IS THERE A GREEN PREMIUM FOR CHINESE GREEN LABELLED HOMES IN SHANGHAI?

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1.Introduction

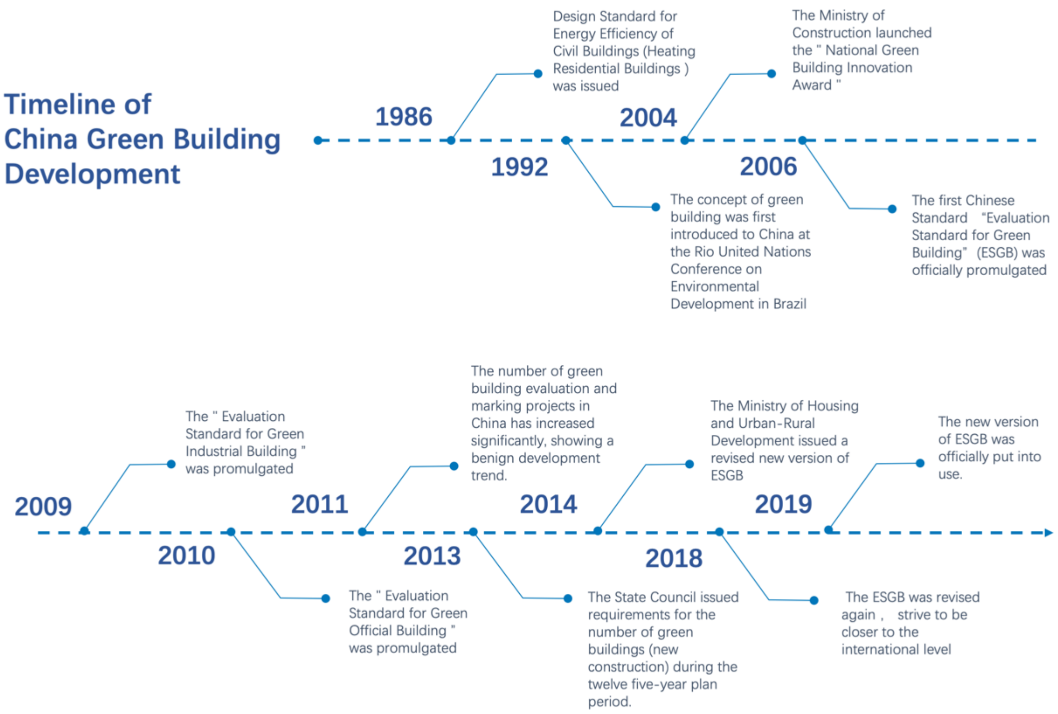
1.1.Background

Since the American architect Paul Sollery proposed the concept of ecological architecture in the 1960s, after nearly 60 years of development, green building has become an important measure for the energy and environmental issues in the construction sector of the world.

It is now increasingly recognized that human beings are facing major challenges such as climate change, resource depletion and environmental degradation. Architecture is an important carrier of urban development. Most activities of human beings are inseparable from architecture, but at the same time the construction industry also consumes a lot of energy, water and raw materials. According to the United Nations Environment Programme, the construction industry consumes 40% of the world's raw materials and 40-50% of global energy. At the same time, it is also the main source of waste for 40% of global solid waste and greenhouse gas emissions.

To address this critical issue, building authorities and industries around the world have been advocating and promoting sustainable buildings for the past two decades, an innovative approach to creating resource-efficient and environmentally friendly buildings.

Figure 1. Timeline of China Green Building Development



China's building energy efficiency work began in the 1980s. In 1986 , the " Design Standard for Energy Efficiency of Civil Buildings (Heating Residential Buildings) " was issued , and the proposed building energy efficiency rate target was 30% (based on the energy consumption of civil buildings built in the early stage of reform and opening up) . In 2004, this standard was revised, the energy saving rate target has been raised to 50%. The concept of green building was first introduced to China at the 1992 Rio United Nations Conference on Environmental Development in Brazil. After the conference, China issued a series of related programs and regulations to support the development of green buildings.

In September 2004, the Ministry of Construction launched the " National Green Building Innovation Award ", which marked the development of

China's green building into a comprehensive development stage. Subsequently, in 2006, the Ministry of Housing and Urban-Rural Development of the People's Republic of China officially promulgated “Evaluation Standard for Green Building” (ESGB), which is China's first multi-objective and multi-level comprehensive evaluation standard for green buildings. Based on that, a nationwide programme, the “Chinese Green Building Label” (CGBL) was launched in 2008(Zhang et al,2016). In 2009 and 2010, the " Evaluation Standard for Green Industrial Building " and " Evaluation Standard for Green Office Building" were launched respectively. Since 2011, the number of green building evaluation and marking projects in China has increased significantly, and the level of green buildings has been continuously improved, showing a benign development trend.

On January 6, 2013, the State Council issued requirements for the number of green buildings (new construction) during the twelve five-year plan period. The goal is to add 20% of green buildings by the end of 2015 based on the current number. The following year, the Ministry of Housing and Urban-Rural Development issued a revised version of ESGB2014 on the basis of the 2006 version. Compared with the previous version, the evaluation method has undergone major changes and the requirements are more stringent and extensive. In 2018 the Standard was revised again. This revision not only redefines the concept of " green building ", but also re-establishes the green building evaluation index system. On August 1, 2019, the new version of the standard was officially put into use.

1.2. Objectives

At present, China has become one of the few developing countries with an official building sustainability rating system (Zhang et al., 2016). In this situation, domestic research focusing on ESGB and other internationally renowned sustainable building evaluation standards, green building design and materials, and green building trends are more common (Sun and Shao, 2010; Ye et al ., 2013 ; Zhang et al., 2016). However, there are relatively few studies on whether there is a premium effect between green labels and house prices (Zhang et al., 2016). In fact, such research can help people to observe the current status of green building development from the perspective of the housing market, and even predict the possible future development of sustainable buildings.

In developed economies, research on green premiums is not uncommon, and most studies have concluded that houses with sustainable labelled compared to other comparable, unsustainable houses has significant price premium on sales or rental (Brounen and Kok, 2011; Fuerst et al., 2015; Marmolejo and Chen, 2018) means that if the premium is large enough and sufficient to offset the adoption of green engineering or technology Incremental costs, even without government-related subsidies, more developers and owners will increase their incentives to invest in green buildings (Kok et al., 2011). In China, this conclusion was also confirmed by the study of (Zhang et al., 2016). They conducted a comprehensive study of the price premiums associated with CGBL in China based on 163 CGBL-labelled projects and 585 unlabeled projects across mainland China. It was concluded that the price of residential transactions with CGBL labelled was 6.9% higher than unlabeled items.

To further understand the green premium effect at China's urban level, I focused on 85 residential projects which received CGBL label between 2014 and 2018 in Shanghai, and 626 comparable unlabeled projects. We make the assumption that if the residential project contains at least one building with CGBL label, the green premium will spread throughout the project. The final result is different of (Zhang et al., 2016) in Shanghai area, residential projects with CGBL labels did not exhibit the expected premium effect.

In addition, the development history of ESGB was elaborated in the early stage of the study, and the three versions of ESGB were compared and analyzed separately, which accumulated the theoretical basis for the subsequent research. In the later part of the study, while analyzing the results of the main research objectives, I also analyzed other factors that have an important impact on housing prices in Shanghai, because these factors are also likely to be important factors that affect whether CGBL has a premium effect in these region.

2.State of the art

2.1.Sustainable Construction Project around the World

2.1.1.United Kingdom

To promote investment in sustainable building environmental development, the UK has developed policies and practices related to financing sustainable building projects. In 2012, the UK established the world's first green investment bank with the primary responsibility of supporting and overcoming barriers to green project investment. In the same year, another sustainable building project financing plan implemented in the UK was The Green Deal, which was designed based on a “pay as you go” model: households receive pre- financing as a loan and use it to first install energy-saving measures in their buildings. And then they use the savings they get to repay the loan. Their utility bills. However, in July 2015, the Conservative government cancelled the plan, saying it failed to achieve its goals.

2.1.2.United States

In recent decades, the US government has provided a range of financing options at the federal, state, and municipal levels to support the development of a sustainable built environment. For example, at the federal level, the US government launched the Energy Efficiency and Conservation Block Grant Program, a climate aid program to support local governments, Indian tribes, and low-income families to renovate their buildings. Similarly, at the state level, a large number of grants, loans, leases and tax rebates have been launched to fund sustainable development. As for the municipal level, various green bonds, such as qualified green buildings and sustainable design project bonds, qualified energy- saving bonds and clean renewable energy bonds, are the main tools for sustainable financing.

2.1.3.Singapore

Singapore is a global leader in the development of sustainable building environments. In the past decade, the number of green buildings in Singapore has increased dramatically, from less than 20 in 2005 to more than 2,100 in 2014. Currently, Singapore has implemented at least ten sustainable building government financing programs. The tasks of these programs vary widely, from providing credit facilities to building owners to energy efficiency retrofits (for example, energy efficiency financing for building renovations), and co-funding building owners for energy efficiency retrofits (eg, existing green sign incentive programs). Support the private sector to develop green buildings (such as the green signage area of the building area). These plans reflect the true commitment of local policymakers to the development of Singapore's built environment.

2.2.Green labels in the world

Green rating systems play an important role in promoting green building, as the problem of information asymmetry and adverse selection is particularly acute in the green building sector: most users do not have the expertise or sufficient information to determine the energy efficiency of buildings. Indicates the need for reliable market signals, such as green building certification by third parties such as governments or independent agencies. The demand for these signals has led to a surge in green labels in major economies such as LEED and ENERGY STAR in the United States, BREEAM in the United Kingdom, CASBEE in Japan and the Green Mark in Singapore.

2.2.1. ENERGY STAR

Energy Star is a government program jointly implemented by the US Department of Energy and the US Environmental Protection Agency to better protect the living environment and save energy. In 1992, the US Environmental Protection Agency participated in the promotion of computer products, and then gradually extended to motors, office equipment, lighting, home appliances and so on. Later, it expanded to the building. The US Environmental Protection Agency actively promoted the Energy Star Building Program in 1996. The EPA assisted voluntary participants in assessing the energy use of buildings (including lighting, air conditioning, office equipment, etc.) and planning the building. Energy efficiency improvement action plan and follow-up operations. The aim is to build a new type of building with an energy efficiency increase of 30%.

First, the applicant must commit to continuously improve the energy efficiency of the building, reduce the energy consumption per unit, and establish an energy management team and establish an energy management policy. Next, they need to assess the energy use of the building in a certain period of time. By comparing the current energy consumption of the building with the set energy consumption benchmark of the same type of building, they can determine whether the building is an energy-efficient building and use this as the basis for continuous improvement. On this basis, set feasible energy-saving targets. Then, according to the target, the applicant needs to develop a detailed action plan to ensure the improvement of energy efficiency and complete the established energy conservation goals. Finally, through the statistics and analysis of energy use data, the annual energy-saving effect is evaluated, and the personnel who help to obtain the building energy-saving results are rewarded and recognized. The information collected during the evaluation process is used to formulate a new action plan to identify the best. Practice, set new execution goals, and make continuous improvement. ciency improvement action and follow-up operations.

2.2.2.LEED

LEED (Leadership in Energy and Environmental Design) is the world's most recognized and successful green building evaluation standard. Established in 1993 by the US Building Council (USGBC), aims to transform the entire construction industry by promoting green buildings. LEED has undergone several revisions and supplements since its inception. The first and second editions were released in 1999 and 2000 respectively. The LEEDV2 was released in 2006 and the LEEDV3 was adopted in 2009. Since 2011, the LEEDV4 number has been collected. At the end of May 2013, USGBC released

LEEDV4 and passed the membership vote. In November 2013, it began to replace LEEDV3. Compared with V3, V4 has a wider range of uses and reduced the evaluation version to 5. They are Building Design and Construction (BD&C), Interior Design and Construction (ID&C) Operations and Maintenance (EB: O&M), Cities and Communities/Residential (HOMES).

LEED evaluation system conducts green assessments of building projects in 6 areas, including: sustainable site design, efficient use of water resources, energy and environment, materials and resources, indoor environmental quality and innovative design, in each respect, LEED proposes assessment Purpose, requirements and corresponding technologies and strategies. According to the different buildings, the terms and the proportion of the evaluation criteria are different. They are divided into the mandatory

clauses and the score clauses. The assessment score is the sum of the scores of the full- value clauses, but the necessary clauses must be realized. As more credits are obtained, the building's certification level rises. There are four certification levels. These include Certified, Silver, Gold, and Platinum.Among all the published standards, energy and the environment account for the highest proportion, which also reflects the characteristics of green buildings.According to the 2017 China Green Building Report: From Green to Healthy, China's LEED certification program has grown at a CAGR of 77% from 2006 to 2016, making it the largest LEED certification market outside the US. As of August 2017, China's accumulated LEED certification projects cover an area of over 48 million square meters, covering 54 cities.

