

The evaluation and research to the transaction reserve price of commercial land and the premium regular based on the Hypothetical Development Method which is improved by the Monte-Carlo simulation: Based on the situation of land market from 2003 to 2010 of Beijing

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Key words: Monte Carlo simulation, the Hypothetical Development Method, reserve price, premium, evaluation, China.

SUMMARY

Along with the implementation of the “bidding, auction, listing transferring system”, the transaction price of land and the premium rate have increased gradually. Why the land transaction price differs largely from the reserve price of the land that the government confirms? The phenomenon indicates that there exist deficiencies in reserve price determination by the government department. So it is significant to evaluate reserve price scientifically and reasonably to make the “bidding, auction, listing transitioning system” rational. The paper improves the Hypothetical Development Method by the Monte Carlo simulation and evaluates the transaction reserve price of commercial land and the premium regular using the improved method. And at last, we test the reliability of the new methodology according to a transferred case of Beijing.

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1. INTRODUCTION

1.1.1 The analysis of State-owned land transfer market situation

The “Bidding, auction, listing transferring state-owned land use rights provision” which is enacted by the Ministry of Land and Resources in 2002 marks the transfer of state-owned land entering market allocation stage formally and completely. And along with the implementation of the “bidding, auction, listing transferring system” and the influence of the marketization process, the promoted interest, the inadequate supervision in land development and the land fiscal of the government etc., the land transaction price has kept increasing and the “land king” phenomenon gradually becomes normal. It indicates that the real estate market situation is conflict with the government regulation and this phenomenon threatens the economic security greatly.

This paper defines the premium rate as Equation 1 shows:

$$R = (TP - OP) / OP \quad 1$$

R : Premium rate; TP : Transaction price; OP : Opening price

The paper uses samples of 627 commercial lands transferred from 2003 to 2010 in Beijing. Rejecting one land whose premium rate is below 0 and 71 lands transferred by bidding, we analyze the remained 555 lands transferred by auction and listing.

The gross area of these 555 lands is 56,648,187 square meters (s.m), involving 38,094,688s.m construction land and 18,553,499s.m collected land. And the total area and the gross amount of these lands over the years are graphed in Figure 1 and Figure 2:

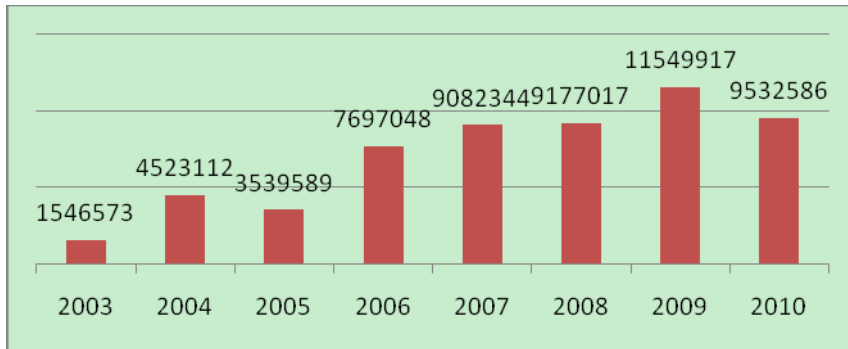


Figure 1 the total area of lands transferred by listing and auction in 2003-2010 in Beijing (s.m)

Data source: Beijing land reserve center website

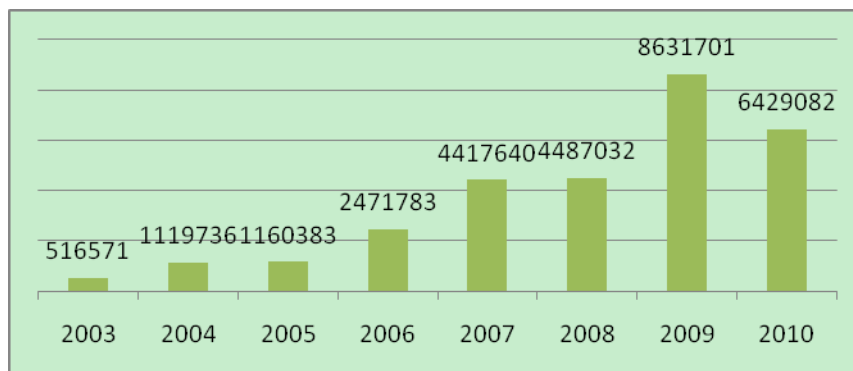


Figure 2 the total sum of lands transferred by listing and auction in 2003-2010 in Beijing (10 thousand YUAN)

Data source: Beijing land reserve center website

As seen in Figure 1 and 2, the variation tendency of the total area and the total money is almost the same.

