and business activities related to real estate.

(4) The real estate is always necessary for human survival and life as the basis and carrier of all economic activities. When people only need it for survival, the definition of real estate is merely the land and the appendants on it which need to be developed and utilized by people. When people treat real estate as assets, it is an indispensable part of productivity.

2.1.2 Financial features of real estate

The essence of finance is capital financing and financial pricing. In short, financial features can be understood as the asset nature of commodities which is mainly determined by the liquidity

and value-added function of commodities. In the history of human development, due to the huge rigid demand and ease of transaction of commodities, they generally possess financial features. Housing is also a large consumer commodity with certain financial features. The real estate is like ordinary commodities with use value and physical circulation, but also has the same function of value preservation and capital financing as financial products. Further, the real estate has both commodity properties and financial features.

The financial attributes of real estate have two meanings: on the one hand, real estate has the characteristics of a financial product, as it can be circulated and thus earn a profit in the process of circulation. On the other hand, real estate also has the financial function those financial products have, as it can reallocate various resources across different groups of people, geographical areas, and maturities.

The characteristics of real estate derive from the characteristics of the inseparable land resources with which it is associated. Land resources tend to have much greater price volatility than houses while the land naturally possesses financial features. Thus, in other words, the financial features of land are the root of the financial features of real estate. In economics, real estate is also known as immovable property which is immovable, indivisible and expensive, thus forming the distinctive features of large capital investment, weak property replaceability and aggregated business risks throughout the entire period of real estate investment, construction, sales and property management.

In terms of the financial features of real estate it is an asset of its owner capable of preserving or increasing the value and diversifying and hedging capital risks. On the other hand, real estate also has natural properties such as fixation and durability. The real estate which has both natural and economic properties meet the intrinsic requirements of the financial industry through its large-scale operations, long-cycle investments, and ability to serve as collateral. Therefore, the financial features of real estate itself continue to be strengthened under the impetus of economic financialization, and the financialization result of economic features of real estate is obtained based on the natural features of real estate.

As China's urbanization accelerates, more and more rural people are moving into the cities, and driven by this, housing prices are rising rapidly. At the same time, the urban population wants to be upgraded in terms of housing location, housing area and housing environment. The foreign population, on the other hand, must buy a house in the city to be able to live. The different housing needs of the urban population and the foreign population have increased the real estate investment effect. For some real estate projects with excellent location and concentrated commercial centers, they become the object of purchase by the crowd, because

such commodity houses have more investment value and highlight the financial attributes of real estate.

The operation of the financial system as well as the financial regulatory system constructed over the forty years of reform and opening in China has been designed to enhance the economic model of urbanization development in various regions and the continued promotion of the national industrial progress, resulting in the continuous increase in the financialization of real estate. In the context of an increasingly complex international economic situation, China hopes to gradually get rid of its dependence on the real estate sector through its economic structural transformation and upgrading strategy to cultivate new economic growth points, to avoid a considerable degree of debt default and economic recession that may be triggered by the lowering of economic indicators and the increase in the country's debt burden. As a result, real estate regulation and control policies have been enacted several times, and the overall regulation and control measures been carried out more than 420 times from January to October in 2021 with the macroeconomic regulation of the real estate market adhering to the principle of housing without speculation (Phoenix, 2021).

It is obvious that the increasing financial features of real estate in China have generated many real estate bubbles and triggered the Chinese government to enact various regulatory measures on the real estate industry, which has also greatly increased the uncertainty of investment in real estate projects in this context.

2.2 Institutional background of real estate in China and related studies

2.2.1 Land finance system in China

The land ownership is owned by the nation in China while land is one of the necessary elements for production and construction. Meanwhile, due to the country's special fiscal and taxation system, each local government sells land usage right to obtain the main source of local fiscal revenue, thus leading to constant fluctuations in China's macro economy due to the significant impact of land price increases and decreases.

The local governments in China have used bidding, auction and listing to sell land usage right since 2002, thus pushing up the price of land and gaining considerable revenue from land usage right and related taxes and fees. More importantly, it is possible to depend on land mortgages to directly borrow money from banks, eventually forming the investment and financing model of selling land to generate wealth and pledging to float a loan (Fan & Mo,

2014). The monopoly of the local governments on the land market has resulted in excessive reliance on land concession revenues in the regions, which inevitably leads to an increase in the macroeconomic risks.

In 1999, the proportion of local revenue from land concessions in China was 8.14% (C. Xin et al., 2021) and 84% in 2020 (Tencent, 2021). Therefore, it could be found that the local governments have become more dependent on land concession revenues while the phenomenon of so-called land finance emerged (C. Ding, 2007; Peterson, 2007). The research shows that the land finance system enables the local governments more power to determine the amount and timing of land concessions which leads to the monopoly on land supply. Therefore, the main characteristic of land finance is that local governments rely on land sales as the main source of revenue.

Land revenue consists of a variety of elements, including both the revenue generated from the sale of land use rights and the various taxes associated with the sale of land use rights, including land value-added tax (LVRT) generated during the sale of land use rights, and various taxes such as land use tax, deed tax and property tax. This shows that land finance is an important part of fiscal revenue and plays an important role in the development of the national economy. According to the data of fiscal revenue released by the Ministry of Finance, the revenue from land concessions of Chinese government was 8.41 trillion yuan in 2020, accounting for 84.03% of the local fiscal revenue in that year, and the ratio would reach 103.7% if the taxes related to land were added (Tencent, 2021). The study found that the correlation coefficient between the revenue from land usage right transfer and the market financing scale in China reached 0.95 from 2002 to 2017, thus showing that the marketization and financialization of land resources in China has become obvious.

China has witnessed rapid urbanization and industrialization in the recent twenty years and the increasing demand for public services. On the one hand, the government should provide more public services, and on the other hand, should depend on the large-scale infrastructure construction as the main means to attract investment and drive economic growth. Land finance not only promotes the development of local construction and real estate industries as well as the local economic growth, but also drives the growth of related taxes, which are consistent with the interest pursuit goals of local governments, hence it provides an important revenue guarantee for local governments. Meanwhile, the local governments' absolute control over land-related revenue coupled with the high premium rate generated by land concessions have given rise to the strong incentive for local governments to gain revenue through land concessions. Under the circumstance, local governments can only obtain funds through land

finance to meet their needs in various aspects. Du et al. (2009) found have shown that land finance can increase local government revenue as well as increase investment in fixed assets, and therefore local governments , with the role of land finance, play a significant role in promoting government functions. Xiang et al. (2017) suggested that land finance drives macroeconomic growth. They concluded that local governments obtain higher tax revenue through land finance to promote the growth of GDP so as to meet the need for political promotion, which also ensures the short-term economic growth but overdraw the local future development space. Z. Huang (2011) figured out that the main performance appraisal mechanism of local governments under the current taxation system in China is the economic development, thus leading to the fact that land finance is an inevitable choice for local governments. Jia et al. (2012) analyzed the data of local governments in China from 2003 to 2008, and the results proved that the competition for promotion of local government officials is the root cause of land finance. Y. Li et al. (2013) studied the relationship between land finance and promotion mechanism and found that the promotion mechanism of local governments is closely relate to the land finance, which is a key factor for the long-term rapid growth of China's economy.

As local governments become more and more dependent on land finance, a development pattern of expropriating land, developing the expropriated land, and offering the developed projects for sale has gradually developed, leading to a geometric expansion of land finance. However, in such a situation, a cycle is formed and the financial pressure on local governments gradually increases, resulting in further dependence on land finance by local governments, which is increasing year by year. Economic expenditure accounts for the bulk of local fiscal expenditure compared to expenditure on people's livelihoods, which continues to accelerate the rate of land urbanization, while weakening the attractiveness of foreign populations, causing the population to gradually lag in terms of the urbanization of the population, resulting in a situation where a large number of newly built houses go unpurchased, and a large number of industrial parks are not occupied by enterprises. The external manifestation of land finance is that it attracts more investment and promotes the development of the real estate sector, but land finance violates the objective laws of development and undermines the effect of the market's spontaneous matching of resources, thus creating a mismatch between supply and demand and causing changes. While, initially, land finance will generate higher economic growth, it will undermine the potential for future economic growth. On the other hand, considering that infrastructure construction does not bring higher tax revenue, the financial difficulties of local governments will be further aggravated so as to result in higher indebtedness of local

governments year by year. Andrew and Iwata (2005) suggested that the increasing risk of local government debt and its impact on macroeconomic fluctuations are due to the development model of local governments' over-reliance on borrowing debt through land, which lead to the local government debt. Fan and Mo (2014) conducted the in-depth study on the leverage role played by land finance and concluded that, on the one hand, local governments obtain high fiscal revenues through transferring land usage right, and they obtain bank loans through land mortgages on the other hand, which are used for infrastructure construction and investment to play leverage role in local economic growth. Hence land finance builds a link between local government debt and economic growth. Reinhart et al. (2013) showed that land finance raises long-term interest rates through credit expansion to trigger the increased short-term consumption volatility. However, the decline in private consumption or investment caused by the increased government spending, also known as crowding-out effect, would have a negative impact on economic growth in the long term. Guo and Gu (2013) argued that the negative impact of inflated industrial structure due to the local governments' land finance lies in the fact that the accumulation of industries cannot meet the excessive expansion of urban land, and the development of productive industries or services by local governments lags behind the development of the real estate sector. Zou and Liu (2015) found that land finance accelerates urbanization but neglects the balanced development of secondary and tertiary industries as well as the efficient allocation of resources.

Since the cost of land is one of the most important components of housing prices, the land finance practice of local government pushes up commercial building prices, while land or commercial building as the main collateral affects related credit resources, which further transmits volatility to real investment and the macro economy. Carroll et al. (2011) have shown that the increase of each one dollar in commercial building prices in the U.S. would boost short-term and long-term consumption by 0.2 and 0.9 dollars respectively. Ge and Qian (2014) thought that every 1% increase in land concession revenue in China leads to a 0.173% increase of the local economy and this effect is expanding. Davis and Heathcote (2007)confirmed that the fluctuation in house prices is mainly caused by land price fluctuation. probed into the impact of land concession ways on land prices and house prices, while S. Zhang and Li (2010) started from the relationship between local governments' land finance and changes of local commercial building price to find that the higher the dependence of local governments on land finance, the faster real estate prices rise in cities through the regression analysis of historical data. W. Lv and Liu (2012) showed that the speculative bubble in China's real estate market has been evident in many cities since 2003 and has grown tremendously in each city since 2005, and that

land finance has become an important cause of the creation of speculative real estate bubble in China.

The land financing of local governments exacerbates the problem of final overcapacity to a certain extent and has a negative impact on economic fluctuations. With the increasing scale of local government debt, regional economic fluctuations have become more intense with persistence, while economic fluctuations have been affected by local government debt to an extent that cannot be ignored. As a result, many scholars have found through their research that where local governments obtain funds through land financing, creating local debt, it is underpinned by this debt that allows local governments to spend more, and that government spending can have a huge impact on the local economy, and consequently on the economy. Jian Lv (2015) found that the revenue received by local governments through the sale of land use rights is positively proportional to the size of local debt. The significant increase in local debt has been accompanied by a significant acquisition of land by the local government. His research shows that debt can contribute to local economic growth when the ratio of new local government debt to local GDP is within the 6% range. However, the massive borrowing of debt through land to drive local investment and economic growth is only a short-term action that will damage the local economy in the long run. Therefore, as the scale of local government debt grows, so does the pressure to service it. Under this cycle, the dependence of local lands on land finance gradually develops, especially in times of economic recession, and the role of land finance in supporting local governments becomes more obvious. The government work reports have repeatedly raised in previous years that local governments across China have invested funds on a larger scale in the process of accelerating economic development, leading to the situation where the social investment efficiency of funds is low, especially in some regions or industries where impulsive investment and low-level duplication of construction is very serious.

The rising commercial building prices and land finance in China constitute the important element and distinctive features of the urban development with Chinese characteristics. Considering that land finance has a huge impact on the fluctuation of commercial building prices, it therefore increases the uncertainty of real estate development enterprises. From the perspective of the real option, whether and when a real estate development enterprise buys land and when it develops the land after purchase become the uncertainty factors. There is a delay in land development after real estate enterprises purchase land, and they would only develop land when the price of commercial building rises to a certain level, which is consistent with the fact that real estate enterprises in China have a certain scale of land reserves in various cities. Therefore, the higher the uncertainty in the real estate market, the more delayed the optimal

investment timing.

2.2.2 Commercial building price fluctuation and property-value bubble

The price theory has been an indispensable subject of economics research, the meaning of which is that price is the embodiment of commodity exchange relations and the basis for the formation of a market. The price theory during the 17th to 19th century considered that the price is determined by the labor and production costs used in the production of goods. The price theory during the end of 19th century to the end of 20th century which still prevails today put forward that the price depends on the relationship between supply and demand.

The commodity housing has significant dual properties. On the one hand, the price of a commercial property is determined by the cost of land and the cost of construction, which are key factors in determining the price of a commercial property, and on this basis, the price of a commercial property also depends on the relationship between supply and demand. On the other hand, commodity housing also has the characteristics of a financial good, as it has the characteristics of a financial good in terms of value preservation and appreciation. Therefore, the price of commercial building under uncertainty should consider the possibility of investment appreciation of commercial building in addition to the land cost and construction cost. Between the attributes of consumer goods and capital asset, the price of commercial building ultimately depends on supply and demand with the asset attribute being an important factor in the fluctuation of commercial building price. With the development of asset pricing model in the financial market, the investment attribute of commercial buildings is widely recognized while the pricing model of commercial building has changed from supply and demand pricing to capitalized pricing. The capitalized pricing approach makes commercial building possess obvious financial attribute, which would drive strong fluctuations in commercial building prices when the speculative investment is excessively involved. The frequent and significant price fluctuations further strengthen the financial attributes of commercial properties.

Due to the special nature of real estate industry and its important position and role in the macro economy, the fluctuation of commercial building price becomes a complex issue. The house price volatility is a phenomenon that does not have a clear and uniform concept but rather manifests itself in unstable changes in commercial building prices, which may change over time or geographically. The changes in commercial building prices are usually considered as deviations from the basic economic development, and indicators such as population, income,

prices, interest rates, unemployment rates and construction costs are usually used to reflect the basic economic development. However, the definition of the fluctuation of commercial building prices should consider not only the economic development factors but also the currency and capital market. The price of commercial building in China was 1,854 yuan/m^2 in 1998 and 9287 yuan/m^2 in 2019 with the cumulative increase of 400.92% (H. He, 2021). According to the statistic of the people ‘s bank of China, the share of property in the assets of Chinese urban households reached 70 % by October 2019, thus revealing the significant financial effect of commercial building price fluctuations.

There are many factors influencing the fluctuation of commercial building prices, and a lot of literature have studied the causes of commercial building price fluctuations. But domestic and foreign studies lack unified metrics and it is difficult to define a reasonable range of indicators, among which the income, population and consumer expectation are the main research directions. Allen (1988) argued that the lasting income of residents exerts an important influence on house prices. L. Liu et al. (2003) concluded that growth rate of real estate price or real growth rate of GDP, housing loans or residents’ monthly income, and the ratio of housing price to income can be important indicators for measuring real estate bubbles. Jianglin Lv (2010) analyzed various indicators of real estate bubbles, combining theory and the actual situation in China, one of the most reasonable indicators to measure the existence of a bubble economy in a country's real estate sector is housing price-to-income ratio. He also calculated that a reasonable range of house price-to-income ratios that urban residents in China can afford is between 4.38 and 6.78 times. And in his study of 35 cities in China between 2006 and 2008, his research showed that the average value of the ratio of commercial housing prices to income in these 35 cities was around 10. Only nine cities were within the normal range, and 15 cities were above 10 times. Diego et al. (2015) thought that the housing price to income ratio is a critical indicator to measure the real estate bubble, which is a more intuitive indicator referring to the years for a household to buy a commercial building with the income. Many scholars have also conducted studies on the population. For example, Mankiw and Weil (1992) studied the demand for housing among different age groups in the United States and concluded that the newly born population would not impress the real estate market during the same period. Lu et al. (2014) found that immigrants have a huge impact on the increase of local commercial housing prices, namely higher prices in cities with a larger number of immigrants, on the basis of a study on the number of immigrants in a city. Buiter (2010) concluded that real estate wealth is a boost to consumption when the real estate bubble is rational. Under the influence of a real estate bubble, the price of a commercial property will be higher than its base value, and therefore the owner

of a commercial property can earn more rental income by renting out his commercial property. This rental income is the expenditure of the tenant, and the total amount of consumption of the whole society remains unchanged after the rental income and rental expenditure have been offset. However, owners of commercial properties can obtain more financial support by mortgaging their commercial properties, thus increasing the total consumption of the whole society. B. Chen and Zhang (2016) studied the effect of human capital factors on the price of commercial housing, and the results showed that the price of commercial building would increase by 4.6% to 7.9% for every 1% increase in the share of higher education population. Xu et al. (2012) explored the relationship between the juvenile dependency ratio and the elderly dependency ratio and the price of commercial building. The study showed that an increase in the juvenile dependency ratio leads to a decrease in the price of commercial housing while an increase in the elderly dependency ratio to an increase in the price of commercial housing, and that the price of commercial building would gradually decrease when the savings of the elderly are released. Y. Chen and Chen (2021) analyzed the impact of real estate on China's urbanization process and conclude that the development of real estate has a significant impact on the urbanization of the population, economy, and land, and that the rise in real estate prices has different effects on the population in different regions, but in terms of economic and land urbanization, it is conducive to attracting high-tech companies and top talent. As for the consumer expectation, Clayton (1997) studied the real estate market in Vancouver and conducted an empirical study. The findings show that rising and falling real estate prices have an inverse relationship with homebuyers' consumption expectations, which infers that irrational consumption expectations exist in real estate.

The process of gradual concentration of systemic financial risk is reflected in the rapid rise in commercial building prices and the significant increase in household and bank leverage. As commercial building prices are expected to continue to rise, most home buyers choose to purchase commercial building through taking loans from banks. On the other hand, considering that banks are more inclined to anticipate optimistically the future development of real estate market, they would provide considerable loan amounts to real estate development enterprises or individuals, thus forming a gas pedal of rising commercial building prices and growing bank loans which constantly exacerbates the reversal of expectations and slump of housing prices. The burst real estate bubbles are coupled with the significant increase in the default rate of repayment and further deterioration of bank asset quality, which lead to the serious lack of liquidity of assets and eventually comprehensive systemic risks in the entire financial systems.

Among the empirical studies of commercial building price bubbles, some scholars have

defined bubbles in terms of the process of commercial building price changes. Kindleberger (1987) argued that the real estate bubble, with a continuous surge in asset prices, created an expectation that the price of the asset would continue to grow, but that when the asset price rose to its peak, it would quickly plummet, eventually leading to a financial crisis. At the same time, he also pointed out that it was the expectation of rising asset prices that led to the creation of the bubble. Yoshi (1998) considered that a bubble is considered to be a process whereby the price of securities and all types of real estate dramatically exceeds their value, and their prices are severely divorced from the normal production and distribution chain of the economy, resulting in a price spike followed by a rapid price collapse. Garber (1990) argued that asset prices continue to rise but cannot be explained by indicators such as cash flow and discount rate, and that the part that cannot be explained is the asset bubble. Case and Shiller (1990) also explained the formation of bubbles from the perspective of expectations and processes, which is a scenario of higher prices mainly due to the expectation of excessive price increases in the future. They argued that the emergence and maintenance of bubbles is the result of a manic psychology, a general over-optimism that is severely disconnected from the reasonable expectations of the country's long-term economy. Riddel (2011) put forward that commercial building prices consist of a base price and a bubble price, of which the former is influenced by factors such as population and income while the latter drives the price transmission of commercial building. Franklin and Elena (2013) argued that macro policies play an important role in the formation of commercial building price bubbles, while the transmission of commercial building price bubbles is essentially the phenomenon of currency flow. Teng et al. (2016) studied the effect of spatial price difference between central and peripheral urban areas on commercial building price bubbles, and its findings suggested that the contagion of commercial building price bubble is caused by the existence of price difference. Fang (2015) concluded that the continuous increase in commercial building prices has led to the expectation that commercial building prices would only go up but not down, which further stimulates many people to take out debt to buy commercial building. Moreover, the banking institutions has a close relationship of community of interest with the real estate industry, while the development of the construction industry, steel industry and other industries are closely related to the real estate industry, hence the real estate and its related industries would flow more credit funds invested by the banking institutions.

The commercial building price fluctuations and commercial building price bubbles are both price phenomena and market price deviations from the base price. But there are differences between the two, including: 1. commercial building price fluctuations reflect price changes over

time which is both a process and a state. The commercial building price bubbles reflect the degree of price deviation which is a state. 2. Both are related and different in that commercial building price fluctuation is the premise of commercial building price bubble, while commercial building price bubble is the result of commercial building price fluctuation. commercial building price fluctuation does not necessarily produce bubble, but it would produce bubble after reaching a certain degree. Moreover, the fluctuation is around the rise or fall of the base price, hence commercial building price bubble would have both positive and negative directions.

2.2.3 Advance sale system of commercial building in China

The advance sale system of commercial building is one of the main forms of sales in the real estate sales market, in which home buyers purchase houses under construction sold by real estate enterprises through paying the deposit or house payment in advance, forming the commercial building advance sale system in China (Ministry Of Housing Urban Rural Of Housing Development Of The People Republic Of China [MLNR], 2001). The original advance sale system of real estate originated in Hong Kong just after the Second World War in the early 1950s, with a huge demand for residential and commercial buildings due to the large influx of population and rapid economic development. In the context of development, the Hong Kong Li Xin Real Estate Company Limited founded by Henry was the first to pioneer the advance sale method of office and residential buildings in layers and units, selling the off-plan property and introducing the sales model of paying the house payment in installments. In 1956.

The Hong Kong Special Administrative Region Government issued the Consent to Advance Sale of Off-plan Property, which marked that the advance sale system of off-plan property has been formally established and regulated in law since then.

The characteristics of the advance sale system of commercial building in China can be summarized as four points: (1) The pre-sold commercial properties have significant commercialized and socialized attributes. (2) The pre-sold commercial properties are part of the construction in progress and are in a normal state of construction, just not completed. (3) Property developers are the primary responsible parties for conducting the pre-sale of commercial properties. (4) In conducting the pre-sale of commercial properties, all its processes must strictly comply with the relevant Chinese laws and regulations.

The development of real estate economy in China has been largely driven by the positive effect of the establishment of commercial building advance sale system. The advance sale of commercial building in China has become the most common way to sell houses and one of the

factors driving the rapid economic development of China. Its advantages mainly include: (1) For real estate development enterprises, it could shorten the cycle of capital recovery, reduce the risk of capital breakage, and effectively meet the huge financing needs. (2) For the demand, the property under construction often has greater price concessions than the ready house, hence the real estate advance sale system and the way of paying for the house in installments effectively lower the threshold for consumers to purchase houses and stimulate the potential demand of the market.

However, the Commercial Housing Sales Management Measures does not make specific provisions on how to supervise the advance sale funds of commercial building, hence some defects exist in this system. To make up for the shortcomings, each city has issued some local regulatory documents to strengthen the supervision of the advance sale funds of commercial building. But even so, it is still difficult to avoid various risks arising from the inadequate supervision of advance sale funds.

Meanwhile, the advance sale system of commercial housing is affected by the unbalanced socioeconomic development, the uncoordinated market economy and the laws and regulations to be improved. The defects have brought about various social problems: (1) The lack of a supervised financing mechanism. The real estate development enterprises receive the entire house payment at once in the housing construction link, which is essentially a substitute for the consumer to bear the potential financing pressure and the risks faced by the property developers before obtaining the property. As a result, home buyers are exposed to the legal risks of possible housing quality problems, delayed application for housing ownership certificates, jerry-building by real estate development enterprises, misappropriation of construction funds by property developers and even illegal absconding. In terms of the transaction of ready house, the property developers would bear huge capital and cost pressure during the construction of the house as well as the operational risk brought by the stagnant sale of house during the sales period, leading to the increasing market elimination rate in the real estate industry. The commercial building advance sale system can change the situation, so that the real estate developers gain greater profit margin while more risk transferred to the house buyers. However, if the developers divert the advance sale funds to other investment projects, or if the real estate developers go bankrupt or even abscond with the advance sale funds, it will lead to heavy losses for the house buyers and bring great potential danger to social stability. (2) Under the advance sale system, real estate developers can sell the houses under development and construction to home buyers through obtaining advance sale licenses for commercial building that enable them to quickly recover the initial capital invested, which could lower the investment standards for

the real estate development industry and attract many developers to enter the real estate industry but leads to a vicious expansion of the real estate industry. Meanwhile, the money used by house buyers to pay for the advance sale of commercial building mainly comes from bank loans. Therefore, real estate developers transfer real estate bubbles and systemic financial risks to the banking system through the real estate advance sale system. (3) Along with the development of real estate economy in China, a series of laws and regulations have been implemented to regulate the real estate market. However, the social and economic problems caused by the commercial building advance sale system cannot be effectively controlled under the existing legal system, revealing that the laws and regulations related to the commercial building advance sale system are relatively outdated. Meanwhile, government departments are not effective in supervision and the lack of government management functions makes it difficult to efficiently perform the supervision of the real estate industry and market behavior, so that the interests of house buyers are not protected.

To prevent the bursting of real estate bubbles from having a huge impact on the financial market, triggering systemic risks, and even leading to financial and economic crises, the Chinese government has been reinforcing the regulation of real estate industry. Meanwhile, the defects of real estate advance sale system have been gradually obvious, while the positive effects of the advance sale system of commercial building in the early years have gradually diminished. It has revealed the problems including too much inclination to the interests of developers, lack of corresponding regulatory mechanism, and no perfect market environment to cooperate.

Several issues that need to be urgently addressed to strengthen the future of commercial building advance sale funds.

(1) It is supposed to improve the management methods for advance sale of commercial housing. The 17th Report on China's Urban Competitiveness proposed that the urban population in China is expected to increase to 131 million in 2035, accounting for 70% of the national total population, who are an important purchasing group for commercial housing in China's cities and towns. Therefore, effective supervision of the advance sale funds of commercial houses is related to the protection of the huge property of hundreds of millions of people, which can legally safeguard the legitimate rights and interests of property rights and housing rights of home buyers, maintain the fair competition among real estate developers, and implement the comprehensive supervision of the capital chain in the process of real estate development and construction, including the collection and use of development funds. Therefore, the establishment of sound legal supervision provisions related to the advance sale

funds of commercial building can highlight the authority, constraint, and stability, which is related to the survival of real estate enterprises and the stable development of the whole real estate industry.

(2) It is necessary to clarify the responsibilities of regulatory parties and improve the procedures for the supervision of advance sale funds of commercial building. About the advance sale funds obtained from the advance sale of commercial building, the advance sale funds supervision system and the monitoring mechanism with effective participation of the purchasers shall be established in all aspects of the deposit, collection, disbursement, and use of the funds. In particular, the developer's liability for breach of contract and its obligation to earmark and deposit the funds exclusively must be clarified in the advance sale contract, and the developer cannot directly collect and manage the advance sale funds. At the same time, the banking system regulators shall strengthen the comprehensive supervision and verification of the financial business carried out by the branches of commercial banks at all levels. The China Banking Regulatory Commission and the Central Bank should depend on regulatory means to lead housing construction departments or real estate management departments at all levels to exert the supervisory functions in urban construction and real estate transactions, so as to clarify the earmarking of funds in key aspects of the flow of advance sale funds.

(3) It is supposed to gradually abolish the pre-sale system for commercial properties. As China's current credit policy in the real estate industry is gradually tightening, in this context, the asset and liability ratio of real estate enterprises is in a high state. Under such circumstances, if the pre-sale system of commercial properties is hastily abolished, it will be difficult for real estate enterprises to obtain financing from financial institutions quickly, and in the case of a bad real estate market, it is likely to lead to a break in the capital chain of real estate enterprises, which will further lead to the cessation of projects under construction and even the bankruptcy and collapse of real estate development enterprises. Therefore, the abolition of the pre-sale system for commercial properties should be done gradually based on minimizing risks.

2.3 Classical studies related to real options

2.3.1 Concept of real option

The concept of real option dates to the United States and Europe in the early 18th century, which is simply an option that gives the holder of a contract the right to choose a certain asset in the future. The holder of real option could buy or sell a certain amount of subject matter asset at a

fixed price on or before a specific date in the future. The option contract must contain at least two parties, a buyer, and a seller. The implementation price in the contract is a predetermined price, which could be divided into call option and put option according to whether the agreed assets are purchased or sold, into European option and American option according to the time of enforcement of rights for the agreed option, and into physical option and financial option according to the difference in the agreed implementation of subject matter.

The ideas of option theory include: (1) The value is generated by the uncertainty of the future. It is because of the uncertainty that the option has value, while the uncertainty and the value increase in a positive way. (2) The option holder has the right to purchase or sell the option after agreeing to and paying a certain option fee without affording the corresponding obligation.

The real option is a derivative instrument that has evolved with the development of financial option theory and been gradually used in the real asset area. According to MIT Professor Myers (1977), who originally introduced the concept of real option, the use value of currently owned assets and the opportunity value of future investment options constitute the intrinsic value of an asset item. The so-called real option value is the opportunity value that the enterprise obtains a right to purchase or sell the real asset or investment project at a certain price in the future.

The real option usually refers to the tangible physical asset rather than the financial instrument. In contrast to the fact that subject matter investment in the concept of financial option is the financial assets such as the stock, interest rate or foreign exchange, subject matter of a future investment in the real option is the physical asset usually in the form of planned investment in a project carried out in the market. The investor can make profits through investing in different projects according to the changes in the market. Meanwhile, the investor has the option to choose whether to invest in the project or not. When the investor believes that the future market conditions are favorable, he chooses to invest, and converse he can choose to wait or give up.

2.3.2 Differences between real option and financial option

The real option developed from financial option is the further promotion and extension of the pricing theory and ideology derived from the application of financial options in real or non-financial asset investments. The specific theories and practice should learn from the pricing theory of financial option, but the pricing method of financial option cannot be copied completely. Hence the differences between the two types of options should be distinguished in

the specific research and application process. Like the financial option, the rights and obligations of the holder are asymmetrical for real option and the investor must pay a certain amount of principal to obtain the corresponding rights. The biggest difference between real option and financial option lies in subject matter. subject matter of a real option is usually a project, plant, equipment, etc., while subject matter of a financial option generally contains stocks, bonds, foreign exchange, and other financial assets. The right to invest in a project or manage an asset is the right in the concept of a real option, while the right in a financial option is the right to purchase or sell subject matter financial asset for an agreed amount in the future. The financial option is usually governed by an explicit contractual agreement, but real option is not. The parameters of a real option are like those of a financial option but are distinct from each other, which is manifested as follows:

(1) The financial option is a contract as the legal guarantee for the holder, which is exclusive without competition. In contrast, real options have two types including the exclusive real option and the shared one. For example, the product patent is an exclusive real option where the owner has the exclusive right to develop the product for a certain period. Often, real options are often the shared ones when an investment opportunity is jointly owned by multiple competitors.

(2) subject matter price of financial option would not generate a negative value, yet the price of subject matter asset of a real option may be positive or negative because the price of subject matter asset of a real option is usually based on the present value of cash flows.

(3) Financial options have a shorter term while real options have a longer term.

(4) Uncertainty in market prices results in the main source of risk for financial options, which is an external risk. The risk of real options can arise from both internal technical risk and external market risk.

(5) The exercise price of a financial option is pre-determined and is determined in advance of the exercise However the exercise price of a real option can change in response to changes in market conditions.

(6) In the financial market, subject matter financial options can be traded publicly, but the investment opportunities or asset management flexibility in real options are usually not tradable. As is shown in annexes 2.1.

2.3.3 Types of real options

Classification of Triggers: Lenos Trigeorgis (1997) classified real options into seven categories: (1) option to defer; (2) option to expand; (3) option to contract; (4) option to abandon; (5) option

to staged investment; (6) multiple interacting options; (7) option to shut down and restart.