2.2.3.BREEAM

BREEAM - Building Research Establishment Environmental Assessment Method was founded in 1990, the world's first green building assessment method.As the world's leading sustainability evaluation standard, BREEAM covers planning projects, infrastructure projects and building monolith projects. It is a sustainable development mark trusted by more than 78 countries around the world. BREEAM helps owners, designers, builders, operators, infrastructure and urban master plans achieve sustainable development goals. The BREEAM evaluation standard comprehensively evaluates the procurement, design, construction and operation of the project to ensure that each phase meets the performance requirements of the target. The assessment process is evaluated by an independent, licensed assessor and is assessed and certified on a qualified, good, very good, excellent and outstanding level. BREEAM advocates “health and comfort” standards in the human settlements environment and conducts rigorous evaluations on energy, health livability, innovation, land use ecology, materials, management, pollution, transportation, waste treatment, and water ten indicators. Each sub-item analyzes the factors that have the greatest impact on the built environment, including low-carbon design, energy conservation and emission reduction, design durability, resilient cities, climate change factors, ecological values and species diversity protection. Under each sub-item, the project will receive a corresponding assessment score, and the final overall score of the project will determine the rating of the project.

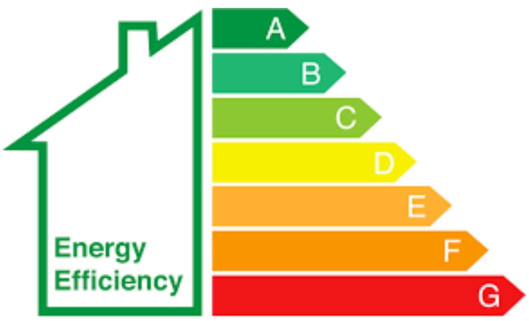
2.2.4.CASBEE

In April 2001, with the support of the Housing Bureau and the Ministry of Land, Infrastructure and Transport, Japan launched a community project of industrial organizations, government organizations and scientific research organizations, which led the organization of the Japan Green Build Council (JaGBC) and the Japan Sustainable Building Consortium (JSBC). set up. The organization's secretariat is managed by the Institute for Building Environment and Energy Conservation and is responsible for the implementation of the CASBEE assessment certification system and the reviewer

registration system.JaGBC and JSBC and its affiliates work together on the research and development of the Comprehensive Assessment System for Building Environmental Efficiency(CASBEE) Kyoto Protocol Target Achievement Plan (approved by the Cabinet on April 28, 2005) have promoted the improvement and widespread dissemination of building integrated environmental performance evaluation systems. In recent years, some local governments have also introduced CASBEE into building management. Now, CASBEE has been implemented in many Japanese buildings.

CASBEE is a method for evaluating and classifying the performance level of a building environment. There are 5 different levels: excellent (S), very good (A), good (B+), poor (B-), and poor (C). In 2002, CASBEE's first evaluation tool was completed: CASBEE tools for office buildings, then CASBEE tools for new buildings were completed in July 2003, CASBEE tools for existing buildings were completed in July 2004, and CASBEE tools for renovation buildings were completed in July 2005. . CASBEE is unique in Japan due to its new concept: it evaluates buildings from two perspectives, including the environmental quality and performance of the building (Q=quality) and the external environmental load of the building (L=load). When evaluating the overall environmental performance of a building, define a new comprehensive evaluation indicator: Building Environmental Efficiency (BEE), BEE = Q/L. The four basic evaluation tools of CASBEE are for the construction life cycle. In addition to this, there are extended evaluation tools to suit specific evaluation needs.

2.2.5.EPC



The European Parliament and the Council of the European Union adopted the Energy Performance of Buildings Directive(EPBD) in December 2002. The directive was implemented in January 2003 and was implemented in 25 EU member states on January 4, 2006. The main contents of EPBD include: building energy consumption calculation method; establishing minimum building energy efficiency standards; building energy efficiency labeling; periodic inspection system for

boilers and air conditioning systems.
On June 18, 2010, the European Union officially introduced EPBD (recast) to replace EPBD. The main contents include: establishing a general framework for comprehensive energy performance calculation of buildings and their internal facilities; stipulating minimum energy-saving standards for new buildings and their internal facilities and refurbished buildings, building units, and building components; National plan for the number of buildings with energy consumption; building energy efficiency labeling; regular inspection of heating and air conditioning systems in buildings; independent control systems for energy efficiency labeling and inspection reports.

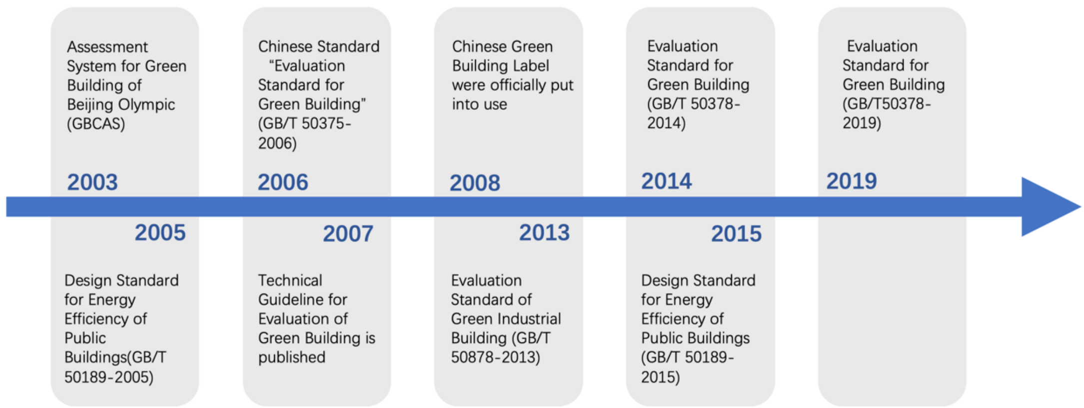
In general, EPBD (recast) is more realistic and more comprehensive than EPBD requirements, and some non-mandatory provisions of EPBD are changed to mandatory in EPBE (recast), requiring implementation in building technology systems and new buildings. EPBD (recast) stipulates that member states should take the necessary measures to establish a building energy efficiency labeling system. The energy efficiency label shall

include reference values such as the energy consumption value of the building and the minimum energy efficiency standard to allow the owner or household of the building or building unit to compare or assess the energy consumption status. The energy efficiency label should also include additional information such as the annual energy consumption of the non-residential building and the percentage of renewable energy in the total energy consumption, as well as recommendations for improvements in the economic operation or cost-effectiveness of the building or building unit, unless there is no energy saving requirement. Reasonable improvement potential. In this context, Energy Efficiency Certificates (EPC) came into being.

2.3. Chinese green building label

Although LEED evaluation standard has made great progress since it entered China in 2003, but LEED certification is not completely in line with China's national conditions. First, LEED evaluation criteria focus on energy efficiency, carbon dioxide emissions, and ecological harmony, emphasizing the high comfort of building users. This has led to the so-called energy-efficient buildings in the United States may be more energy-consuming than the average domestic building. For example, the setting temperature in the European heating room is 21 ° C ~ 24 ° C, which is about 15% higher than the energy consumption of China's 18 ° C heating set. In China, the uneven distribution of energy and resources, small per capita occupancy, and low energy conversion efficiency determine that LEED evaluation criteria are not applicable to all projects. Secondly, applying for LEED certification requires high certification fees. Ordinary developers are often unable to afford high construction costs and certification fees. Only well-known developers are keen to apply for LEED certification. Therefore, it is imperative to formulate sustainable building evaluation standards that are more in line with China's development and suitable for China's national conditions. The introduction of CGBL complements this vacancy and provides a good prerequisite for the development of sustainable buildings in China.

Figure 2. Timeline of Evaluation Standard for Green Building Development



In 2003 , Assessment System for Green Building of Beijing Olympic (GBCAS) became the first authentic green building evaluation system in China. Two years later, Design Standard for Energy Efficiency of Public Buildings(GB/T 50189-2005) was issued. 2006, the Ministry of Housing and Urban-Rural Development officially promulgated Chinese Standard "Evaluation Standard for Green Building" （ESGB） . In 2007 Technical Guideline for Evaluation of Green Building is published, and in 2008 Chinese Green Building Label (CGBL) were officially put into use. 2013 Evaluation Standard of Green Industrial Building (GB/T 50878-2013) was issued, it is specialized for green industrial buildings. 2014, the published of Evaluation Standard for Green Building (GB/T 50378-2014) It's the newly version of that enacted in 2006, and marking system is applied instead of counting numbers. And in 2014 Based on the revision of ESGB in 2006, the 2014 version ESGB was formally implemented. Recently, according to the Ministry of Housing and Urban-Rural Development of the People's Republic of China No. 61 of 2019, the national standard " Evaluation Standard for Green Building " (GB/T50378-2019) was officially implemented on August 1, 2019. The original "Green Building Evaluation Standards" (GB/T50378-2014) was also abolished at the same time.

Figure 3. Certificates of Chinese Green Building Label (Residential)

2.3.1. ESGB Vision 2006

On the basis of studying and studying the foreign green building evaluation system, Chinese scholars summed up the practical experience and research result in / from domestic green buildings and compiled China's first green building evaluation system. The standard was released on March 7, 2006 and began nationwide on June 1, 2006. Its release and implementation not only promoted the research and design of green buildings in China, but also standardized the sound development of green buildings.

Because the national conditions of different countries are different, the understanding of the concept of green ecology is also different.

Therefore, the functional structure of green building evaluation standards, the evaluation indexes items and the sub-projects have different priorities too. But the perceptions of the following areas are similar:

(1) Resource conservation. It mainly includes savings on energy, water resources and land resources. It is one of the important links between sustainable development.

(2) Reduce carbon emissions. Designed to protect ecosystems and biodiversity.

(3) Recycling of wasting and sewage.

(4) Create a comfortable indoor environment. Including natural ventilation and lighting, noise reduction and improved air quality.

The 2006 version of Chinese Standard "Evaluation Standard for Green Building"(ESGB2006) draws on international advanced experience and has developed 6 major evaluation indicators :

(1) Land Saving and Outdoor Environment

(2) Energy Saving and Energy Resource Utilization

(3) Water Saving and Water Resource Utilization

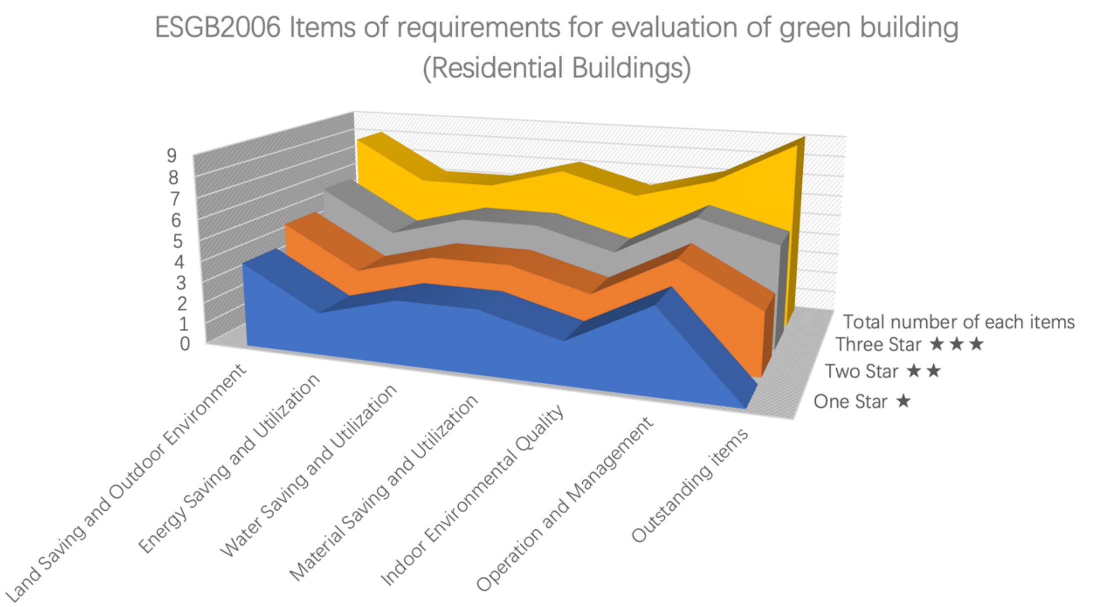
(4) Material Saving and Material Resource Utilization

(5) Indoor Environmental Quality

(6) Operation and Management

Compared with the foreign green building evaluation system, most of them adopt a multi-level index system, and the classification of sub-index items is relatively clear. The 2006 evaluation index system is relatively simple. And the sub-index items are not classified and are in a side-by-side relationship. In other words, each segment is equally important to the evaluation. The composition of this evaluation method is simple, but it also weakens the importance of key indicator projects (Yuan, 2007).