We can conclude from Table 1 that though most transferred lots (449) have their premium rate ranging from 0 to 100% in the 555 lands, there are 13.4% above 50%. There are 106 lands' premium rates above 100%, accounting for 19% of the total amount. And there are 10 lots even more than 400% among them. On the hypothesis that developers are rational when they try to buy the land, we can infer the phenomenon of excessive premium rate reflects the fact that there exists huge gap between the reserve price government confirms and the market value of real estate. According to the variation tendency presented in Figure 3 and 4, we can know that along with the land market prosperity, the premium rate gradually increases. The tendency still reflects that the methodology government uses to evaluate the transaction price does not conform to the rule of market development.

Table 1 the premium rate of lands transferred by listing and auction in 2003-2010 in Beijing

Premium rate	Amount	Premium rate	Amount
0	185	$3 < x \leq 4$	6
$0 < x \leq 0.5$	204	$4 < x \leq 5$	4
$0.5 < x \leq 1$	60	$5 < x \leq 6$	2
$1 < x \leq 2$	62	$6 < x \leq 7$	1
$2 < x \leq 3$	28	$7 < x \leq 7.5$	3

Data source: Beijing land reserve center website

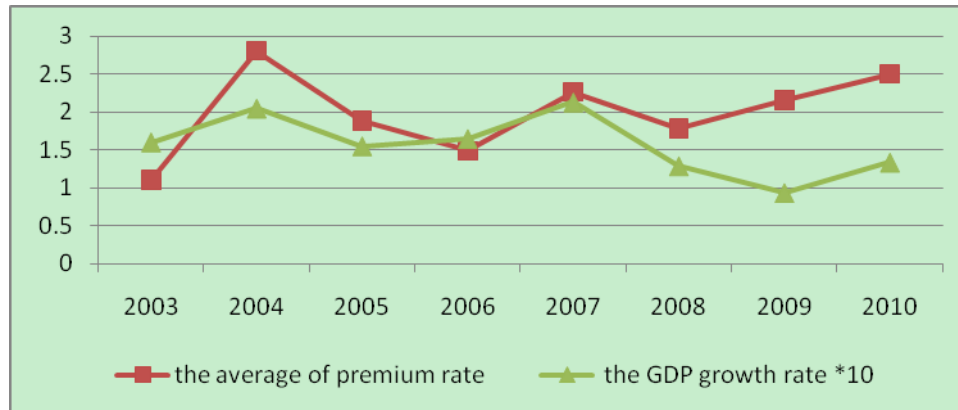


Figure 3 the trends of premium rate beyond 1 and the GDP growth rate (expanded ten times) in 2003-2010 in Beijing

Data source: Beijing land reserve center website

Figure 3 shows the average premium rate of lands whose premium rate is above 100% and the local GDP growth rate over the years from 2003 to 2010 in Beijing. As known from the statistics, the local GDP growth rate differs from the premium rate in ten times, so the figure can't show their variation tendencies obviously. Hence, we expand the local GDP growth rate ten times for an easy comparison. And we can see their variation tendencies are approximately similar from Figure 3.

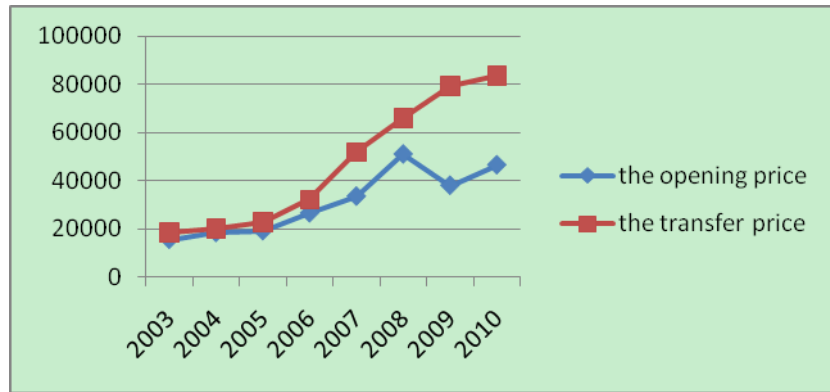


Figure 4 the trends of average land transaction prices in 2003-2010 in Beijing
Data source: Beijing land reserve center website