The option to defer is commonly interpreted as the right to defer investment in a project to address the future uncertainty faced by the investment now. The option to defer allows the investment decision maker to invest after obtaining more market information and determining that the information is beneficial to the investment decision maker. The option to defer is suitable for projects with high uncertainty and long investment cycles, and the higher the degree of uncertainty the greater the value of the investment option to defer. In view of the uncertainty of risk, deferring the investment could reduce the risk and loss of the investment project. Considering that deferring the investment can control the loss and risk of the investment project, the investment decision maker is gaining the value of a waiting option when deferring the investment plan.

The option to expand: When the investment in the project is completed, with the passage of time and the continuous changes in the market, the actual situation of investment project could be considered to reinforce the investment efforts and expand the scale of investment to maximize profits in the future. The use of the option to expand is an opportunity for investors to take advantage of future growth opportunities, which not only increases the value of the project but even has the important strategic significance of tapping new profit growth points for investment decision makers.

The option to contract, as opposed to the option to expand, is an action taken by an investor to reduce or terminate an investment to reduce losses or risk when sales and market conditions deteriorate or remain depressed. The option to contract reduces investment expenses and makes the project less valuable in the future.

The option to switch is the investment decision maker’s right to switch between multiple investment decisions in the future after making an initial investment. If the sales price or market demand changes in the future, the company can decide the best input and output according to its actual situation and judgment of the future market, which is the option to switch owned by the investment decision maker.

The option to abandon: When market conditions become worse or a large loss of previous investment is caused by the enterprise, enterprise managers can determine whether to abandon future investments based on the amount of investment to be paid in the future compared with the amount of investment already paid. The early abandonment can reduce losses if managers hold the pessimistic view of future expectations, hence the decision maker’s right to abandon is the option to abandon.

The option to staged investment divides the overall investment in a project into several

stages with the investment in the latter stage depending on the actual results of the previous stage. If the previous stage of investment meets expectations, the next stage of investment will continue, otherwise the investment will be delayed or even abandoned. The option to staged investment offers the enterprise the opportunity to make the next investment each time it makes an investment through flexible investment options.

Classification of Sharp: Sharp (1991) divided real options into two categories, namely incremental Option, and flexibility option. Incremental option refers to the investment opportunities that enterprises gradually increase to gain more profit. In an uncertain environment, the enterprise firstly makes a small trial investment, and chooses different flexibility options under different scenarios when the uncertainty gradually becomes favorable.

Myers and Mc Guiuan argued that real options are in the forms of waiting option, exit option and growth option. Dixit classified the real options that could arise when the enterprise makes an investment, including the option to defer, option to expand, option to contract, option to abandon, growth option and option to switch. These six basic options are relatively independent, but their combination could give rise to diversified forms of options known as the compound options. Each project in real-life decision making contains multiple options, namely compound options, at the time of investment, and compound options are therefore more realistic.

2.3.4 Research on the reasons for financing dilemma of SMEs

The traditional investment decision methods are mainly used to determine whether to invest in a project through analyzing and evaluating the economic benefits of the investment project. These methods can be divided into static evaluation indicators and dynamic evaluation indicators according to whether time value is considered. Static evaluation indicators are used to analyze and evaluate investment projects according to the concept of accounting without considering the time value factor, which mainly include return on investment and static payback period, etc. Dynamic evaluation indicators considering the time value of money mainly include net present value, present value index, embedded payoff rate, etc.

(1) Rate of return on investment (ROI) method

The ROI method compares the annual amount of earnings with the total amount of investment to arrive at the rate of return on investment and evaluate the effectiveness of investment through comparing the rate with the industry benchmark rate of return on investment. Its formula is as follows:

ROI= the annual amount of earnings/the total amount of investment×100%

If the ROI is greater than the industry benchmark ROI, the project investment is available, and otherwise it is not. The advantages of this method lie in that it is simple to calculate and easy to understand. The disadvantages are that it does not consider the time value of money factor, cannot accurately reflect the project construction cycle and the impact on the amount of investment recovery under different investment methods, and cannot directly take advantage of the net cash flow information.

Therefore, this method is suitable for excluding some projects with poor ROI in the initial project selection period.

(2) Static payback period method

The static payback period method is to calculate the time required to recover the total investment after the project investment. This indicator is compared with the industry benchmark payback period to analyze the feasibility of project as a analysis method. The method uses the present value of the net cash flow of investment project to offset the entire time required for the present value of original investment. The calculation formula is as follows:

$$\sum_{t=1}^{r} c_t - c_0 \tag{2.1}$$

T is the payback period, c_t is the cash inflow in period t, and c0 is the initial investment amount.

The static payback method is simple to calculate so that the project is available for investment if the calculated payback period is less than the industry benchmark investment period. However, this indicator only calculates the years of payback but fails to indicate the profitability of project and to consider the time value of fund. Hence it is only suitable for the initial selection of project.

(3) Net present value (NPV) method

When real estate enterprises invest in projects, they more often use the net present value method to determine whether the solution is feasible. This method refers to the discounting of the difference between the future cash inflows and cash outflows from the production and operation activities of the enterprise, and if the discounted amount is greater than zero, the project can be invested in. Conversely, if the discounted amount of the difference between cash inflows and advanced outflows is less than zero, the project cannot be invested in. The net present value formula is as follows.

$$NPV = \sum_{t=1}^{n} \frac{C_t}{(1+r)^t} - C_0 \tag{2.2}$$

NPV is the net present value of the investment project, C_t the net cash flow in the year t, *r* the discount rate, *n* the life cycle of the investment project, and C_0 the initial investment amount.

The NPV method has a wide range of applications and is more theoretically sound than other methods. The NPV method firstly considers the time factor, which discounts the difference between the future cash inflows and outflows of the business and uses the magnitude of the NPV to determine whether to make an investment. Secondly, it considers the level of the rate of return on investment, which depends on three factors, the market interest rate, the expected rate of return for investors and the average rate of return for the industry, by which the level of risk of the investment project is measured. However, the NPV method also has its shortcomings. For projects with different payback periods and investment amounts, the NPV method is not applicable when making investment decisions for the project. Moreover, the NPV method is also difficult to choose when making the choice of the investment return rate, which in turn determines the size of the NPV. Finally, the NPV method requires complete data in the calculation process and requires the use of the discounted cash flow method for the calculation, so the calculation process is more complex.

The difference between the real options approach and the NPV approach in making investment decisions is obvious. When companies use the NPV method to make investment decisions, they are more likely to use the financial data and various information already available to them. The real options approach, on the other hand, uses existing data and information to forecast future data and information, and makes judgements and investment decisions based on this. The biggest difference between the two methods is the availability of flexible decision-making. Clearly NPV does not have this feature, whereas the real options approach does. When comparing the two calculation methods, the main features are.:

Different views on uncertainty. The NPV method usually involves various calculations based on the data already available to the business to arrive at cash outflows and cash outflows, and the difference between the two is discounted to arrive at the final NPV, which is used to determine whether the project should be invested in. However, the entire calculation process does not consider the uncertainty of the project during the investment process. Unlike the real options approach, which is based on the NPV approach, the uncertainties in the investment process are considered to calculate more scientifically accurate data than the NPV approach. This is because the real options approach considers uncertainty to be the main factor in creating

greater value.

The NPV method has three main options for making the choice of investment return, including: the market rate of interest, the investor's expected rate of return and the industry average rate of return. The real options approach also considers volatility on top of this, and the selection and calculation of volatility needs to be more rigorous and scientific.

In the process of investing in real estate projects, more value can be created due to the irreversibility of the investment and the flexibility of the investment decision. As the NPV method is used to determine whether to make a project investment decision by the magnitude, positive or negative, of the net present value. And once a decision has been made, no other possibilities are considered. The real options approach, however, is different in that it is used to make investment decisions based on the needs of the business, market conditions, policy changes and many other perspectives. These investment decisions include different types of real options, which contain a significant amount of value. These values include both the net present value and the value of the different types of options.

(4) Internal rate return (IRR) method

The internal rate return method refers to the discount rate at which future cash inflows are equal to the present value of future cash outflows, i.e., the discount rate at which the net present value of the investment program is zero. The formula for the internal rate return is as follows:

$$\sum_{i=1}^{n} \frac{NCF_t}{(1+IRR)^{t-1}} - NII\ (\ (1+IRR)^i = 0 \tag{2.3}$$

n is the economic life of project, r the discount rate, NCF the net cash flow in year t, NII the net incremental investment amount of project.

The advantages of the internal rate return method include that it can compare the return over the life of project with the total investment, calculate the rate of return for the project, and use this rate of return to compare with the benchmark investment rate of return in the same industry to determine whether to invest in the project. The disadvantages of the internal rate return method include that it can only assess whether the project is worth investing in but cannot determine the amount of investment in the project. For investors, they not only need to know whether the invested project is worth investing in but also want to know the overall value of the invested project, which the internal rate return method cannot meet. Therefore, this method is more suitable for individual project investment.

Considering that the internal rate return is not equal to the actual rate of return in many cases, some unreasonable results would occur when this method is used for project evaluation.

Therefore, a more scientific modified internal rate of return (MIRR) is introduced, which corrects the underestimation of the present value of the project's late outflow of funds for original indicators and uses opportunity cost as the discount rate for the project's late outflow. In doing so, the actual return rate of the project is reflected precisely.

(5) Present value index (PVI) method

The present value index method involves discounting the cash inflows of an investment option for a project and discounting the cash outflows of that project and comparing the two discounted values. The formula for calculating the present value index method is as follows:

$$PVI = \frac{\sum_{t=1}^{n} A_t (1+i)^{-t}}{PV} \tag{2.4}$$

PVI is the present value index, $\sum_{t=1}^{n} A_t (1+i)^{-t}$ is the total present value of future cash injections, and PV the original investment amount.

If the present value index is greater than one, it means that the project can be invested, and vice versa, it means that the project is unprofitable and cannot be invested.

Net Present Value (NPV) and Present Value Index (PVI) are two different indicators. NPV reflects the magnitude of the value of the invested project and is used to measure the future earnings of the project. The present value index, on the other hand, reflects the efficiency of inputs and outputs. However, when making investment decisions, one should not just use one of the calculations alone but should refer to multiple calculations at the same time before making an investment decision. In contrast to the above two indicators, the embedded rate of return reflects the rate of return on investment for the projects in which the company invests. In the event of a conflict between NPV and IRR calculations, the decision to invest in the project should be based on the NPV method.

The traditional investment methods have unique advantages in short-term, low-risk and low uncertainty situations so that they are widely used. The most common method for evaluating investment projects has long been the net present value method. However, it does not consider how to make investment decisions when the investment environment changes., so it cannot be changed once the investment is determined, and it cannot respond as it should even if the investment environment changes. It is because the NPV approach fails to consider the value created by uncertainty when making investment decisions that the NPV approach lacks the flexibility to make investment decisions, much less capture the value created as a result of flexible decisions. The limitations of the NPV approach are mainly as follows: 1. The future

opportunity value of the investment project cannot be considered. The NPV method considers only the time value of money, so it will underestimate the future value of the project. 2. The NPV method fails to accurately reflect the uncertainty of investment activities. Considering that a discount rate is chosen when using this method, the potential strategic value of the project will be ignored if a larger discount rate is chosen, and the investment cost will be increased if a smaller discount rate is chosen. 3. The NPV method is static and one-time. When certain uncertainties become determinable, the business decision makers will adjust production operations and sales according to the actual situation, so that the NPV method cannot reflect these factors.

Therefore, in view of the shortcomings of traditional investment methods, a more reasonable method should be applied to evaluate the true value of investments in an uncertain environment.

2.3.5 Classical studies related to real options

The earliest theoretical research on real options began in 1900 with Bacheller's doctoral dissertation the speculative theory firstly resorting to Brownian motion in stochastic process theory to describe the movement of security prices over a continuous time domain, which initially mentioned the pricing of real options in the thesis. In terms of the studies on the theory of real option, Black and Scholes (1973) from the University of Chicago published the paper Real Option Pricing and Corporate Debt in the American Journal of Political Economy, which successful explored the analytical expression for European-style options through introducing the idea of no-arbitrage. Merton (1973) study became an important point in the history of finance. He further added to and refined the various assumptions in the Black-Scholes model, and on this basis produced the option pricing model, which has become a very important result in financial theory. John C. Cox and Ross (1976) the discrete-time binomial pricing model, followed by a pricing method for the subject matter being discrete variation by J. C. Cox et al. (1979) which was named after the binomial tree pricing method. Madan and Milne (1991) the binomial tree model and developed it into a polynomial model, which was the enrichment of the real asset model approach.

Each separate study of real options has mainly dealt with various types of single options. In terms of the options to defer, McDonald and Siegel (1986) analysis of the geometric Brownian motion of revenues and costs identifies the most favorable point in time to make the investment in the project. Myers and Turnbull (1977) studied growth options and concluded

that if there is an investment opportunity in a company, then that investment opportunity is a growth option. At the same time, his research also concluded that the value of a company is not just the value of the company itself. It is the sum of the value of all the assets owned by the company and the value of the growth option. Aldwin and Ruback (1986) studied the effects of inflation, interest rates and uncertainty on assets and found that the effects of inflation are not monolithic. If asset prices are in equilibrium with relatively low inflation and interest rates, a small increase in inflation raises the break-even price of short-term assets. If asset prices are in equilibrium with relatively high inflation and interest rates, a small increase in inflation lowers the break-even price of short-term assets with the increase in the inflation rate. Meanwhile, it was noted that the uncertainty of future market conditions provides project investments with the option to switch, and the increased volatility of prices leads to the purchase of short-term assets at higher prices due to the earlier occurrence of conversion opportunity. Therefore, the option to switch is more valuable when making short-term project investments. Dixit and Pindyck (1998) conducted the systematic studies of theories related to real option and found that the irreversibility of investment and delayed decision making are two important processes of making investment decisions, and that the investment opportunity that an enterprise has when making an investment is an option like a financial call option. It is a right rather than an obligation for the enterprise. When an enterprise makes an investment, it can execute the option to invest and give up waiting or obtaining the possibility of a better investment opportunity if an irreversible investment expenditure occurs. Even if the market environment has reversed, it cannot stop investing. They also analyzed the lag phenomenon and optimal investment strategy for project investment. In terms of the abandon option, Myers and Majd (1983) considered the abandon option as an American-style put option through comparing the net present value of standard machine tools with a secondary market and specialized equipment without a secondary market, and introduced the concept of project salvage value. It argued that the true value of the project includes the scrap value of the project, which depends on the salvage value of the project and the optimal time to scrap.

When an enterprise makes an actual investment, the project in which the investment is made usually contains multiple single options and the values of these options affect each other. Majd and Pindyck (1987) analyzed the model for multi-stage investments in real options as well as the pricing model for multi-stage compound options that can delay the investment but not reverse it. They firstly showed how to derive decision rules suitable for each stage of project development and apply them to project evaluation. Secondly, they introduced the impact of project construction time on the value of investment plans and investment decisions. Finally,

they concluded that the uncertainty may have a dampening effect on the level of investment due to the interaction of construction time and uncertainty, and that this effect may be magnified. Brennan and Schwartz (1985) studied the decision model for the mining and closure of a mine and analyzed the value of the compound options. Kulatilaka (1988) explored how the compound options produce optimal outcomes during the execution process and how the options interact with each other. Geske and Shastri (1985) use complex mathematical equations when studying the stochastic process of the underlying asset, while still using multiple technical analysis methods.

The earliest area where the real option method has been used in practice is in natural resource exploitation because the relevant parameters could be found in the futures market. Paddock et al. (1988) evaluated the option value of the undeveloped oil reserves. Morck et al. (1989) measured the value of forest for stocks and prices under the stochastic assumption. L Trigeorgis (1990) studied the option to cancel the expansion when mineral development was carried out and calculated the value of the option for copper mines. Bengtsson and Olhager (2002) considered the multiple purposes of production capacity, organizational structure, automation level and resources. The real option method is also used in the planning and investment management of the enterprises, providing dynamic investment management that turns uncertainty into the advantage for the enterprise. Martins et al. (2015) considered the introduction of the concept of flexibility in the design phase of a project for estimating future possibilities. The concept is more important both academically and professionally because of its ability to manage uncertainty. Real options are options for enterprise decision makers to expand, change, or reduce a project in response to changing economic, technological, or market conditions. Ford and Lander (2002) proposed that the real option method has been widely used in project evaluation and provided a new dynamic decision model for corporate decision makers, thereby improving decision accuracy and efficiency. Martins et al. (2015) identified several types of real options with the differences in flexibility taken into consideration. One of the most important types is the option to defer, which allows an enterprise to postpone the real estate project investment without losing the investment opportunity if the market environment is unfavorable prior to the investment in the project. C. H. Wang et al. (2013) argued that it is also a delayed development strategy that many real estate developers usually adopt after purchasing land for a higher return on investment.

Fei and Yuan (2013)study the possibility of replacing the discounted cash flow method with a real options approach to investment measurement, while pointing out that the net present value method ignores the flexibility of investment decisions. On this basis, the prospects for the

development of real options pricing models in conducting investment valuation are sorted out. K. Huang (1998) studies the application of option pricing theory to corporate investment, which enables investment decision-makers to better evaluate investment projects scientifically and thus discover the strategic value of the projects. It also provides quantifiable ways and tools for striving for management flexibility. Balasubramanian et al. (2000) applied the real option method to the evaluation of IT infrastructure investments. X. Zhang and Sun (2016) studied the application of the real option method to investment decisions in offshore wind projects, and the results showed that for offshore wind projects with the options to defer, the longer the validity period, the greater the value volatility and the greater the option value. L. Ding et al. (2012) modeled the investment in the power plant project under a multi-stage compound option framework and used the compound option approach to evaluate the project, allowing uncertainty factors that are difficult to quantify under the NPV method to be evaluated to improve the science and flexibility of investment decisions.

2.4 Studies related to the of real options in real estate project

The real estate industry is an important area for conducting real options research since its industry characteristics fit well with the premise of real options theory application when it comes to real estate investments. Barthélémy and Prigent (2009) studies have shown that when making investment decisions, investors will be able to generate higher expected returns using dynamic investment models, while the opposite is true for static investment models. Moreover, the volatility of commercial housing prices is not closely related to investment returns, which leads to the conclusion that a flexible sales strategy increases investment returns while avoiding the risk of commodity house price fluctuations as much as possible. Holland et al. (2000)studied the total investment and uncertainty in the real estate market, and the results showed a negative correlation between the two. Bula et al. (2009) found that the factors leading enterprises to delay investment include both systematic and unsystematic risks. Kim and Song (2018) firstly attempted to measure the size of the bubble in the Korean real estate market through the combination of real options approach and the Korean Jensen system. Compared with the traditional real options pricing model, the framework considers the measured bubbles in the market, and resorts to volatility with heteroskedasticity to improve numerical accuracy, and a binomial tree model with heteroskedasticity to determine long and long investment decisions. Meanwhile, it determined the investment according to the size of the bubble to eliminate arbitrage opportunities early. The results demonstrated that the early operation eventually

reduces the bubble through eliminating the arbitrage opportunity, which also indicates that the proposed model successfully measures the bubble. Cheng et al. (2019) refined the development option model in which the rights become a separate stage in the compound options and the developer controls each stage for the purpose of risk reduction. The model covers two sources of entitlement risk while predicting the impact of entitlement risk, including: 1. Uncertainty of authorization will induce developers to execute the entitlement process earlier. 2. All else being equal, large construction price fluctuations will reduce the value of the project. 3. Higher entitlement will lead to increased risk when costs are negatively correlated with home prices. On this basis, the interaction between the timing of investment decisions by real estate developers and the uncertainty of the replanning process is investigated. Yao and Pretorius (2014) established a binomial model and a long-term American call option model to study the valuation of leasehold land in Hong Kong, and they suggested that with a financial option pricing approach and observable market variables independent of investor preferences, the option of waiting to construct a building becomes valuable if there is significant uncertainty about future real estate asset prices. It makes the decision to develop the land at the current time less attractive while delaying development becomes more valuable. It is also found that combining the binomial model with the optimal development timing characteristics of the perpetual American call option model is more appropriate for the valuation of leasehold land in Hong Kong. Ying (2021) explored the problem of tourism property investment decisions from the perspective of real options. Couto et al. (2021) studied the value of undeveloped urban land in Portugal and evaluated the value of the Portuguese real estate market through the binomial and trinomial models of the Quinn model to identify the three variables that have the greatest impact on value, including the price of new apartment buildings, the size of new apartment buildings and construction cost. Its findings showed that the option to defer increases the value of undeveloped land, which should be taken into account in the investment decision process. Henry and Womack (2020) revealed the complexity of urban land values, and its findings suggested that location plays a key role in both process and results of determining land values. Han Wang et al. (2019) quantified the study area from the perspective of American call option to progressively verify the formation mechanism of land speculation, and confirmed that the real option pricing model is useful for assessing investment and market uncertainty. Honglin Wang et al. (2020) studied the relationship between housing prices and rents, and investigated the effects of real options on rental demand, supply, and rental rates. Durica et al. (2018) studied the real estate project in Prague, the capital of the Czech Republic, to evaluate the local real estate investment projects through the option to expand, option to contract, and option to

abandon. The expansion option, option to contract and abandon option to the option pricing model for real estate investment, arguing that a diverse investment model can better analyze real estate market conditions. Yeh and Lien (2020) applied the mixture of option pricing model and Monte Carlo simulation method to study the waiting value of real estate development projects. D. Li et al. (2014) investigated the model for valuing private public housing based on real options under the option to defer. Clapp et al. (2013) explored the relationship between redevelopment scenarios and house price dynamics, and the results showed that the re-construction program for properties with high development potential to the increase in their value. Kemala and Simatupang (2020) separated investment and development into two steps, considering that each step of the authorization in a real estate project is a real option process. Cheng et al. (2019) refined the original model through decomposing the real estate development process into four steps, including the project initiation, payment, obtaining construction permit and starting construction. The classical development option model is improved by further decomposing the four processes of authorizing project initiation, payment, obtaining construction permits, and starting construction. The second type is to increase the variety of options available to developers at each step.

Tsekrekos and Kanoutos (2011) investigated the current state of the land and real estate market in Greece and analyzed the value of land and premiums, concluding that the most beneficial approach for landowners is to postpone project development until more favorable conditions emerge in the market. Kaklauskas and Daniunas (2015) resorted to a physical period approach to study investment projects related to the purchase of properties with 15 unfinished houses in Latvia, which are subject to significant price and cost fluctuations with strict policy regulation. In doing so, they proposed the conclusion of three scenarios and verified them accordingly.

Antonio and Massimiliano (2016) found that the market value of a property in cities depends on the geographical location, namely the area and surroundings where the real estate project is located as well as the specificity of the real estate project itself. Therefore, it is important for the real estate project investment to determine the location of the city where the real estate project is located and the functional specifications of the real estate project, and to analyze the buildings surrounding the real estate project. Greco and Bencardino (2014) considered that the study of the real estate market is beneficial for the city where the project is located, because it is possible to identify the buildings that need to be rehabilitated whether they are fully or partially intervened. Calabrò and Spina (2014) proposed that urban renewal will increase the economic value of not only the buildings being rehabilitated, but also the value of

related cities and all the buildings surrounding. Razzak (2017) classified the real estate market into two types. The first type is the real estate transactions including the type of property as well as the valuation, location, and characteristics of the building. The second one is the real estate investment which includes real estate and market ratings.

Choi (2011) studied the real estate problem through mathematical modeling, which uses complex mathematical formulas and tools with the main goal of reflecting the real situation as much as possible without losing ease of operation. The results of the study showed that the real options model predicts fairly different conclusions to the traditional methods. Alexander and Xi (2012) regarded market prices as a single source of uncertainty to model investment opportunities, showing that the value of real options is related to the expected return, volatility and the initial price of the underlying assets. C. H. Wang et al. (2013)analyzed and modeled the option to defer and abandon option. The model allowed for the assessment of the risks involved in the project at different stages, and provided an option for when to develop and abandon the project and defer development. Yang and Tan (2014) studied the optimal investment timing to explain the reasons why real estate developers postpone their investments. The findings showed that investment timing can increase the value of a project due to the management flexibility, and the factors that influence optimal investment timing were discussed through sensitivity analysis.

2.5 General review of the literature

To better illustrate the relationship between real estate and valuation, investment decisions, real options and the status of research, statistics on the specified keywords were conducted through two journal databases in Chinese (CNKI) and English (Elsevier). Among them: Chinese (CNKI) only counts the number of Chinese literatures. The specified keywords for the search include six combinations: "real estate, investment decisions" "real estate, valuation" "real estate, real options" "real estate, valuation, real options" "real estate, investment decisions, real options" "investment decision, valuation, real option". The statistical results are shown in Table 2.1：

Table 2.1 Specified keywords statistics table

Year	real estate investment decision	real estate valuation	real estate real option	real estate valuation real option	real estate investment decision real option	investment decision valuation real option
Before 2000	7	10	1	0	0	1
2000	0	3	0	0	0	0
2001	3	0	2	0	1	1
2002	2	1	1	0	1	1
2003	6	1	2	0	0	2
2004	10	2	6	0	4	2
2005	15	3	11	0	6	3
2006	19	9	12	0	4	5
2007	19	3	14	1	7	6
2008	20	11	19	1	6	2
2009	25	5	25	0	9	8
2010	20	8	13	0	6	5
2011	20	7	14	0	7	5
2012	23	11	11	1	4	3
2013	21	13	10	0	5	2
2014	23	15	4	1	5	8
2015	25	23	13	1	1	6
2016	14	21	4	1	0	7
2017	14	24	5	1	0	2
2018	14	16	3	0	0	4
2019	13	14	6	2	0	6
2020	13	13	4	0	2	4
2021	8	21	4	2	2	7
Total	334	234	184	11	70	90

Table 2.1 shows that the study of real estate has been of great interest to scholars. However, there are more studies on 'real estate investment decisions' and 'real estate valuation', and fewer studies on real estate valuation and investment decisions using real options methods.

When real estate is combined with valuation and real options, there are only 11 relevant literatures. When real estate is combined with investment decisions and real options, there are 70 relevant literatures. The search for specified keywords in this direction has no reference value, as "valuation investment decisions real options" includes areas such as pharmaceutical research and development and oil field development.

The use of real options theory to study real estate development was first introduced in 1985 by (Titman, 1985). In China it was introduced in 2001. The study of real options theory in real estate in China started relatively late.

By collating the relevant literature on real options theory in real estate valuation and decision making, the status of research on real options theory in real estate can be understood. As shown in Table 2.2:

Table 2.2 Literature on real options theory in real estate

Serial number	Literature name	Research subject	Valuation Methods	Option Type	Case or data source
1	Guardigli et al. (2018)	Project valuation	NPV		Italian Bologna
2	Amato et al. (2019)	Project valuation	Real option	Option to defer	City of L'Aquila in the southeast of Italy
3	Kaklauskas and Daniunas (2015)	Project valuation	Real option	Option to expand、Option to defer	Sun Village
4	D. Li et al. (2014)	Project valuation	Real option	Option to expand	PRH project of Nanjing
5	Y. Mao and Wu (2011)	Investment decision	Real option	Option to expand	Bin Jiang district of
6	Rocha et al. (2007)	Project valuation	Real option	Option to defer	Theoretical Research
7	Shi et al. (2015)	Investment decision	Real option	Option to defer	Beijing
8	Hughen and Read (2017)	Investment decision	Real option	Option to switch	Theoretical Research
9	Barthélémy and Prigent (2009)	Investment decision	Real option		Theoretical Research
10	Kim and Song (2018)	Project valuation	Real option	Option to defer	Korean real estate market
11	Ying (2021)	Project valuation	Real option	Option to defer	Tourism real estate
12	Yao and Pretorius (2014)	Project valuation	Real option	Option to defer	Hong Kong
13	Henry and Womack (2020)	Project valuation	Real option	Multiple interacting options	Miami
14	Durica et al. (2018)	Project valuation	Real option	Option to expand、Option to contract、Option to abandon	Czech real estate market
15	Yeh and Lien (2020)	Project valuation	Real option	Option to defer	Theoretical Research
16	D. Li et al. (2014)	Project valuation	Real option	Option to defer	PRH project in an urbane
17	Clapp et al. (2013)	Project valuation	Real option		Theoretical Research
18	Couto et al. (2021)	Project valuation	Real option	Option to defer	Portuguese real estate market

19	Choi (2011)	Investment decision	Real option		Theoretical Research
20	C. H. Wang et al. (2013)	Investment decision	Real option	Option to defer、Option to abandon	Theoretical Research
21	Cheng et al. (2019)	Investment decision	Real option		Theoretical Research
22	Holland et al. (2000)	Investment decision	Real option		Theoretical Research
23	Han Wang et al. (2019)	Investment decision	Real option		Theoretical Research
24	Alexander and Xi (2012)	Investment decision	Real option		Theoretical Research
25	Bula et al. (2009)	Investment decision	Real option	Option to defer	Stan Hamilton and the offices of the BC
26	Yang and Tan (2014)	Investment decision	Real option		project
27	Sun (2005)	Investment decision	Real option	Option to defer、Option to abandon	Theoretical Research
28	H. Gao and Chen (2004)	Investment decision	Real option	Option to defer、Option to expand	Real Estate Projects
29	Fu et al. (2009)	Investment decision	Real option	Option to defer、Option to expand	Real Estate Projects
30	J. Zhang and Liu (2002)	Investment decision	Real option	Option to defer	Real Estate Projects
31	Zeng (2007)	Investment decision	Real option	Option to defer、Option to abandon、Option to expand	Theoretical Research
32	C. H. Wang et al. (2013)	Project valuation	Real option	Option to defer、Option to expand	Theoretical Research
33	Y. Kong et al. (2007)	Investment decision	Real option	Option to defer	Real Estate Projects
34	J. He (2012)	Investment decision	Real option	Option to defer	Company A X Project
35	W. Kong (2008)	Investment decision	NPV		Chengdu CREC Property Development Co.
36	Sun (2005)	Investment decision	Real option	Option to defer	B real estate development company developed " X

					residential community "
37	K. Wang (2021)	Investment decision	Real option	Option to defer	X real estate project in Nanjing
38	N. Li (2008)	Project valuation	Real option	Incremental option	Chaoyang Vanke Center
39	S. Zhao (2016)	Project valuation	Real option	Option to defer	Y Project in Jilin City
40	R. Wang (2007)	Project valuation	Real option	Option to defer	X Project in Handan City
41	Cao et al. (2007)	Project valuation	Real option	Option to defer	Theoretical Research
42	M. Huang (2008)	Project valuation	Real option	Option to defer、option to staged investment	Chengdu City X Project
43	Cui (2005)	Investment decision	Real option	Option to defer	TJTZ Company Project
44	Hui Wang (2015)	Investment decision	Real option	Option to defer	Chengdu City X Project
45	J. Wang and Peng (2008)	Investment decision	Real option	Incremental option	Theoretical Research
46	Fei and Yuan (2013)	Investment decision	Real option	Option to defer	Theoretical Research
47	T. Zhao (2013)	Project valuation	Real option	Option to defer	Chongqing Xuhui Group
48	D. Chen (2009)	Project valuation	Real option	Incremental option	X Project
49	Deng (2009)	Investment decision	Real option		Theoretical Research
50	Yu (2009)	Investment decision	Real option	Option to defer、Option to abandon	Theoretical Research
51	Y. Y. Mao (2014)	Investment decision	Real option	Option to expand	Theoretical Research
52	C. Li (2010)	Investment decision	Real option	Option to expand	Lijiang City Yulong County X Project

While most of the literature uses the discounted cash flow model for valuation and investment analysis, a few literatures use the real option method for real estate investment analysis. Nevertheless, none of them can well describe the multi-stage characteristics of the real estate industry and the compound options that may be contained in them, and even lack a

comprehensive case study of actual cases.

Thus, this thesis closely combines the three economic characteristics of the real estate industry: multi-stage, high uncertainty, and investment irreversibility. Taking the discounted cash flow model as the benchmark and using the binary tree option pricing model of real options, it reveals the value-creating effect of corporate discretionary decision flexibility in real estate project decision-making. To explore an investment decision-making path.

Further, in terms of the integration of practical cases and theories, this thesis has selected real estate company SC, where I have worked for many years and have a wealth of information material, to conduct a case study on the valuation and investment decision of a property development project using the method based on real options

Based on this, the thesis will not only theoretically enrich research at the intersection of business management and decision science, but also provide practical guidance for the case objects and related enterprises in the industry to conduct scientific enterprise valuation, implement effective executive incentives and other management practices.