Table 1. ESGB2006 Items of requirements for evaluation of green building (Residential)



	Land Saving and Outdoor Environment	Energy Saving and Utilization	Water Saving and Utilization	Material Saving and Utilization	Indoor Environmental Quality	Operation and Management	Outstanding items
One Star ★	4	2	3	3	2	4	0
Two Star ★★	5	3	4	4	3	5	3
Three Star ★★★	6	4	5	5	4	6	5
Total number of each items	8	6	6	7	6	7	9

(Source: ESGB2006)

ESGB2006 adopts the measure score method and divides a large-scale sub-evaluation project into three parts: a control item, general item and outstanding items. Control items are the basic requirements that must be met. For general items and preferences, they are divided into qualitative measures and quantitative measures. For the qualitative measures, the implementation of this item will add points, while for the quantitative measures, specific quantitative indicators will be required to score. Finally, the scores of each project are simply added together, and the corresponding grades (one-star, two-star, and three-star) are evaluated according to the number of items that meet the requirements.

In general, ESGB2006 has the characteristics of simple scoring method and easy operation. However, due to the lack of a weight evaluation system, the importance of various measures in the construction is difficult to reflect, which may have an impact on the accuracy of the final evaluation results.

2.3.2. ESGB Vision 2014

In order to meet the social and economic development and the advancement of green technology, the Ministry of Housing and Construction completed the revision of ESGB2006 in 2014. Compared with the 2006 version of the standard, ESGB2014 has the following major changes:

(1) Expanded the scope of application of the standard. The standard scope of application extends to office buildings, mall buildings and

hotel buildings in residential and public buildings to various types of civil buildings.

(2) Divide the evaluation criteria into design evaluation and operational evaluation.

(3) Add a new evaluation indicator project . In addition to the original six categories of Land Saving and Outdoor Environment, Energy Saving and Energy Resource Utilization, Water Saving and Water Resource Utilization, Material Saving and Material Resource Utilization, Indoor Environmental Quality, Operation and Management, the evaluation index of " Construction and Management " is added .

(4) Adjust the evaluation method, score each evaluation index, and determine the green building level with the total score rate. Accordingly, the general item in the old version of the standard is changed into the rating item, and outstanding items is canceled.

(5) Add additional points to encourage innovation and improvement in green building technology and management .

(6) Defining the evaluation method and grade determination method of single-unit multi-purpose comprehensive buildings.

(7) Modify some of the evaluation provision and assign evaluation scores to all score and bonus points.

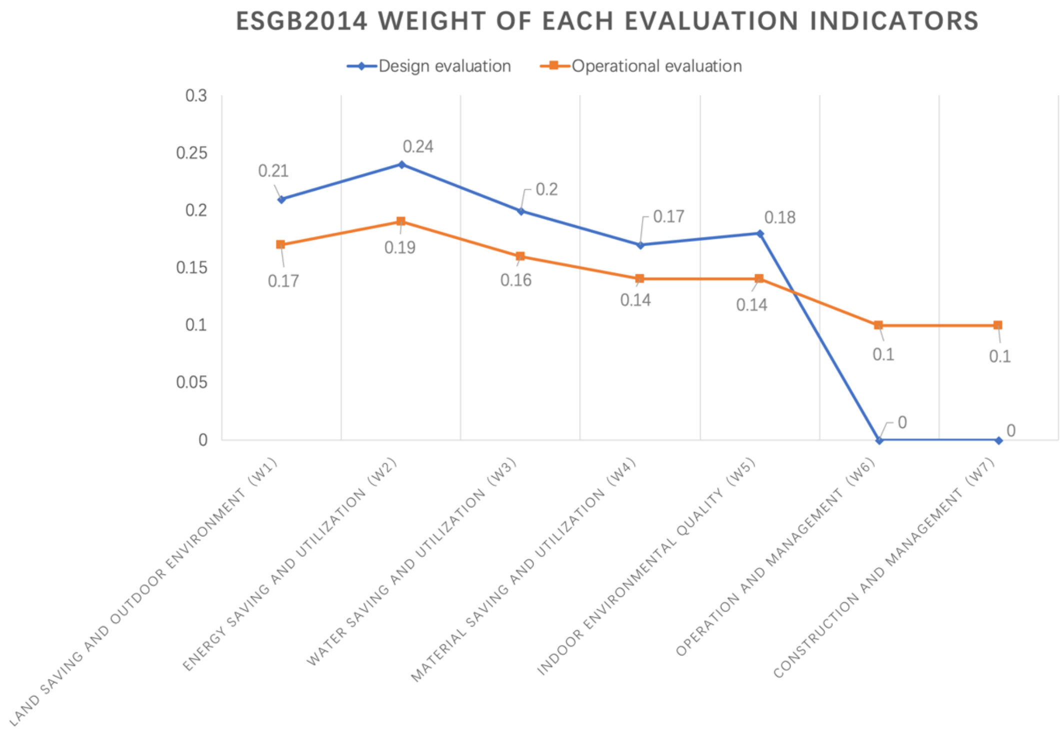
According to ESGB2014, the total score of the green building evaluation is calculated by the following formula, and the total score of each types of indicators is 100 points. The score of each of the 7 types of indicators Q1, Q2, Q3, Q4, Q5, Q6, and Q7 are calculated by dividing the score of the index of the participating buildings by the total score and multiplying by 100 points. Q8 is an additional score.

$$\Sigma Q = w_1 Q_1 + w_2 Q_2 + w_3 Q_3 + w_4 Q_4 + w_5 Q_5 + w_6 Q_6 + w_7 Q_7 + Q_8$$

ΣQ	50	60	80
Green building level	★	★★	★★★

In accordance with the final score, green buildings will be split into one-star, two-star and three-star. All three levels of green buildings should meet the requirements of all controls in this standard, and the score for each type of indicators should not be less than 40 points. When the total score of green buildings reaches 50 points, 60 points, and 80 points respectively, the green building grades are one-star, two-star, and three-star.

Table 2. ESGB2014 weight of each evaluation indicators



(Source: ESGB2014)

The 2014 version of ESGB has made great progress of the 2006 version. It makes up for the lack of the weight evaluation system of the old version and builds its own weight system. Enhance the operability and applicability of the standard, improve the scientific rationality of the technical indicators and adapt to local conditions.

2.3.3. ESGB Vision 2019

With the continuous deepening of China's ecological civilization construction, the whole society's concept, understanding and demand for green buildings have gradually improved. ESGB2014 has encountered new problems and challenges. The core issue is that the standard is based on engineering as the main line to assess the green level of the building and may not allow the people to feel the advantages of green building in terms of health, comfort and quality. In order to change this emphasis on technology and ignore feelings, focus on design stage evaluation and ignoring the mode of operation evaluation, expand the connotation of green buildings, improve the quality of green buildings, form a high-quality green building technical index system, and effectively link with mandatory engineering construction standards, The latest revision of the ESGB2019 came into being.

Table 3. ESGB2019 Total score of each Scoring Items

	Prerequisite Items (Q0)	Total score of each Scoring Items					Bonus Items of Promotion and Innovation (QA)
		Safety and Durability (Q1)	Health and Comfort (Q2)	Occupant Convenience (Q3)	Resources Saving (Q4)	Environment Livability (Q5)	
Pre-evaluation	400	100	100	70	200	100	100
Evaluation	400	100	100	100	200	100	100

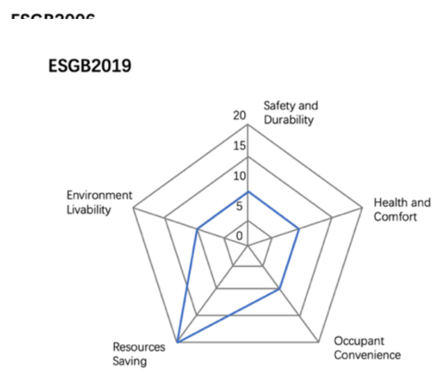
$$Q=(Q0+Q1+Q2+Q3+Q4+Q5+QA)\ /10$$

Q	60	70	85
Green building level	★	★★	★★★

(Source: ESGB2019)

Compared with the previous two versions of the standard, ESGB2019 has the following main content and innovation highlights:

(1) Reconstruct the evaluation index system to respond to changes in the main needs of society. The index system of the 2006 edition and the 2014 edition of the Standard is based on the traditional "four savings and



one environmental protection". The new "standard" aims to implement the green development concept, promote the high-quality development of buildings, and conserve resources to protect the environment. Reconstructed the five major indicators of "Safety and Durability, Health and Comfort, Occupant Convenience, Resources Saving, and Environment Livability".

(2) Reset the evaluation stage and guide the implementation of green technology. The 2006 edition of the Standard stipulates that the evaluation of green buildings is operational evaluation, and the 2014 edition of the Standards stipulates that the evaluation of green buildings is divided into design evaluation and operational evaluation. The design evaluation shall be carried out after the approval of the construction project construction drawing design document, and the operation evaluation shall be carried out one year after the completion of the building acceptance and commissioning. During the revision of the "Standards", the study confirmed that "the evaluation of green buildings should be carried out after the completion of the construction project", and the design evaluation is cancelled, but the pre-evaluation can be carried out according to the relevant technical content in the design stage.

(3) Increase the Basic Level of green buildings and comprehensively promote green buildings. The 2006 edition and the 2014 edition of the Standard all stipulate that the green building grade is one-star, two-star and three-star. The new "Standard" has added "Basic Level" on the basis of Three-Stars, and the grade of green building is divided into four levels: Basic Level, One-Star, Two-Star and Three-Star. The green building evaluation provisions meet the requirements of "Prerequisite Items",

which is “Basic Level”. All the Basic Level control items will be included in the 39 full-text mandatory engineering specifications being prepared. It is expected that the new buildings will fully meet the green building standards around 2025; Increasing the Basic Level also takes into account the imbalance of regional development and the imbalance between urban and rural development. In addition, the green building is divided into four levels and is also a common practice for international major green building evaluation standards, facilitating international cooperation and exchanges in the field of green building.

(4) Expanding the connotation and technical requirements, adapting to the development of building technology. The rapid development of building technology, the revised research has increased the 2006 and 2014 editions of the "standard" considered less or not considered content, such as building industrialization, sponge city, waste resource utilization, health and livability, building information model and other related technical requirements, Expand the connotation of green buildings.

(5) Improve building performance and promote high-quality development of green buildings. The first two editions of the Standard do not cover the promotion of physical and mental health in the building. The new Standards reflect safety, health and fitness requirements in various chapters, such as building balconies, stairs, floor-to-ceiling windows, etc. Set fall prevention measures, suitable for old age, suitable technical measures, barrier-free facilities, outdoor communication space, fitness conditions, livable outdoor environment, indoor air quality improvement, water quality requirements, comfortable indoor environment.

2.4. Literature review

2.4.1. Evidence of green labels on housing prices

Table 4. Evidence of green labels on housing prices

Researchers	Years	Location of Study	Objectives	conclusion
Carlos Marmolejo & Ai Chen	2018	Barcelona	The Uneven Price Impact of Energy Efficiency Ratings on Housing Segments	The impact of EPC ratings is small, but not balanced in the housing sector.
Pascuas	2017	Europe	The impact of EPC ratings on house prices	The impact of EPC ratings on house prices was negligible, especially in Spain.
Pontus Cerin et al	2014	Swedish	The mandatory energy performance certificate for private residential transactions	Energy labels have a greater impact on sales prices relative to rental prices.
Andrea Chegut et al	2013	London	The economic impact of commercial office environmental certification	Green buildings have a middle-class effect.
Hyland	2013	Ireland	The impact of EPC on leasing and sales listing prices	Energy labels have a greater impact on sales prices relative to rental prices.
Biointelligence Services	2013	Europe	The impact of EPC on sales prices	EPC ratings appear to have a greater impact on the hinterland than capital cities
Brounen＆Kok	2011	Dutch	" Green labels" on residential prices	Found a positive correlation between the best rated home and the sale price

In the UK over the past decade, the commercial property sector has rapidly increased its focus on "sustainability" and energy efficiency rating programs. Since 1999, it has been certified by the BREEAM rating program to provide economic insights into the "green" certification of the commercial real estate market. Fertile soil. Andrea Chegut, Piet Eichholtz and Nils Kok(2013)investigated the economic impact of London's commercial office environmental certification through a post-trade feature model (Rosen, 1974) and conducted a robustness check. The results indicate that green buildings have a middle- class effect. During the period 2000-2009, the expansion of green building supply in specific London communities had a positive impact on average rents and prices, but rents and prices for environmentally-certified real estate declined. However, for each additional “green” building, the marginal effects of certification in the leasing and trading markets are reduced by 2% and 5%, respectively. In addition, controlling lease contract characteristics, such as contract length and rent-free period, can change the impact of environmental certification on rental prices.