1.1.1 Evaluation methodology to land transaction price

Hitherto, the government mainly uses the Market Comparable Method, the Hypothetical Development Method and the Basic and Standard Land Value Coefficient Correction Method to evaluate the real estate reserve price. According to the "valuation of urban land" and the characteristic of the "bidding, auction, listing transferring system", the first choice to evaluate the reserve price is the Market Comparable Method and the Hypothetical Development Method. And the Basic and Standard Land Value Coefficient Correction Method can be taken into consideration in the regions of less developed real estate market as well. The final reserve price is determined by the city or county government land administrative departments according to the land evaluation result and the government industrial policy. And the assessment is generally conducted by the qualified evaluation institution which the government entrusted.

At present, the Chinese government departments at all levels mainly adopt the Basic and Standard Land Value Coefficient Correction Method to evaluate the reserve price of state-owned lands. But the deficiency is that most of the city's standard land price can't update timely leads to the bias between the evaluation results and the actual price of real estate market inevitably. The present phenomenon of excessive premium rate has been predominant evidence. As listed in Table 2 that in the 104 lots which transferred in Suzhou, China in 2010, there are 34 lots, whose premium rates are beyond 50%, accounting for one third of the total.

Table 2 the premium rate of lands transferred by listing and auction in 2010 in Suzhou

Premium rate	Amount
$0 \leq x < 0.5$	70
$0.5 \leq x < 1$	16
$x \geq 1$	18
sum	104

Data source: Suzhou land reserve center website

In order to sidestep shortcomings of the Basic and Standard Land Value Coefficient Correction Method, the government department will intend to use the Hypothetical Development Method in regions that have an active market and plentiful land transactions to evaluate the land reserve price.

The Hypothetical Development Method is also called Residual Method. When use the method, we should forecast the value of the evaluated plot after development at first. Then, we will use the value minus the costs, the taxes and the profits which produced in the developing process. And at last, we can get the reserve price. The basic equation is:

$$V = CV - DC - AE - I - ST - DP - BT \quad 2$$

V : the evaluation value; CV :the real estate value after development; DC : the development costs; AE : the administrative expenses; I : the interest on investment; ST :the sales taxes; DP :the development profit; BT :the buyer's account taxes.

We can see from Equation 2 that the Hypothetical Development Method which is based on the expected principle builds the evaluation value and parameters for other variables on the future expectations when evaluates the land transaction reserve price. Then the method discounts the value to the evaluation date according to a certain discount rate (dynamic). So, the result of this method can match the actual situation of the land market at the point. And whether the result is accurate or not largely depends on the degree that the quality of each parameter complies with the future trend.

Here is an evaluation case gets from Haidian District, Beijing.

The plot is located to the south of SHANGDI Information Technique Industry Base, Haidian District of Beijing. The total area is 456,139.6s.m, and the planned construction area is 701,617.5s.m. The planned use of this plot is residential, commercial and finance and complex. The particular case is listed in Table 3.

Table 3 the transfer information

Floor area ratio	The kind of use	Period	Planned construction area (s.m)	Building control scale (s.m)	Greening rate
2.25	Residence, business and finance, complex	Residence: 70 years Complex: 50 years Business and finance: 40 years	Residence: 236530 Business and finance: 25000 Complex: 25400 Others: 24900 Collected: 144309.6	Residence: 558242.95 Business and finance: 94614.55 Complex: 22420 Other: 26340	30%

Data resources: the transfer notice of land in Qinghe Town, Haidian District of Beijing

We fix the evaluation date on August 1, 2005 and use the Hypothetical Development Method (static) to value the residential portion of the land. And the selling price is based on 2006. The result can be seen in Table 4:

Table 4 the expenditure of variables (10 thousand Yuan)

Completed value	457759
Development costs	171939
Administrative expenses	45776
Sales taxes	36621

According to the relevant state laws and regulations, we determine the buyer's account taxes as 4% account for the evaluation value and define the evaluation value as V. The calculation process is:

$$V = CV - DC - AE - I - ST - DP - BT = 457759 - 171939 - 45776 - 36621 - V * 4\%$$

So the final evaluation reserve price is 2,118,990 thousand Yuan.