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Chapter 3: Methodology

3.1 Case study method

The case study method is a type of field research. The researcher selects one or several scenes as the object, systematically collects data and information, and explores the situation of a phenomenon or problem in a real-life environment through specific analysis and research and thus seeks solutions to the phenomenon or problem. R. K. Yin (2009) defines the case study method as the empirical study of various real-life phenomenon using data and sources of evidence. As interpreted by different scholars, the case study method can be summarized as: unique design logic, specific data collection and unique data analysis method.

The case study method is one of the important methods of social science research. Therefore, the case study method has a very important place in the theoretical development and innovation of management disciplines, and many theories are also constructed based on the case study method. The point of a case study is to answer the 'why' and 'how' questions, not the 'what' questions. The case study method analyzes the logical relationship between different variables based on the obtained data and experience, and then tests and develops the existing theoretical system.

Harrison et al. (2017) thinks case study designs can address a wide range of questions that ask why, what, and how of an issue and assist researchers to explore, explain, describe, evaluate, and theorize about complex issues in context. For Thomas (2013) case study is about studying something in its completeness, looking at it from many different angles and trying to understand the interconnectedness of all the elements comprising it. Simons (2009) defines a case study method as one that allows for the study and analysis of a project or program from multiple perspectives. Stake (2005) has a different perspective, arguing that case studies are a design framework, not a method. Case study research scientifically investigates into a real-life phenomenon in-depth and within its environmental context. Such a case can be an individual, a group, an organization, an event, a problem, or an anomaly (Burawoy, 2009).

The type of case study can be a company or a project, or a country or a region. In real life, the object of case study can be one or more cases. Therefore, there are many types of case study and the definitions do not have general validity. Case study methodology is a collection of various types of research methods including exploratory, descriptive, explanatory, theory generating, and theory testing. Rather than looking at the interaction of a few variables in many

cases, case studies explore real-life events by looking at the complex interaction of many variables in a few cases. Thus, the key to case studies is to bring the object of study close to reality so that complex phenomena can be answered and explained through case studies (Ragin, 1999). Therefore, the case study methodology allows for a detailed and in-depth explanatory narrative to be obtained from a small number of case studies (Roger et al., 2001).

3.2 Background of the case

SC is a real estate enterprise mainly engaged in real estate investment and construction. The company primarily uses the discounted cash flow method when valuing investments in real estate projects and decides whether to make an investment in a real estate project based on the amount of the net present value. Therefore, the thesis selects the BCD real estate project in Tianjin invested by SC enterprise as the research object or case study. The BCD project is constructed in two phases from 2020 to 2024 with a total saleable area of 250,000 square meters. Moreover, I have first-hand experience of SC as I have worked for the company and understand its financial status, construction progress and sales progress. The experience enables me to perform better investment analysis on the project and conduct more in-depth research.

3.3 Raw data collection and process

This thesis collects various data of BCD project in detail and in-depth by going deep into the real-life situation of SC Real Estate Company's BCD project. Include:

(1) The BCD project of SC enterprise constructed in two phases covers the land area of 100,000 square meters and the sales area of 250,000 square meters. The project is expected to have the all-in cash inflow of 3.98 billion yuan and the cash outflow of 3.625 billion yuan. The time range of the BCD project is from 2020 to 2024.

(2) Data category: Income, cost, expense, tax, term, discount rate, risk-free rate.

(3) Data Sources：Enterprise data comes from the relevant departments of the company, Including: finance department, sales department, engineering department. External data comes from the People's Bank of China, the tax bureau, and the benchmark real estate project in the location of the BCD project.

(4) Data collection process: Because I work in the finance department, I can get the company data such as income category, cost category, expense category and sales period within the company during my work. Additionally, in the daily operation and management of the

enterprise, external data such as taxes, discount rate, sales price of BCD project benchmarking projects, and risk-free rate of return can also be obtained. Data source table, as shown in Table 3.1:

Table 3.1 Data types and sources

Serial number	Data Type	Data Name	Data source	Influence parameters
1		Income category	Finance department	Underlying asset (S)
1.1		Sales unit price	Sales department	Underlying asset (S)
1.2		Sales area	Sales department	Underlying asset (S)
1.3		Sales ratio	Sales department	Underlying asset (S)
1.4		Sales carry-forward ratio	Sales department	Underlying asset (S)
2		Cost category	Finance department	Underlying asset (S)
2.1		Land cost	Prophase department	Strike price (X)
2.2		Initial cost	Prophase department	Underlying asset (S)
2.3	Company data	Construction cost	Engineering department	Underlying asset (S)
2.4		Garden cost	Engineering department	Underlying asset (S)
2.5		Capitalized interest	Finance department	Underlying asset (S)
3		-Expense category	Finance department	Underlying asset (S)
3.1		Managing cost	Finance department	Underlying asset (S)
3.2		Marketing cost	Finance department	Underlying asset (S)
3.3		Financial cost	Finance department	Underlying asset (S)
4		Sale period	Sales department	Option term (T)
5		Tax category	Tax bureau	Underlying asset (S)
5.1		Value added tax	Tax bureau	Underlying asset (S)
5.2		Land value-added tax	Tax bureau	Underlying asset (S)
5.3		City tax	Tax bureau	Underlying asset (S)
5.4		Education tax	Tax bureau	Underlying asset (S)
5.5	Tax data	Local tax	Tax bureau	Underlying asset (S)
5.6		Flood control tax	Tax bureau	Underlying asset (S)
5.7		Property tax	Tax bureau	Underlying asset (S)
5.8		Land use tax	Tax bureau	Underlying asset (S)
5.9		Stamp duty	Tax bureau	Underlying asset (S)
5.10		Income tax	Tax bureau	Underlying asset (S)
6	Capital market data	Risk-free rate of return	People's Bank of China	Underlying asset (S)
7	Real estate industry data	The historical sales prices of benchmark real estate projects in BCD project locations	Benchmark real estate projects in BCD project locations	Volatility (σ)
8	Capital market data	Three-year treasury bond rate 4%	People's Bank of China	Risk-free rate of return (r)

3.4 Real options model and key parameters estimation

Based on the traditional discounted cash flow method, a conceptual model of multi-stage real

option valuation and decision-making of real estate projects is constructed.

The various data and sources of data for the BCD project are known through table 3.1. The key parameters in the real options model are obtained mainly through the calculation of these data. The key parameters in the real options model include five: present value of the underlying asset、volatility、strike price、option term、risk-free rate of return.

3.4.1 Present value of the underlying asset S

The calculation of the present value of the underlying assets includes the following:

(1) Determine the accounts in the balance sheet and income statement that maintain a fixed ratio to the main business income.

(2) Forecast the main operating income and the cost, expense and tax subjects in the income statement and balance sheet that are assumed to maintain a fixed ratio to the main business income.

(3) Fill the accounts in the income statement and balance sheet that do not maintain a fixed ratio to the main business income. For example, the amount of annual depreciation is maintained at a fixed amount every year, and the amount of paid-in capital remains unchanged.

(4) Adjust the accrual-based income statement and balance sheet to the cash flow statement on a cash basis. Thus, the annual cash flow can be obtained.

(5) Using the discounted cash flow method, the annual cash flow is discounted according to the market capitalization rate to obtain the annual net present value. The annual net present value is added up to obtain the total net present value, which is the value of the underlying asset.

3.4.2 Volatility σ

Volatility is one of the core parameters in the real option pricing model, and volatility has a significant impact on option pricing. Therefore, it is closer to reality to use the historical sales prices of benchmark real estate projects in BCD project locations as the basis for calculating volatility.

3.4.3 Strike price X

Since the land cost is a one-off payment at the initial stage of the BCD project, the land cost is used as the strike price.

The land cost of the BCD project is RMB 1.5 billion and will be constructed in two phases. Therefore, the land cost needs to be apportioned according to the construction area proportion

of the two phases. The construction area ratio of the first phase and the second phase is 28% and 72% respectively. After being apportioned according to the proportion of construction area, the land cost of the first stage is 420 million yuan, and the land cost of the second stage is 1.08 billion yuan.

3.4.4 Option term T

Option term refers to the expiration time of the option. The sales period of the BCD project is 5 years, of which: 2 years for stage 1 and 3 years for stage 2. That is, each year is a period.

3.4.5 Risk-free rate of return r

The risk-free rate is the rate of return on investment that can be obtained by investing money in projects that do not carry any risk. The international risk-free rate usually adopts the interest rate of the short-term treasury bond. Since China issues less one-year treasury bonds, there are more treasury bonds with maturities of more than one year. Therefore, using the three-year treasury bond rate as the risk-free rate, the three-year treasury bond rate in 2019 is 4%.

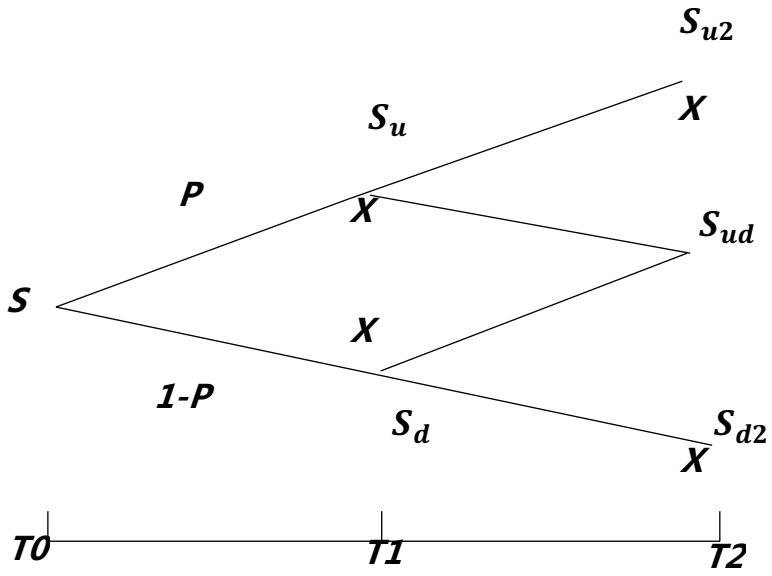
The binomial tree option pricing method for real options is still closely tied to the net present value. This is because the project value assessed by the real option method includes the net present value after discounting the expected cash flow and the option value of flexible decision-making. As shown in Table 3.2:

Table 3.2 Key parameters of the binomial model

Parameter	Stage	Accounting subject	Calculation instruction
Underlying asset (S)	Data calculation	Income category	Sales unit price × Sales ratio
		- Cost category	
		Initial cost	Initial cost payment amount × Sales carry-forward ratio
		Construction cost	Construction cost payment amount ×Sales carry-forward ratio
		Garden cost	Garden cost payment amount × Sales carry-forward ratio
		Capitalized interest	Capitalized interest payment amount × Sales carry-forward ratio
		--Expense category	
		Managing cost	Managing cost payment amount × Sales carry-forward ratio
		Marketing cost	Marketing cost payment amount × Sales carry-forward ratio

		Financial cost	Financial cost payment amount
		-Tax	Accounts received in advance ×T ax rate × Sales carry-forward ratio
	Cash flow adjustment	Net profit	
		+Depreciation	Balance sheet amount of the accounting subject for the year
		- Inventory	Balance sheet amount of the accounting subject for the year
		- Accounts received in advance	Balance sheet amount of the accounting subject for the year
		+ Prepayments	Balance sheet amount of the accounting subject for the year
		+ Other accounts payable	Balance sheet amount of the accounting subject for the year
		+ Tax	Balance sheet amount of the accounting subject for the year
		- Fixed assets	Balance sheet amount of the accounting subject for the year
		- Capitalized interest	Balance sheet amount of the accounting subject for the year
		- Current accounts received in advance	Sales unit price ×Sales area
	Calculate NPV	Net cash flow	Net cash flow
		÷Discount rate	11%
		NPV	Net cash flow ×Discount rate
Strike price (X)		Land cost	stage I 4.2 亿； stage II 10.8 亿
Volatility (σ)		The historical sales prices of benchmark real estate projects in BCD project locations.	
Risk-free rate of return (r)		Three-year treasury bond rate 4%	
Option term (T)		Sales period of 5 years	stage I 2 years; stage II 3 years

The key parameters are obtained by calculation, and the binary tree option pricing model of real options is used to carry out dynamic valuation, and the corresponding dynamic decision-making path is obtained. As shown in Figure 3.1:



S = Underlying asset
X = Strike price
σ = Volatility
T = Option term
r = Risk-free rate of return
F = Real option value

$u = e^{\sigma\sqrt{\Delta t}}$ = Rising ratio

$d = e^{-\sigma\sqrt{\Delta t}}$ = Falling ratio

Figure 3.1 Binary tree model scheme framework

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Chapter 4: Analysis of the economic features of real estate development project

4.1 Multistage

Real estate project development has the characteristics of long development cycle, large capital investment, complex technology, and involves many approval and other characteristics. The whole process includes land acquisition, positioning decision-making, product design, engineering construction, commercial housing sales, property operation and other links, so it has obvious multi-stage characteristics.

As shown in figure 4.1, according to the whole real estate project development cycle, it can be roughly divided into three stages, including the land acquisition stage, project construction stage and sales stage.

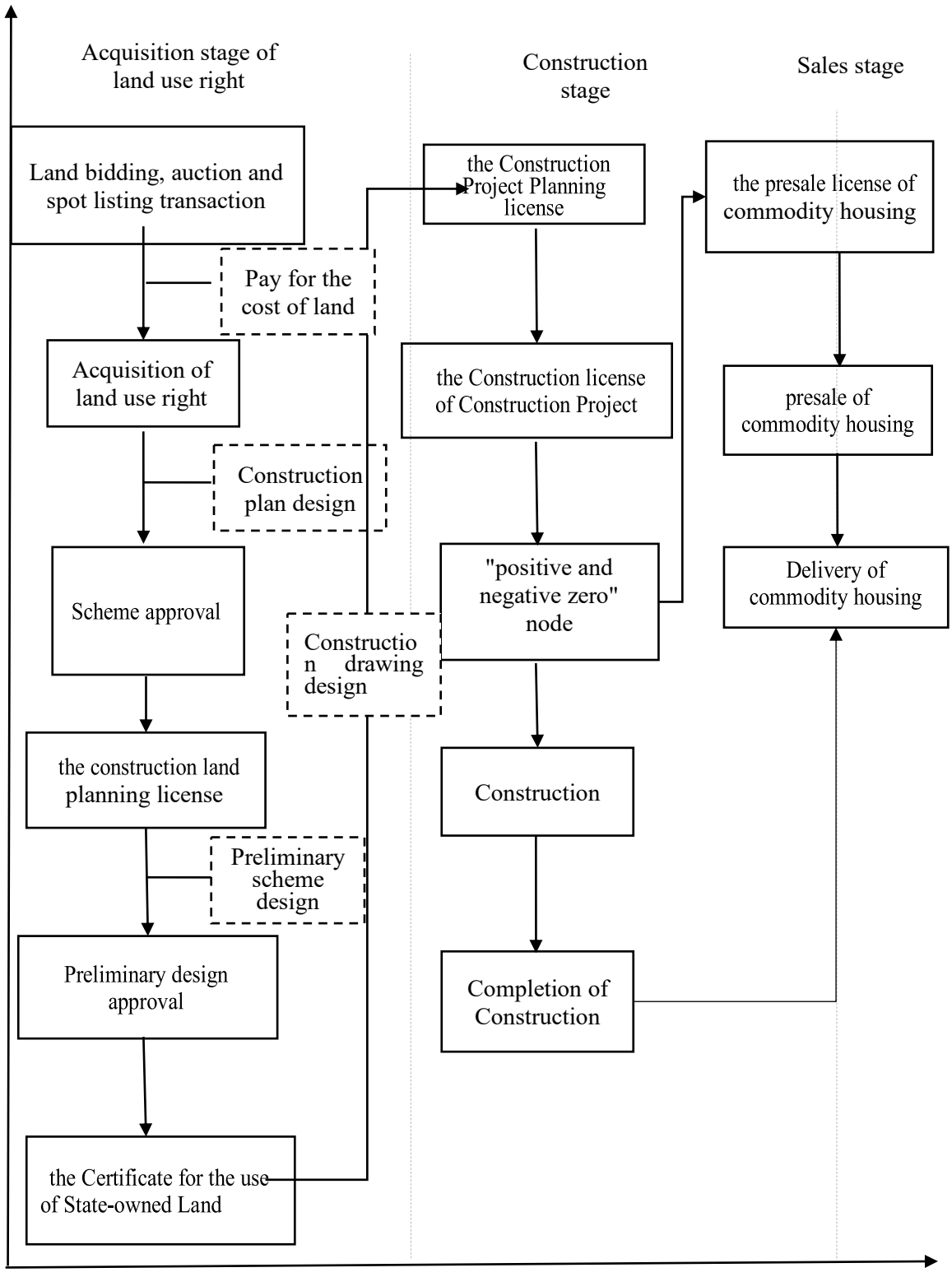

Figure 4.1 Stage flow chart of real estate development project

4.1.1 Acquisition stage of land use right

The characteristic of China's land system is that the land ownership is monopolized by the government, but the land use rights can be sold. Local governments manage land use rights in

accordance with their respective jurisdiction.

Therefore, there are three ways to obtain land-use rights in China, including (1) Acquisition of land-use right through government transfer including bidding, auction, listing and agreement transfer. (2) Acquisition of land-use right through transfer of other enterprises including the acquisition of land and the acquisition of real estate project companies. (3) Access to land-use right in cooperation with enterprises which have the land-use right, mainly through project acquisition.

Among them, bidding, auction, and listing are the three main ways for real estate enterprises to obtain land-use rights through government. As shown in Figure 4.2, these three ways of obtaining land use right are all obtained through the market competition mechanism, but there is a difference in running the program.

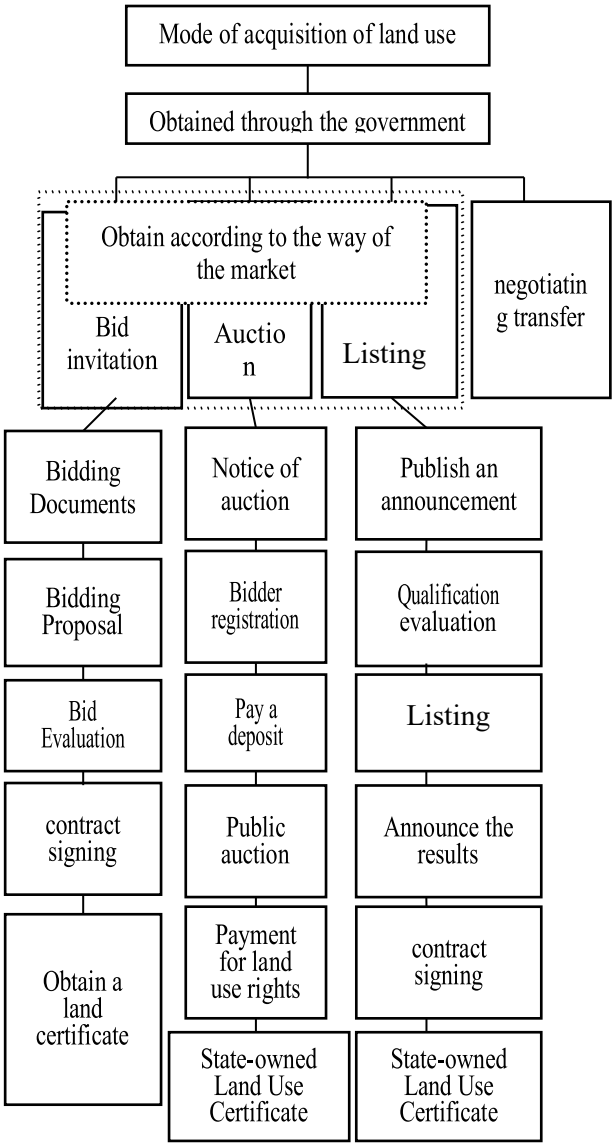

Figure 4.2 Land use rights sale process

Source: MLNR (2002)

Take a 6-storey high-rise building with a construction area of 72000 square meters as an example, the total cycle of the project is nearly 4 years, as shown in Annexes 4.1. In the land acquisition and early stage, processing time of the whole process from the preliminary feasibility study stage of the project to the acquisition of the land use right certificate will take 6 months to 7 months.

The right to the use of land obtained through bidding, auction and listing in the way of government transfer is different not only in terms of operating procedures, but also in terms of content. As shown in Annexes 4.2.

At this stage, real estate development enterprises should complete all kinds of examination and approvals of land acquisition stage and obtain “construction land planning permit license" and " certificate for the use state-owned land ". Acquisition of land use rights and preliminary stages are important parts of the selection and feasibility study of real estate projects. And the accuracy of its investment analysis determines the success or failure of the project. In addition, in the stage of land acquisition, market analysis and financial evaluation should be carried out on the area where the project is located, mainly through the analysis of local policies, supply and demand, economic environment, competitive environment, affordable price for residents and other factors, to finally determine the feasibility of the project.

4.1.2 Project construction stage

At this stage, the real estate project construction can start construction based on completing the construction drawing design and obtaining the " construction land planning permit license" and "construction license of construction project". In this process, there are mainly three stages: the pre-construction preparation stage, the engineer construction stage, and the completion acceptance stage.

According to different building types, real estate projects can be divided into low-rise (3-storey), and high-rise buildings as shown in Annexes 4.3, there are great differences in the construction cycle of different types of buildings. the construction period of single low-rise is generally 9 to 12 months, the construction period of a single small high-rise is generally 18 months.

The overall construction process of the project is further divided into the pre-construction preparation stage, the engineer construction stage, the completion acceptance stage. Different stages contain a lot of work items. The government's examination and approvals of each node also runs through the whole construction process. This stage includes planning and design,

qualification examination and approval, on-site investigation, on-site surveying and mapping, material procurement, body structure construction and installation of supporting facilities and many other work links. In the pre-construction preparation stage, it is necessary to obtain a "Construction license of Construction Project" which represents the official start of the project construction work. At this stage, designers should fully understand the policies and regulations of the city where the project is located, avoid conflicts with government planning, and make full use of the project plot ratio and the surrounding environment of the project. The main work at this stage is to use a series of professional methods to compare different schemes, and finally determine the scheme that both in line with the actual situation is effective for cost management. while the acquisition of the "acceptance certificate for construction project completion planning" represents the final completion of the whole project.

Following the above example, in the construction phase of the engineering, as shown in Annexes 4.4, it takes about 41 months from the preliminary drawing design to the completion of the project. Due to the large number of nodes, complex processes, and different types of building forms, the construction cycle is also different.

As can be seen from the above figure, the construction stage is the most critical stage in the process of real estate project development, and the management and control at this stage will be directly related to the final quality and profit of the project. For example, a small mistake in the design will not only affect the overall construction quality of the real estate project, but also may most lead to the deterioration of the sales situation. In the process of construction, the construction technology will affect the progress and quality of the entire project, and the risks arising from the bidding mode, contract signing, cost control, construction staff salary, equipment use and others will cause serious consequences to the project. At the same time, the construction risk brought by the progress of science and technology will force the real estate enterprises to make additional investment and cause increase in cost.

Therefore, there are many construction nodes and complicated work in the construction stage. It usually takes three to five years from pre-construction preparation to completion and acceptance. From construction to sales, there is not only a lot of financial pressure, but also a certain market risk. The longer time of the project development, the uncertainty of the cost in the later stage and the price of commercial housing after completion is also relatively increased, and the greater the risk.

4.1.3 Sales stage

In China, most of the sales of commercial housing by real estate development enterprises will adopt the pre-sale system. The pre-sale system of commercial housing refers to a kind of sale method that guarantees the pre-sale of commercial housing based on the credit and strength of real estate development enterprises and the necessary condition of government administrative license. By adopting this sales method, the financial security of commercial housing buyers has been more guaranteed. For the sale of commercial housing in real estate projects, it is a necessary and sufficient condition to obtain "pre-sale permit for commodity housing". As shown in Annexes 4.5, successfully obtaining the " pre-sale permit for commodity housing" will not only will not only help real estate development companies grasp the opportunity to enter the market for the sale of commercial houses, but also facilitate the rapid return of funds for the sale of commercial houses.

In China, the project nodes required to obtain the "Pre-sale permit for commercial housing" for commercial housing with different business operation forms are different, as shown in Annexes 4.6

Follow the above example, in the sales stage of commercial housing, it takes about 21 months from the construction of the model room to the delivery of commercial housing to the buyer. During this period, the sale of commercial housing and the construction of the engineering are carried out simultaneously., as shown in Annexes 4.7, after the construction of the engineering meets the requirements specified by the state and obtains the " pre-sale permit for commodity housing ", the commercial housing can be sold until the completion and acceptance of the commercial housing and the delivery of the commercial housing to the buyer.

In the stage of commercial housing sales, real estate developers will take the initiative to find market demand and price information and choose the timing of sales by pre-sale in installments. Compared with passively waiting for other real estate developers to act first, this sales strategy can enter the market faster, speed up sales and make profits. Moreover, due to the high asset-liability ratio of China's real estate market and the uncertainty of real estate development, real estate developers will choose to sell as soon as possible to achieve the return of funds.

Moreover, different real estate development enterprises have different scale, different management levels and development goals.so different stages will be formed in the process of real estate project development, construction, and sales.

There will be differences in the choice of sales timing, larger-scale estate development

enterprises are more inclined to rapid development and construction and rapid sales, to obtain more capital to support large-scale project construction and new real estate project development. On the other hand, smaller real estate development companies prefer to delay sales, to wait for better sales opportunities to make more profits. Under the circumstance of tightening control policies and poor market conditions, real estate enterprises will take price reduction measures to sell, thus giving up profits and pursuing more cash flow, to ensure that enterprises have sufficient funds for development and construction, loan repayment, and coping with various a risk

In addition, due to the uncertainty of all kinds of information faced by real estate development enterprises, therefore, any real estate development enterprise cannot guarantee that the market conditions when the real estate project development plan is completed can guarantee the realization of its investment objectives.

With the deepening of the project development process, real estate development enterprises have more information, but at the same time, the maneuverability is also decreasing. Therefore, the developers have the greatest uncertainty at the beginning of the development process, and it becomes a definite result by the end of the process, which also means that no more changes can be made.

4.2 Uncertainty

The value of real options is determined by the uncertainty in the future. In an uncertain environment, the right to choose different investment timings according to changes of the investment situation is owned by the investor. Investors can get more information about the market and choose the best time to invest. However, this kind of initial investment has the characteristics of irrecoverable, so if it fails, it needs the corresponding cost. Therefore, to evaluate real options for real estate development projects, it is also necessary to analyze the uncertainty of real estate development projects. The main reasons for the uncertainty of real estate development projects include policy uncertainty, market uncertainty and internal management uncertainty, as shown in Table 4.1.

Table 4.1 Uncertain factors of real estate project

Content	Policy factors	Market factors	Internal management factors
land acquisition Stage	1. Regulations on the acquisition of land through bidding, auction and listing. 2. Planning and design review. 3. Scheme approval;	1. Competition in the same industry. 2. Whether the project construction can be carried out within the specified time. 3. Whether the optimal plan can be designed to obtain maximum value;	1. Enterprise strength assessment. 2. Whether the land price can be paid in full within the specified time. 3. Whether the land certificate can be obtained in accordance with the requirements of the state;
Project construction Stage	1. General contractor determination and related construction qualification requirements. 2. In addition to national regulations, other construction requirements: "Green Environmental Protection Project" regulations, winter construction requirements and others;	1. Arrange the project progress based on market conditions. 2. The impact of project payment on the progress of the project;	1. Design capability and level. 2. Project construction speed. 3. Engineering construction quality;
Project sales Stage	1. Obtain the "Commercial Housing Pre-sale License" 2. Pre-sale conditions for different construction types: multi-rise must reach 2/3, high-rise must reach 1/3, small high-rise 1/2 pre-sale conditions;	1. Compete in the same industry and region. 2. Product scarcity. 3. Corporate brand influence;	1. Market positioning 2. Customer group positioning 3. Assist in processing loan time

4.2.1 Policy uncertainty

Policy uncertainty, the probability of its potential occurrence is unpredictable, involving uncertain decision-making, the probability of its potential output is unpredictable (Duncan, 1972). Fox and Tversky (1995) believe that uncertainty is usually divided into two types, one from the inside and the other from the outside. McGrath (1997) believes that internal uncertainty is mainly due to the lack of internal knowledge reserves of the company. And believes that the uncertainty from the outside mainly comes from changes in the external environment, including the future demand for this product and the feasibility of new technologies. Dixit and Pindyck (1998) believes that due to the uncertainty caused by the lack of internal knowledge reserves, the lack of knowledge can be offset by investment in uncertain knowledge, because investment is an effective way to obtain knowledge from internal uncertainty. These uncertainties are not affected by firm behavior, but the effects on firms

become apparent over time by (Falta, 1998).

Since the market-oriented reform of China's real estate industry, the government's regulation of the real estate industry has never stopped, and various regulatory policies have also determined the price of commercial housing. Scholars at home and abroad have done a lot of research on the control policy of commercial housing prices, including: 1. Reasons and basis for control; 2. Research on specific control policies. Many scholars have commented and expounded why the government adjusts and controls the real estate market from different aspects.

In the study of the impact of monetary policy on the price of commercial housing, Kemala and Simatupang (2020) believes that monetary policy will affect the price of financial assets, thus affect the price of commercial housing, but also affect the total amount and cost of credit funds, and ultimately affect the scale of consumer debt and the demand for commercial housing. Fratantoni and Schuh (2003) believes that commercial housing prices are sensitive to real interest rates and has a negative correlation, but Jud and Winkler (2002) believes that the impact of interest rates on housing prices is uncertain. Wheaton and Nechayev (2008) shows that the impact of interest rate changes on commercial housing prices is uncertain. Shi et al. (2014) found that there is no significant impact between real interest rates and commercial housing prices, and the increase of real interest rates will not reduce commercial housing prices. Scholars not only study the tax rate, but also study the impact of credit policy on commercial housing prices. Research by Ping and Chen (2004) shows that credit has a positive correlation on commercial housing prices. T. Gao and Kang (2006) compared the impact of credit policy and interest rate on commercial housing prices. The results show that the impact of interest rates on commercial housing prices is uncertain, while credit instruments have a greater impact on commercial housing prices. Credit policy should be the main regulation and control of commercial housing prices. L. Wang and Guo (2007) analyzed the influence of interest rate and money supply. The results show that money supply has a long-term continuous positive impact, interest rate has a negative impact, the contribution of money supply is greater than that of interest rate, and money supply shows an accelerated upward trend.

In terms of fiscal policy, the relevant policy is as important as monetary policy. Datta and Jones (2001) believes that fiscal policy has a great impact on housing consumption, and the level of local fiscal expenditure has a great impact on housing prices. Similarly, research by and Zhou and Wu (2008) shows that local fiscal expenditure has significantly pushed up commercial housing prices.

In the aspect of land policy, Mayer and Somerville (2000) studied the influence of land

control and urban planning on commercial housing prices. Song and Liu (2009) found that the rise of commercial housing prices is closely related to the land system, and land price is the key factor in the rise of commercial housing prices. Y. Wang and Zhang (2010) study showed that the land bidding, auction and listing system increased the average price of commercial housing in China by 13.2%. Z. Huang (2011) study shows that there are defects in China's land transfer system and tax system, which have led to the rapid rise in commercial housing prices in China.

The Chinese government's regulatory policies on the real estate industry plays an important role in the formation of commercial housing price expectations. The real estate project industry is affected and constrained by a variety of policies. Although the Chinese government has repeatedly adjusted the real estate industry, the uncertainty of the policy leads to the inconsistency between the original intention of the policy implementation and the actual effect of the policy implementation, and even there is a big deviation. As far as enterprises are concerned, there is a great deal of uncertainty about other factors such as when the government will release economic policies, the information contained in the policies and the inherent functions related to them. In terms of the economy, generally due to the backwardness of information, the macro-control economic policies implemented by the government may be somewhat lacking, and because of the repeated changes in economic policies, the uncertainty in economic policies also increases accordingly. D. Xin (2018) changes in real estate policy not only determine the scale and income of the projects invested by real estate developers, but also determines the channels, methods, difficulties, interest rates and other factors for real estate developers to raise funds., and ultimately affect whether there is a demand for real estate in the market, which further leads to the instability of prices in the real estate market.