Pontus Cerin et al(2014) analyzes the mandatory energy performance certificate for private residential transactions in 2009-2010 after the implementation of the European Union directive on building energy performance in the Swedish private residential market, found that energy performance is associated with transaction prices. They also recorded real estate price forecasts for energy performance between the housing sector built before 1960 and the transaction price per square meter. And make recommendations on which housing segments need policy support to encourage energy improvements.

The paper of Carlos Marmolejo and Ai Chen(2018)analyzes the Uneven Price Impact of Energy Efficiency Ratings on Housing Segments using the multi-family listing data of Barcelona Metropolis.

Nowadays, based on the Building Research Establishment Environmental Assessment Method (BREEAM), High Quality Environmental standards (HQE), Leadership in Energy and Environmental Design (LEED), Green Mark, ENERGY STAR and Minergie to find the relationship both rental and sales prices with the green labels have been studied a lot, but there are relatively few studies focusing on the EPC program. And these studies usually use a hedonic analysis based on marginal prices and the same source of information: listing data.

In the context of the reform of the Directive 2010/31/EU and Directive 2012/27/31 of the European Parliament and of the Council on the energy performance of buildings.

Brounen & Kok's (2011) groundbreaking study analyzed the impact of these new “green labels” on Dutch residential prices, and the results of the study found a positive correlation between the best rated home and the sale price.

In different cities in Ireland, Hyland (2013) was the first to compare the impact of EPC on leasing and sales listing prices. In general, they found that energy labels have a greater impact on sales prices relative to rental prices.

Research by Biointelligence Services (2013) shows that EPC ratings appear to have a greater impact on the hinterland (eg, Belgium and Ireland, with the exception of Austria) than capital cities. According to the authors, the need to save energy bills is even more important in urban areas where housing prices are lower than in the capital. In addition, a higher energy rating does not always mean a market premium.

Denmark was the first country to introduce the “A”-“G” energy label in 1997. Jensen et al (2016) found that the EPG label became mandatory in Denmark in 2010, and the energy grade premium increased significantly. Parkinson et al (2013) found no correlation between EPC ratings and rental value. Their findings show that the aesthetics of the facility is the main driver of rent. Compatible evidence can be found in the study by Pascual et al. Pascuas (2017) based on surveys of real estate agents in eight countries showed that the impact of EPC ratings on house prices was negligible, especially in Spain, where only 15% of respondents confirmed the existence of a premium for efficient flats.

So far, there is no significant evidence of the impact of EPC on the value of housing across Europe, but there is no conclusive evidence that this may be due to differences in income, energy costs, building codes/traditions, climate and environmental issues. In addition, EPBD has different differences in different policies and regulations of different countries, and there are also differences in collective evaluation criteria, so it is difficult to assess cross-border comparisons. In Spain, Marmolejo used the hedonic model to analyze the relationship between the real estate sales value of Barcelona's metropolis and the EPC. The results showed that the rating from G to A increased by 5.11%, which is much lower than other European cities and the market. The lack of energy rating information exacerbates information asymmetry. These are not conducive to Spain's implementation of the European Energy Efficiency Directive, and it is necessary to redesign it.

The impact of EPC ratings may vary between market segments. In Sweden, Pontus et al. Households with tight budgets and can only buy cheaper homes seem to value energy bills for efficient homes. In contrast, those who can buy high-priced housing seem to think that the EPC rating is not important. In the UK, Fuerst et al. found that EPC's biggest impact on the UK residential market was townhouses, which had a greater impact on apartments than detached homes. However, their results contradict the results of Salvi et al. Salvi et al. studied the impact of the Swiss Minergie certification and found that single-family homes have a greater impact on apartments. They believe that this finding is associated with greater energy demand in single-family homes. So far, the research studied has carried out univariate segmentation, ignoring the fact that market segmentation is composed of multiple attributes of architectural and locating features, so this article takes this into account.

The method is divided into five stages: (1). Data collection, preliminary index calculation, geoprocessing, purification and representative analysis. (2). Specification and calibration of characteristic models for all purified samples. (3). Separate purification sample (4). Specification and calibration of the feature model for each segment. (5). Finally, the Chow test was used to determine the structural differences in the hedonic agenda for each market segment. The results show that, in general, the impact of EPC ratings is small, but not balanced in the housing sector: in recent high-yielding homes, ratings play an ineffective role in price formation. Conversely, in residential areas with lower prices and better quality, energy ratings have become an important driver of the formation of listing prices. Finally, for old residential areas that are typically located in 19th century expansion areas and wealthy communities, there is a market premium below the worst residential. This may be due to the misunderstanding of the EPC rating target among low-income and low-educated residents who believe it is an indicator of global household quality. These people who living in inefficient housing have little chance of transforming in their homes for cognitive and economic reasons. Therefore, if corrective measures such as rehabilitation subsidies are not introduced, then a good environmental policy may have an unexpectedly harmful effect from a social perspective.

Dominique Pride(2018)examines the impact of the 2008-2015 Home Energy Rebate Program on the sales price of single-family homes in the Fairbanks Polaris municipality. Residents in the interior of Alaska face a cold climate and relatively high energy prices, which results in high household energy expenditures. Improving the energy efficiency of housing can help reduce household energy expenditures. Following the adoption of the peak oil price in 2008, the household energy rebate program was created. Homeowners participating in the program are eligible for a refund of up to $10,000 for pre-approved home energy efficiency improvements. Using the hedonic pricing analysis, the results showed that the home price of the home energy rebate program in the Fairbanks Polaris Municipality was 15.1-16.5% higher than the similar house that did not complete the plan, indicating that the investment in residential energy efficiency was obtained. make up. This is the first study to study the impact of energy efficiency on market prices in markets with subarctic climates.

2.4.2. Evidence of Chinese green label on housing prices

Table 5. Evidence of Chinese green label on housing prices

Researchers	Years	Location of Study	Objectives	conclusion
Jiajun Lu et al	2018	Shanghai, China	The relationship between the perspective of an apartment and the value of its property in the context of the Shanghai housing market	The south-facing direction is related to 14% of the property value.
Li Zhang et al	2016	China	Price premium effect on CGBL housing	The labelled housing project has a price premium of 6.9% compared to the unlabeled housing project.
Science and Technology Development Promotion Center	2012	China	The economic cost-effectiveness of green building technology	The higher the green building star rating, the higher the incremental cost.

China Science and Technology Development Promotion Center of Ministry of Housing and Urban-Rural Development and Peking University Urban Planning and Design Center by investigating the application of green building technology in the China Green Building Evaluation and Labeling Project, the economic cost-effectiveness of green building technology was studied and analyzed. Through research, collection and collation of relevant data on technology selection, cost input, energy resource consumption and incremental cost of green building evaluation and identification projects of different regions, different star types and types, the research team selected 55 green buildings that have been acquired. Evaluate the identified architectural items and collect and collate relevant technical information. Study the relationship between the geographical distribution of green buildings and the overall economic conditions of the city; determine the technical choices in the green building identification project, and the cost and related energy and energy conservation goals and effects of the green building project application technology; according to the design data, according to the application technology Costs of materials, equipment and labor are used for local market research and inquiry, valuation of conventional and green construction costs, measurement of incremental costs and benefits; preliminary assessment of China's green building projects through analysis and estimation of GDP growth, green employment opportunities, etc. The impact on the overall benefits of macroeconomics.

The study found that the construction unit has obvious differences in the selection of different indicators, and the difference in the compliance rate of different indicators is also very large. At present, the combination of indicators for different projects reaching the same star rating reflects that the market is in the development stage of green building design technology, experience, cost control management, and cost perception. It has not yet established an overall high information level and Mature market environment. This study gives a clear definition of "incremental cost" for green buildings and analyzes the incremental costs of 55 green building projects. Overall, the higher the green building star rating, the higher the incremental cost. The study further analyzed the "benefits" of green buildings (including energy conservation, water conservation and carbon reduction). From the perspective of energy saving, the energy saving range and average energy saving of green residential buildings increase with the increase of star rating, One-Star is 4.95kWh/m2.a, Two-Star is 8.1kWh/m2.a, Three-Stars. It is 13.56 kWh/m2.a.

To understand the impact of green building incremental investment on the macro economy, this study analyzes the impact of green buildings as part of the real estate industry on economic output and employment. The overall macroeconomic benefits of China's green buildings during the 12th Five-Year Plan period were estimated by using the models of the backward and forward impacts of direct and indirect related industries, and the incremental relationship between the incremental output value of green buildings and their own employment. It is estimated that during the 12th Five-Year Plan period, the total efficiency of green building macroeconomics will reach more than 200 billion yuan, thus creating nearly 570,000 jobs. It is foreseeable that green buildings will have a significant driving effect on China's green industry.

The paper of (Li Zhang et al, 2016) examines the existence and magnitude of price concessions associated with official green labels in the residential sector. Based on the unique datasets of green labels, new housing projects and their unlabeled housing projects across China in 2013, empirical analysis shows that the labeling housing project has a price premium of 6.9% compared to the unlabeled housing project. These results provide preliminary evidence that investment in building energy efficiency may be beneficial to Chinese housing developers through this official rating system, and this profit may drive the rapid development of China's urban green housing market.

There are 16 administrative districts in Shanghai, and the level of development varies greatly. The average value of real estate close to the city center is higher because various resources are usually concentrated there. Shanghai has many famous urban landmarks that affect the local housing market. However, due to the direction of the viewing angle, it is possible to directly see that the value of a landmark is different from the value that is only close to it. (Lu, 2018) studied the relationship between the perspective of an apartment and the value of its property in the context of the Shanghai housing market. He used the hedonic pricing model to analyze the apartment properties, environmental environmental indicators and urban spatial structure data obtained by Fang.com, indicating that the south-facing direction is related to 14% of the property value.

3.Methodology

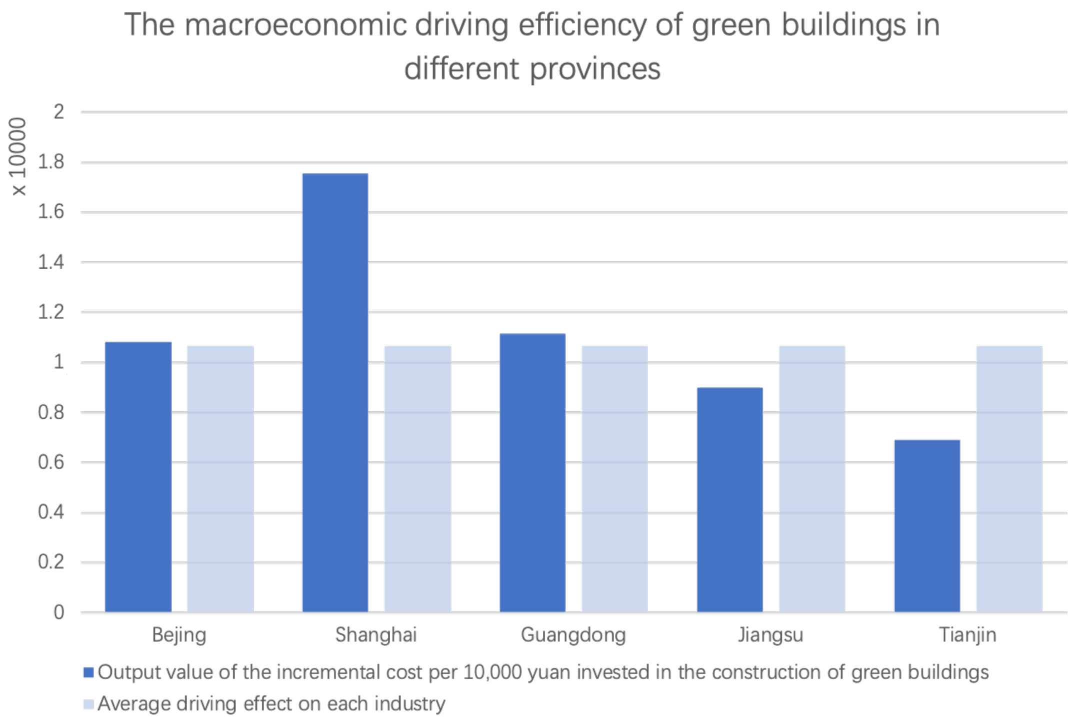
3.1. Case Study.

Located at the forefront of the Yangtze River Delta in China, Shanghai is placed at the mouth of the Yangtze River and has been an important port for China's external transportation and trade since ancient times.

As one of the only four municipalities in China, Shanghai is not only a populous city with a prosperous economy, but also has become an international financial and trade center. Therefore, the residential market in Shanghai is also very important across the country.

Developed economies are generally more active in sustainable construction than in developing and underdeveloped economies. This is because developed economies usually have better economic conditions to address the development of a sustainable built environment. The developed regions have strong technical strength, a developed green awareness, and strong economic carrying capacity. It is inevitable that the green transformation of existing buildings in the emerging field will take the lead in these areas. Green building investment is part of the real estate industry, and additional investment will have a macroeconomic impact through the real estate industry's macroeconomic drivers. The statistics of National Bureau of Statistic 2007 pointed out that for every 1 unit of output value of green building investment in China's real estate industry, the average driving effect on each industry is 1.0648. That is to say, if green buildings invest an incremental cost of 10,000 yuan in order to improve the energy conservation and emission reduction level of the building, an additional economic output value of 10,648yuan will be generated in the entire economic system.