Although the Hypothetical Development Method has improved a lot compared to the Basic and Standard Land Value Coefficient Correction Method and the result is also closer to the market reality, certain flaws still exist in the Hypothetical Development Method:

First, the fact that parameters for variables used in the traditional Hypothesis Development Method (static) are mainly came from the deduction of the present market situation leads to the evaluated result does not conform to the market realities reflected by variable economic factors in China such as the high inflation rate and the price rise etc. And with the deviation exists in the technique itself, the evaluation value may has great bias to the real price. Second, though the Hypothetical Development Method (dynamic) takes the discount rate into

consideration, the parameters are still built on the utopian hypothesis. And this makes the evaluation result largely influenced by the uncertainty of future market conditions. In brief, the flaws that it disposes the complexity of economic environment in a utopian way, that it lacks of rigorous mathematical argument in quantifying parameters and that the result is easily be influenced by subjective factors make the Hypothetical Development Method can't satisfy the requirement of land value evaluation.

In order to rectify the shortages of the Hypothetical Development Method, to make the evaluation result more valuable and to help the local government make scientific land transfer policies, this paper applies Monte Carlo simulation to the Hypothetical Development Method to improve the methodology using the characteristics of Monte Carlo simulation that it can describe substances and physical experiment processes stochastically, that the deviation is easily to determine and that the evaluation results could be shown in probability distributions.

2. LITERATURE REVIEW

The Monte Carlo simulation is a technique to forecast variables under uncertain environment. When make use of the method, we should establish a probability model or random process which is to forecast the variables distributions at first. Then, we will calculate the characteristics of parameters through observing the model (process) or the sampling test, plenty of random experiments would be need in this procedure to make the simulated results efficient. And at last, we will provide the most probable value and related statistical analysis results according to the simulation result. (Xu Zhongji 1985, Jiang Shaozhong 2009)

Although the idea of Monte Carlo simulation has been applied in the 19th century to the famous "Buffon Needle", the complexity and non-operability of this technique makes it difficult to be put into practice until the 1940s after the invention of computers. Now it has been widely used in the fields like particle transport problems, the vacuum technique, the laser technique and military etc. (Lin Hai, Gao Kun 2010). And in recent years, along with the improvement of Monte Carlo simulation and the development of related software, the technique has also been applied to asset evaluation, risk prediction, securities pricing and other fields. However, as the application of Monte Carlo simulation in these areas has just begun, there are a few of related researches in this field both at home and abroad so far. According to the published year of the collective literature, the researches to the Monte Carlo simulation have increased from 2007 at home and most of them focus on the risk analysis, just a few researches are related to the real estate market.

Most of the researches on the Monte Carlo simulation abroad focus on the fields mentioned above as well. The simulation technique is always used for some assets and financial derivatives which are difficult to be estimated (Michel Baroni, Fabrice Barthélémy, Mahdi Mokrane, 2006). There are only three papers in the collected foreign literature whose topics are directly related to our paper. Kelliher, Mahoney (2000) describe the significance of three

types of income assessment: the discounted cash flow method, the definition method and the experience value method in long-term investment decisions. They improve the three methods above by Monte Carlo simulation using computer technique, and elaborate the appliance of improved discounted cash flow method in real estate investment in detail. Martin Hoesli, Elion Jani and André Bender (2005) improve the methodology which is to determine the discount rate and other parameters of variables of the discounted cash flow method. They use empirical data to infer the distribution types of the variables and calculate the discount rate combining with CIR sampling model. Michel Baroni, Fabrice Barthélémy, Mahdi Mokrane (2006) regard the real estate investment as a cash flow just like financial assets. They study the distribution type of the investment return and changes of value of real estate using the Monte Carlo simulation. They also compare the improved cash flow analysis method with the traditional method and get the conclusion that the improved method is much more accurate in estimating price distribution and VAR value.