Financial policy mainly adjusts the money supply and stabilizes the currency value through monetary policy, interest rate policy and exchange rate policy, and thereby regulating the domestic financial market and foreign exchange market. The most direct impact of financial policies on real estate companies is the impact on financing. Changes in financial policies will have an impact on loan quota, loan purpose, loan term, and loan interest rate and other factors. The tax policy mainly has an indirect impact on the real estate industry through tax types and tax rates related to the real estate industry. Administrative measures are the unilateral decisions and handling of specific practical problems that are implemented by state administrative organs during administrative management activities. It is the most widely used state administrative management method. In terms of real estate, it is mainly manifested in the management of the sales price of commercial housing. The land policy is the Chinese government's criterions for the development, utilization, governance, protection, and management of land resources. Its

impact on real estate projects is mainly reflected in the management of the sale price of land use rights and the regulations on the development time of real estate projects and others. These real estate control policies are formulated by the state and flexibly implemented by local governments according to local actual conditions.

Policy uncertainty is mainly caused by two reasons. On the one hand, after nearly 20 years of development of real estate in China, real estate investment has a great role in promoting China's economic growth. Chinese economic growth depends to a large extent on the development of real estate; On the other hand, the Chinese government has realized that the asset bubble caused by high housing prices is worried. A series of regulation and control policies on real estate has been launched with the goal of making real estate develop more steadily and for a longer time avoiding systemic risks caused by overheated investment in the real estate market. As shown in Annexes 4.8, these two factors cause the government not only to maintain economic growth, but also to avoid systemic risks, so it leads to the repetition of real estate regulation and control policies.

China's real estate policy established the position of positioning the real estate industry as a national pillar industry during the period of 1998-2003, but due to the continuous rise of commodity house prices, a series of adjustments were carried out from 2004 to 2007, but it was affected by the 2008 economic crisis. Influenced by the real estate control policy, a stimulus policy was adopted, from "controlling the real estate market" to "saving the real estate market", a large amount of funds flowed into the real estate market, as shown in Annexes 4.7, the real estate market bottomed out and recovered, with house prices falling first and then rising sharply. From 2010 to 2013, through the implementation of various real estate regulation and control policies, the momentum of excessive rise in overall commercial housing prices had been temporarily restrained, but the regional differentiation is obvious, and the problem of large fluctuations in the real estate market was prominent. From 2014 to 2016, housing prices in Beijing, Shanghai, Guangzhou, Shenzhen, and provincial capital cities soared, while commercial housing prices in county-level cities remained stable and continued to reduce inventories. At the end of 2016, the Chinese government proposed for the first time that "houses are for living, not for speculation." Therefore, from 2017 to 2020, real estate-related departments have issued matching policies one after another, and by speeding up the establishment of a housing system of multi-agent supply, multi-channel security, rent and purchase will further promote the implementation of real estate control policies and regulatory regulations by banking institutions.

The impact of policy uncertainty on real estate projects in the development process is also

different: (1) at the stage of land acquisition, it will require the relevant qualifications of the real estate development enterprises, the amount and proportion of their own funds, the number of completed projects, the area and types of completed projects, and can be qualified for land auction only if the conditions are met.; (2) during the construction phase of the project, in addition to reviewing the construction policies stipulated by the state, local policies have also been established in different regions, such as Beijing and Tianjin to implement the regulations of "Green Environmental Protection Projects" for the sake of environmental protection, and the policy of not allowing winter construction, these policies will have an impact on the development and construction of real estate enterprises; (3) in the stage of commercial housing sales, before the pre-sale of commercial housing, it is necessary to obtain "State-owned Land use Certificate", "Construction Land Planning license", "Construction Project Planning license", "Construction Project Construction permit" and "Commercial Housing pre-Sale permit". The sale of commercial housing can only be carried out with a sales license. At the same time, there are also requirements for different types of commercial housing construction nodes, such as: multi-rise buildings need to complete more than 2/3 of the main project, high-rise buildings need to complete more than 1/3, and others.

Due to the different development process of the real estate market, the regulation and control policies in real estate will continue to change. In the early stage, the Chinese government will provide favorable conditions in terms of policies for developing enterprises and people, which in turn is conducive to the rapid and vigorous development of the market. such as loose credit policies, encourage developers to increase investment in the real estate industry and increase residents' desire to buy houses; The market is in a confused and booming stage, and the government can scale back the relevant policies to a certain extent, such as reducing credit., raising taxes, restricting loans, restricting purchases and others, which can help to reduce irrational demand, cool the real estate market slowly, and bring house prices down to the right price. Therefore, the corresponding requirements of different stages are different, regulatory policies are also divided into two different forms, loose regulatory policies, and tight regulatory policies.

When house prices continue to rise and the scale of investment continues to expand, the Chinese government has gradually increased the scope of regulation since 2003, mainly in the form of monetary and land-related policies and purchase restrictions. the aim is to stabilize real estate prices and balance the development of the market.

The policy continues to increase the number and intensity of issuance to demonstrate the government's determination to control the stability of the real estate market, as shown in Table

4.2.

Table 4.2 Major real estate regulation and control policies from 1998 to 2019

Serial number	Year	Sector	Policy document	Policy type	Effect
1	1998	General Office of the State Council of the People's Republic of China	Notification of the State Council on further deepening the Reform of Urban Housing system and speeding up Housing Construction，it marks the marketization of real estate.	Administrative measure	Encourage
2	2002	Ministry of Land and Resources of the People's Republic of China	Provisions on the transfer of the right to the use of state-owned land by bidding, auction and listing	Land policy	Encourage
3	2003	General Office of the State Council of the People's Republic of China	In August, the notice on promoting the sustained and healthy Development of the Real Estate Market was issued, positioning the real estate industry as a national pillar industry.	Administrative measure	Encourage
4	2004	People's Bank of China	In October, the people's Bank of China announced an increase in deposit and lending rates.	Financial policy	Tighten
5	2005	Ministry of Construction of the People's Republic of China	In May, opinions on stabilizing housing prices were issued.	Administrative measure	Tighten
6	2006	State Administration of Taxation	In July, the notice on issues related to the collection of personal income tax on housing transfer.	Fiscal and taxation policy	Continuous tightening
7	2007	People's Bank of China	In September, the notice on strengthening the credit management of commercial real estate.	Financial policy	Continuous tightening
8	2008	General Office of the State Council of the People's Republic of China	In December, some opinions on promoting the healthy development of the real estate market.	Administrative measure	Stimulation
9	2009	China Banking Regulatory Commission	In June, notice on further strengthening the risk management of commercial loans.	Financial policy	Tighten
10	2010	General Office of the State Council of the People's Republic of China	In April, a notice was issued to curb the excessive rise of house prices in some cities.	Administrative measure	Tighten

11	2011	People's Bank of China	From January to June, the people's Bank of China raised the deposit reserve ratio six times. From February to July, the people's Bank of China raised the benchmark deposit and loan interest rates four times.	Financial policy	Tighten
12	2012	Ministry of Land and Resources of the People's Republic of China	In July, the economic notice of further tightening the management of real estate land and consolidating the results of the regulation of the real estate market	Land policy	Tighten
13	2013	General Office of the State Council of the People's Republic of China	In March notice on further strengthening the regulation and control of the real estate market.	Administrative measure	Tighten
14	2014	Ministry of Finance of the People's Republic of China	In October, all localities were required to relax the conditions for provident fund loans.	Financial policy	Tighten
15	2015	State Administration of Taxation	In July, the announcement of simplifying the procedures of exemption from business tax for individuals to grant the right to the use of real estate free of charge.	Fiscal and taxation policy	Tighten
16	2016	Central Economic Working Conference	Make clear the direction of real estate development , "housing is for living in, not for speculation".	Administrative measure	Continuous tightening
17	2017	Ministry of Construction of the People's Republic of China	In April, a notice was issued to strengthen the management of housing land supply and the regulation and control of related work.	Administrative measure	Continuous tightening
18	2018	Ministry of Construction of the People's Republic of China	Notice on issues related to further regulation and control of the real estate market.	Administrative measure	Continuous tightening
19	2019	China Banking Regulatory Commission	Notice of carrying out special inspection of real estate business of banking institutions in 2019	Financial policy	Continuous tightening

Through the above real estate regulation and control policies, we can see that the Chinese

government has continuously promulgated various regulation and control measures for the real estate industry to make the real estate industry develop healthily and orderly, but the results are unsatisfactory. In the market economy, the implementation of administrative means for regulation and control is itself a helplessness move under abnormal circumstances. The main reason why China's housing sales prices are "growing under regulation" is that, on the one hand, the Chinese government defines the real estate industry as an important pillar industry of the national economy, on the other hand, it is worried that the continuous rise in housing sales prices will lead to price bubbles, and this rise is due to the irrational investment behavior expected by real estate development enterprises, banks and investors. This kind of irrational investment behavior will further promote the housing sales price bubble. Once the housing sales price falls, it will lead to the bursting of the bubble, and the resulting credit losses will spread to the whole real estate market and financial market. and cause the losses of real estate development enterprises, families, governments, banks, investors, and other market participants, and ultimately form a systemic risk.

The classification of China's real estate regulation and control policy includes three kinds: (1) the policy of restricting purchase and restricting loans, which suppresses demand mainly by restricting the purchasing qualification and quantity of buyers and the structure of funds for house purchasers, so as to alleviate the contradiction between supply and demand in the real estate market to a certain extent, in order to achieve the purpose of alleviating the rise in housing sales prices; (2) the policy of restricting sales, which requires buyers to obtain a real estate certificate for two years after purchasing a house before they can transfer it, so as to avoid the speculative behavior that buyers sell the house soon after buying the house, thus playing a role in restraining speculation. Moreover, the sales restriction policy can strengthen the residential property of the house and reduce the financial attribute of the house; (3) the policy of equal rights of rent and sale, which means that renters and buyers enjoy the same rights, including employment, business and nearby schooling and others. On the one hand, the policy is to guarantee the right of education for the children of people who have local household registration but do not have housing. Another aspect is the right to receive education for the children of immigrants who hold talent green cards.

(1) The monetary regulation and control policies of real estate in China and its changes

Since 1998, with the advancement of China's urbanization process and the continuous expansion of residents' demand for housing, the sales price of commercial housing has continued to rise, and the People's Bank of China has repeatedly cooperated with the government to regulate and control the real estate industry, trying to control commercial

housing prices within a reasonable range. According to the changing trend of commercial housing prices, monetary policy can be divided into five stages:

From 1998 to 2003, it changed from a loose monetary policy to a prudent monetary policy.

The People's Bank of China has cut the benchmark lending rate five times, and the benchmark lending rate dropped from 10.35% to 5.75%. The decline in interest rates has reduced the cost for residents to buy commercial housing, thus stimulating the rise in commercial housing prices.

In terms of credit policy, the People's Bank of China promulgated the "Notice on Regulating Housing Finance Business" in June 2001, the purpose of which is to standardize the qualifications, credit grades and collateral and others that real estate development enterprises need to have when applying for real estate development loans and have made strict requirements on these aspects. In June 2003, the People's Bank of China again promulgated the "Notice of the People's Bank of China on Further Strengthening the Management of Real Estate Credit Business", which further clarified the down payment ratio between the first purchase of commercial housing and the second purchase of commercial housing (including more than two purchases).

Due to the support in the credit policy to stimulate the prosperity and development of the real estate industry, but due to the rapid rise in commercial housing prices, but also produced many speculative, there is a tendency of real estate bubble in some areas.

From 2004 to 2007, it gradually changed from a prudent monetary policy to a tighter monetary policy.

In 2004, China gradually came out of the Asian financial crisis and began to grow rapidly. The improvement of the economy further promoted the rise of commercial housing prices. To prevent real estate investment from overheating, the People's Bank of China has increased the frequency of regulation and control of the real estate industry, and monetary policy has gradually changed from prudent to tighter. In September 2004, the People's Bank of China promulgated the "Guidelines for the Risk of Real Estate Loans of Commercial Banks" and raised the benchmark deposit and loan interest rates, which clearly stipulated the capital ratio of real estate enterprises, the loan and income ratio of individuals applying for housing loans, which shows that the Chinese government has gradually turned to a state of restraint on the real estate industry.

In 2005, the People's Bank of China further adjusted the policy of personal housing mortgage loans. At the same time, the State Council of China issued the "Notice on Effectively Stabilizing Housing Prices" to regulate the development of the real estate industry. In May 2006,

Chinese Premier Wen Jiabao once again put forward six regulation and control measures to promote the healthy development of the real estate industry at the executive meeting of the State Council. In September 2007, the "Notice on Commercial Real Estate Credit Management" was promulgated, which clearly stipulated that the interest rate of commercial loans should not be lower than 110% of the benchmark lending rate, and the proportion of the down payment for the second purchase of a house should not be lower than 40%. This shows that the Chinese government is worried about the overheated development of the real estate industry.

From 2004 to 2007, although the People's Bank of China raised the statutory deposit reserve ratio and the benchmark loan interest rate for many times, during this period, it was still unable to control the rising trend of commercial housing prices, and the implementation effect of various regulation and control policies was not significant.

From 2008 to 2011, it gradually changed to loosen monetary policy.

In August 2008, the The People‘s Bank Of China [PBOC] (2008) cut the deposit reserve ratio three times in a row and cut the benchmark lending rate five times the from October to December. In November, the loan interest rate and the first payment ratio for first-time home purchases were cut.

In 2009, to achieve the goal of stable economic growth, the Chinese government further relaxed the control over the real estate industry, reduced the proportion of capital owned by real estate enterprises, and gave policy support to residents who purchased commercial housing for the first time.

In 2010, with the rising trend of commercial housing prices becoming more and more obvious, the state council of China promulgated strict real estate regulation and control policies, which strictly limited the area and down payment ratio of the first purchase, the down payment ratio of the second purchase and the personal loan interest rate and raised the Statutory deposit reserve ratio and the loan benchmark interest rate again in October and November of the same year. Monetary policy has gradually changed from loose to strict. Although the original intentions of these policies are to restrain real estate speculation and the excessive rise of commodity housing prices, commodity housing prices still fluctuate sharply, and some fundamental factors that promote the excessive rise of commodity housing prices have not been solved, such as limited supply, the expectation of commodity housing rise is not self-reinforcing, the game between local government and central government (Xiao et al., 2012).

During this period, due to the loose monetary policy, the restraining effect of various regulation and control policies on housing prices became very weak, which further stimulated speculation and bubbles in the real estate industry.

From 2012 to 2016, return to a prudent monetary policy.

In 2012, China's macroeconomic policy was redefined as "proactive fiscal policy and prudent monetary policy". That year, the People's Bank of China cut the statutory deposit reserve ratio twice in a row and interest rates twice. At the same time, commercial banks are required to strictly implement the relevant credit policies and are not allowed to issue loans to residents who purchase third sets of commercial housing.

However, in 2013, commercial housing loans rebounded rapidly, personal housing loans also increased significantly, and real estate development loans increased by 16.3% year-on-year.

In 2014, China's real estate market operated smoothly. The number of commercial housing sales, sales prices and total real estate development investment all decreased significantly, and the price index of newly built commercial housing in many cities showed a downward trend.

In 2015, China began to carry out economic restructuring, and the people's bank of China cut the benchmark lending rate five times in a row. In 2016, Chinese cities adhered to the central government's position that "houses are for living, not for speculation". Different cities formulated different regulation and control policies on the local real estate market and strictly restricted the flow of all kinds of loans to speculative real estate.

From 2017 to the present, it has been transformed into a moderately tightened monetary policy.

Based on summarizing the experience at home and abroad, the People's Bank of China emphasizes that different cities adopt different regulation and control policies. Based on the national unified policies, different cities independently determine the minimum down payment ratio of personal housing loans for commercial banks.

In order to restrain the overheated real estate market, while formulating various regulation and control measures, the Chinese government clearly proposed that it is necessary to adhere to the tenet of "houses are used for living and not for speculation," and uniformly use a variety of means, such as finance, land, finance and taxation, investment, legislation, and others, so that the basic system and long-term mechanism with the characteristics of both national conditions and market laws can be established as soon as possible. In this way, it can not only suppress the emergence of the real estate bubble, but also prevent the economy from fluctuating greatly. At the same time, the major cities have successively formulated corresponding real estate regulation and control policies based on their own characteristics. The Chinese government has recognized the huge bubble in the real estate market, so it has taken a variety of measures to control the real estate market and prevent the occurrence of risks.

(2) China's real estate financial regulation and control policy and its changes.

The financial regulation and control policies of real estate in China are mainly tax policies. In July 1999, the Ministry of Finance and the State Administration of Taxation jointly issued the "Notice on Adjusting Several Tax Policies in the Real Estate Market", which stipulates the business tax, land value-added tax and individual income tax related to real estate respectively.

In January 2007, the ministry of finance and the state administration of taxation issued the "notice of officials implementing the decision of the state council to amend the interim regulations on urban land use tax of the people's republic of China" to raise taxation standards and strictly control tax reduction and exemption. In 2010, it was stipulated that personal income tax could not be paid for houses sold for less than one year and repurchased. In January 2011, income tax requirements were put forward again. If a house purchased by an individual is sold within 5 years, the full amount of tax will be paid, and the income tax policy on personal transfer of real estate should be strictly implemented.

In February 2017, the ministry of housing and urban-rural development made it clear that it would speed up the legislation on property tax, which is an important measure to regulate the real estate industry and help curb speculation in the real estate market and the potential risks caused by the sharp rise in commercial housing prices.

The uncertainty of policy has a direct impact on the regulation and control of the real estate industry, and the quality of the real estate market will change with the tightening and relaxation of regulation and control policies. These regulation and control policies not only cause changes in the expectations of the real estate market, but also affect the trajectory of the operation of the real estate market.

4.2.2 Market uncertainty

China's real estate industry is affected not only by policy uncertainty, but also by market uncertainty, which mainly comes from industry competition and economic fluctuation. In the aspect of industry competition, the industry concentration is getting higher and higher, which gradually shows the Matthew effect of "the stronger the strong, the weaker the weak". In terms of economic fluctuations, mainly manifested in the global economic downturn, the Chinese government should not only maintain stable economic growth, but also avoid systemic risks, so it is necessary to make comprehensive considerations in policy formulation.

(1) Market uncertainty caused by industry competition

With the implementation of more and more real estate regulation and control policies of the Chinese government, the process of survival of the fittest in the real estate industry has been

accelerated and the tendency of concentration and differentiation of the real estate industry has become more. The market share of real estate enterprises with sales of TOP10 has increased from 8.1% in 2009 to 26.9% in 2018, while the market share of real estate enterprises with sales of TOP20 has increased from 11.8% in 2009 to 37.4% in 2018.The change of industry concentration is closely related to the market cycle. From the data changes of the last decade, as shown in Annexes 4.8, the market concentration of real estate enterprises increased most in 2012, 2014 and 2016. Therefore, real estate companies will use Michael Porter's "Five Forces" model to analyze their competitiveness in the industry, which mainly include: the bargaining power of suppliers, the bargaining power of buyers, the threat of new entrants in the industry, the threat of alternative products, and the competitive intensity of competitors in the same industry. These five factors are interdependent and influence each other, and this way is used to determine the mode of the enterprise in the industry competition, to further determine the competitive position in the industry.

By comparing the sales data of the market over the years, we can see that the sudden slowdown in sales growth is a common feature. In terms of cyclical markets, they all change after the soaring stage, and the previous year is often the peak of the market at this stage. Therefore, the improvement of industry concentration can be regarded as the phenomenon of strong stay and weak elimination caused by the soaring stage. The slow pace of sales represents a gradual decline in the prosperity of the industry. At this stage, it is usually affected by policies which strengthen the test of the overall strength of enterprises, to make the market competition more intense. Small and medium-sized real estate enterprises are generally faced with the deterioration of the living environment and weaken the sustainability of development which will be eliminated in this process. Large-scale housing enterprises rely on their own comprehensive strength to purchase more land, or through M & A expansion, further enhance the comprehensive strength, leading to the stronger the strong and accelerating the increase in industry concentration.

For example, Sun China, which ranks fourth in the sales list, has seen a rapid increase in sales in recent years due to the advantages of acquisitions, mergers and acquisitions and cooperation. It can be seen from the data that in 2017, Sun China acquired land not only through "bidding, auction and listing", but also through mergers and acquisitions, so its land reserve exceeded 200 million square meters at that time. More than 96% of them are in the first tier and nearby and central cities, and 60% of them come from mergers and acquisitions. In terms of financing, due to the tightening of financial supervision, financial institutions in the allocation of credit resources, the first choice of state-controlled real estate enterprises, followed by top-

ranked large real estate companies.

In terms of financing costs, there is a big difference. The average financing cost of large real estate enterprises is 5.06%, while that of small and medium-sized real estate enterprises is 12% and 15%, even the financing costs of some real estate enterprises are higher. At the same time, due to the tightening of the Chinese government's policy regulation on the real estate industry, various regions of China have issued intensive policies on household registration reform and the settlement of talents, as well as lending standards for the settlement of talents. It objectively stimulates the real estate market. But overall, China's real estate market shows an overall cooling trend. In this case, real estate enterprises have adopted the sales strategy of "price for quantity". However, because large real estate enterprises seize the market by selling at reduced prices, they have more advantages than small and medium-sized real estate enterprises. As a result, it further squeezes the space of small and medium-sized real estate enterprises.

The inter-industry competition increases the uncertainty of the real estate market, which makes it possible to make huge profits as well as huge losses in the investment of real estate projects. At the same time, with the influence superimposed political, economic, financial and market changes and others, the success of investment depends on real estate developers' control of various uncertain factors in the process of investment.

(2) Market Uncertainty Caused by the Fluctuation of Economic Environment

Economic environment refers to a kind of regional economic level and system, economic structure, development trend, economic structure, and its development trend, and it is a kind of cyclical change, and the ups and downs of economic behavior often occur in a period, and there are no rules. In this case, when the economic environment is impacted by external factors, it will cause it to deviate from the established direction of development. This deviation can last for months or even years, and fluctuations in this economic environment can have a significant impact on the development of a country.

After the subprime mortgage crisis in the United States, to promote their own economic recovery, central banks released more liquidity, which led to a global asset price bubble. The fluctuation of commercial housing prices in China's real estate market is also an important part of the global asset price bubble. In this context, to maintain the economic growth rate, China's the monetary policy remains stable and loose, and the market risk-free interest rate shows a downward trend. China's money supply (M2) increased from 61.02 trillion yuan to 193.55 trillion yuan from 2009 to 2019, an increase of 3.17 times. Interest rates have also gone through the process of falling from low to high, as shown in Annexes 4.9.

Due to the lack of high-yielding assets that can be invested in China, high net worth people in China can only choose to buy houses by investment when they have no other assets to invest in. At the same time, the excessive issuance of currency and the policy of low interest rates have further stimulated the sharp rises in house prices and land prices.

From 2005 to 2018, China's real estate showed an upward trend year by year in terms of land purchase expenses, accumulative real estate investment, commercial housing sales and the area of commercial housing sales. The average annual growth rates of each index were 22.82%, 17.31%, 19.83% and 10.19% respectively, much higher than the GDP growth rate in the same period.

Real estate investment accounts for a large proportion of the total investment in various industries. The total investment increased from RMB 1.58 trillion in 2005 to RMB 12.03 trillion in 2018. The average investment in real estate accounts for more than 19.5% of the total investment.

With the regulation from 2016 to 2018, real estate sales began to show the characteristics of regional sales differentiation since 2019. Sales in first line and second-tier cities of 40 large and medium-sized cities began to show signs of bottoming up with sales growing by 50% year-on-year. However, the sales of third-tier cities of 40 large and medium-sized cities increased by-2% compared with the same period.

In the first half of 2019, the real estate market continued a steady trend of last year, although the overall sales decline trend, the sales prices rose slightly during the stable period. From a city-by-city point of view, sales in first-and second-tier cities have cooled rapidly, which is related to the acceleration of price reduction and collection of real estate enterprises in the context of tight real estate financing. After rapid growth in the past two years, sales in third-and fourth-tier cities are facing a situation of demand overdraft and declining dividends, resulting in greater downward pressure on the market.

The task of destocking of real estate in China has been basically completed, and the current inventory of commercial housing is equivalent to the level at the end of 2013. Commercial housing sales in 2015, 2016 and 2017 increased by 14.4%, 34.8% and 13.7% respectively compared with the same period last year, and the sales area increased by 6.5%, 22.5% and 7.7% respectively compared with the same period last year. The growth rate of real estate development investment was 1.0%, 6.9% and 7% respectively. Sales greatly exceed investment, so inventory commercial housing sales are relatively sufficient. The area for sale of commercial housing in October 2019 is equivalent to the level at the end of 2013.

Market uncertainty also has different effects on real estate projects at different stages: (1)

In the stage of land acquisition, due to the rising trend of the real estate market every year, there will be many real estate developers bidding in the land auction stage, and the key to bidding is the bidding price. Therefore, in a fully competitive environment, the key to obtaining land-use rights is the highest bidder. In this stage, whether we can design more high-quality products based on meeting the construction conditions will also affect the future sales profits and progress of real estate development enterprises. (2) In the construction stage of the project, the real estate development enterprise will decide whether it is necessary to speed up or delay the construction, expand the construction scale, and shrink the construction scale according to the market conditions at that time. At this stage, the speed and amount of sales repayment will directly affect the progress of project payment. (3) In the stage of commercial housing sales, if there are different real estate developers in the same area to develop and sell commodity housing, the quality of commercial housing sales will be more affected by the influence of the enterprise brand, sales strategy, sales price, discount ratio, product scarcity, reasonable household design and other factors. For example, in the same region, type, quality of commercial housing, the average selling price of large real estate enterprises is higher than that of ordinary real estate development enterprises.

China's real estate policy affects the prosperity, stability, depression, and recovery of the real estate industry. Although reducing the debt ratio of real estate enterprises is of great significance to the national macroeconomic regulation and control, and the country has been trying to adjust the economic structure, at present, real estate still plays an extremely important role in China's economy. Landing too fast will inevitably be accompanied by huge risks.

4.2.3 Project operation uncertainty

The internal management of the real estate industry involves many aspects, such as capital management, cost management, product design, construction units, suppliers, marketing agents, customers and so on. Therefore, the level of internal management of real estate development enterprises also directly affects the income and risk of real estate development projects. (1) In the stage of land acquisition, the early departments are mainly responsible for the license processing and the examination and approval of each link, and its work efficiency determines the time of obtaining the license and the speed of the examination and approval link, which also determines the start time of the project. (2) During the construction phase of the project, the design concept and capability of the design department will affect the cost of the whole project and whether the product design is excellent or not, which will directly affect the future sales

situation. At this stage, the speed and quality of project construction are also the key. Good construction units can complete the project construction work in quality and quantity on time, but bad construction units cannot complete the construction work on time. Moreover, there will be great hidden dangers in the quality of engineering construction. (3) In the project sales stage, the sales ability of the sales team will affect the sales price, profit, and payback speed of the whole project.

Therefore, different real estate enterprises have great differences in internal management, and these differences also cause great uncertainty for real estate enterprises. The same project, by different real estate enterprises to undertake construction and sales, is possible to form two completely different results.

Policy uncertainty, market uncertainty and internal management uncertainty will involve different stages of the real estate project, and their impacts on the real estate project are also different, as shown in annexes4.10.

In the process of investment decision-making, enterprises will face many uncertain factors hidden in their investment environment, such as the impact of government macro-control policies on them, different length of investment cycle, multi-stage, and others. Therefore, in the process of real estate project investment decision-making, the policies and regulations of real estate project investment should be analyzed, project types and development procedures and cycles, as well as the industry environment and market conditions of real estate projects. All these factors will play an important role in the investment decisions of investment enterprises.

4.3 Investment irreversibility

A core assumption of the real option theory is that the investment is irreversible, which means that once the investment is made, it is difficult to be used for other purposes. Therefore, the investment amount will become a sunk cost. The irreversibility of investment in real estate development projects means that the cost of investment cannot be recovered by selling assets or changing their use. Therefore, once the initial investment willingness changes, the investment that has already occurred will be irreversible. From the perspective of internal investment in real estate enterprises, irreversibility is an extreme manifestation of asymmetric investment adjustment costs.

Economists have explained the reasons for the irreversibility of investment from different angles. It is considered that asset specificity is a more appropriate explanation for the irreversibility of investment. Specific assets means that the value of assets can only be brought

into play when combined with a special purpose, otherwise, even if it is valuable, compared with the investment input of investors, the value of assets is far less than the cost of investment, and investors can only suffer losses. There are five kinds of special assets: (1) human assets (2) geographical location (3) brand trademarks (4) material assets (5) special agreed services. Through the above classification, the concept of asset specificity is better explained. Because of the particularity of its investment, once the initial transaction fails, or the asset is diverted to other uses, the transaction cost will be very expensive. Zhou (2003) believes that the reason for the irreversible formation of investment is mainly due to the formation of the investment process, including: 1. Because of the cost paid by the investment, once the decision is changed after the investment, the cost already invested cannot be recovered; 2. The expected return on investment in fixed assets is uncertain and risky. 3. Investment opportunities continue to exist, and investors can analyze the information about investment prospects more scientifically and accurately through further information collection. Therefore, the essence of prudence, waiting and observation is to exercise deferred options and find the best investment time and time. Thus, asset specificity is a necessary investment that investors must make in order to complete the transaction, and once the investment starts, if it is used for other purposes, it will depreciate seriously.

For real estate enterprises, investment irreversibility mainly includes initial investment cost irreversible, construction cost irreversible, capital cost irreversible, irreversible due to policy changes.

4.3.1 Land cost and upfront rxpenses are irreversible

The initial investment cost of the real estate industry is mainly composed of land transfer fees, demolition compensation fees, municipal matching fees, deed tax and other projects. These initial costs need to be fully paid by real estate enterprises within 60 days after signing the land-use right transfer contract.

With the rapid development of urbanization and the rapid growth of real estate market demand, there is a huge demand for urban residential land. While the real estate industry promotes the development of many industries, it makes the local government revenue grows rapidly, which leads to the local government's increasingly serious dependence on land finance. As shown in Figure 3 -13, land revenue rose from 1.51876 trillion yuan to 6.849747 trillion yuan from 2009 to 2017, an increase of 4.5 times. The proportion of local revenue increased from 46.58% to 74.89%, an increase of 1.6 times.

Local governments' dependence on land revenue distorts the relationship among governments, banks and enterprises. The local government will sell the operating land at a high price to the developers, and a large amount of land revenue goes into the local finance. In this process, real estate developers obtain land resources at high prices and use land as collateral for financing to obtain capital for further development and operation. Through the commercial housing pre-sale system, real estate developers in their own funds do not need to be too high increasing the leverage of household debt. Through this system, bank loans have become the main source of funds for real estate development. As the largest urban land developer, the local government, real estate enterprises and banks constitute an interest community. However, this community of interests is based on the healthy and rapid development of the real estate industry. Once the real estate market is unstable, it will lead to a series of adverse chain reactions.

At the same time, due to the immobility of land, its mobility is limited. The invested funds can't be fully recovered before the project investment function is realized. If the transfer is carried out before completion, the transfer price will be significantly lower than the purchase price, and investment withdrawal and functional changes will be subject to government regulation or relevant regulations.

In addition, according to the relevant provisions of China's measures for the disposal of idle land, those who fail to carry out development and construction for one year after obtaining the land-use right need to pay the land idle fee in accordance with 20% of the land transfer fee already paid, and those who fail to carry out development and construction for two years after obtaining the land-use right will be recovered free of charge.

It can be seen from this that once a real estate enterprise decides to invest in a real estate project and pays the relevant land use right fees, the investment is irreversible.

4.3.2 Construction cost is irreversible

In the construction stage, real estate development enterprises will pay many planning and design fees, upfront costs, project construction fees, equipment procurement fees, equipment installation fees, and others. These expenses are huge, accounting for 50%-60% of the total project. If the project terminates investment and development, the loss will be huge.