Table 6. The macroeconomic driving efficiency of green buildings in different provinces

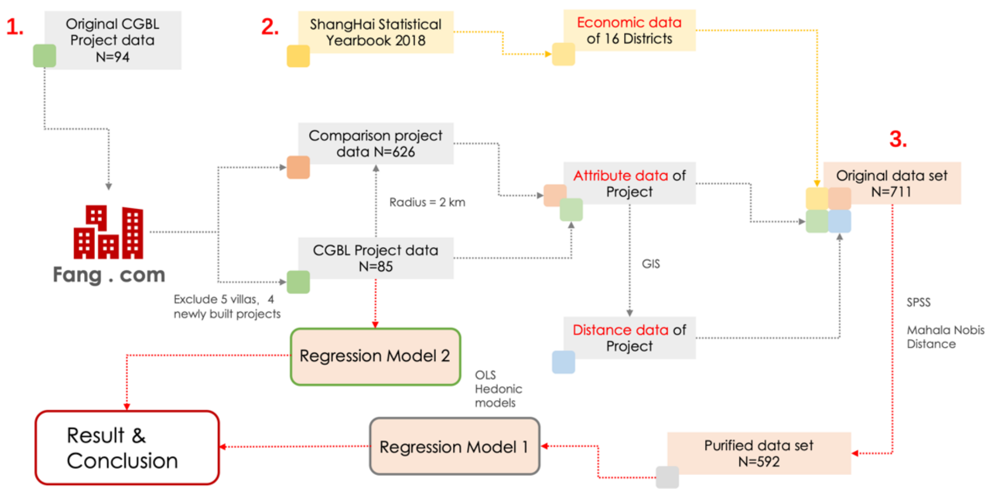


(Source:ZudaYe,2012)

According to relevant data analysis (ZudaYe,2012), in 2007, the macroeconomic driving efficiency of green buildings was the highest in Shanghai, and the total benefit coefficient reached 1.7554. The incremental cost per 10,000 yuan invested in the construction of green buildings in Shanghai will generate an additional economic output value of 17,554 yuan in the entire urban economic system, ranking the highest among urban areas in the country. The total driving efficiency coefficients of other cities and provinces are: Beijing 1.0833, Guangdong Province 1.115, Jiangsu Province 0.8995, Tianjin City 0.6903. The coefficients for Jiangsu and Tianjin are all less than 1, which means that the amount of return on green buildings in the region is not enough to cover the construction costs. Due to the sustainability of green buildings, the benefits may be difficult to show in the short term, but over time, it can be predicted that the returns generated will eventually cover the construction costs and generate additional benefits.This also proves that developed regions have a faster acceptance rate for green buildings than other regions, therefore, this paper uses Shanghai as the case study.

3.2. Method

Figure 4. Methodological summary scheme



The research process can be divided into three main routes:

(1) Collection and organization of project data

a. According to the original plot information of 94 Shanghai green residential buildings, the specific product name of the project is determined by using webpage search and other methods.

b. Use data capture software to get the price of green items, house types and other data that may affect the price of the house from the fang.com website.

c. Exclude projects with villa type and new built projects because they do not meet the type of research focuses on: existing ordinary residential projects.

d. Using 85 initial cleaned project coordinates with green building labels as the origin, with a radius of 2 km, search for unlabeled residential projects within the target range as a comparable example of research.

e. Integrate all labelled and unlabeled items and create the dummy variable CGBL, marking the labelled item as 1; unlabeled 0.

f. Use GIS combined with Shanghai shapefile dates to calculate the distance between each project and traffic sites, natural scenery, schools, hospitals, leisure places, and generate distance variables, then dummy variables according to the different service scope.

(2) Collection statistical data in each districts of Shanghai

a. According to the contents of 2018 Shanghai Statistical Yearbook, collect relevant population and economic information from 16 districts in Shanghai.

b. Correspondence between the collected statistical information of each district and the actual district of each project.

(3) Data cleansing and regression analysis

a. Integrate all variable information obtained in processes (1) and (2) for preliminary clean-up work. The maximum value and the minimum value are back-checked, and the missing data is subjected to entire mean completion or hierarchical mean completion according to different situations. Consider the deletion process for variables that missed more than 40% of the data.

b. Perform a normality test before the regression on the dependent variable—the average price of project and try a normal conversion if it does not conform to the normal distribution.

c. Clean the data twice to remove extreme values and outliers. The range of the dependent variable is calculated by the result of mean value plus 2.5 times std and minus 1.5 times std., and the outlier is removed by calculating the Mahala Nobis Distains.

d. Using the data set after two-round clean-up with the dependent variable conforms to the normal distribution, multiple linear regression is performed to obtain Model1.

e. Multiple linear regression using 85 items with CGBL labelled to get Model2.

f. A final conclusion: According to the results of linear regression analysis, residential projects with CGBL labels have no significant green premium effect in Shanghai.

3.3. OLS Hedonic price model

The hedonic price model is often used to deal with the relationship between heterogeneous product differentiation characteristics and product prices, especially in the real estate field.

In the study of real estate prices, more attention is paid to the detailed study of the impact of a feature on real estate prices, including air quality, environmental quality, demographics, building age, landscape, light rail and airport noise. Due to the spatial fixedness of real estate products, the heterogeneity is very obvious. There are obvious characteristics of the various use values between products, such as the location, level, orientation, and structure of the house. It is precisely because of these characteristics of real estate that the hedonic price model has been widely used in the real estate field.

The hedonic residential price model was proposed by (Lancaster, 1966) and (Rosen, 1974). Lancaster pointed out that the market price of commodities is determined by the attributes of commodities rather than the goods themselves, thus providing a theoretical basis for microeconomics; Rosen proposed a specific Hedonic residential price model, followed by residential prices and living conditions. Widely used in research. There are three main types of factors that affect residential prices: location, structure, and neighborhood. Therefore, the residential price P can be expressed as an equation:

$P = f(L, S, N)$ (1)

The location (L) in equation (1) refers to the convenience of employment and life, including the distance to the city center and the place of employment; the building structure (S) refers to the material form characteristics of the house, including the building area, the building age, and the number of rooms, floor, indoor equipment such as air conditioning; neighborhood environment (N) refers to the type of community, service level, landscape, environmental pollution, including school quality, service facilities scale and distance, landscape sight, noise, air pollution levels.

The feature price model does not have a unified theoretical formula, and is generally determined based on actual problems and specific data. When using the characteristic price model to study the factors affecting the residential price, the residential price is usually used as the dependent variable, and the various characteristic attributes of the house are used as independent variables. In order to facilitate the analysis, certain assumptions are always given when building the model.

In this paper the functional expression will be using:

$$\ln(P) = k + \sum_{A=1}^{n} BA + \sum_{E=1}^{n} BE + \sum_{L=1}^{n} BL + e \qquad (2)$$

In the equation(2),In(P) is the natural logarithm of the average price of the cleaned sample; A,E and L are vectors, including architectural features and social factors that may affect the research project; finally B is the coefficient and e is the overall error term.

4.Data

First, we obtained the names of 94 residential plots in Shanghai that were all CGBL-labelled during the period of 2014-2018 through the original information from the website of the Shanghai Green Building Association. And through the way of web search comparison, the actual name of their project is finally determined. In the 94 green residential projects with CGBL labeling, 4 new housing projects and 5 villa projects that did not meet the research type were excluded, we got 85 CGBL-labelled residential projects that could be used as research cases. Next, we use the geographical coordinates of the labelled project as the origin, set the range of two kilometers as the radius, and get the other 626 unlabeled items set as comparable examples, so the initial data set includes a total of 711 cases.

4.1. Data Sources

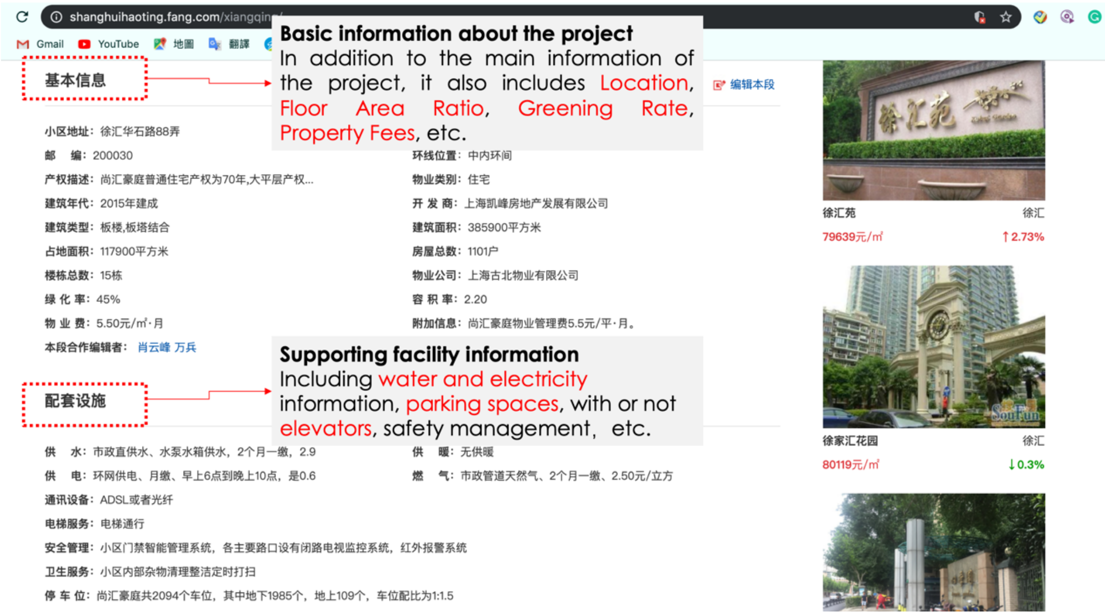
Fang.com is China's leading real estate transaction information platform. Compared with many other real estate portals in China, Fang.com has the characteristics of greater influence and more comprehensive housing information. Therefore, we chose Fang.com as the main source of variable information for the study case. Fang.com's housing information mainly includes three sections: new housing, second-hand housing and renting. In this study, we focus on the second-hand housing market.

Figure 5. Information extraction process

(source: Fang.com)

With the help of the data acquisition software, we put the original 711 case URLs into the arranged circular chain, which in turn includes the project average price, address, construction year, house type, number of buildings, number of households, and property company. The main information of the project, such as the name of the developer. In addition, we have captured basic information about projects that are usually closely related to housing prices, such as project location, floor area ratio, and property fees.

Figure 6. Project web information



(source: Fang.com)

In addition to the main information and basic information of the project, we also collected some information related to the project supporting facilities. Including water and electricity information, parking spaces, with or not elevators, safety management,etc.

For some distance data that cannot be obtained at Fang.com, such as the linear distance between the project and the transportation site, natural scenery, school, hospital, and leisure place, the GIS software is used to calculate the data points of various Shapefiles in Shanghai. In addition to the focus on the project's own property attributes, we also want to observe the impact of the overall situation of the project area on housing prices. Therefore, based on the contents of the 2018 Shanghai Statistical Yearbook and Statistical Bulletin, we collected information on population, land, and economy in 16 districts in Shanghai.

4.2. Data purification

As one of the most important preparations before the study, data cleansing can make the research results more accurate. First, I did a preliminary cleanup of the raw data during the data collection process. For the maximum and minimum values of the original data, the unconventional outliers are not checked, and the wrong data is deleted or modified.

When collecting variables related to the project's own attributes, due to the limitations of the website information, the lack of data is more common. In order to solve this problem, the following measures have been taken: First, refer to the rental and sale websites other than Fang.com to find missing information. For the variables that are still missing more than 40% after the initial completion, delete them. For variables that are missing within 40%, is subjected to entire mean completion or hierarchical mean completion according to different situations.

For some economic-related missing variables, the use of other information-complete variables to derive partial missing variables is also used. For example, the total unemployed population and total unemployment rate in Shanghai are known. The total labor force population in Shanghai is first calculated, and the total labor participation rate in Shanghai is calculated based on the total working-age population in Shanghai. Next, use the total working-age population in all districts of Shanghai multiplied by the labor participation rate to calculate the labor force in each district. Finally, the unemployment rate of all districts in Shanghai is calculated by dividing the unemployed population in various districts of Shanghai by the calculated labor force. So far, the initial data set includes more than 140 housing information for 711 projects and economic information for the region in which it is located.