The main reasons for stopping the construction of the project in the construction stage include: (1) the capital chain is broken because the real estate development enterprises are not fully prepared in the early stage of the project development, which leads to the shortage of funds in the middle of the start of the construction project; (2) Due to the inaccurate market

positioning, the sales prospect is bleak, and the project is unable to offset the expenditure, which leads to the suspension of the construction of the project; (3) The construction is suspended due to poor construction quality and substandard construction safety.

Since 2016, there have been frequent incidents of small and medium-sized real estate development enterprises breaking their capital chains due to financing and lending difficulties with the tightening of Chinese government's regulation and control policies on the real estate industry. In the first half of 2019 alone, 271 small and medium-sized real estate enterprises declared bankruptcy and liquidation. The factors such as the restriction of purchase, the restriction of sales and the increase of financing cost are the main reasons for the deterioration of the capital situation of small and medium-sized real estate enterprises, and finally leads to the break of the capital chain.

In contrast, large real estate development enterprises with high premium and strong sales ability have strong advantages in terms of capital. Therefore, the investment in the construction stage is irreversible, which has a great impact on small and medium-sized real estate enterprises, and even related to the survival of enterprises.

4.3.3 Capital is irreversible

According to the relevant regulations of the Chinese government, the self-owned funds of real estate development enterprises shall not be less than 35% of the total investment in the development project, and the cost of land will account for 30%-40% of the total investment in the project. Therefore, in the project construction stage, most of the construction funds of real estate development enterprises come from loans from financial institutions.

With the gradual tightening of financial policy, the channels for real estate development enterprises to obtain funds through financial institutions have become very few. Even if they obtain funds, the cost of capital is also very high. At present, the capital cost of small and medium-sized real estate enterprises is about 13%-18%. Even, to survive, some small and medium-sized real estate enterprises can only obtain funds through other channels with a higher cost of capital.

Take the Tianjin Xing Yao Wu Zhou project as an example， Xing Yao Group bought 4000acres of land at a total price of 6.29 billion yuan in 2010. The land transfer fee and pre-development funds of the project are more than 10 billion, and the total investment is more than 26 billion, which is obviously too huge for Xing Yao Group, which has only 12 billion in total assets and an annual output value of 2 billion. In 2008, to solve the capital problem, the real

estate development enterprise mortgaged all the land-use rights and obtained a real estate trust fund of 6.89 billion yuan. To solve the debt and interest covered by it, Xing Yao raised funds from two other trusts to cover the investment and repay the debt. Although 1.88 billions of sales were completed in 2009, it is far from covering 3.3 billion of principal of a loan and 1.3 billion interests. The project is financed mainly through bank loans and trust loans, with loan interest rates of 15% and 20%, respectively. The average net interest rate of the real estate industry is 10.5%, and its cost of capital is much higher than the net interest rate. In addition, due to the liquidity crisis caused by market factors, when the sales rebate is unable to pay the interest on the loan, it finally leads to the breaking of the capital chain of the project and the cessation of construction.

Due to the multi-stage, uncertainty, and irreversibility of real estate, it determines that the risks faced by real estate development projects at different stages are different, how to analyze and judge the risk factors scientifically, it is particularly important in the analysis of real estate investment. Therefore, the use of real option method can make decision-makers aware of the future real estate market situation and make better use of flexible tools to make investment decisions from a perspective that is more in line with strategic planning. And the combination of the real option method and the traditional net present value method will help decision makers to evaluate the value of the project more accurately and make different decisions at any time due to the change of different risk factors.

Chapter 5: Real option valuation and dynamic investment decision of BCD project

In the previous introduction, the types of real options in the process of real estate construction and sales are analyzed. The fifth chapter, taking the real estate project of my company as a case, introduces the application of real option method in real estate project, and forms the multi-stage binary tree option model of real estate development project.

5.1 BCD introduction

As one of the four municipalities directly under the Central Government in China, Tianjin has its own unique advantages in economic, cultural, educational, and other aspects, so it has a strong attraction to the residents of many other provinces and cities. To promote economic development, the Tianjin Municipal Government adopted the policy of relaxing the conditions for the change of household registration from 1994 to 2014 and adopted the policy of introducing talents in 2018. The implementation of these policies not only promotes economic development, but also attracts a large population of other cities, as shown in Annexes 5.1 From 2000 to 2018, the foreign population in Tianjin increased from 870000 to 5.177 million, and the entry of many people from other provinces and cities promoted the positive development of the real estate industry.

The BCD project, located in Bei Chen District, Tianjin, is a residential project with an area of 100000 square meters, a saleable area of 250000 square meters and a plot ratio of 2.5. The land use right of the project is sold by bidding, auction and listing, and the total land transfer fee is 1.5 billion yuan. The BCD project is built and sold in two stage s, including Stage I mid-rise building and Stage II high-rise building, with a construction period of 5 years. The analysis shows that the price of commercial housing in the area where the BCD project is located shows an upward trend every year, as shown in Annexes 5.2 The BCD project will start in 2020 and will decide whether to invest in Stage II according to the sales of Stage I. If the sales of Stage I are good, the construction of Stage II will continue, or the investment in Stage II will be expanded. If the sales of Stage I are not good, the construction of Stage II will be delayed or the Stage II will be transferred at a transfer price of RMB 300 million. BCD project schedule, as shown in Annexes 5.3.

5.2 Cash flow forecast for BCD projects

5.2.1 BCD project cash flow measurement process

BCD project cash flow measurement process is as follows:

(1) The sales area, unit price, annual sales proportion, and annual sales carry-over ratio of Stage I and Stage II are calculated respectively.

(2) Calculate the unit cost, annual payment ratio and annual cost carry-over ratio of Stage I and Stage II respectively.

(3) Determine the proportion of accounting subjects that are linked to the balance sheet, profit statement and cash flow statement.

(4) Calculate the amount of advance receipts、 prepayments、sales revenue , main business income and VAT.

(5) Calculation of the amount of accounting accounts directly related to the main business income and the main business cost of the BCD project.

(6) Because Profit statement is based on accrual basis, Cash Flow Statement is based on cash basis. Therefore, you need to adjust the Balance Sheet and Profit statement data so that the adjusted data is consistent with the Cash Flow Statement data. The designed accounting subjects include Inventory, Advance from customers, Advances to suppliers, Finance expense and other subjects.

5.2.2 BCD project income parameter setting

The sales area, unit price, annual sales proportion, and annual sales carry-over ratio of Stage I and Stage II are calculated respectively. The sales process of real estate project is divided into three stages, including: signing sales contract, obtaining advance receipts, confirming Advances from customers as sales revenue. (1) Stage I signed the contract but did not receive the payment. (2) Stage II receives Advances from customers, which is a liability, not real income. (3) Stage II confirms advance receipts as Main operating revenue and delivers commercial housing to the buyer in Stage II, which means that all rights and obligations related to commercial housing have been transferred.

The commercial housing sales pricing of the BCD project Stage I and Stage II fully considers the salary level of the local population, the purchasing power level and the market price of other real estate projects around the BCD project. The BCD project is divided into mid-rise building and high-rise building, in which Stage I is a 6-storey residential building and Stage II is a 12-storey residential building.

In terms of sales schedule, it is expected that Stage I sales will begin in 2020, Stage I sales will

be completed by 2021, and all sales will be recovered in early 2022. If Stage I sales are good, Stage II construction and sales will continue. Stage II went on sale at the end of 2021 and will be sold out in 2023.It is expected to recover all sales by the end of 2024. As shown in Table 5.1:

Table 5.1 Sales progress and unit price of BCD project

Item	Stage /Unit price	Area	Progress and proportion				
			2020	2021	2022	2023	2024
Sales contract area	Stage I	70,000	57%	43%			
	Unit price		15,000	15,000			
	Stage I	180,000			44%	33%	22%
	Unit price				13,040	17,387	21,190
Sales collection area	Stage I	70,000	37%	63%			
	Unit price		15,000	15,000			
	Stage II	180,000			28%	36%	36%
	Unit price				16,300	16,300	16,300
Sales revenue area	Stage I	70,000	29%	71%			
	Unit price		13,761	13,761			
	Stage II	180,000			23%	34%	43%
	Unit price				14,954	14,954	14,954

As can be seen from the above table, the total area of each stage of the BCD project is the same in different stages, but the meaning expressed in different stages is different, and the financial treatment is also different.

There are also differences in the schedule for the recognition of sales contract amount, sales collection amount and sales revenue amount. The amount of the sales contract is only the amount signed in writing, at this time, the buyer may still break the contract. The funds obtained from the sales are "accounts received in advance", which are liabilities in nature and may still be returned to the buyer. The amount of sales revenue is carried forward by advance receipts and recognized as sales revenue. At this time, all the rights and obligations related to sales have been handed over to the buyer, and the sales process is finally completed.

5.2.3 BCD project cost parameter setting

Calculate the unit cost, annual payment ratio and annual cost carry-over ratio of Stage I and Stage II respectively.

The BCD project is divided into two stage s for construction and sales, and the total cost includes Land cost, Project upfront cost, Infrastructure cost, Construction cost, other costs and Capitalized interest. Among them: Stage I sales area of 70000 square meters, Stage II sales area of 180000 square meters. The unit cost, payment schedule, cost carry-over progress of Stage I and Stage II respectively, as shown in Table 5.2:

Table 5.2 BCD stage I and stage II unit cost and payment schedule

Detailed subjects	Unit cost	2020	2021	2022	2023	2024
Land cost	6,000	100%	0%	0%	0%	0%
Project upfront cost	963	37%	63%	0%	0%	0%
Infrastructure cost	1,180	37%	63%	0%	0%	0%
Garden cost	578	37%	63%	0%	0%	0%
Construction cost	2,960	37%	63%	0%	0%	0%
Other costs	282	37%	63%	0%	0%	0%
Capitalized interest	714	50%	50%	0%	0%	0%
Stage I Total unit cost	12,678	67%	33%	0%	0%	0%
Land cost	6,000	100%	0%	0%	0%	0%
Project upfront cost	963	0%	0%	28%	36%	36%
Infrastructure cost	1,180	0%	0%	28%	36%	36%
Garden cost	578	0%	0%	28%	36%	36%
Construction cost	2,960	0%	0%	28%	36%	36%
Other costs	282	0%	0%	28%	36%	36%
Capitalized interest	278	0%	0%	50%	50%	0%
Stage II Total unit cost	12,241	49%	0%	15%	18%	18%

The cost of land accounts for 48% of the total cost, and it is paid in full at the initial stage of the BCD project, so there is a great pressure on the capital of real estate enterprises, as shown in Annexes 5.4.

According to the relevant regulations on land use rights in China, land users should pay all the land use right grant fees within 60 days after signing the land use right transfer contract, that is, the payment should be paid in the same year when the land use right transfer contract is signed. Therefore, through the BCD project cost payment schedule, the initial financial pressure of real estate enterprises can be clearly shown, as shown in Annexes 5.5.

While paying the land transfer fee, it is also necessary to pay the infrastructure fee, so in 2020, the cumulative payment ratio will reach 52% of the total cost of the project, in addition to the payment of land transfer fees, infrastructure fees need to be paid at the same time, so in 2020, the cumulative payment ratio reached 52% of the total cost of the project, reflecting the irreversibility of the cost.

The amount of the "construction cost" subject is carried over to the "main business cost" subject, which follows the principle of " Accrual basis". The project payment is included in the "development cost", which follows the principle of " Cash basis", and the difference is mainly the time difference. As shown in Annexes 5.6.

5.2.4 BCD project expense and tax parameter setting

Determine the proportion of accounting subjects that are linked to the balance sheet, income statement and cash flow statement.

The marketing cost of the real estate industry usually account for 2.5% to 5% of the total

sales revenue, and the managing cost account for 1% to 3% of the total sales revenue. The proportion of marketing cost varies in different regions and different types of housing.

The marketing cost of the BCD project account for 2.38% of the total sales revenue, and the marketing cost paid are recognized as "prepayments ". Marketing costs are recognized as current sales expenses in the same way as business costs, and at the same time "Advances from customers" is recognized as income, it is carried forward proportionately from the "Advances to suppliers" account and is recognized as current marketing cost.

The BCD project managing cost account for 0.97% of the total sales income, mainly for the salaries of managers and daily office expenses. Since the managing cost incurred are related to the current management activities, the managing cost are recognized as the current expenses in the current period.

Financial cost mainly includes bank charges and interest expenses related to loans. All interest expenses are capitalized and included in the subject of "Development cost-capitalized interest".

The VAT payment method of the real estate industry is the prepayment system, with Advances from customer as the basis for VAT payment, and VAT is paid at a rate of 3 %. At the end of the project, the financial liquidation of the project shall be carried out, the VAT payable shall be calculated according to the added value, and the VAT shall be paid or refunded.

The method of income tax payment is also a pre-payment system, in which the gross profit is calculated according to the estimated gross profit margin, and the income tax is calculated based on the estimated gross profit. The estimated gross profit margin of the BCD project is 15%. The gross profit is calculated based on the 15% gross profit margin of sales revenue excluding VAT, and after deducting other taxes and expenses for the current period, the income tax is calculated at the income tax rate of 25%. At the time of financial liquidation, the income tax shall be paid or refunded according to the difference between the actual gross profit and the estimated gross profit.

BCD items marketing cost, managing cost, financial cost and various tax linkage subjects and proportions, as shown in Table 5.3:

Table 5.3 Project fee and tax related subjects and tax rates

serial number	Accounting subject	Calculation basis	Tax rate	Description
1	Main business income	Accounts received in advance		According to the proportion of income carried forward in the current year.
2	Main business cost	Development cost		According to the proportion of income carried forward in the current year.
3	Prepayments	Accounts received in advance	2.60%	Pay in advance
4	Marketing cost	Prepaid accounts-sales expenses		According to the proportion of income carried forward in the current year.
5	Managing cost	Accounts received in advance	0.97%	Charge to current expenses.
6	Value added tax-output tax	Accounts received in advance	3%	Pay in advance
7	Value added tax-input tax	Development cost.	6%-9%	By purchase item amount.
8	Land value-added tax	Accounts received in advance	3%	
9	City tax	VAT-amount actually paid	7%	
10	Education tax	VAT-amount actually paid	3%	
11	Additional tax	VAT-amount actually paid	2%	
12	Flood control tax	VAT-amount actually paid	1%	
13	Property tax	Residual value of real estate	1.2%	
14	Land use tax	Land area.		Pay according to land area.
15	Stamp duty	Contract amount.		
16	Income tax	Accounts received in advance	25%	Pay in advance.

It can be seen from the analysis that the calculation process of main business income, main business costs, expenses and taxes in the real estate industry is complex. The overall process is collection in advance and payment in advance, and then financial liquidation is carried out according to the actual financial situation.

BCD project marketing cost, managing cost, tax payment schedule and carryover schedule, as shown in Table 5.4:

Table 5.4 BCD project marketing cost, managing cost, tax payment schedule and carryover schedule

Items	Accounting subject	Stage	2020	2021	2022	2023	2024
Cost payment	Marketing cost	Stage I	37%	63%			
		Stage II			28%	36%	36%
	Managing cost	Stage I	49%	51%			
		Stage II			33%	35%	32%
Cost carry-over	Marketing cost	Stage I	29%	71%			
		Stage II			23%	34%	43%
	Managing cost	Stage I	41%	59%			
		Stage II			18%	27%	55%
Tax payment	Tax	Stage I and Stage II	10%	15%	19%	22%	35%
Tax carry-over	Tax	Stage I and Stage II	7%	16%	18%	26%	33%

Through the tax calculation table, we can see that due to the tax prepayment system of real estate enterprises, the tax will be paid at a fixed tax rate in the early stage, but at the end of the project, it is necessary to calculate the project. As the real estate companies make more profits, they will pay a lot of taxes in the final stage, so there is less tax payment in the early stage and more tax payment in the later stage.

5.2.5 Calculate the amount of the account directly related to the BCD project

According to the sales progress, unit price and income carry-over ratio of Stage I and Stage II, the amount of related accounting items from 2020 to 2024 is calculated, including contract amount, advance receipts, main business income. Calculate the payment amount, main business cost, marketing cost, managing cost, and financial cost from 2020 to 2024 according to the payment schedule, unit cost, and cost carry-forward ratio of Stage I and Stage II.as shown in Table 5.5:

Table 5.5 Calculation table of main business income, main business cost and expense of BCD project from 2020 to 2024

Items	Stage	2020	2021	2022	2023	2024
Contract amount	Stage I	48,000	57,000			
	Stage II			104,320	104,320	84,760
Sales collection	Stage I	38,400	66,600			
	Stage II.			83,456	104,320	105,624
Main business income	Stage I	28,183	68,147			
	Stage II			61,252	91,878	116,044
Cost payment amount	Stage I	59,766	28,978	-	-	-
	Stage II	108,000	-	33,033	40,666	38,643
Main business cost	Stage I	24,222	58,567	-	-	-
	Stage II	-	-	46,656	69,983	88,390

Marketing cost payment amount	Stage I	914	1,585			
	Stage II			1,986	2,483	2,514
Managing cost payment amount	Stage I	676	705			
	Stage II			811	879	787
Financial cost payment amount	Stage I	27	33			
	Stage II			38	35	31
Marketing cost carry-over amount	Stage I	731	1,768			
	Stage II			1,589	2,384	3,010
Managing cost carry-over amount	Stage I	322	464			
	Stage II			640	931	1,903
Financial cost carry-over amount	Stage I	27	33			
	Stage II			38	35	31

Calculate the amount and carry-over amount of various taxes on BCD projects from 2020 to 2024, as shown in Table 5.6:

Table 5.6 Calculation table of tax payment and tax carry-over for BCD project from 2020 to 2024

Accounting subject	Calculation basis	2020	2021	2022	2023	2024
Value added tax		1,057	1,833	2,297	2,871	3,571
Land value-added tax	Accounts received in advance	1,057	1,833	2,297	2,871	2,907
City tax	VAT-amount actually paid	74	128	161	201	203
Education tax	VAT-amount actually paid	32	55	69	86	87
Local tax	VAT-amount actually paid	21	37	46	57	58
Flood control tax	VAT-amount actually paid	11	18	23	29	29
Property tax	Residual value of real estate	400	400	400	400	400
Land use tax	Land area	165	132	83	33	-
Stamp duty	Contract amount	184	128	123	87	27
Income tax	Accounts received in advance	874	1,216	1,920	2,110	6,416
Tax payment amount	Total	3,874	5,780	7,418	8,745	13,800
Value added tax		1,057	1,833	2,297	2,871	3,571
Land value-added tax	Main business income	846	2,044	1,838	2,756	3,481
City tax	VAT-amount actually paid	59	143	129	193	244
Education tax	VAT-amount actually paid	25	61	55	83	104
Local tax	VAT-amount actually paid	17	41	37	55	70
Flood control tax	VAT-amount actually paid	8	20	18	28	35
Property tax	Residual value of real estate	154	373	335	503	635
Land use tax	Land area	32	77	69	104	131
Stamp duty	Contract amount	42	102	92	138	174
Income tax	Main business income	428	1,537	2,439	3,672	4,559
Tax carry-over amount	Total	2,669	6,233	7,309	10,402	12,964

Through the above steps, we can calculate the annual collection, payment, income, cost, marketing cost, managing cost and various taxes of the BCD project.

5.2.6 Calculation of the amount of other accounting items in BCD project

Calculate the accounts in the balance sheet and profit statement that have no fixed proportion to main business income.

The depreciation of fixed assets is calculated at a fixed proportion every year, and the subjects of other payables and paid-up capital remain unchanged. According to the above process, the balance sheet and profit statement of the BCD project from 2020 to 2024 can be obtained.

5.2.7 Cash flow calculation of BCD project

Based on the balance sheet and the profit statement, the cash flow statement is calculated by using the adjustment method, as shown in Table 5.7:

Table 5.7 Cash flow statement of BCD project from 2020 to 2024

Accounting subject	2020	2021	2022	2023	2024	Total
Cash flow from business activities						
Profit	1,269	2,915	7,318	11,015	13,376	35,893
+Depreciation	86	91	107	46	72	402
-Inventory	142,101	-34,205	-18,723	-37,025	-62,149	-10,000
- Accounts received in advance	-10,217	10,217	-16,691	-4,173	20,864	-
+Prepayments	-622	-150	-675	-93	1,541	-0
+Other accounts payable	50,000					
+Tax	-1,145	5,218	533	1,812	-6,419	-0
Total cash flow from busi	-119,400	-132,297	32,063	42,696	53,978	-145
Cash flow from investment activities						
+Shareholder investment	200,000				-150,000	
-Fixed assets	335	17	50			402
Cash flow from financing activities						
-Financial cost	2,500	2,500	2,500	2,500		10,000
Net increase in cash and equivalents	64,868	29,546	40,146	51,478	150,145	35,893

By comparing the cash inflow and cash outflow of the BCD project, we can see the capital characteristics of the BCD project, as shown in Annexes 5.7. In the early stage of the BCD project, the sales collection amount was less than the payment amount, and with the increase of sales, the collection amount gradually exceeded the payment amount. This reflects the capital-intensive and irreversible characteristics of the real estate industry.

To clearly reflect the cash flow status of Stage I and Stage II, the Stage I and Stage II cash flow statements also need to be calculated separately, as shown in Table 5.8:

Table 5.8 Cash flow forecast for stageIand stage II of BCD project

Items	2020	2021	2022	2023	2024	Total
1. Cash inflows	38,400	66,600				105,000
Amount received by Stage I	38,400	66,600				105,000
2. Cash outflow	65,532	37,054				102,586
Construction cost	57,266	26,478				83,744
Capitalized interest	2,500	2,500				5,000
Value added tax	1,057	1,833				2,890
Tax and associate charge	1,883	2,688				4,570
Fixed assets	335	17				352
Managing cost	676	705				1,381
Marketing cost	914	1,585				2,499
Financial cost	27	33				60
Income tax	874	1,216				2,090
3. Stage I net cash flow	-27,132	29,546				2,414
1. Cash inflows	-	-	83,456	104,320	105,624	293,400
Amount received by Stage II			83,456	104,320	105,624	293,400
2. Cash outflow	108,000	-	43,310	52,842	55,769	259,922
Construction cost	108,000	-	30,533	38,166	38,643	215,341
Capitalized interest			2,500	2,500	-	5,000
Value added tax			2,297	2,871	3,571	8,739
Tax and associate charge			3,175	3,799	3,808	10,782
Fixed assets			50	-	-	50
Managing cost			811	879	787	2,477
Marketing cost			1,986	2,483	2,514	6,983
Financial cost			38	35	31	104
Income tax			1,920	2,110	6,416	10,446
3. Stage II net cash flow	-108,000	-	40,146	51,478	49,855	33,478

5.3 BCD project binary tree model decision diagram

The main purpose of real estate enterprises to obtain land use rights is to carry out construction and sales, to achieve the goal of profit maximization. Moreover, before paying the land payment, the profit of the project will also be measured, and the land transfer fee will be paid only after it is determined that the project is profitable. Therefore, from the perspective of real options, the BCD project can only face immediate development or delayed development after paying the land transfer fee. There is option to defer in Stage I and option to defer expand and option to abandon in Stage II. If the two stages are merged, multiple interacting options will be formed.

Whether Stage II is construction or not depends on the sales of Stage I. If the sales of Stage I meet expectations, the construction and sale of Stage II will continue. If the sales of Stage I are higher than expected, and the policy environment and market environment are favorable to the company, it is possible to increase the investment in Stage II construction. For Stage II commercial housing decoration, although decoration will increase costs, it will also increase

cash inflows by 20%. However, if the sales of Stage I are not satisfactory, the construction of Stage II will be delayed or abandoned. Therefore, there are option to defer expand and option to abandon in Stage II. Stage II option to abandon and option to defer expand are mutually exclusive, which is essentially a put option, while option to defer expand is essentially a call option. As shown in Table 5.9:

Table 5.9 Types and characteristics of real options of stageIand stage II

Stage	Option Type	Option Description	Key features
Stage I	option to defer	After the payment of the land transfer fee, the development can be delayed for two years, so there is a deferred option in Stage I.	Underlying assets：stage I net present value Exercise price：stage I land cost Deadline：2020-2021
Stage II	option to defer expand	The sales of the stage I are better than expected, and the second stage will choose to delay the expansion, that is, to increase the investment of 300 million yuan in the second stage of development and construction for decoration, which will also increase the cash inflow by 20%.	Underlying assets：stage II net present value Exercise price：stage II land cost Deadline：2022-2024
	option to abandon	If the sales of Stage I are not satisfactory, the development and construction of stage II will be abandoned, and the abandoned value of stage II will be the net amount of total income after deducting all costs and expenses, the amount of which is 300 million yuan.	Underlying assets：stage II net present value Exercise price：stage II land cost and expansion costs; Give up value：300 million yuan Deadline：2022-2024

Through the above analysis, we can create a multi-stage binary tree model of the BCD project. The binary tree model represents the value movement with upward (u) and downward (d) actors, for which the inverse of u is d. The risk-neutral probability by which the value would increase or decrease over each time is given by p and 1−p, respectively. Suppose the current price is S, the price in the next period will either be S_u or S_d,n represents the number of execution periods of the model. As shown in Figure 5.1:

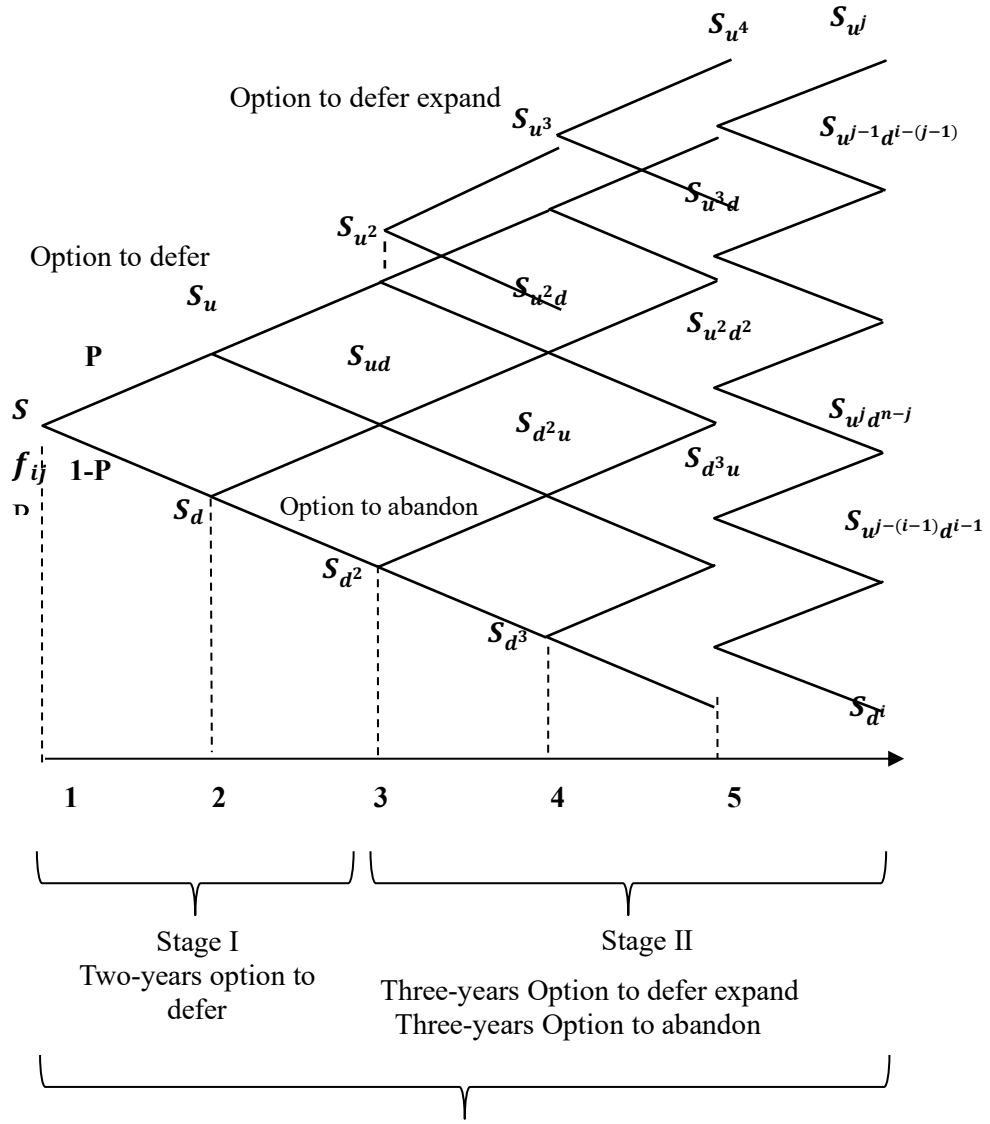

Figure 5.1 Decision diagram of multi-stage binomial tree model for BCD project

On the basis of establishing the binary tree model of project value, the present value tree of n-stage BCD project is calculated, and the final value of BCD project S_{ud}. In the n stage , the decision rules are introduced to calculate the option value on each node at the end of the period. The reverse order recursive method of dynamic programming is used to calculate in turn, from which the real option value of each node in the binary tree graph can be obtained. And get the value of the initial node f_{ij}, $f_{ij}$is the real option value of the BCD project.

As can be seen from the above figure, when at point *S*, if the construction and sales of Stage I are affected by unfavorable factors such as policies or the market, you can choose to "wait". However, according to national regulations can not be more than two years, at this time to choose to wait, that is, the exercise of option to defer. After the end of the sale of stage I, before the construction of stage II, it is necessary to analyze the sales of Stage I and judge the factors such as policy and market during the construction of Stage II to determine whether the stage II

is to be built or not. At the S_{u^2} point, if the sales of stage I meet or exceed expectations, you can choose to continue stage II construction or expand stage II investment, that is, you have an expansion option.If stage I sales do not meet expectations, BCD projects can choose to defer investment or abandon investment, so it has option to defer and option to abandon. According to the above analysis, there are four options in the construction and sale of Stage I and stage II of BCD project, including Option to defer, Option to defer expand, Option to abandon and multiple interacting options.

Call options include Option to defer and Option to defer expand, put options including Option to abandon,multiple interacting options is not the sum of the value of each independent real option, but the value of multiple interacting options is greater than the value of each independent option.

We know that there are many kinds of real options in the BCD project, so in the calculation process, according to the real option calculation steps we first calculate the occurrence value tree according to the upward and downward ratio of the present value of the underlying asset. On this basis, the amount of the present value at the end of the period after deducting the execution cost is taken as the value of the final option.

At this time, the decision rule is introduced, the option value is calculated by the risk neutral probability method, and compared with the intrinsic value of the project, the maximum value is selected as the option value. Furthermore, the reverse recursive method is used to calculate the above steps repeatedly, and the option value at the initial time is obtained.

Given that a portfolio consists of Δ units of underlying assets and 1 unit of option. When the price of the underlying asset rises, the value of the portfolio is $\Delta S_u - F_u$; when the price of the underlying asset falls, the value of the portfolio is $\Delta S_d - F_d$. According to the principle of risk-free arbitrage, $\Delta S_u - F_u = \Delta S_d - F_d$, the portfolio is risk-free, and the rate of return is the risk-free rate *r* at the time. In this case, it is expressed as:

$$\triangle = \frac{\triangle S_u - F_u}{\triangle S_d - F_d} \tag{5.1}$$

The discounted value is：

$$\triangle S_d - F = e^{-r\triangle t}(\triangle S_u - F_u) \tag{5.2}$$

Through the above formula, we can get：

$$F = e^{-r\triangle t}[pF_{u,j} + (1-p)F_d] \tag{5.3}$$

Risk neutral probability：

$$p=\frac{e^{-r\triangle t}-d}{u-d} \tag{5.4}$$

Upward u factors：

$$u=e^{\sigma\sqrt{\triangle t}} \tag{5.5}$$

Downward d factors：

$$d=e^{-\sigma\sqrt{\triangle t}} \tag{5.6}$$

Under the condition of risk neutrality：

$$F_{ij}=e^{-r\triangle t}\left[pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1}\right] \tag{5.7}$$

The formula for call options:

$$F_{ij}=MAX\{e^{-r\triangle t}\left[pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1}\right],S_{u^id^{j-i}}-X\} \tag{5.8}$$

The formula for put options:

$$F_{ij}=MAX\{e^{-r\triangle t}\left[pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1}\right],X-S_{u^id^{j-i}}\} \tag{5.9}$$

Real options in the development process of real estate projects.

From the perspective of real estate development enterprises, the main purpose of enterprises obtaining land transfer rights is to carry out development, construction, and sales, in order to achieve the goal of profit maximization. And before obtaining the land use right, the income of the project will also be estimated, and the land transfer fee will not be paid until it is determined that the project is profitable. Therefore, from the perspective of real options, after paying the land transfer fee, the BHD project can only be faced with immediate development or delayed development. Therefore, in the first stage, there are deferred options, and in the second stage, there are delayed expansion options and abandonment options, and the combination of the first stage and the second stage will form a compound option.

Whether the second phase will be developed and constructed will be determined based on the sales of the first stage. If the first stage of sales meets expectations, the second phase of development, construction and sales will continue. If the sales in the first stage are higher than expected, and the policy environment and market environment are favorable to the enterprise, it is possible to increase the investment in the development and construction of the second stage, from the semifinished housing originally planned to be built into a hardcover house, which will

increase the cost, but it will also increase the cash inflow by 20%。Likewise, if sales in the first stage are not satisfactory, it is possible to delay or abandon the development and construction of the second stage. Therefore, in the second stage, there are deferred expansion options and abandonment options. In the second stage, the abandonment option and the delayed expansion option are mutually exclusive, which is essentially a put option, while the delayed expansion option is essentially a call option.

When calculating all kinds of real options, it mainly includes the following steps:

The first step is to perform a present value tree calculation based on the present value of the underlying asset and the upward and downward ratios to obtain the project value at the end of the period.

The second step is to compare the balance of the ending value of the project after deducting the execution cost and related costs with the option value under different real option methods, and the maximum value is selected as the option value at the end of the period.

The third step is to introduce decision-making rules, use the risk-neutral probability method to calculate the option value, and compare it with the intrinsic value of the project, from which the maximum value is selected.

The fourth step is to use the reverse order solution method to repeat the above steps to get the option value at the initial moment.

The fifth step is to analyze and summarize the value decision-making path of real options.

5.4 Key parameter setting of BCD project

BCD project is divided into stage I and stage II construction and sales, the time period is 5 years. The BCD project will start construction in 2020, and the project will decide whether to invest in stage II according to the sales of stage I. if the sales of stage I are better than expected, it will invest an additional 300 million yuan in stage II and decorate stage II to obtain 1.2 times the original cash flow. If stage I sales are not good, the company will abandon stage II construction. The abandoned value is 300 million yuan of total income after deducting all costs. Therefore, there are different options in different stages, and the relevant parameters of each option need to be set separately. Therefore, there are different options in different stages, and the relevant parameters of each option need to be set separately.

5.4.1 Parameter setting of stage I and stage II real options for BCD project

The BCD project is divided into two stage s of construction and sales, each stage contains different types of real options, so the parameters are also different, and the key parameters need to be set separately.

（1）The value of the underlying asset S

In the process of real estate construction and sale, land cost has no proportion relation with sales revenue, while sales revenue and cost expenditure, expense and tax expenditure all have proportion relation. Therefore, the cash inflow of BCD project should be the amount of sales revenue after deducting construction costs (excluding land transfer fees), fees and taxes.

Therefore, the strike price of the BCD project is the present value of the expected cash inflow of the project.

Through data collation, calculate the net cash flow amount of BCD project Stage I and Stage II (excluding land cost), as shown in Annexes 5.8. After calculating the net cash inflows of BCD project Stage I and Stage II, it is also necessary to discount the net cash inflows of Stage I and Stage II and calculate the present value of Stage I and Stage II.

According to the traditional method, the choice of discount rate mainly refers to three criteria:

Market interest rate

The lowest rate of return on investment that investors want

weighted average cost of capital rate

According to the "Economic Evaluation methods and parameters of Construction projects" issued by China in 2006 as a reference, the state stipulates that the financial benchmark rate of return before financing is 12%, but considering the market environment, policy influence and other factors, the discount rate of BCD project is reduced to 11%. On this basis, the cash inflow present value of the BCD project is calculated, and the net present value of each stage is as follows:

$$NPV_{(stage\ I)} = \left(\frac{14868}{(1+11\%)^1} + \frac{29546}{(1+11\%)^2}\right)/10000 = 3.73 \quad (5.10)$$

$$NPV_{(stage\ II)} = \left(\frac{0}{(1+11\%)^1}\frac{0}{(1+11\%)^2} + \frac{40146}{(1+11\%)^3} + \frac{51478}{(1+11\%)^4} + \frac{49855}{(1+11\%)^5}\right)/10000 = 9.29 \quad (5.11)$$

$$NPV_{(BCD)} = 3.73 + 9.29 = 13.02 \quad (5.12)$$

The BCD project stage I includes option to defer, and stage II includes option to defer expand and option to abandon, the underlying asset is also different, as shown in Annexes 5.9.

（2）Strike price X

There are many types of options in BCD project, but the strike price of different types of options is also different. The land cost of 1.5 billion yuan constitutes stage I and stage II strike price, of which Stage I strike price is 420 million yuan and stage II strike price is 1.08 billion yuan. As shown in Annexes 5.10.

（3）Option period T

The period of validity of a real estate project as an option before construction begins. If the real estate project has the right to decide whether to build the project within a fixed period, then the strike term of the real option is option period, and if it is not implemented beyond this period, the option will be lost. As shown in Annexes 5.11.

（4）Risk-free rate

The Risk-free interest rate refers to the Rate of return on investment that can be obtained by investing money in a project without any risk. The international risk-free interest rate is usually short-term interest rate of national debt. Because China issues less one-year national debt, it issues more national debt of more than one year. Therefore, the three-year interest rate of national debt is used as the risk-free rate, and the three-year interest rate of national debt in 2019 is 4%, that is:

$$r_f = 4\% \tag{5.13}$$

（5）Volatility σ

According to the cash flow data of BCD project, we can know that the sales prices of Stage I and Stage II are different, but the construction costs, expenses and taxes are relatively stable, thus it can be seen that the sales price fluctuates most frequently in all data, so the sales price is used as the volatility parameter.

Volatility is one of the core parameters in the real option pricing model, and volatility has a great impact on option pricing, but volatility cannot be obtained through the market. Therefore, the BCD project using the historical volatility method to calculate the volatility σ is closer to the reality.

The volatility of the BCD project calculates the standard deviation of house price changes based on historical data of average house prices in the area where the project is located. In the case of policy and market stability, replacing future price volatility with historical volatility can be seen as consistent.

$$X_i = \ln\left(\frac{S_{i+1}}{S_i}\right) \tag{5.14}$$

X_i : Logarithm of price change of commercial housing

S_{i+1}: The price of commercial housing in the reporting period

S_i : The price of commercial housing in the base period

$$\bar{X}=(\frac{1}{N}\sum_{i=1}^{n}X_i) \tag{5.15}$$

$$\sigma=\sqrt{\frac{\sum(X_i-\bar{X})^2}{N-1}} \tag{5.16}$$

$\bar{X}$: Logarithmic average of changes in commercial housing prices

N: The price and quantity of commercial housing

σ: The standard deviation of commercial housing price change, that is, volatility

In the selection of historical housing sales price data, the historical sample data should not be too small, and the historical sample data cannot clearly show the law of house price fluctuations, but if there are too many historical sample data, it will lead to a decline in volatility accuracy. Therefore, when calculating the historical volatility, it is generally considered that the reference time for the historical data should be the data of nearly two years (24 months). Therefore, the historical data of the real estate projects in the area where the BCD project is located for nearly 24 months are selected as the reference for calculating the volatility, as shown in Annexes 5.12.

The historical data are sorted out and calculated as the basis of BCD project volatility. Monthly volatility and annual volatility can be calculated from the above data. As shown in Annexes 5.13.

$$\sigma_{month}=\sqrt{\frac{\sum(X_i-\bar{X})^2}{N-1}}=\sqrt{\frac{0.056094}{11-1}}=7.49\% \tag{5.17}$$

$$\sigma_{year}=\sqrt{12}\sigma_{month}=25.94\% \tag{5.18}$$

$$u=e^{\sigma\sqrt{\Delta t}}=1.2962 \tag{5.19}$$

$$d=e^{-\sigma\sqrt{\Delta t}}=0.771 \tag{5.20}$$

Through the risk-neutral probability, it can be concluded that:

$$p=\frac{e^{r\Delta t}-d}{u-d}=0.5133 \tag{5.21}$$

5.4.2 Summary of key parameters of different types of options for BCD Project

Through the above analysis, the different types of real option parameters of BCD project are

sorted out and summarized. The relevant parameters of BCD project stage I and stage II are shown in Table 5.10:

Table 5.10 Key parameters of options in the stage I and stage II of the BCD project

Stage	Real option type	Underlying assets *S*	Executive price *X*	Option term T	Risk-free rate *r*	Volatility σ
Stage I	Expansion option	3.73	4.2	2020-2021	4%	25.94%
Stage II	Deferred expansion option	9.29*1.2	10.80+3	2022-2024	4%	25.94%
	Abandon option	9.29	10.8+3	2022-2024	4%	25.94%

By clearly setting the relevant parameters of different types of options of BCD project Stage I and Stage II, it lays a foundation for more accurate calculation of the value of various types of options of BCD project Stage I and Stage II.

5.5 Net present value of BCD projects

From the cash flow calculation above, it can be seen that the cash inflow of the BCD project is 3.984 billion yuan, the cash outflow amount is 3.626 billion yuan, and the net cash flow is 359 million yuan. On this basis, the calculation of Stage I and Stage II cash flow was carried out respectively.

The net present value method and binary tree method are used to calculate and compare the project value of BCD project, so as to find out the difference between the two calculation methods and determine the optimal investment decision path of BCD project.

Through the analysis of the previous article, the discount rate of BCD project is set at 11%. The NPV method uses the present value of the net cash inflow and the present value of the net cash outflow to calculate the net present value, and then evaluates the investment plan according to the size of the net present value. If the net present value is positive, the investment plan is acceptable; if the net present value is negative, the investment plan is unacceptable. The greater the NPV, the better the investment plan.

According to the first stage NPV measurement table of the BCD project, as shown in Annexes 5.14, the NPV is:

$$NPV_{(stage\ I)} = \frac{-24443}{(1+11\%)} + \frac{-23980}{(1+11\%)^2} = -463 \quad \textbf{(5.22)}$$

Stage I is sold in two years. The sales amount in 2020 and 2021 is 384 million yuan and 666

million yuan, and the annual cost expenditure is 655.92 million yuan and 370.54million yuan, respectively. The cost expenditure includes 420 million yuan of land cost that should be shared by stage I. Therefore, the net cash flow in 2020 is-271.32 million yuan (38400-65532), and the net cash flow in 2021 is 295.46 million yuan (66600-37054). According to the 11% discount rate, the net present value in 2020 is-244.43 million yuan, the net present value in 2021 is 239.80 million yuan, and the total net present value of stage I is-4.63 million yuan.

According to the second stage NPV measurement table of the BCD project, as shown in Annexes 5.14, the NPV is:

$$NPV_{(stage\ II)}=\frac{-108000}{(1+11\%)}+\frac{-0}{(1+11\%)^2}+\frac{40146}{(1+11\%)^3}+\frac{51478}{(1+11\%)^4}+\frac{49855}{(1+11\%)^5}=-4447 \quad \textbf{(5.23)}$$

Stage II is sold in three years. From 2022 to 2024, the annual sales amount is 834.56 million yuan, 1.0432 billion yuan and 1.05624 billion yuan respectively, and the annual cost expenditure is 433.10 million yuan, 528.42 million yuan and 557.69 million yuan respectively. As the land cost is paid in a lump sum, 1.08 billion yuan of the land cost that should be borne by stage II will be included in the 2020 cost payment project. Therefore, the net cash flow in 2020 is-1.08 billion yuan, the net cash flow in 2021 is million yuan, and the annual net cash flow from 2022 to 2024 is 433.10million yuan, 528.42million yuan and 557.69 million yuan, respectively. According to the 11% discount rate, the annual net present value is-972.97 million yuan, 293.55million yuan, 339.10 million yuan and 295.86 million yuan respectively, and the total net present value of stage II is-44.47 million yuan. As shown in Annexes 5.15

Through the calculation, we can see that both stage I and stage II NPV are negative, so we should not invest in BCD projects. At the same time, because the construction of stage II is based on stage I and the net present value of stage I is negative, while giving up the investment of stage I, it will also give up the investment of stage II.

5.6 Mathematical symbols in the binomial tree model of the BCD project

The flexibility of investment decisions of real estate enterprises generally appears in the form of a combination of real options. In the process of stage d investment, decision makers can postpone the investment, expand the investment, or terminate the investment to control investment failure. These real option combinations influence each other, but their value is not equal to the sum of the value of a single real option in the combination.

The binomial tree model can be used to show the changing process of the asset price. after obtaining the asset price of each node, the option value of each node is solved under the risk-

neutral condition. at the same time, the value of the node needs to be compared with the intrinsic value of the project. and in the immediate implementation and continue to wait to choose a larger value as the node option value, finally, the reverse order recursion method is used to calculate the initial option value.

According to the value S of the initial node of the binary tree model, and the equation $S_u = S \times u, S_d = S \times d$. Recursively forward, the binary tree process of dynamic change of project value can be established. Get the value of j point S_{ij} , $S_{ij} = S_{00} * u^i d^{j-i}$, where S_{ij} is the option price of stage I at time *j.* Where J is the year; and I is the stands different states at the same time. End of term: *j=n.*

$$\begin{aligned} &S_{ij}=S_{00}*u^i d^{j-i} \qquad i=0,1,2,L,\ n+1\ ;j=0,1,2,n \\ &S_{in}=S_{00}*u^i d^{n-i} \qquad i=0,1,2,L,\ n+1\ ;j=n \end{aligned} \tag{5.24}$$

By building the binary tree model, we can get the value of the project on each node. In the *n* period, the reverse order inversion method of dynamic programming is used to solve the real option value F_{ij} of the intermediate node in turn, until the value of the initial node F_{in} is obtained, that is, the real option value of the project. As shown in figure 5.2:

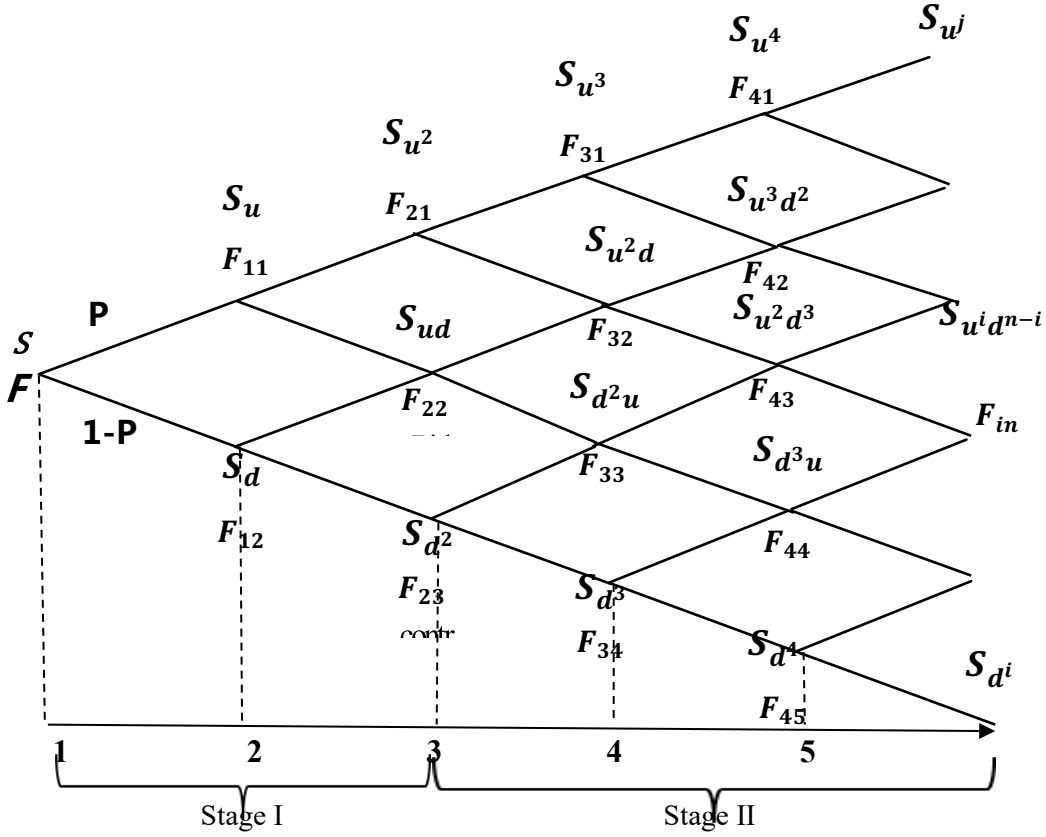

Figure 5.2 multi-stage binary tree model of BCD project

(1) Call option pricing

Supposing an investment option is treated as a call option, the term of the option is divided into n intervals with the length of Δ_{ij}, F_{ij} (0≤j≤n, 0≤i≤j) denotes the call option value of the i-th node at the time of $j\ \Delta_t$, then F_{ij} is regarded as the option value of node (i , j), while $S_{u^i d^{n-i}}$ denoting the asset price at node (i, j). Since the value of the call option is, MAX ($S - X_T$, 0), so we obtain:

$$\mathbf{F_{in}=Max\left(S_{u^i d^{n-i}}-X_t,0\right),\ for\ j=0,1,2.....n} \tag{5.25}$$

(2) Put option pricing

Supposing an investment option is treated as a put option, the term of the option is divided into n intervals with the length of Δ_{ij}, F_{ij} (0≤j≤n, 0≤i≤j) denotes the put option value of the i node at the time of $j\ \Delta_t$, then F_{ij} is regarded as the option value of node (i, j), while $S_{u^i d^{n-i}}$ denoting the asset price at node (i, j),Since the value of the put option is: MAX ($X_T - S$, 0), so we obtain:

$$\mathbf{F_{in}=MAX\left(X_t-S_{u^i d^{n-i}},0\right),\ for\ j=0,1,2.....n} \tag{5.26}$$

5.7 Stage I: option to defer

5.7.1 Option to defer at the first stage and the decision-making ideas

It can be learned from above analysis that there is an option to defer at the first stage of BCD project. If the value of the underlying asset at first stage is represented with S^I and the strike price is X^I, the deferred option value at the first stage is F^I_{DEFin}. Its value and decision-making ideas turn out to be:

(1) Determine the project value at the end of the first stage of the BCD project

$$\mathbf{S^I_{u^i d^{n-i}}} \tag{5.27}$$

(2) Determine the option value at the end of the first stage of the BCD project

$$\mathbf{F^I_{DEFi2}=MAX(S^I_{u^i d^{n-i}}-X^I,0)\ ,\ for\ j=0,1,2.....n} \tag{5.28}$$

(3) The decision rule is introduced to compare of F^I_{DEFij} in the formula and the intrinsic values of the option according to the risk-neutral probability and the reverse order recursion

method, and the present values of the option node from the end of the n-1th year to the end of the first year, and the initial option value are given by:

$$\mathbf{F^{I}_{DEFij}=MAX\{e^{-r\Delta t}[pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1}],MAX[S^{I}_{u^{i}d^{n-i}}-(X^{I}+I^{I}),0]\}} \quad \mathbf{(5.29)}$$

where: $MAX(S^{I}_{u^{i}d^{n-i}}-X^{I},0)$, indicating whether the decision is executed immediately at the end of the first year;$e^{-r\Delta t}\ [pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1}]$, indicating keeping waiting at the end of the first year or deferred to the next year for decision-making.

5.7.2 Calculation process and results of option to defer at the first stage

Refer to the key parameters of the first stage of BCD project in the previous chapter, as shown in Annexes 5.16.

(1) Determine the project value at the end of the first stage of the BCD project

With the combination of binomial model, the increased price of asset is $S_u=S\times u$ the declined price of asset is $S_d=S\times d$, $u=e^{\sigma\sqrt{\Delta t}}=1.2962$, $d=e^{-\sigma\sqrt{\Delta t}}=0.7715$, thus the increased price in the first year of BCD project is S^{I}_{u}=3.73×1.2962=483 million yuan, and the declined price is S^{I}_{d}=3.73×0.7715=288 million yuan. Based on this calculation, the change table of present value in the first stage of BCD project is calculated, as shown in Annexes 5.17.

(2) Determine the option value at the end of the first stage of the BCD project

According to the present value tree of the first stage of the BCD project, combined with the binomial model, the value of the second-year deferred option F^{I}_{DEFi2} in the first stage is obtained, $F^{I}_{DEFi2}=MAX\left(S^{I}_{u^{i}d^{n-i}}-X^{I},0\right)$, $for\ j=0,1,2\ldots\ldots n$. As a result, the option value of the first node at the end of the second year of the first stage of the BCD project is 2.067, as shown in Annexes 5.18.

Taking using of the risk-neutral probability and reverse order recursion, the deferred option value of each node at the end of the first year in the first stage can be calculated, and the maximum value can be selected between continuing to wait and immediate decision, as shown in Annexes 5.19.

(3) The Option to defer value of the first stage of BCD project:

$$\begin{aligned}\mathbf{F^{I}_{DEFi2}}&\mathbf{=MAX\{e^{-r\Delta t}[e^{-r\Delta t}[pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1}],MAX(S^{I}_{u^{i}d^{n-i}}-X^{I},0)\}}\\&\mathbf{=MAX[\frac{0.5133\times 1.0194+0.4867\times 0}{1+4\%},\ MAX(3.73-4.2)]}\\&\mathbf{=MAX(0.5027,-0.47)}\\&\mathbf{=0.5027}\end{aligned} \quad \mathbf{(5.30)}$$

It can be noted from the above calculation that the value of the first stage of the BCD project is 45.64 million yuan (0.5027-0.0463) when considering the deferred option, which is significantly larger than the net present value of -0.0553 billion yuan calculated by the NPV method. It can be seen that the deferred development can add value to a BCD project. The value and decision-making path of the first stage of the project are shown in Table 5.11:

Table 5.11 The deferred option value and decision-making path of the first stage of BCD project

The 0th year	The 1st year 2020	The 2nd year 2021	i/j
0.5027 (Keep waiting)	1.02 (Keep waiting)	2.06 (Instant decision)	0
	0	0	1
		0	2

Based on the above decision-making path, when the option value is larger than the intrinsic value of the project at the end of the second year, thus it should invest immediately. To calculate the option value of each node at the end of the first year according to the risk-neutral probability method and the reverse order recursion method, and the above-mentioned method is adopted to compare and finally obtain the option value of the early stage.

5.8 Stage II: option to defer expansion

5.8.1 Option to defer expansion at the second stage and the decision-making ideas

In the stage II of the BCD project, if stage I sells well, it will increase the investment of 300 million yuan in stage II for decoration, which can increase the value of the original project by 1.2 times, so there is option to defer expansion in stage II of the BCD project.

Let the value of the underlying asset in the second stage be S^{II}, the strike price in the second stage be X^{II}, I^{II} is the additional cost, The value of option to defer expansion in the second stage is F^{II}_{EXPin} Its value and decision-making ideas turn out to be:

(1) Determine the project value at the end of the second stage of the BCD project:

$$\mathbf{S^{II}_{u^i d^{n-i}}} \tag{5.31}$$

(2) Determine the option value at the end of the second stage of the BCD project:

$$\mathbf{F^{II}_{EXPi3}=MAX[S^{II}_{u^i d^{n-i}} -(X^{II}+I^{II}),0]\ ,\ for\ j=0,1,2.....n} \tag{5.32}$$

(3) The decision rule is introduced to compare F^{II}_{EXPi3} in the formula and the intrinsic value of option according to the risk-neutral probability and the reverse order recursion method, and

the present values of the option node from the end of the n-1th year to the end of the first year, and the initial option value are given by:

$$F^{II}_{EXPi2}=MAX\{e^{-r\Delta t}[pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1}],MAX[S^{II}_{u^id^{n-i}}-(X^{II}+I^{II}),0]\} \quad (5.33)$$

5.8.2 Calculation process of option to defer expansion at the second stage

Refer to the key parameters of the second stage of the BCD project in the previous chapter, as shown in Annexes 5.20.

(1) Determine the project value at the end of the second stage of the BCD project

In the second stage, the value of the underlying asset is 929 million yuan, and after it is expanded by 1.2times, the value of the underlying asset is 1.114 billion yuan. With the combination of binomial model, the increased price of asset is S_u=S×u, the declined price of asset is S_d= S× d, $u=e^{\sigma\sqrt{\Delta t}}=1.2962$, $d=e^{-\sigma\sqrt{\Delta t}}=0.7715$, thus the increased price in the first year of BCD project is S_u^{II} =11.15×1.2962=1.445 billion yuan, and the declined price is S_d^{II} =11.15×0.7715=860 million yuan. Based on this calculation, the change table of present value in the second stage of BCD project is calculated, as shown in Annexes 5.21.

(2) Determine the option value at the end of the second stage of the BCD project

According to the present value tree of the second stage of the BCD project, combined with the binomial model, Calculate the option to defer expansion value of the third year of the project F^{II}_{EXP13}=10.47、F^{II}_{EXP23}=0.64,as shown in Annexes 5.22.

Taking using of the risk-neutral probability and reverse order recursion, the compound option value of each node at the end of the first year can be calculated, and the maximum value can be selected between continuing to wait and instant decision, as shown in Annexes 5.23.

$$F^{II}_{EXPi2}=MAX\{e^{-r\Delta t}[pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1}],MAX[S^{II}_{u^id^{n-i}}-(X^{II}+I^{II}),0]\} \quad (5.34)$$

(3) The option to defer expansion value of the second phase of the BCD project:

$$\begin{aligned}&F^{II}_{EXPi2}=MAX\{e^{-r\Delta t}[pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1}],MAX[S^{II}_{u^id^{n-i}}-(X^{II}+I^{II}),0]\}\\&=MAX[\frac{0.5133\times 2.84+0.4867\times 0.16}{1+4\%},\ MAX(11.15-10.8-3)]\\&=MAX(1.4745,-2.65)\\&=1.47\end{aligned} \quad (5.35)$$

The value of the second stage of the BCD project is 102.53million yuan (147-44.47), which is greater than the net present value of -44.47million yuan calculated by the NPV method. The value and decision-making path of the second stage of the project are shown in Table 5.12:

Table 5.12 The option to defer expansion and decision-making path of the second stage of the BCD project

The 0th year	The 1st year 2022	The 2nd year 2023	The 3rd year 2024	i/j
1.47 （keep waiting）	2.85 （keep waiting）	5.47 （keep waiting）	10.48 （Instant decision）	0
	0.16 （keep waiting）	0.32 （keep waiting）	0.65 （Instant decision）	1
		0	0	2
			0	3

Based on the above decision-making paths, when the option value is greater than the internal value of the project at the end of the third year, it is better to invest immediately. To calculate the option value of each node at the end of the first year according to the risk-neutral probability method and the reverse order recursion method, and the above-mentioned method is adopted to compare and finally obtain the option value of the early stage.

5.9 Compound options of two stages: deferred construction of stage I and deferred expansion of stage II

5.9.1 Compound option valuation and decision-making ideas of deferred construction at the first stage and deferred expansion at the second stage

The compound option of deferred construction at the first stage and the deferred expansion at the second stage is not a simple sum of the first stage option and the second stage option, but the second stage decision and value have already been expected when the first stage development decision is made.

Let the value of the underlying asset in the first stage be S^I, the strike price in the first stage be X^I, the value of the deferred option of expansion in the second stage is F_{EXPin}^{II}, and the value of the compound option in the first stage and the second stage is $F_{COMin}^{I\&II}$. The composite option value and decision ideas for the first and second stages of the BCD project are as follows:

(1) Determine the project value at the end of the first stage of the BCD project:

$$\mathbf{S}_{\mathbf{u}^{\mathbf{i}}\mathbf{d}^{\mathbf{n-i}}}^{\mathbf{I}} \tag{5.36}$$

(2) Determine the option value at the end of the first stage of the BCD project:

$$F_{COMi2}^{I\&II}=MAX（S_{u^id^{n-i}}^{I}-X^{I}+F_{扩in}^{II}\ ,0），\ \text{for j=0,1,2.....n} \quad (5.37)$$

(3) The decision rule is introduced to compare $F_{COMin}^{I\&II}$ in the formula and the intrinsic value of option according to the risk-neutral probability and the reverse order recursion method, and the present value of the option node from the end of the n-1th year to the end of the first year, and the initial option value are given by:

$$F_{COMin}^{I\&II}=MAX\{e^{-r\triangle t}[pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1}],MAX(S_{u^id^{n-i}}^{I}-X^{I},0)\ ]\} \quad (5.38)$$

5.9.2 Calculation process and results of compound option value of deferred construction at the first stage and the deferred expansion at the second stage

Refer to the key parameters of the first stage of the BCD project in the previous chapter, as shown in Annexes 5.24.

(1) Determine the project value at the end of the first stage of the BCD project

With the combination of binomial model, the increased price of asset is S_u=S×u, the declined price of asset is S_d=S×d, $u=e^{\sigma\sqrt{\Delta t}}=1.2962$, $d=e^{-\sigma\sqrt{\Delta t}}=0.7715$, thus the increased price in the first year of BCD project is S_u^I=3.73×1.2962=483 million yuan, and the declined price is S_d^I=3.73×0.7715=288 million yuan. Based on this calculation, the change table of present value in the first stage of BCD project is calculated, as shown in Annexes 5.25.

(2) Determine the option value at the end of the first stage of the BCD project

According to the present value tree of the first stage of the BCD project and the deferred option value in the second stage of expansion, combined with the binomial model, the compound option value of the second-year of this project $F_{COMi2}^{I\&II}$, $F_{COMin}^{I\&II}=MAX\left(S_{u^id^{n-i}}^{I}-X^{I}+F_{EXPin}^{II},0\right)$, and the option value at the end of the second year of the first stage of the BCD project are $F_{COM12}^{I\&II}$ =3.55 and $F_{COM22}^{I\&II}=1.01$ respectively, as shown in Annexes 5.26.

Taking using of the risk-neutral probability and reverse order recursion, the compound option value of each node at the end of the first year can be calculated, and the maximum value can be selected between continuing to wait and instant decision, as shown in Annexes 5.27.

$$F_{COMin}^{I\&II}=MAX\{e^{-r\triangle t}[pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1}],MAX(S_{u^id^{n-i}}^{I}-X^{I},0)\ ]\} \quad (5.39)$$

(3) The compound option value of deferred development at the first stage and the deferred expansion at the second stage:

$$\begin{aligned} F_{COMin}^{I\&II} &= MAX\{e^{-r\Delta t}[pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1}], MAX(S_{u^i d^{n-i}}^{I}-X^{I},0)\} \\ &= MAX[\frac{0.5133\times 2.22+0.4867\times 0.5}{1+4\%},\ MAX(3.73-4.2)] \\ &= MAX(1.33,-0.47) \\ &= 1.33 \end{aligned} \tag{5.40}$$

The value of the BCD project is 83.75 million yuan (133-4.63-4.63-44.47), which is greater than the net present value of -49.10 million yuan (-4.63-44.47) calculated by the NPV method. From here we see that the compound option of the first and second stages can increase the value of the BCD project. The value and decision-making path of the first stage and the second stage of the project are shown in Table 5.13:

Table 5.13 The compound value and decision-making path of the first stage and the deferred expansion at the second stage of the project

The 0th year	The 1st year 2020	The 2nd year 2021	i/j
1.33 （keep waiting）	2.22 （keep waiting）	3.55 （invest immediately）	0
	0.5 （keep waiting）	1.01 （invest immediately）	1
		0	2

Based on the above decision-making paths, when the option value is greater than the internal value of the project at the end of the second year, it is better to invest immediately. To calculate the option value of each node at the end of the first year according to the risk-neutral probability method and the reverse order recursion method, and the above-mentioned method is adopted to compare and finally obtain the option value of the early stage.