Table 7. Descriptive Statistics of 711 projects

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Price_Project_Sep_Yuan_㎡	711	9663	145085	41634.78	18133.828
Valid N (listwise)	711				

The primary condition for multiple linear regression is that the dependent variable should conform to the normal distribution. First, the normality of the average price of 711 items is tested. The results of the K-S and S-W tests have sig values less than 0.01. The normality test was not passed, so a second round of data cleaning was required to remove the extremes and outliers.

Table 8. Depurated projects

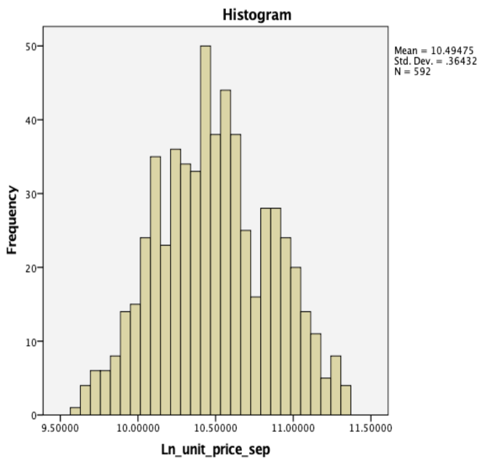
average-1.5STD	average+2.5STD	N_depurated
14434.038	86969.35	698

First, descriptive statistics were performed on the dependent variables. Calculate the result of mean value plus 2.5 times std and minus 1.5 times std. Keep cases in this range , the extremum was reduced to 698 cases. Take the natural logarithm of the dependent variable.

The regression analysis was performed using the case after the extreme value was removed. After many attempts, a model with better regression effect was determined, and the Mahala Nobis Distance (MND) was retained. The Probability of MND was calculated according to the regression result, and the value was retained to be greater than or equal to 0.1. Case. After screening to remove the outliers, 592 cases were finally left.

Table 8. Normality test of dependent variable

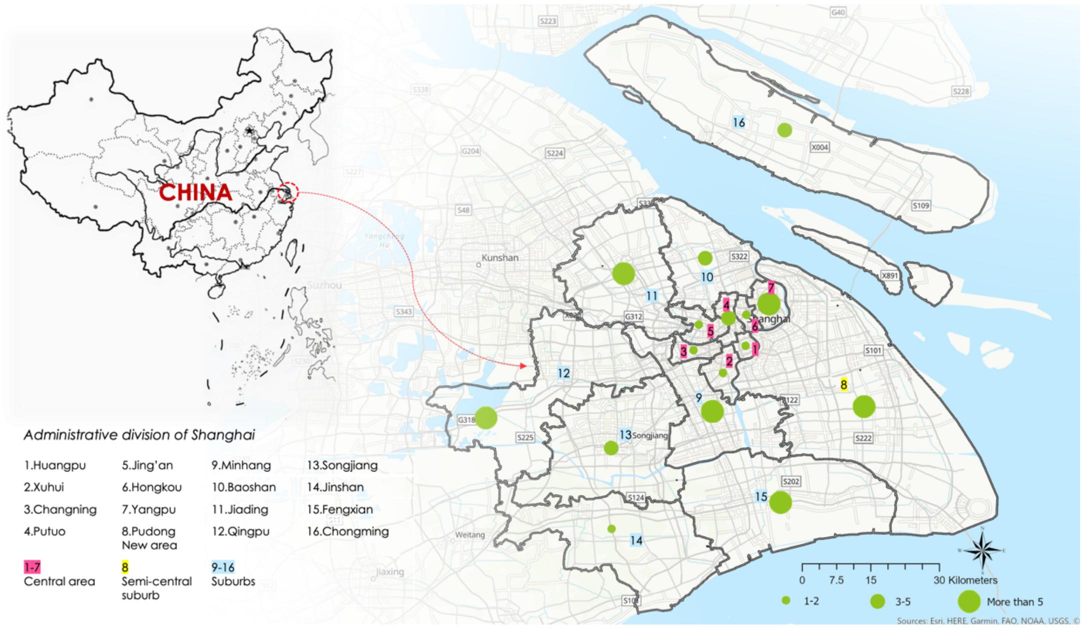
Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Ln_unit_price_sep	0.042	592	0.014	0.992	592	0.003
a. Lilliefors Significance Correction						



Once again, the normality test was performed on the dependent variable, and the regression results showed a normal distribution with a confidence interval of 90%. Meet the basic requirements of multiple linear regression.

4.3. Data description

Figure 7. Distribution of CGBL-labelled housing projects in the sample



(Source: Authors' calculations based on data from Fang.com)

With a total area of 6,341 square kilometers, Shanghai consists of 16 regions, including 7 central areas, one semi-central sub-suburb, and eight suburban areas (including one outer island). The total area of the central area is about 500 square kilometers, less than one tenth of the suburban area. According to the spatial distribution of projects with CGBL labelled in Shanghai, the overall performance of the suburbs has more labelled projects than the central region. This may be due to the difference in area.

Of the 592 cases after cleaning, there were 64 with CGBL labelled and 528 non-labelled. Among the labelled projects, the two-star project has the largest number of 39 , the three-star project has the fewest number of 8 and the number of Two-Star is 17.

Table 9. Projects with/without CGBL label

Projects without CGBL label					
	N	Minimum	Maximum	Mean	Std. Deviation
Price_Project_Sep_Yuan_㎡	528.00	14940.00	84792.00	38573.85	14174.02
Price_Project_Sep_Euros_㎡	528.00	1867.50	10599.00	4821.73	1771.75
Valid N (listwise)	528.00				
Projects with CGBL label					
	N	Minimum	Maximum	Mean	Std. Deviation
Price_Project_Sep_Yuan_㎡	64.00	16003.00	81239.00	38874.56	16279.99
Price_Project_Sep_Euros_㎡	64.00	2000.38	10154.88	4859.32	2035.00
Valid N (listwise)	64				

We obtained the average transaction price in September 2019 (Price_Project_Sep). This is calculated by dividing the total value of new housing units sold in the project in the month by the total floor area of these units. After descriptive statistics on the average September price of the labelled and unlabeled items, the unconditional average price is 38573.85 yuan/m2 (4821.7313 Euros/m2) for the non-labelled projects, and 38874.56 yuan/m2 (4859.32 Euros/m2) for the labelled projects. This may be prima evidence of a green price premium, but the final conclusion depends on further research.

Table 10. Descriptive Statistics of Structural characteristics variables

Variables	Definition	N	Min.	Max.	Mean	Std. Deviation
CGBL	Unit with CGBL=1; Unit without CGBL=0	592.00	0.00	1.00	0.11	0.31
CGBL_Level	Three-Star=3; Two-Star=2; One-Star=1; Otherwise=0	592.00	0.00	3.00	0.20	0.61
Price_Project_Sep_Yuan_㎡	Average price of the project in September 2019 （yuanes）	592.00	14940.00	84792.00	38606.36	14401.68
Price_Project_Sep_Euros_㎡	Average price of the project in September 2019（euros）	592.00	1867.50	10599.00	4825.79	1800.21
Active_Index_Sep	Combined with the website's search volume and houses listing number for the month.	592.00	0.00	37.59	3.42	4.45
Dum_Active_level_Sep	Active/ Generally active=1；Inactive =0	592.00	0.00	1.00	0.01	0.08

Maturity_level	Comprehensive evaluation of the located area of project (refer to surrounding facilities, traffic conditions)	592.00	1.00	3.00	1.35	0.59
Dum_Mature_project	Very mature stage=3; Maturity stage=2; Less maturity stage=1	592.00	0.00	1.00	0.06	0.23
Property_level	Excellent=4; Good=3; Ordinary=2; Less well=1	592.00	1.00	4.00	2.84	0.75
Dum_Excellent_property	Excellent=1; Others=0	592.00	0.00	1.00	0.16	0.37
School_District_level	Excellent school district=1; Ordinary school district=2; Non-school district=1	592.00	1.00	3.00	1.02	0.16
Dum_Quality_school_Exc	Excellent school district=1; Others=0	592.00	0.00	1.00	0.00	0.06
Construction_Year	Year of construction of the project.	592.00	1976.00	2019.00	2005.42	8.54
Age_Building	Building age	592.00	0.00	43.00	13.58	8.54
Inverse_Building_age	Inverse_Building_age	592.00	0.02	1.00	0.14	0.17
Tower	Building type	592.00	0.00	1.00	0.05	0.22
Slab	Building type	592.00	0.00	1.00	0.91	0.29
Combined	Building type	592.00	0.00	1.00	0.04	0.19
Num_Households	Number of households in the project.	592.00	10.00	6440.00	1065.53	814.23
Num_Buildings	Number of buildings in the project.	592.00	1.00	323.00	22.42	26.26
Num_Homes	Number of homes in selling on the website.	592.00	0.00	923.00	31.88	47.37
Num_Homes_sold	Number of sold homes on the website.	592.00	0.00	244.00	19.26	31.20
Rate_Sold	Num_Homes_sold/Num_Households	592.00	0.00	0.07	0.00	0.00
Percentage_Sold	Rate_Sold/Building age	592.00	0.00	0.40	0.02	0.03
Price_Year_Increase	Compared with the rate of change in average house prices during the same period last year.	592.00	-0.34	0.76	-0.09	0.12
Location_Within_inner	Within the inner ring=1; Others=0	592.00	0.00	1.00	0.07	0.25
Location_Inner_middle	Between the inner and middle ring=1；Others=0	592.00	0.00	1.00	0.07	0.26
Location_Middle_outer	Between the middle and outer ring=1; Others=0	592.00	0.00	1.00	0.12	0.32
Location_Outside_outer	Outside the outer ring=1; Others=0	592.00	0.00	1.00	0.74	0.44
Area_floor	Total floor area of the project. (m2)	592.00	278.20	1800000.0	111235.56	168068.08

Area_land	Total land area of the project. (m2)	592.00	146.42	1500000.0	70123.63	130287.61
Floor_Area_ratio	Area_floor/Area_land	592.00	0.20	5.60	1.81	0.63
Rate_Green	Green area rate of the project	592.00	0.10	0.82	0.36	0.07
Elevator	Yes=1；No=0	592.00	0.00	1.00	0.61	0.49
Num_Parking	Number of parking spaces within the project	592.00	10.00	5654.00	592.31	616.37
Ratio_Parking_household	Num_Parking/Num_Households	592.00	0.02	55.10	1.15	2.98
Cost_Management_fee	Property management fee per m2/mes	592.00	0.10	6.50	1.43	0.98

With the help of the data acquisition software, we put the project's URL link into the arranged circular chain, which in turn includes the project average price, address, construction year, house type, number of buildings, number of households, property company, developer. The main information of the name and other items. In addition, we have captured basic information about projects that are usually closely related to housing prices, such as project location, floor area ratio, and property fees.

In China, in addition to taking care of the entire project, the property company is responsible for the safety of the project, as well as the cleanup of public health, the maintenance of public facilities, and the handling of housing-related problems generated by residents during their stay in the project. . The level of property fees is usually directly related to the average price of the project. Compared with two projects with the same location conditions, the average price of the project that charges higher property fees is also higher, because it means that the project has a higher quality service. In fact, the results of subsequent research have also proved this point very well.

Figure 8. China's current mainstream residential types

Slab | Tower | Combined

(source: https://kknews.cc/house/p5ajm58.html)

China's current mainstream residential types are Slab, Tower and Combined. Compared with the other two, the Slab type residential project often has the characteristics of low volume ratio and high greening rate. But relatively speaking, it also will bring higher management costs, so the price of Slab houses is usually higher than that of Tower and Combined.

In addition to the main information and basic information of the project, we also collected some information related to the project supporting facilities. Including water and electricity information, parking spaces, with or not elevators, safety management, etc. Due to the limitation of the way webpage information is expressed, the difference of such data among various items is not obvious, and there are serious data missing situations. So, in subsequent studies this type of information did not show a correlation with house prices. But this may not mean the actual situation, some of them are usually not fully displayed on the information of the webpage, and the more subjective factors often affect the housing price.

Table 11. Descriptive Statistics of Location attribute variables

Variables	Definition	N	Min.	Max.	Mean	Std. Deviation
DIST_Park	Straight line distance between the project and the nearest park	592.00	0.00	10214.30	1851.93	1554.81
Dum_Park	Dum_Park	592.00	0.00	1.00	0.59	0.49
DIST_River	Straight line distance between the project and the nearest river/lake	592.00	0.00	1214.63	253.92	231.64
Dum_River_200m	Dum_River_200m	592.00	0.00	1.00	0.52	0.50
DIST_Bus	Straight line distance between the project and the nearest bus station	592.00	6.66	4729.10	538.81	530.32
Dum_Bus_500m	Dum_Bus_500m	592.00	0.00	1.00	0.62	0.49
Dum_Bus_1000m	Dum_Bus_1000m	592.00	0.00	1.00	0.87	0.33
DIST_Hospital_AAA	Straight line distance between the project and the nearest AAA-hospital	592.00	385.55	50607.61	15282.80	10457.70
Dum_Hospital_AAA_5000m	Dum_Hospital_AAA_5000m	592.00	0.00	1.00	0.23	0.42
DIST_Shopping_Mall	Straight line distance between the project and the nearest Shopping Mall	592.00	58.84	6808.70	1660.99	1410.16
Dum_Shopping_Mall_1000m	Dum_Shopping_Mall_1000m	592.00	0.00	1.00	0.42	0.50
DIST_Metro	Straight line distance between the project and	592.00	65.34	32885.81	3725.39	5659.99

	the nearest metro station					
Dum_Metro_1000m	Dum_Metro_1000m	592.00	0.00	1.00	0.41	0.49
DIST_Highway	Straight line distance between the project and the nearest highway	592.00	1.26	22653.44	3292.26	3818.89
Dum_Highway_1300	Dum_Highway_1300	592.00	0.00	1.00	0.35	0.48
DIST_Railway_Station	Straight line distance between the project and the nearest railway station	592.00	179.80	51587.06	15601.00	11097.64
Dum_Railway_Station_8000m	Dum_Railway_Station_8000m	592.00	0.00	1.00	0.28	0.45

The second set of variables is the location attribute. Although CGBL-labelled items and their matching unmarked items are within a 2km radius, they can be considered similar in many location features, but there may still be some differences in their distance from locally available facilities.

Therefore, we use GIS software combined with Shanghai shapefile dates to calculate the distance between each project and traffic sites, natural scenery, schools, hospitals, leisure places, and generate distance variables and dummy variables according to their respective service areas.

Table 12. Descriptive Statistics of Indicators of social hierarchy variables

Variables	Definition	N	Min.	Max.	Mean	Std. Deviation
District_Land_area_km2	District_Land_area_km2	592.00	23.46	1210.41	575.02	405.47
Population_Permanent_10000	Population_Permanent_10000	592.00	69.46	552.84	233.63	165.96
Total_Households_10000	Total_Households_10000	592.00	17.44	117.05	47.32	35.85
Population_Registred_10000	Population_Registred_10000	592.00	48.35	298.96	123.91	90.07
Growth_Population_Registerd	Growth_Population_Registerd	592.00	-0.06	0.05	0.02	0.02
Migration_Internal_10000	Migration_Internal_10000	592.00	14.19	235.09	102.04	73.64
Rate_Migration_Internal	Rate_Migration_Internal	592.00	0.19	0.60	0.43	0.14
Density_Population	Density_Population	592.00	586.00	34058.00	8236.74	8741.43
Migration_In	Migration_In	592.00	1172.00	27248.00	12143.98	9147.83
Rate_Migration_In	Rate_Migration_In	592.00	0.00	0.02	0.01	0.00
Migration_Out	Migration_Out	592.00	168.00	8679.00	3911.74	3037.99
Rate_Migration_Out	Rate_Migration_Out	592.00	0.00	0.01	0.00	0.00
Ratio_Flow_people	Ratio_Flow_people	592.00	1.61	6.98	3.68	1.23
Unemployed_Population_10000	Unemployed_Population_10000	592.00	0.47	3.20	1.58	1.04
Rate_Unemployment	Rate_Unemployment	592.00	0.02	0.09	0.04	0.03
GDP_Total_yuan	GDP_Total_yuan(100 million)	592.00	332.84	9651.39	3002.74	3350.89
GDP_Total_euros	GDP_Total_euros(100 million)	592.00	41.61	1206.42	375.34	418.86
GDP_Per_Capital_yuan	GDP_Per_Capital_yuan	592.00	47918.23	174578.36	105991.31	41757.00
GDP_Per_Capital_euros	GDP_Per_Capital_euros	592.00	5989.78	21822.29	13248.91	5219.62
GDP_growth_rate	GDP_growth_rate	592.00	0.04	0.11	0.07	0.02
GDP_Primary_Industry	GDP_Primary_Industry(100 million)	592.00	0.00	107.90	16.48	26.74
GDP_Secondary_Industry	GDP_Secondary_Industry(100 million)	592.00	72.17	2423.56	1004.40	763.64
GDP_Second_Industry_Growth_R	GDP_Second_Industry_Growth_Rate	592.00	-0.07	0.15	0.06	0.05
GDP_Tertiary_Industry	GDP_Tertiary_Industry(100 million)	592.00	172.27	7206.13	1981.86	2620.95

GDP_Tertiar_Industry_Growth_R	GDP_Tertiar_Industry_Growth_Rate	592.00	0.06	0.13	0.09	0.02
Total_Patent_Authorization	Number of Patent_Authorization	592.00	425.00	18753.00	7688.93	5822.35
Total_Technology_Company	Number of Technology_Company	592.00	4.00	256.00	78.85	69.99
Density_Economy	GDP_Total_yuan/District_Land_area_km2	592.00	2807.62	461952.28	95933.73	110691.58
Superficie_Live_Per_Capital	Superficie_Live_Per_Capital	592.00	21.42	31.58	26.70	3.09
Total_Revenue_Finance	Total_Revenue_Finance	592.00	200.28	3937.96	1312.95	1339.19
Revenue_Finance_Growth_Rate	Revenue_Finance_Growth_Rate	592.00	0.01	0.32	0.15	0.08
Retail_Sales_Consumer_Goods_T	Total Retail Sales of Consumer Goods	592.00	116.88	2201.34	963.69	653.39
Retail_Sales_Growth_Rate	Retail_Sales_Growth_Rate	592.00	-0.03	0.09	0.07	0.02
Urban_Green_hectare	Urban_Green_hectare	592.00	423.33	32569.37	12328.46	9783.92
Urban_Green_Per_Capital	Urban_Green_Per_Capital	592.00	5.30	468.89	62.67	78.08
Coverage_Rate_Green	Coverage_Rate_Green	592.00	0.22	0.43	0.34	0.06
Park_Area_hectare	Park_Area_hectare	592.00	156.31	6869.16	2312.23	2388.76
Park_Area_Per_Capital	Park_Area_Per_Capital	592.00	1.96	12.42	7.97	3.43
Height_Floor	Height_Floor (above 8)	592.00	11.47	17.88	14.40	1.16

The third set of variables is population, economic and public data for 16 regions in Shanghai. Because there are huge differences in the central area and suburbs in terms of population density, regional size or economic performance, we want to know whether these social factors have a potential impact on housing prices, and how the impact is specific.

Although only a few of these data were involved in the regression model in later studies, they helped me to understand more about the socio-economic situation in Shanghai during the data collection process. This will also be of great help in the process of building the model.

5.EMPIRICAL ANALYSIS

5.1. Regression model 1

Table 13. Model for the complete depurated sample

Model Summary					
Model 1	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
	0.879	0.773	0.766	0.17631814	1.421
ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Regression	60.629	18	3.368	108.346	0
Residual	17.813	573	0.031		
Total	78.443	591			
Coefficients[a]					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	9.98	0.061		164.846	0.000
CGBL	-0.016	0.026	-0.014	-0.609	0.543
Active_Index_Sep	0.008	0.002	0.099	4.656	0.000
Price_Year_Increase	0.384	0.069	0.122	5.587	0.000
Dum_Excellent_property	0.106	0.027	0.106	3.896	0.000
Cost_Management_fee	0.072	0.01	0.194	7.036	0.000
Rate_Green	0.326	0.105	0.065	3.117	0.002
Location_Within_inner	0.185	0.045	0.127	4.075	0.000
Location_Inner_middle	0.273	0.038	0.195	7.131	0.000
Location_Middle_outer	0.142	0.031	0.126	4.519	0.000
Dum_Park	-0.051	0.016	-0.068	-3.179	0.002
Dum_Hospital_AAA_5000m	0.328	0.039	0.381	8.465	0.000
Dum_Bus_1000m	0.152	0.025	0.139	6.203	0.000
Dum_Metro_1000m	0.116	0.019	0.157	6.197	0.000
Dum_Railway_Station_8000m	0.068	0.02	0.083	3.327	0.001
Revenue_Finance_Growth_Rate	-0.588	0.114	-0.134	-5.147	0.000
Growth_Population_Registerd	1.366	0.622	0.093	2.195	0.029
Rate_Migration_In	9.385	2.468	0.109	3.802	0.000
Urban_Green_hectare	-2.90E-06	0	-0.078	-2.423	0.016
a.Dependent Variable: Ln_unit_price_sep					

Ordinary least squares regression was performed using 592 cleaned and unlabeled cases. After many attempts, a model with a good fit was obtained. The value of Adjusted R Square was 0.766. This means that 76.6% of cases can be explained by this model.

In the coefficient list, we see that the Sig value of the main focus variable CGBL in this study is 0.0543, which is not significant for the model. In the correlation list, the Person Correlation value of CGBL and the dependent variable Ln_unit_price_sep is -0.006, which means that there is only a very weak negative correlation between them. Combined with the above results, we can draw the basic conclusion: At present, CGBL has not caused a green premium impact in Shanghai.

Observe other variables entering the model, where Active_index_Sep represents the active index of the project in September. According to the information on Fang.com, the activity of the project is a comprehensive evaluation of the searched quantity, transaction quantity and other information of the month. Although the higher activity index can prove that the project is more concerned than other projects, there is a greater chance of quality projects, but this is not the most powerful proof of housing prices, because it may be because of better cost performance And being paid attention to by buying a house, not a higher house price. Price_Year_Increase represents the growth rate of the project compared to the average price of the same period last year. The growth rate of 1 unit can increase the house price by 38.4%, which fully proves that the higher price houses can have more room for appreciation.

The next two variables are related to property information. In China, residents are very concerned about the quality of the property company. The high average price community is often equipped with a quality property company that matches the quality of the property and the cost of the property. Direct correlation, the results of the model are also a good proof of this connection. The high greening rate of the project is also one of the performances of high-quality residential buildings. In China, the greening rate of newly built residential quarters clearly stipulates that it should not be lower than 30%, and residential projects with a greening rate higher than 40% are often considered as high-end residential. . For the Location variable of the project, in the case of selecting Location_ Outside_outer as the control item, the other three loop ranges have a significant positive impact on the house price, which is also consistent with the expected result, which is closer to the center of the city. Housing prices will also have a tendency to increase.

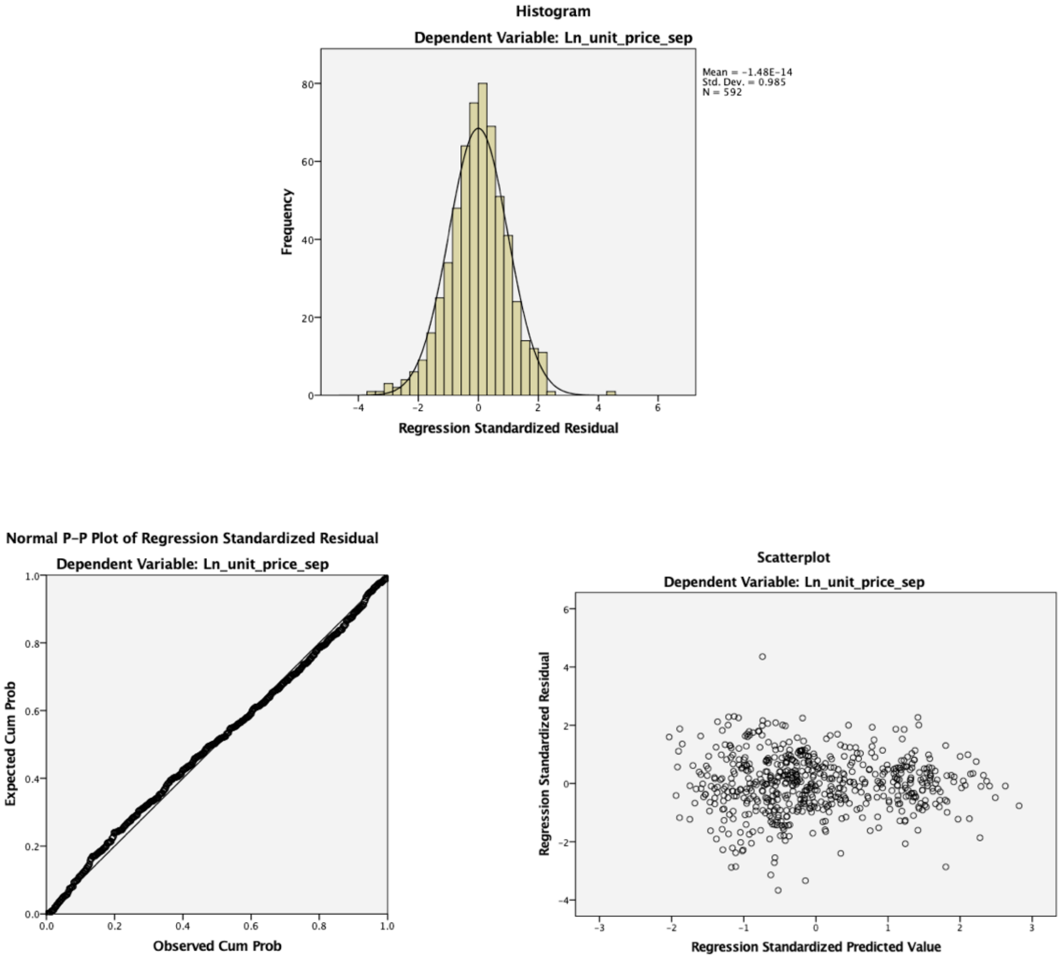
We usually think that the price of a residential project with a closer distance park will be higher, but in this model, the dummy variable of the park distance has a negative impact on the house price by 5.1%, which may be due to the variable setting. In Shanghai, the park is divided into four grades and has a corresponding service radius according to its size. For example, the city park has an area of more than 10hm2, and its service range is up to 5km, while the smallest community and park area The area requirement is only 0.04hm2 and the service range is only 500m. In the previous data description, we see that the spatial distribution of this case is more suburban than the urban area, which determines that the suburban projects have a greater chance of being included in the various parks than the urban projects. Therefore, high-priced housing close to the urban area does not show an advantage in this park variable.