The value of the first stage and second-stage compound option is not a simple addition of the value of the two-stage options, but the decision and value of the second stage are expected when the first-stage development decision is made. The value of the second-stage option is added at the end of the stage. On this basis, the risk-neutral method and the reverse order recursion method are used to calculate the value of the first stage and second-stage compound option.

5.10 Expansion situation of consideration of giving up option

5.10.1 Stage I: option to defer and the option to abandon

5.10.1.1 Stage I: Valuation and decision-making ideas of deferred option and abandoned option

In the first stage of BCD project, if the sales situation is not optimistic, the development, construction, and sales of the first stage may be abandoned, and the land use right of the first stage will be sold at a net value of 150 million yuan.

Let the value of underlying assets at the first stage be S^I and the strike price be X^I, the abandoned value is S^I_{remain}, and the abandoned option value at the first stage is F^I_{ABAin}. Its deferred option value and decision-making ideas at the first stage of BCD project under the situation of consideration of giving up option:

(1) Determine the project value at the end of the first stage of the BCD project

$$S^I_{u^i d^{n-i}} \tag{5.41}$$

(2) Determine the option value at the end of the first stage of the BCD project

$$F^I_{ABAi2}=MAX\left(S^I_{u^i d^{n-i}}-X^I,\ S^I_{remain}\right),\ for\ j=0,1,2.....n \tag{5.42}$$

(3) With the introduction of the decision rule, the present value of the option node from the end of the n-1 year to the end of the first year, and the initial option value are obtained according to the risk-neutral probability and the reverse order recursion method:

$$F^I_{ABAin}=MAX\{e^{-r\triangle t}[pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1}],MAX(S^I_{u^i d^{n-i}}-X^I,\ S^I_{remain})]\} \tag{5.43}$$

5.10.1.2 Stage I: Calculation process and results of deferred option and abandoned option

Refer to the key parameters of the first stage of the BCD project in the previous chapter, as shown in Annexes 5.28.

(1) Determine the project value at the end of the first stage of the BCD project:

Since this step is calculated based on the deferred option of the first stage, the calculation steps and results of this stage are the same. After the present value tree is expanded, the project value at the end of the second year are: S^I_{12}=6.26, S^I_{22}=3.73, $S^I_{32}=2.22$, as shown in Annexes 5.29 shown.:

(2) Determine the option value at the end of the first stage of the BCD project:

In this stage, it is the comparison between the present value after the expansion of present value tree and the deduction of strike price, and the abandoned value of the first stage, and the maximum value is selected from the two. The option values at the end of the first stage and the second year are respectivelyF_{12}^{I}=2.06, F_{22}^{I}=1.5, $F_{32}^{I}=1.5$. A table of change in the present value of abandoned options in the first stage of the BCD project is shown in Annexes 5.30.

The risk-neutral probability and reverse order recursion are applied to calculate, and choose between the decision to give up in the next year and the decision to give up in the current year for each node at the end of the first year, and select the maximum value as the value of the node $F_{ABAij}^{I}=MAX\{e^{-r\Delta t}[pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1}]\ ,MAX(\ S_{u^i d^{n-i}}^{I}-X^{I},\ S_{remain}^{I}\ )]\}$.The option value of every node at the end of the 1st year is F_{11}^{I}=1.72, F_{21}^{I}=1.5, as shown in Annexes 5.31.

(3) The deferred option value of the first stage while considering giving up option

$$\begin{aligned}F_{ABAin}^{I}&=MAX\{e^{-r\Delta t}[pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1}]\ ,\ MAX(\ S_{u^i d^{n-i}}^{I}-X^{I},\ S_{remain}^{I}\ )\}\\&=MAX[\frac{0.5133\times 1.72+0.4867\times 1.5}{1+4\%},\ MAX(3.73-4.2,1.5)]\\&=MAX(1.55,1.5)\\&=1.55\end{aligned}\qquad (5.44)$$

In the case of considering giving up the option, the deferred option value of the first stage of the BCD project is 150.32 million yuan (155-4.63), which is greater than the net present value of -4.63 million yuan calculated by the NPV method. It can be noted that the value of the first stage of the BCD project can be increased via abandonment. The value and decision-making path of the first stage of the project are shown in Table 5.14:

Table 5.14 The deferred option value and decision-making path of the first stage of BCD project in case of considering giving up the option

The 0th year	The 1st year 2020	The 2nd year 2021	i/j
1.55 （keep waiting）	1.72 （keep waiting）	2.06 （keep waiting）	0
	1.5 （abandon investment）	1.5 （abandon investment）	1
		1.5 （abandon investment）	2

It can be learned from the above decision-making path that when the option value is greater than the abandonment value at the end of the second year, it is better to invest immediately. Otherwise, the first-stage project development shall be abandoned. While calculating according to the risk-neutral probability method and the reverse order recursion method, the same method is used for comparison, to obtain the option value at the beginning of the period at the end of the first year.

5.10.2 Stage II: option to defer expansion and the option to abandon

5.10.2.1 Stage II: Valuation and decision-making ideas of deferred expansion option and abandoned option

In the second stage of BCD project, if the sales situation is not optimistic in the first stage, the development, construction, and sales of the first stage may be abandoned at the second stage. Therefore, the expansion is adopted with an optimistic sale condition; conversely, abandonment is adopted. As a result, the land use right of the second stage will be transferred at a net value of 300 million yuan.

Let the value of underlying assets at the second stage be S^{II} and the strike price be X^{II}, the additional cost is I^{II}, the abandoned value at the second stage is S^{II}_{remain}, and the abandoned option value at the second stage is F^{II}_{ABAin}. Its deferred option value and decision-making ideas at the second stage of BCD project under the situation of consideration of giving up option:

(1) Determine the project value at the end of the second stage of the BCD project

$$S^{II}_{u^i d^{n-i}} \tag{5.45}$$

(2) Determine the option value at the end of the second stage of the BCD project

$$F^{II}_{ABAi3}=MAX\left(S^{II}_{u^i d^{n-i}}-(X^{II}+I^{II}),\ S^{II}_{remain}\right),\ \text{for } j=0,1,2.....n \tag{5.46}$$

(3) With the introduction of the decision rule, the present value of the option node from the end of the n-1 year to the end of the first year, and the initial option value are obtained according to the risk-neutral probability and the reverse order recursion method:

$$F^{II}_{ABAin}=MAX\left\{e^{-r\triangle t}\left[pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1}\right],MAX\left[S^{II}_{u^i d^{n-i}}-(X^{II}+I^{II}),\ S^{II}_{remain}\right)\right]\} \tag{5.47}$$

5.10.2.2 Stage II: Calculation process and results of deferred expansion option and abandoned option

Refer to the key parameters of the waiver option in the second stage of the BCD project in the previous chapter, as shown in Annexes 5.32.

(1) Determine the project value at the end of the second stage of the BCD project:

Since this step is calculated based on the deferred option of the second stage, the calculation steps of this stage are the same as that of the deferred option at the second stage. After the present value tree is expanded, the project value at the end of the second year are: S^{II}_{13}=24.27, S^{II}_{23}=14.44, $S^{II}_{33}=8.6$, $S^{II}_{43}=5.12$, as shown in Annexes 5.33 shown.

(2) Determine the option value at the end of the second stage of the BCD project:

In this stage, it is mainly the comparison between the present value of assets after the expansion of present value tree and the deduction of strike price and expansion cost, and the abandoned value of the second stage, and the maximum value is selected from the two. The option values at the end of the second stage in the third year are respectively F_{13}^{II}=10.47, F_{23}^{II}=3, F_{33}^{II}=3, F_{43}^{II}=3. The option value in the third year of second stage of the BCD project is shown in Annexes 5.34.

The risk-neutral probability and reverse order recursion are applied to calculate, and choose between the decision to give up in the next year and the decision to give up in the current year for each node at the end of the first year, and select the maximum value as the value of the node, The option value of every node at the end of the 1st year is F_{11}^{II}=4.64, F_{21}^{II}=3, as shown in Annexes 5.35.

(3) The deferred option value of the second stage while considering giving up option

$$\begin{aligned} F_{ABAin}^{II} &= MAX\{e^{-r\Delta t}[pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1}],MAX[S_{u^i d^{n-i}}^{II}-(X^{II}+I^{II}),\ S_{remain}^{II})]\} \\ &= MAX[\frac{0.5133\times 4.64+0.4867\times 3}{1+4\%},\ MAX(11.14-10.8-3,3)] \\ &= MAX(3.69,3) \\ &= 3.69 \end{aligned} \tag{5.48}$$

In the case of considering giving up the option, the value of the second stage of the BCD project is 324.65 million yuan (369-44.47), which is greater than the net present value of -44.47 million yuan calculated by the NPV method. It can be noted that the value of the second stage of the BCD project can also be increased via abandonment. The value and decision-making path of the second stage of the project are shown in Table 5.15:

Table 5.15 The deferred option value and decision-making path of the second stage of BCD project in case of considering giving up the option

The 0th year	The 1st year 2022	The 2nd year 2023	The 3rd year 2024	i / j
3.69 (keep waiting)	4.64 (keep waiting)	6.57 (keep waiting)	10.48 (invest immediately)	0
	3 (instant abandonment)	3 (instant abandonment)	3 (instant abandonment)	1
		3 (instant abandonment)	3 (instant abandonment)	2
			3 (instant abandonment)	3

It can be learned from the above decision-making path that when the option value is greater than the abandonment value at the end of the third year, it is better to invest immediately. Otherwise, the second-stage project development shall be abandoned. While calculating the option values of each node at the end of the first and second years according to the risk-neutral probability method and the reverse order recursion method, the same method is used for comparison, to obtain the option value at the beginning of the period.

5.10.3 Compound option of two stages in the case of abandonment

5.10.3.1 Valuation and decision-making ideas of compound option of two stages in the case of abandonment

Obviously, there are compound options when there are deferred expansion options and abandonment options in the second stage of the BCD project from the previous analysis. Therefore, when making the first-stage development decision, the second-stage decisions and value are anticipated.

When the value of the underlying asset in the first stage is S^I, the strike price is X^I, the abandoned value of the first stage is S^I_{remain}, and the abandoned option value of the first stage is F^I_{ABAin}, and the option value of the second stage in the case of abandon is F^{II}_{ABAin}, the deferred option value and decision-making ideas of the for the first stages of the BCD project in the case of giving up options is as follows:

(1) Determine the project value at the end of the first stage of the BCD project:

$$\mathbf{S^I_{u^i d^{n-i}}} \tag{5.49}$$

(2) Determine the option value at the end of the first stage of the BCD project:

$$\mathbf{F^{I\&II}_{COMi2}=MAX\left(F^{II}_{放in}+S^I_{u^i d^{n-i}}-X^I\ ,\ S^I_{remain}\right),\ for\ j=0,1,2.....n} \tag{5.50}$$

(3) The decision rule is introduced to compare $F^{I\&II}_{COMin}$ in the formula and the intrinsic value of option according to the risk-neutral probability and the reverse order recursion method, and the present values of the option node from the end of the n-1th year to the end of the first year, and the initial option value are given by:

$$\mathbf{F^{I\&II}_{COMin}=MAX\{e^{-r\triangle t}\left[pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1},MAX\left(S^I_{u^i d^{n-i}}-X^I\ ,\ S^I_{remain}\right)\right]\}} \tag{5.51}$$

5.10.3.2 Calculation process and results of compound option value of two stages in the case of abandonment

Refer to the key parameters of the first stage of the BCD project in the previous chapter, as shown in Annexes 5.36.

(1) Determine the project value at the end of the first stage of the BCD project:

Since this step is calculated based on the deferred option of the first stage, the calculation steps of this stage are the same as that of the deferred option at the first stage. After the present value tree is expanded, the project value at the end of the second year are:S_{12}^{I}=6.26, S_{22}^{I}=3.73, $S_{32}^{I} = 2.22$, as shown in Annexes 5.37 shown.

(2) Determine the option value at the end of the first stage of the BCD project:

In this stage, it is mainly the comparison between the present value of assets after the expansion of present value tree and the deduction of strike price and option value of the second stage, and the abandoned value of the first stage, and the maximum value is selected from the two. The option values at the end of the first stage in the second year are respectivelyF_{12}^{I}=5.76, F_{22}^{I}=3.22, $F_{32}^{I} = 1.71$. A table of changes in the present value of waived options in the first stage of the BCD project is shown in Annexes 5.38.

The risk-neutral probability and reverse order recursion are applied to calculate and choose between the decision to give up in the next year and the decision to give up in the current year for each node at the end of the first year and select the maximum value as the value of the node, $F_{COMin}^{I\&II}=MAX\{e^{-r\Delta t}[pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1},MAX(S_{u^i d^{n-i}}^{I}-X^{I},\ S_{remain}^{I})]\}$. The option value of every node at the end of the 2nd year is F_{12}^{I}=4.35, F_{22}^{I}=2.39, as shown in Annexes 5.39.

(3) The compound option value of two stages while considering giving up option

$$\begin{aligned} F_{COMin}^{I\&II} &= MAX\{e^{-r\Delta t}[pF_{i,\ j+1}+(1-p)F_{i+1,\ j+1},MAX(S_{u^i d^{n-i}}^{I}-X^{I},\ S_{remain}^{I})]\} \\ &= MAX[\frac{0.5133\times 4.35+0.4867\times 2.39}{1+4\%},\ MAX(3.73-4.2,1.5)] \\ &= MAX(3.26,1.5) \\ &= 3.26 \end{aligned} \tag{5.52}$$

In the case of considering giving up the option, the compound option value of two stages is 276.93million yuan (326-4.63-44.47), which is greater than the net present value of - 49.09 million yuan calculated by the NPV method. It can be noted that the increased value adopted compound option method is larger than single option value. The compound option value and decision-making path of the first and second stages in the case of considering giving up the option are shown in Table 5.16:

Table 5.16 The compound option value of two stages of BCD project while abandonment

The 0th year	The 1st year 2022	The 2nd year 2023	i/j
3.26 （keep waiting）	4.35 （keep waiting）	5.76 （invest immediately）	0
	2.39 （keep waiting）	3.22 （invest immediately）	1
		1.71 （invest immediately）	2

It can be seen from the above decision-making path that in the case of considering abandonment, when making the first-stage development decision, the decision and value of the second stage are anticipated. Therefore, after the first-stage expansion, the value of the present value tree, which is used to deduct the execution cost and the second-stage option value, is compared with the abandonment value of the first stage. When the option value is greater than the abandonment value, it is better to invest immediately. Otherwise, the first-stage project development shall be abandoned. While calculating the option values of each node at the end of the first and second years according to the risk-neutral probability method and the reverse order recursion method, the same method is used for comparison, to obtain the option value at the beginning of the period.

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Chapter 6: Discussion

6.1 The value created by flexibility in decision making

In the literature on real options in real estate investment and valuation, Kim and Song (2018); Amato et al. (2019); Couto et al. (2021) explored option to defer decision flexibility. D. Li et al. (2014); Y. Y. Mao (2014) explored option to expand decision flexibility. C. H. Wang et al. (2013); Henry and Womack (2020) explored multiple interacting options decision flexibility.

In contrast, the research in this thesis discusses the impact of various real options such as option to defer, option to expand, option to abandon and multiple interacting options on project valuation. More importantly, this thesis also considers two mutually exclusive options, option to defer and option to abandon, and multiple interacting options in the first and second stages.

The inclusion of option to expand, option to contract, and option to abandon in a real options pricing model for real estate investments and the inclusion of various options enables better analysis of the current state of the real estate market (Durica et al., 2018). Consider the differences in flexibility among various options, of which option to defer is one of the most important (Martins et al., 2015).

Unlike the existing literature which only considers option to defer, option to expand and multiple interacting options this thesis is to closely integrate the multi-stage, high uncertainty, and irreversibility of investment characteristics in real estate development, consider multiple decision-making flexibilities simultaneously, apply the real options method to scientifically evaluate the value of real estate projects, and give dynamic decision-making paths that accompany the revelation of uncertainty.

Firstly, the NPV of the BCD project is calculated on the basis of NPV, and the NPV of the first stage and the second stage are $NPV_{(stage\ I)}$ = -4.63 million yuan and $NPV_{(stage\ II)}$ = -44.47 million yuan respectively. The net present value calculation shows that the BCD project has a negative net present value in both stages and therefore the project is not viable for investment.

However, as the real options approach considers the flexibility of decision-making, the results of the calculation are more accurate. The value of the first stage of the BCD project, considering option to defer, is 50.27 million yuan, an increase of 45.64 million yuan (50.27-4.63) compared with the net present value without considering the option value. The value of the second stage of the BCD project, considering option to defer expansion, is 147.44 million

yuan, an increase of 102.97 million yuan (147.44 – 44.47) compared with the net present value without considering the option value.

On this basis, in the case of further considering multiple interacting options of option to defer in the first stage and option to defer expansion in the second stage in the BCD project, its value is 132.85 million yuan, which is an increase of 83.75 million yuan (132.85-4.63-44.47) compared with the net present value without considering the option value.

Since option to abandon exists for both the first stage and the second stage of the BCD project, multiple interacting options for both stages under the abandonment situation can be further considered. The calculation shows that the value of the two-stage multiple interacting options considering the abandonment situation is 326 million yuan, which is an increase of 276.93 million yuan (326 - 4.63 - 44.47) compared with the net present value without considering the option value.

It is clear from the above analysis that, compared with the existing literature, this thesis not only considers the value of each option at different stages, but also builds on this by further considering the value of mutually exclusive options and multiple interacting options. It is also clear from the calculations that it is the flexibility of the real options approach to decision-making that creates more value. And the more flexibility in decision-making that is considered, the greater the value created.

6.2 Impact of key parameters on project valuation

Real estate development projects have three important characteristics of high uncertainty, investment irreversibility and multi-stage. This section discusses the impact of key parameters on valuation results for each of the three characteristics.

6.2.1 Uncertainty: volatility of project cash flow

Policy factors, market factors and operational management during the development of real estate project can all lead to an increase in uncertainty, which can directly affect the rising or falling sales price of commercial housing.

Policy uncertainty, the probability of its potential occurrence is unpredictable, involving uncertain decision-making, the probability of its potential output is unpredictable (Duncan, 1972); In China, the government's macroeconomic policies may be somewhat lacking, and uncertainty about economic policies has increased as a result of repeated changes in economic policies (D. Xin, 2018). In terms of market uncertainty, there is an increasing trend towards

concentration and differentiation in the real estate sector (Z. Yin, 2019,).

The BCD project uses the historical average house price in the area where the project is located as the basis for calculating the volatility σ. The most important parameter affecting uncertainty when using the real options method for calculations is the volatility σ.

In Chapter 5, the volatility of the BCD project, σ = 25.94%, based on which the option value is calculated to be 50.227 million yuan for the first stage and 147.44 million yuan for the second stage. Still using the Chapter 5 calculation, if the volatility σ is increased to 35%, the option value for the first stage is 677.67 million yuan and the option value for the second stage is 229.39 million yuan. The option value increases by 17.4 million yuan (67.67-50.27) and 81.95 million yuan (229.39-147.44) for the two stages respectively.

If volatility continues to increase, then the calculated option value will also continue to increase. It follows that volatility, whether formed for policy or market reasons, the greater the volatility, the greater the option value will be.

6.2.2 Investment irreversibility: land cost

The initial investment cost in the real estate industry is mainly the cost of land. Due to the immovability of land, the capital already invested is not fully recoverable until the investment function of the project is realized. Therefore, the cost of land is irreversible in terms of investment.

In real estate development, the three variables that have the greatest impact on value are sales price, construction cost and construction scale, and in particular the value added by land costs under option to defer should be considered when making investment decisions (Couto et al., 2021).

The causes of investment irreversibility are mainly due to the investment process, including: 1. the costs already invested cannot be recovered if the decision is changed after the investment has been made; 2. the uncertainty and riskiness of the expected return on the investment (Zhou, 2003). Due to the complexity of urban land values, geographical location plays a key role not only in determining land values, but also plays a central role in the process of determining land values (Henry & Womack, 2020).

The parameter that has the greatest impact on investment irreversibility is strike price X, that is, the cost of land. The greater the amount of land cost, the greater the impact on the value of the option. For example, without considering the option value, the NPV of the first stage is -0.0463 billion yuan. The value considering option to defer was 50.27 million yuan, an increase

of 45.64（50.27-4.63）million yuan over the NPV.

If the first stage strike cost of 420 million yuan is increased by 30 million yuan, the strike cost becomes 450 million yuan. Then the NPV of the first stage is -31.66 million yuan and the option value is 42.97 million yuan when considering the deferred option, an increase of 11.31 million yuan over the NPV.

Comparative analysis shows that as the cost of land increases sunk costs also increase. The NPV with the increase in land cost has a 488.97%$\left[-0.3166-\left(-0.0463\right)\right]/-0.0463=583.80\%$ increase in sunk costs and a 14.52%$\left[0.4297-0.5027\right]/0.5027=-14.52\%$ decrease in its option value compared to the NPV without the increase in land cost.

6.2.3 Multi-phase: phased development

Real estate project development has the industry characteristic of a long development cycle. Moreover, the entire process includes the land use rights acquisition stage, the project construction stage, and the sales stage. Based on this, there will be further division of real estate projects into multiple stages of construction and sales due to a variety of circumstances.

The real estate investment process is divided into two steps, investment and development, each of which is authorized as a real options process (Kemala & Simatupang, 2020). (Cheng et al., 2019) has further refined the original model by dividing the real estate development process into four steps: project initiation, payment, obtaining a construction permit and starting construction. The development selection model has been improved by further disassembling the four processes of authorizing the start of a project, payment, obtaining construction permission and starting work.

In this thesis, the BCD project construction period is 5 years and is divided into two phases for construction and sales. However, corporate decisions are not adjusted once every few years, but may be adjusted every month.

In Chapter 5, the BCD project is divided into just two phases. Of this amount: the multiple interacting option value of 147.44 million yuan considering the first stage of delayed development and the second stage of delayed expansion and the multiple interacting option value of 326 million yuan considering the abandonment situation for the first and second stages. It is conceivable that if the BCD project was divided into 5 stages or if each month was calculated as a stage, the calculation results would be more accurate and closer to actual situation. Thus, the binomial tree model can be further refined and even a continuum model can be used for valuation purposes.

6.3 Research questions and solutions

The following two questions are proposed and solved in this thesis.

(1) How to abstract and refine the characteristics and types of real options in real estate, considering their economic characteristics and investment practices?

In this thesis, the real options are divided into two stages of a five-year real estate project using SC's BCD project as a case study, from which multi-stage, high uncertainty, and irreversible investment characteristics of real estate projects in the development process are abstracted and refined. Of these: In the first stage, option to defer are included. In the second stage, option to defer, option to expand, multiple interacting options and option to abandon are included.

(2) How to simultaneously consider various real options including mutually exclusive options、multiple interacting options, use case company data to estimate key parameters, quantitatively measure the value created by decision-making flexibility, and obtain a dynamic path for real estate investment decision-making?

Of the various options we consider in this thesis, option to defer and option to expand are mutually exclusive options, and the first and second stages are multiple interacting options. The calculations show that if only the net present value is considered, the net present value of the BCD project is -49.09 million yuan for both stages and 133 million yuan when considering the multiple interacting options of delayed development in the first stage and delayed expansion in the second stage. The value of the two-stage multiple interacting options, when considering the abandonment situation, is 326 million yuan. It can be seen in real estate investment decision - making, the real options analysis method is more effective in controlling downward uncertainty and better exploiting upward uncertainty. Therefore, based on the idea of real options, the greater the uncertainty, the greater the value of the business investment.

It can also be seen that the project valuation increases for each additional management decision flexibility considered, whether it is option to defer or option to expand, or whether it is the first or second stage, or a combination of the two stages. At the same time, the path of the decision changes.

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Chapter 7: Conclusions and contributions

7.1 Conclusions

This thesis begins with an introduction to the current state of real estate in China and an analysis of the reasons for its current state. As the price of commercial properties in China continues to rise, the Chinese government has issued more and more policies to restrict the real estate sector. Against this backdrop, the investment environment in the real estate industry has become increasingly complex. Moreover, relying solely on the traditional discounted cash flow model for investment analysis and on the experience and intuition of decision makers to make investment judgements can be extremely risky. As a result, there is an urgent need to solve the problem of how to make more scientific real estate valuation and investment decisions.

To achieve the purpose of the study, this thesis is based on data collection, analysis, and program design for the BCD project at SC Real Estate and draws the following conclusions. In the process of real estate investment, real estate companies face policy uncertainty, market uncertainty and operational uncertainty. In the process of real estate investment, real estate enterprises not only face policy uncertainty, market uncertainty and operational uncertainty but also have the characteristics of multi-stage and irreversibility, which further highlights the complexity of real estate investment. Making this highly uncertain investment process rich in option value. The analysis demonstrates that the core of project value is decision flexibility, that a project with a negative NPV does not imply abandonment, and that the total value of the project is not a simple summation of the value of a single option. Due to the uncertainty of the future, investment decision makers in the real estate industry should combine the company's strategic and management flexibility to enhance the ability to cope with environmental changes.

7.2 Contributions

The conclusions are as follows:

(1) Theoretical contribution: In the related literatures on real estate development projects, most of the existing research either adopt NPV decision rules, or only qualitatively discuss the impact of uncertainty on project value and investment decisions, with only a few literatures using the real option method to explore the impact of typical decision flexibility on the valuation of real estate development projects.

(2) The few case studies that use real options in investment decision-making applications, although they point out the advantages of the real options method over the discounted cash flow method, are largely computational examples or exemplary due to the lack of comprehensiveness of the case material and the lack of detailed and realistic data. Moreover, these cases rarely consider the two mutually exclusive options of expand and option to defer at the same time, multiple interacting options in the multi-stage development process and other real options to conduct comprehensive research on the valuation of case objects and investment decisions, and therefore have a certain gap with management practice.

This thesis firstly characterizes and summarizes three characteristics of real estate development investment which are highly uncertainty, multi-stage, and investment irreversibility. Secondly, based on the traditional discounted cash flow model, a real option model with multiple decision-making flexibility including option to deferred, option to abandonment and multiple interacting options is constructed. Taking the BCD project of a Chinese SC company that the author continuously follows and is responsible for as a case study, the value-creating role of flexibility in management decision-making is studied and a decision-making methodology that can practically guide the investment decision-making practices of the SC company is obtained, which can provide a reference basis for the management practices of other companies in the real estate industry.

7.3 Research limitations

The limitations of the research are as follows：

(1) In the real option theory, the real estate investment decision-making has not formed a set of scientific system, mainly stays at the theoretical level. Moreover, because the real option method involves the knowledge of finance and mathematics, the mastery of relevant knowledge also hinders the use of the real option method. In the selection of parameters, there is no fixed mode and standard, and it will vary from person to person. Therefore, how to establish a set of scientific, simple, and practical real option model also needs to be studied, which can be more in line with the actual situation and is conducive to the promotion and use of the real option method.

(2) There are still differences between the real option model and the reality, and many assumptions do not exist. How to combine the real option model with the reality is also the focus of the research on the real option method in the future. The application of real option method in real estate investment decision-making needs to be further studied in the future. Make

the real option method more convenient to use and continue to provide services for investment decisions in the real estate industry.

7.4 Areas for future research

The real estate investment process usually includes a variety of real options, and the different real options not only affect each other but also compound each other.

Although real options theory is still at an exploratory stage in real estate investment, it has more obvious advantages over traditional analysis methods in the analysis of real estate investment uncertainty. It can help real estate companies to make more accurate judgements and decisions when making real estate investment decisions and prevent investment decision makers from ignoring the potential value.