Shanghai's medical resources are in a leading position in China. In China, AAA-class hospitals are the most recognized high-quality hospitals. Shanghai's AAA-level distribution covers almost the entire central area. Only a few AAA-class hospitals are located in the suburbs. The hospital's variables showed strong correlation with house prices and were 32.8% higher than those outside the service. In large cities, public transportation is inseparable from the lives of residents, and projects with more convenient public transportation have higher prices that we expected. Although the urban area creates more wealth than the suburbs, it is undeniable that the development space of the suburbs is larger than that of the urban areas. After observing the growth rate of fiscal revenue in various districts of Shanghai, we found that the suburbs showed a multiple growth compared with the urban areas. rate. This explains why Revenue_Finance_Growth_Ratea has a negative impact on house prices. The population growth and mobility usually reflect the economic situation of the region. Compared with the suburbs, the urban area has a higher population inflow rate, and the results of the model also conform to this pattern. Finally, the urban green space area has a negative impact on housing prices, which is also consistent with the characteristics of the suburbs having a larger area of green space than the urban area.

Table 14. Correlations of variables in Model 1

Correlations			
	Pearson Correlation	Sig. (1-tailed)	N
Ln_unit_price_sep	1	.	592
CGBL	-0.006	0.438	592
Active_Index_Sep	0.144	0.000	592
Price_Year_Increase	0.044	0.142	592
Dum_Excellent_property	0.138	0.000	592
Cost_Management_fee	0.251	0.000	592
Rate_Green	0.106	0.005	592
Location_Within_inner	0.372	0.000	592
Location_Inner_middle	0.334	0.000	592
Location_Middle_outer	0.331	0.000	592
Dum_Park	0.09	0.015	592
Dum_Hospital_AAA_5000m	0.696	0.000	592
Dum_Bus_1000m	0.372	0.000	592
Dum_Metro_1000m	0.505	0.000	592
Dum_Railway_Station_8000m	0.375	0.000	592
Revenue_Finance_Growth_Rate	-0.414	0.000	592
Growth_Population_Registerd	-0.454	0.000	592
Rate_Migration_In	0.545	0.000	592
Urban_Green_hectare	-0.454	0.000	592

Figure 9. Regression results of Model 1



5.2. Regression model 2

Table 15. Model for the complete 85 CGBL-Labelled sample

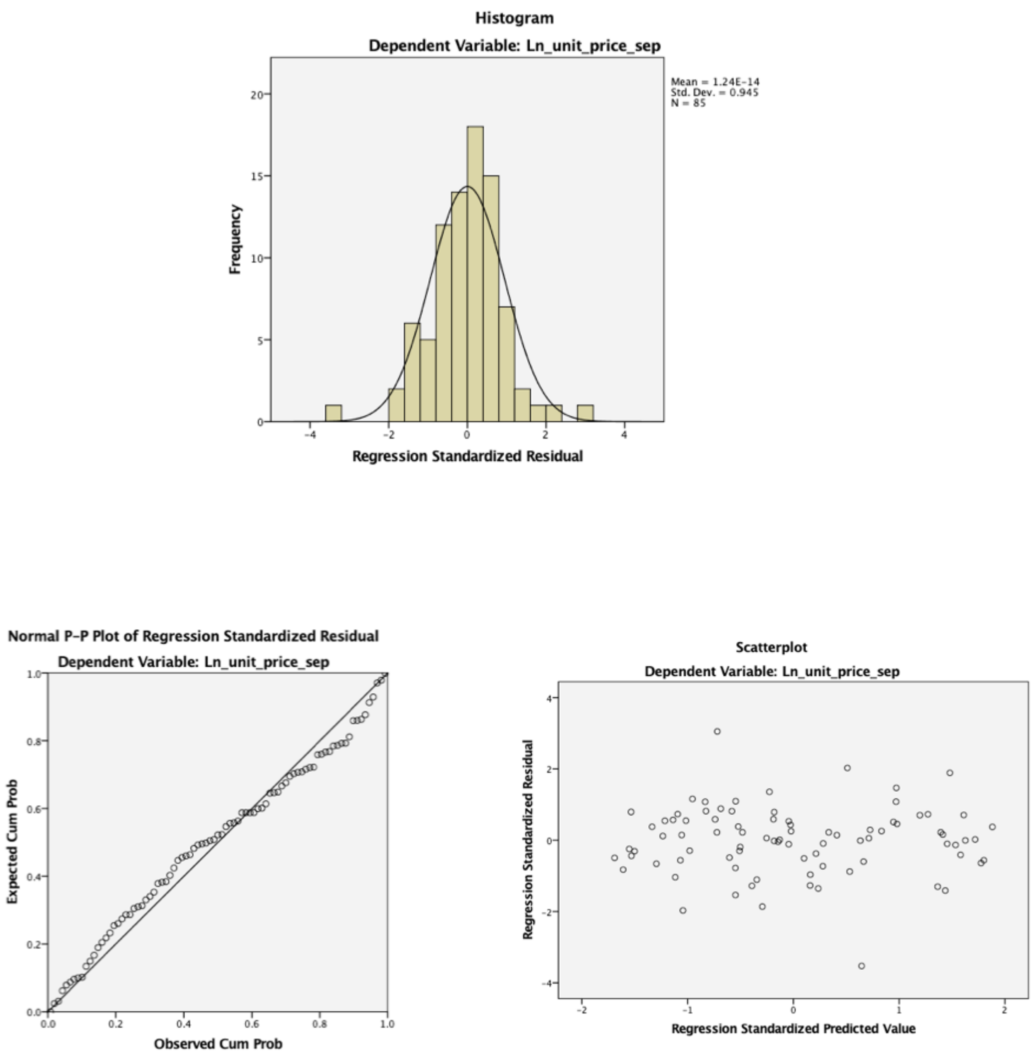
Model Summary					
Model 2	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
	0.908	0.824	0.803	0.22603528	1.946
ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Regression	17.998	9	2	39.141	0
Residual	3.832	75	0.051		
Total	21.83	84			
Coefficients[a]					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	10.627	0.127		83.613	0.000
Two_Star	0.107	0.061	0.104	1.773	0.080
Three_Star	0.100	0.080	0.073	1.250	0.215
Cost_Management_fee	0.027	0.011	0.146	2.479	0.015
Price_Year_Increase	0.860	0.275	0.164	3.130	0.002
Location_Outside_outer	-0.240	0.083	-0.216	-2.888	0.005
DIST_Bus	0.000	0.000	0.293	4.298	0.000
Dum_Bus_1000m	0.283	0.078	0.251	3.609	0.001
DIST_Hospital_AAA	0.000	0.000	-0.514	-6.539	0.000
Dum_Railway_Station_8000m	0.206	0.069	0.178	2.987	0.004
a.Dependent Variable: Ln_unit_price_sep					

To further confirm whether the CGBL-labelled items at each level have an impact on house prices, 85 labelled items were used for a new round of regression analysis. In the case of using One-Star as a control variable, Two-Star, Three-Star is not significant for the dependent variable Ln_unit_price_sep, which may be due to the small sample size. For other variables that have entered the model, we can see that the property cost, the annual growth rate of the house price, the location of the project, the public transportation situation, and the distance from the quality hospital are still variables that have a strong correlation with the house price. This again validates some of the results in Model 1.

Table 16. Correlations of variables in Model 2

Correlations			
	Pearson Correlation	Sig. (1-tailed)	N
Ln_unit_price_sep	1	.	85
Two_Star	0.059	0.297	85
Three_Star	0.08	0.232	85
Cost_Management_fee	0.52	0	85
Price_Year_Increase	0.135	0.109	85
Location_Outside_outer	-0.745	0	85
DIST_Bus	-0.312	0.002	85
Dum_Bus_1000m	0.53	0	85
DIST_Hospital_AAA	-0.791	0	85
Dum_Railway_Station_8000m	0.59	0	85

Figure 10. Regression results of Model 2



6.CONCLUSION

In developed economies, it is common to use the hedonic model to study the premium effect of green indicators on house prices. Since China became one of the few independent sustainable building evaluation standards in 2006, domestic research on green premiums has begun to emerge.

Zhang et al.conducted a comprehensive study of the price premiums associated with CGBL in China based on 163 CGBL-labelled projects and 585 unlabeled projects across mainland China. It was concluded that the price of residential transactions with CGBL labelled was 6.9% higher than unlabeled items.

To further understand the green premium effect at China's urban level, I focused on 85 residential projects which received CGBL label between 2014 and 2018 in Shanghai, and 626 comparable unlabeled projects. We make the assumption that if the residential project contains at least one building with CGBL label, the green premium will spread throughout the project. The final result is different of (Zhang et al., 2016) in Shanghai area, residential projects with CGBL labels did not exhibit the expected premium effect.

Summarizing the reasons for this difference may be due to the following three reasons:

1. Due to the limitation of the original data, there are only 94 projects with CGBL label collected in the Shanghai area within 5 years(85 after depurated), the sample size is probably the main reason why the influence of CGBL is not significant.

2. The research scope of Zhang.et is carried out nationwide, and the average price of new green projects in the same period is selected as the research object. This study narrowed the scope of the target to the city. Since there are only 4 new green projects in Shanghai during the same period, it is impossible to conduct regression analysis.

Therefore, we use the average price of second-hand housing transactions for all projects that have obtained CGBL labels within 5 years. Compared to new projects, the green premium benefits of second-hand housing may have been greatly reduced.

3. We have relatively more precise control over the attributes of the project, but this deep control of quality may also be one of the reasons for the loss of correlation between green labels and prices.

Although the results of the study do not show the expected results, this does not mean that the development trend of green buildings in Shanghai and even China is not optimistic. On the contrary, the 2019Vison of ESGB launched this year has added many new highlights compared with the previous two versions, especially the addition of the basic level, which may indicate that the evaluation of green indicators will become a mandatory requirement for new buildings in the future.

7.Prospect and limitation

In the 1980’s China, 60% of people in Shanghai (now Shanghai's central area) only have a per capita living area of less than 4m2. The per capita living area of the city is only 4.3m2, which is the most serious shortage of per capita living space in the country. Today, Shanghai's per capita living area has increased to 29m2, which is still far from the per capita living area of the country (36.6m2), and the situation of “shortage of living space” still exists in the central area of Shanghai. This aspect has historical reasons, and on the other hand, the inevitable contradiction brought about by the urbanization process. In Shanghai, the geographic location of the house is the more important reason for the dominant house price than the quality of the house.

In fact, in the study we can also find that all the analysis of the variables outside the house's own attributes can be converted into the same intrinsic core - the location. This may explain why the Shanghai CGBL label and house prices do not show similar relevance to the national situation (Zhang et al, 2016). Since the location of different cities in the country is different, this result may change after considering the microscopic differences in each region, but this speculation needs further research to prove. In Europe, there is evidence that precise control of housing quality can result in a loss of relationship between energy label and housing prices. In fact, we have tried to reduce the control of housing quality in the study of Shanghai to observe the changes between CGBL label and house price, but unfortunately, no matter how much the control of housing quality is reduced, at this stage None of the CGBL label showed a significant impact on house prices. We expect this phenomenon to be confirmed or reveal new findings in future research on China.

We chose Shanghai as a case study city, not only because Shanghai is one of the best performing cities in China, but also because Shanghai is a city with strong absorptive and enforcement capacity for new policies. On July 1, 2019, as the first pilot city, the Domestic Waste Classification and Recycling Policy was officially implemented in Shanghai. According to the work plan of the Ministry of Housing and Urban-Rural Development, before the end of 2020, the remaining 46 pilot cities will also carry out the policy gradually. This is another major step in China's implementation of sustainable development. We have reason to believe that both waste sorting and sustainable buildings have good prospects for development in China, and we look forward to new research to provide theoretical support for this view.

8. Acknowledgemen

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