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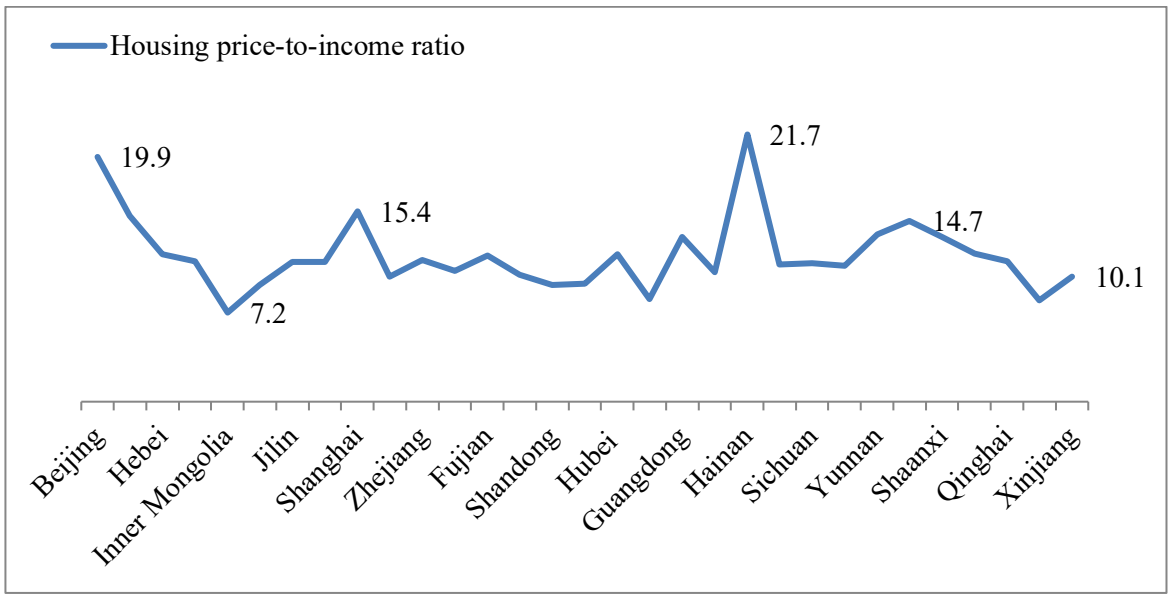
Appendix



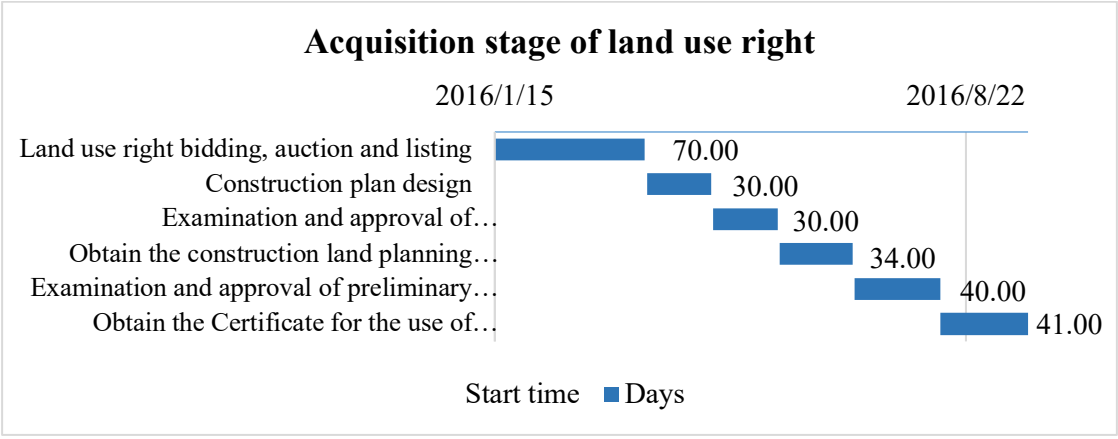
Annexes 1.1 35 China's housing price-to-income ratio in 2019

Source: RBS (2021)

Annexes 2.1 Differences between real options and financial options

Parameters	Real Options	Financial Options
Underlying assets	physical assets, investment projects	financial assets including stocks
Value of Subject Matter	present value of expected cash flows of investment projects	financial Asset Prices
Exercise Price	investment project cost	firm price
Due Date	the point at which the opportunity disappears	appointed day
Risks	project cash flow volatility	financial asset price volatility
Contract Form	without contract	with contract

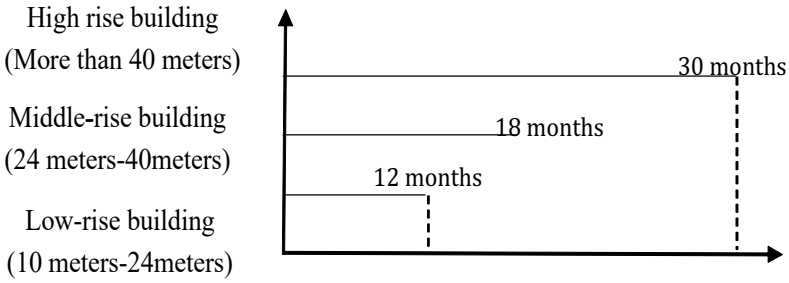
Source：Zhu (2003)



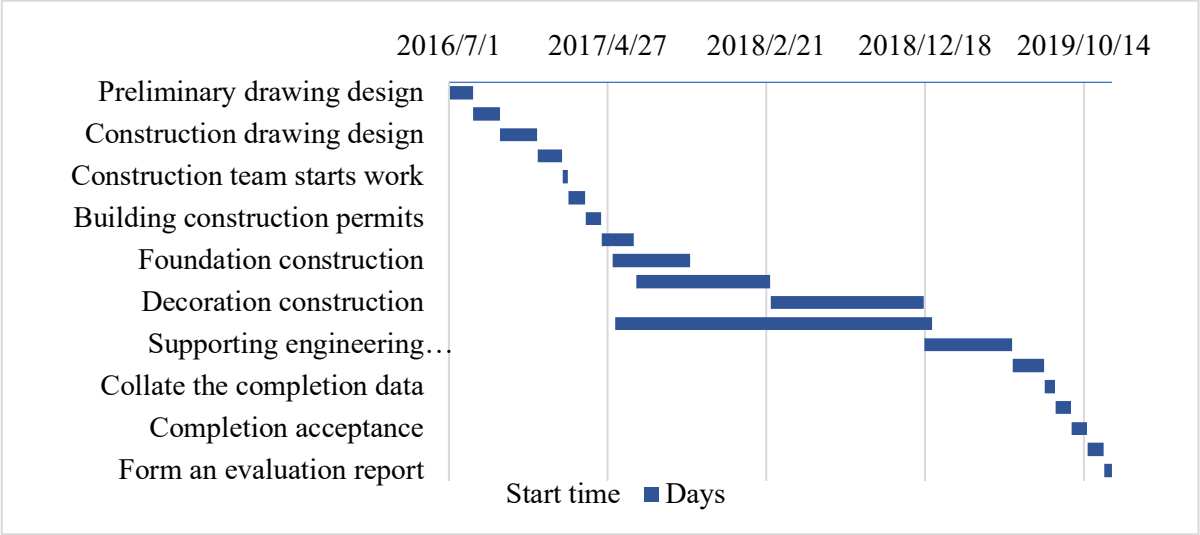
Annexes 4.1 Flow chart of acquisition stage and pre-construction stage of land use right

Annexes 4.2 Table of difference land acquisition methods of bidding, auction and listing

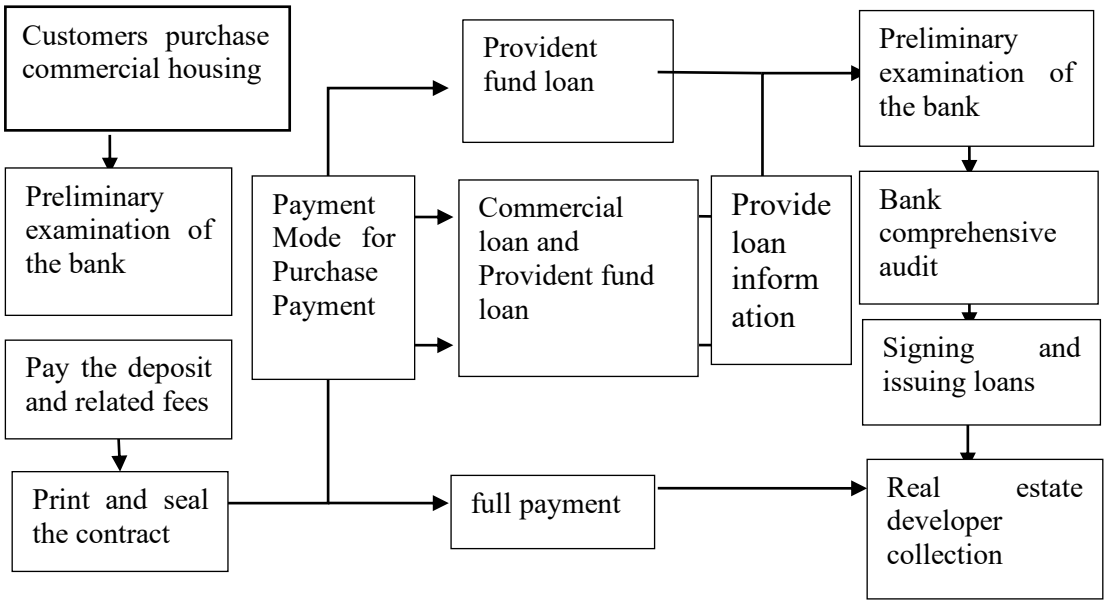
Content Reserve price disclosure	Bidding Publicity	Auction Not Publicity	Listing Not Publicity
Reservation price discloser	Client	Auction committee	Bidding committee
Decision-making organization	NO	Auction committee	Bidding committee
Quotation method	Computer quotation	Brand quotation	Fill in tender
Number of quotation	Multiple offers	Multiple offers	One offer
Number of bidders	≥1 person	≥2 person	≥2 person
Bidding rules	The highest bidder	The highest bidder	The highest bidder
Place of announcement	Trading centers and the Internet		
Announcement period	Not less than 30 days		
Announcement issuer	Client		



Annexes 4.3 Project construction cycle diagram



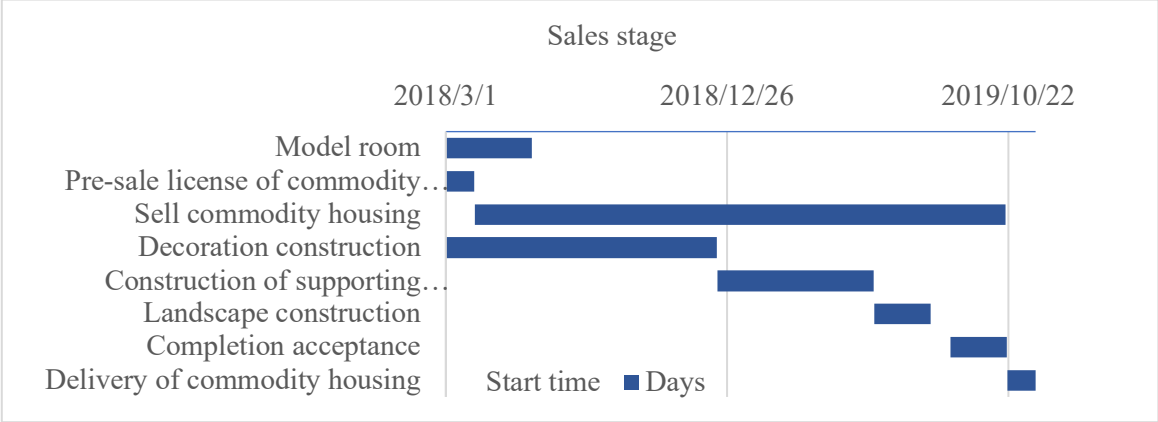
Annexes 4.4 Project construction stage diagram



Annexes 4.5 Commercial housing sales payback flow chart

Annexes4.6 The construction nodes that need to be reached for the pre-sale of commercial housing

Architectural form	Construction progress to meet sales conditions
High rise building	Construction schedule≥30%
Middle-rise building	Construction schedule≥50%
Low-rise building	Complete the first floor construction



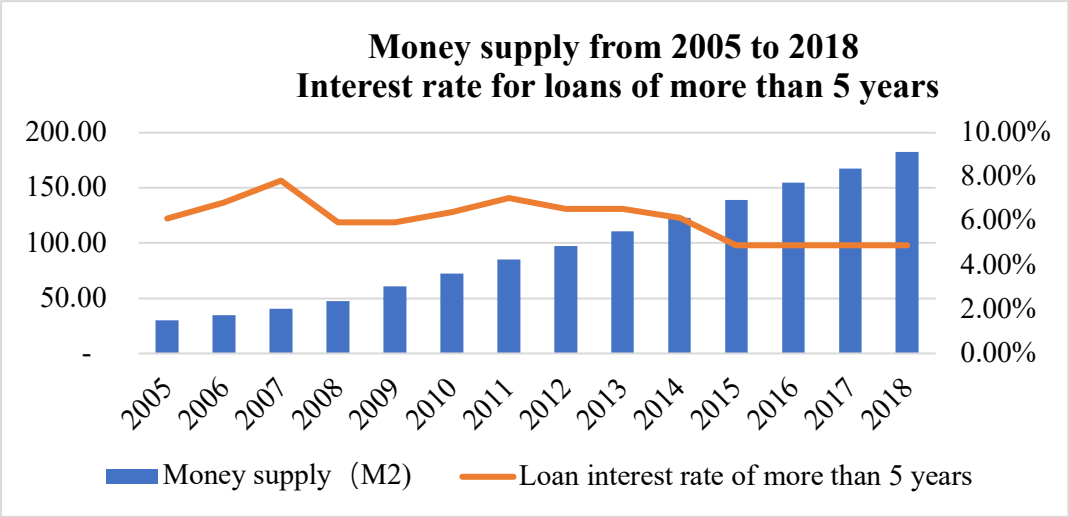
Annexes 4.7 Commercial housing sales payback flow

Annexes 4.8 Major real estate regulation and control policies from 1998 to 2019

Serial number	Year	Sector	Policy document	Policy type	Effect
1	1998	General Office of the State Council of the People's Republic of China	Notification of the State Council on further deepening the Reform of Urban Housing system and speeding up Housing Construction，it marks the marketization of real estate.	Administrative measure	Encourage
2	2002	Ministry of Land and Resources of	Provisions on the transfer of the right to the use of state-owned land by	Land policy	Encourage

		the People's Republic of China	bidding, auction and listing		
3	2003	General Office of the State Council of the People's Republic of China	In August, the notice on promoting the sustained and healthy Development of the Real Estate Market was issued, positioning the real estate industry as a national pillar industry.	Administrative measure	Encourage
4	2004	People's Bank of China	In October, the people's Bank of China announced an increase in deposit and lending rates.	Financial policy	Tighten
5	2005	Ministry of Construction of the People's Republic of China	In May, opinions on stabilizing housing prices were issued.	Administrative measure	Tighten
6	2006	State Administration of Taxation	In July, the notice on issues related to the collection of personal income tax on housing transfer.	Fiscal and taxation policy	Continuous tightening
7	2007	People's Bank of China	In September, the notice on strengthening the credit management of commercial real estate.	Financial policy	Continuous tightening
8	2008	General Office of the State Council of the People's Republic of China	In December, some opinions on promoting the healthy development of the real estate market.	Administrative measure	Stimulation
9	2009	China Banking Regulatory Commission	In June, notice on further strengthening the risk management of commercial loans.	Financial policy	Tighten
10	2010	General Office of the State Council of the People's Republic of China	In April, a notice was issued to curb the excessive rise of house prices in some cities.	Administrative measure	Tighten
11	2011	People's Bank of China	From January to June, the people's Bank of China raised the deposit reserve ratio six times. From February to July, the people's Bank of China raised the benchmark deposit and loan interest rates four times.	Financial policy	Tighten
12	2012	Ministry of Land and	In July, the economic notice of further	Land policy	Tighten

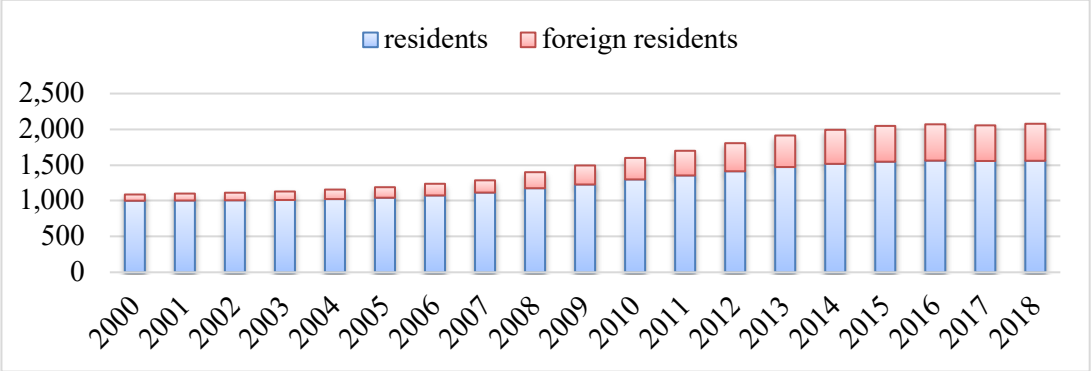
		Resources of the People's Republic of China	tightening the management of real estate land and consolidating the results of the regulation of the real estate market		
13	2013	General Office of the State Council of the People's Republic of China	In March notice on further strengthening the regulation and control of the real estate market.	Administrative measure	Tighten
14	2014	Ministry of Finance of the People's Republic of China	In October, all localities were required to relax the conditions for provident fund loans.	Financial policy	Tighten
15	2015	State Administration of Taxation	In July, the announcement of simplifying the procedures of exemption from business tax for individuals to grant the right to the use of real estate free of charge.	Fiscal and taxation policy	Tighten
16	2016	Ministry of Finance of the People's Republic of China	In February, the notice of adjusting the preferential policies of deed tax and business tax in real estate transactions.	Fiscal and taxation policy	Tighten
17	2016	Central Economic Working Conference	Make clear the direction of real estate development ， "housing is for living in, not for speculation".	Administrative measure	Continuous tightening
18	2017	Ministry of Construction of the People's Republic of China	In April, a notice was issued to strengthen the management of housing land supply and the regulation and control of related work.	Administrative measure	Continuous tightening
19	2018	Ministry of Construction of the People's Republic of China	Notice on issues related to further regulation and control of the real estate market.	Administrative measure	Continuous tightening
20	2019	China Banking Regulatory Commission	Notice of carrying out special inspection of real estate business of banking institutions in 2019.	Financial policy	Continuous tightening



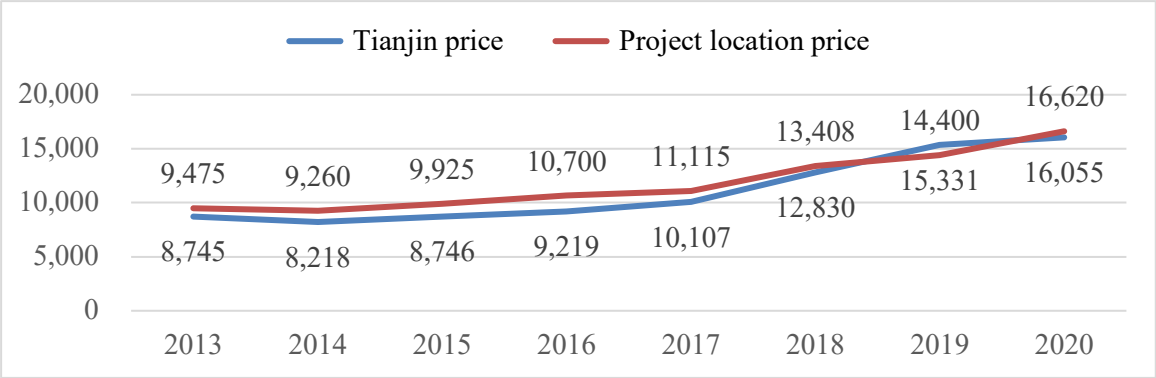
Annexes 4.9 Money supply (M2) statistics from 2005 to 2018 and lending rates over the years

Annexes 4.10 Uncertain factors in different development stages of real estate project

Content	Policy factors	Market factor	Company management factors
Acquisition stage of land use right	1.provisions on the acquisition of land by bidding, auction and listing 2. Planning and design review 3. Examination and approval of the scheme;	1. Competition in the same industry 2. To carry out project construction within a specified period of time 3. The design scheme is the best and the maximum value is obtained.	1. Evaluation of enterprise strength 2. To pay off the land price within a specified period of time 3.To obtain the land certificate in accordance with the requirements of the state;
Project construction stage	1. Determination of construction units and construction qualification requirements 2. Other construction requirements: "Green Environmental Protection Project" provisions, winter construction requirements, etc.	1. Arrange the progress of the project according to the market situation 2. The influence of project payment on the progress of the project	1. Design ability and level. 2. The speed of project construction 3. The quality of engineering construction
Sales stage	1.Pre-sale license of commodity housing 2.Different types of construction have different pre-sale conditions.	1. Competition between the same industry and the same region 2. Product scarcity 3. The influence of enterprise brand;	1. Market positioning 2. Customer base positioning 3.The time to assist in handling the loan;



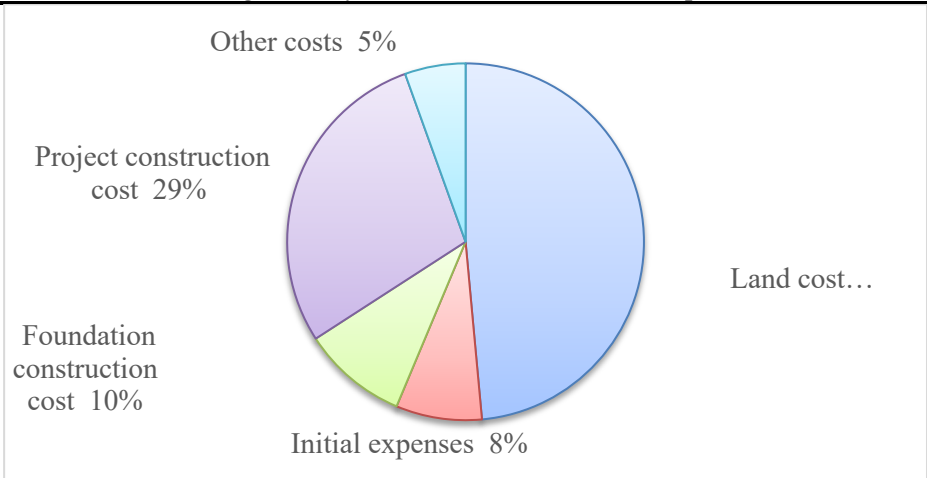
Annexes 5.1 Statistics of Tianjin's population over the years (10,000 people)



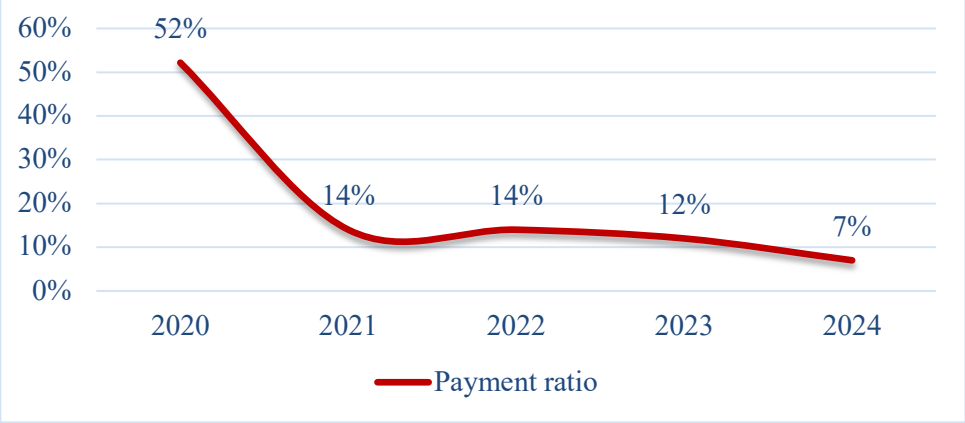
Annexes 5.2 Average sales price of commercial housing in Bei Chen district, Tianjin over the years

Annexes 5.3 Project construction schedule

Construction schedule	Duration
Foundation construction	September 2020
Construction of BCD	September 2020
Sales	April 2024
Construction is complete	July 2024
Completion acceptance	November 2024
Commercial housing delivery	September 2020



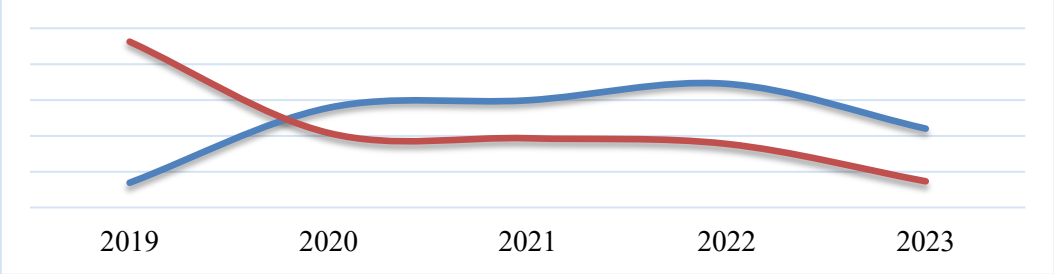
Annexes5.4 Development cost proportion chart



Annexes 5.5 The annual payment ratio of the BCD project

Annexes 5.6 The annual cost carry-over ratio of the first and second stages of BCD

Stage	Unit cost	2020	2021	2022	2023	2024
Stage I	11,827	29%	71%	0%	0%	0%
Stage Ⅱ	11,391	0%	0%	23%	34%	43%



Annexes 5.7 BCD project capital inflow and outflow comparison table

Annexes 5.8 Calculation of cash inflows of BCD projects

Stage	2020	2021	2022	2023	2024	Total
Stage I	14,868	29,546				44,414
Stage Ⅱ			40,146	51,478	49,855	141,478
Cash inflow amount	14,868	29,546	40,146	51,478	49,855	185,893

Annexes 5.9 Stage I and Stage II of the BCD project the value of the underlying assets

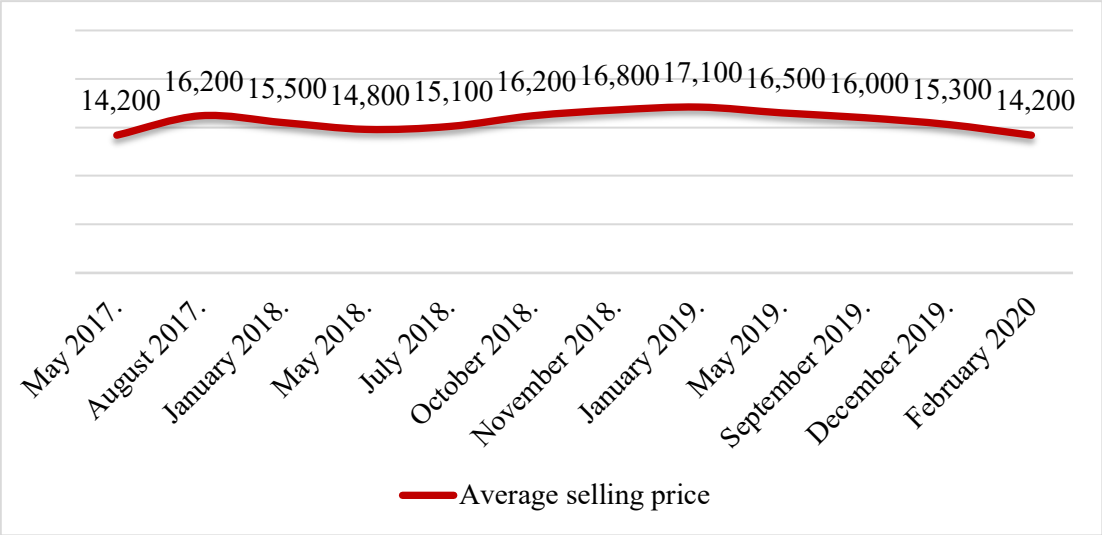
Stage	Types of real options	The value of the underlying assets S（billion）
Stage II	Option to defer expansion	9.29
	Option to abandon	9.29
Stage I	Option to defer	3.73

Annexes 5.10 Stage I and stage II strike price of BCD project

Stage	Types of real options	Strike price X（billion）
Stage II	Option to defer expansion	10.80
	Option to abandon	10.8 and Net income 3
Stage I	Option to defer	4.20

Annexes 5.11 Stage1 and stage I option period of BCD project

Stage	Types of real options	Option period T
Stage II	Option to defer expansion	2022~2024
	Option to abandon	2022 年~2024
Stage I	Option to defer	2020 年~2021



Annexes 5.12 The trend of commercial housing price in the area where the BCD project is located

Annexes 5.13 BCD project volatility calculation table

Content	Start sales time	Sales unit price	$\frac{S_{i+1}}{S_i}$	$X_i = \ln\left(\frac{S_{i+1}}{S_i}\right)$	$(X_i - \bar{X})^2$
Star City.	May 2017	14,200			
View Hills Court.	August 2017	16,200	1.1408	0.131769	0.017363
Chengnan residence.	January 2018	15,500	0.9568	-0.044171	0.001951
Future city.	May 2018	14,500	0.9355	-0.066691	0.004448
Ideal city.	July 2018	15,300	1.0552	0.053704	0.002884
Fenghua International.	October 2018	16,500	1.0784	0.075508	0.005701
Diamond Bay.	November 2018	16,900	1.0242	0.023953	0.000574
Heaven, earth and mansion.	January 2019	17,500	1.0355	0.034887	0.001217
Wanhe City.	May 2019	16,500	0.9429	-0.058841	0.003462
Tongxin project.	September 2019	14,800	0.8970	-0.108733	0.011823
Longhua Square.	December 2019	15,300	1.0338	0.033226	0.001104
Yuanshan City	February 2020	14,200	0.9281	-0.074611	0.005567
			$\sum (X_i - \bar{X})^2$	0.056094	

Annexes 5.14 Calculation Table of stage I net present value of BCD Project

Stage1	2020	2021	2022	2023	2024	Total
Cash inflow amount	38,400	66,600	-	-	-	105,000
Cash outflow amount	65,532	37,054	-	-	-	102,586
Net cash inflow	-27,132	29,546	-	-	-	2,414
Discount rate 11%						
NPV	-24,443	23,980	-	-	-	-463

Annexes 5.15 Calculation table of stage II net present value of BCD Project

Stage2	2020	2021	2022	2023	2024	Total
Cash inflow amount	-	-	83,456	104,320	105,624	293,400
Cash outflow amount	108,000	-	43,310	52,842	55,769	259,922
Net cash inflow	-108,000	-	40,146	51,478	49,855	33,478
Discount rate 11%						
NPV	-97,297	-	29,355	33,910	29,586	-4,447

Annexes 5.16 Key parameters of option to defer for stage I of BCD project

Stage	Real option type	The value of the underlying asset S	Strike price X	Option period T	Risk-free rate r	Volatility σ
Stage I	Option to defer	3.73	4.2	2020-2021	4%	25.94%

Annexes 5.17 BCD project stage I present value event tree

The 0th year	The 1st year 2020	The 2nd year 2021	i/j
3.73	4.83	6.27	0
	2.88	3.73	1
		2.22	2

Annexes 5.18 BCD project option to defer value at the end of the second year of stage1

The 0th year	The 1st year 2020	The 2nd year 2021	i/j
		2.067	0
		0	1
		0	2

Annexes 5.19 BCD project option to defer value at the end of the first year of stage1

The 0th year	The 1st year 2020	The 2nd year 2021	i/j
	1.0194	0	0
		0	1
		0	2

Annexes 5.20 Key parameters of option to defer expansion for stage Ⅱ of BCD project

Stage	Real option type	The value of the underlying asset S	Strike price X	Option period T	Risk-free rate r	Volatility σ
Stage II	Option to defer expansion	（9.29*1.2） 11.14	10.80	2022-2024	4%	25.94%

Annexes 5.21 BCD project stage II present value event tree

The 0th year	The 1st year 2022	The 2nd year 2023	The3rd year 2024	i/j
11.15	14.45	18.73	24.28	0
	8.60	11.15	14.45	1
		6.64	8.60	2
			5.12	3

Annexes 5.22 BCD project option to defer expansion value at the end of the third year of stage II

The 0th year	The 1st year 2022	The 2nd year 2023	The 2nd year 2024	i/j
			10.47	0
			0.64	1
			0	2
			0	3

Annexes 5.23 BCD project option to defer expansion value from the first year to the end of the second year

The 0th year	The 1st year 2022	The 2nd year 2023	The 2nd year 2024	i/j
	2.84	5.46		0
	0.16	0.32		1
		0		2
				3

Annexes 5.24 Key parameters of multiple interacting options for stage I and stage Ⅱ of BCD project

Stage	Real option type	The value of the underlying asset S	Strike price X	Option period T	Risk-free rate r	Volatility σ	Stage Ⅱ option value
Stage I	Option to abandon	3.73	4.2	2020-2021	4%	25.94%	1.48

Annexes 5.25 BCD project stage I present value event tree

The 0th year	The 1st year 2020	The 2nd year 2021	i/j
3.73	4.83	6.27	0
	2.88	3.73	1
		2.22	2

Annexes 5.26 BCD project stage I at the end of the 2nd year multiple interacting options value

The 0th year	The 1st year 2020	The 2nd year 2021	i/j
		3.55	0
		1.01	1
			2

Annexes 5.27 BCD project stage I 1st year multiple interacting options value

The 0th year	The 1st year 2020	The 2nd year 2021	i/j
	2.22		0
	0.5		1
			2

Annexes 5.28 Key parameters of option to abandon for stage I of BCD project

Stage	Real option type	The value of the underlying asset S	Strike price X	Option period T	Risk-free rate r	Volatility σ	Give up value
Stage I	Option to abandon	3.73	4.2	2020-2021	4%	25.94%	1.5

Annexes 5.29 BCD project stage I present value event tree

The 0th year	The 1st year 2020	The 2nd year 2021	i/j
3.73	4.83	6.27	0
	2.88	3.73	1
		2.22	2

Annexes 5.30 BCD Project Stage I option to abandon value at the end of the 2nd year

The 0th year	The 1st year 2020	The 2nd year 2021	i/j
		2.06	0
		1.5	1
		1.5	2

Annexes 5.31 BCD project stage I option to abandon value at the end of the 1st year

The 0th year	The 1st year 2020	The 2nd year 2021	i/j
	1.72		0
	1.5		1
			2

Annexes 5.32 Key parameters of option to abandon for stage Ⅱ of BCD project

Stage	Real option type	The value of the underlying asset S	Strike price X	Option period T	Risk-free rate r	Volatility σ	Expansion cost	Give up value
Stage II	Option to abandon	11.15	10.8	2022-2024	4%	25.94%	3	3

Annexes 5.33 BCD project stage Ⅱ present value event tree

The 0th year	The 1st year 2022	The 2nd year 2023	The3rd year 2024	i/j
11.15	14.45	18.73	24.28	0
	8.60	11.15	14.45	1
		6.64	8.60	2
			5.12	3

Annexes 5.34 BCD project option to abandon value at the end of the third year of stage II

The 0th year	The 1st year 2022	The 2nd year 2023	The 2nd year 2024	i/j
			10.47	0
			3	1
			3	2
			3	3

Annexes 5.35 BCD project option to abandon value from the first year to the end of the second year

The 0th year	The 1st year 2022	The 2nd year 2023	The 2nd year 2024	i/j
	4.64	6.57		0
	3.00	3.00		1
		3.00		2
				3

Annexes 5.36 Key Parameters of multiple interacting options for stage and stage Ⅱ of BCD project

Stage	Real option type	The value of the underlying asset S	Strike price X	Option period T	Risk-free rate r	Volatility σ	Stage Ⅱ Real option value	Stage I Give up value
Stage II	Multiple interacting options	3.37	4.2	2022-2024	4%	25.94%	3.69	3

Annexes 5.37 BCD project stage I present value event tree

The 0th year	The 1st year 2020	The 2nd year 2021	i/j
3.73	4.83	6.27	0
	2.88	3.73	1
		2.22	2

Annexes 5.38 BCD project multiple interacting options value at the end of the 2nd year of stage II

The 0th year	The 1st year 2020	The 2nd year 2021	i/j
		5.76	0
		3.22	1
		1.71	2

Annexes 5.39 BCD project multiple interacting options value at the end of the 1st of stage Ⅱ

The 0th year	The 1st year 2020	The 2nd year 2021	i/j
	4.35		0
	2.39		1
			2