Some scholars have studied the price evaluation of U.S. financial assets like options and stocks. N.Meinshausen, B.M.Hambly (2004) conduct a further investigation on the assessment to option price using Monte Carlo simulation based on the new duality ideas on option price and prove the improved methodology is more effective on the prosperous option derivatives market. Cecilia Maya Ochoa (2004) evaluates the financial assets follow stochastic volatility or jump-diffusion process. N.Bolla,S.Juneja (2005) tackle the difficult problems to price American options focusing on the new Monte Carlo techniques: regression-based methods, random tree methods and stochastic mesh methods. Both the ideas and the methods are better than N.Meinshausen,B.M.Hambly (2004) use.

Florenz Plassmann, T.Nicolaus Tideman (2000) examine the impact of taxing structure (one-rate tax, two-rate tax) on construction in practice. They first assume the number of building permits follows a Poisson distribution and the inspection indicates it is not true. Then they find a Poisson-lognormal distribution is better. They also estimate the model of variables with a Markov chain Monte Carlo method to reduce the standard errors. Mehari Mekonnen Akalua, Rodney Turner (2002) compare SVA (shareholder value analysis) with NPV (net present value) model based on Monte Carlo simulation by sensitivity analysis and error estimation. Ren Hong (1998) mainly introduces how to get the maximum, the mean and the standard deviation of consumption elements by the histogram and related calculations. All the three papers above mainly describe how to disposal the parameters in Monte Carlo simulation, which is of great help for the paper.

According to the collected literature, the first research to apply the Monte Carlo simulation to market prediction in China is Sun Jiahe, Zhu Rongbao (1983), they study the use of Monte Carlo simulation for market prediction. And the first paper to combine the real estate market with the Monte Carlo simulation is Hao Liping, Ge Yong (2000), they predict the risk of the real estate market and calculate the FNPV and FIRR and other economic indicators using the Monte Carlo simulation technique. Guo Qiang and Wu Qing (2005) examine the optimization

function the Monte Carlo simulation works on the income approach. They also think that the Monte Carlo simulation technique can expand the range of the parameter analysis of the income approach. Li Bo (2009) studies the collateral price assessment using the income approach improved by the Monte Carlo simulation technique. We don't find researches that combine the Hypothetical Development Method with the Monte Carlo simulation. It is still blank in this field.

The main direction of the study that Chinese scholars conduct on the Hypothetical Development Method is the determination of parameters. Jin Hongliang (1998) studies the function of interest rate in the Hypothetical Development Method and the time value of capital in evaluation. Yuan Yin (2007) tries to analyze the interest on investment and development profits synthetically. Le Jianming (2010) briefly introduces the problems such as the profit-sharing, the interest calculations, and the capitalization rates encountered in the Hypothetical Development Method.

According to the advantage of the Monte Carlo simulation and the characteristics of the Hypothetical Development Method, this research applies the Monte Carlo simulation to the Hypothetical Development Method to improve the evaluation methodology. Thus, the improved method changes the way to collect data: We don't have to determine a certain parameter of a variable any longer, what we should do is to get a series of random values under limited conditions using Monte Carlo simulation and analyze the random values and their distribution. The result of the evaluation is no longer a certain value, but a distribution under various random conditions and it is more practical and meaningful to decision-makers. It is no longer to determine a certain value of variables in the Hypothetical Development Method for appraisers when use the improved method. What we should do is to provide a range of values and make sure the certainty of variables in this range is high. And we also need to determine the distribution types of variables. According to the result of large number of random simulations, we can calculate the average value, the extremism, the standard deviation and other statistical variables. We can also get the distributions depending on the result.

3. THE IMPROVEMENT OF THE HYPOTHETICAL DEVELOPMENT METHOD USING THE MONTE CARLO SIMULATION

To evaluate the land transaction reserve price using the Hypothetical Development Method, the key point is to determine the value and distribution type of parameters including the real estate value after development, the development costs, the administrative expenses, and the interest on investment, the sales taxes, the development profits and the buyer's account taxes. So, when use the Monte Carlo simulation technique to improve the Hypothetical Development Method, the first thing we should do is to change the way we determine the values of variables above: First, we should use certain methodology to estimate their expected values, standard deviations, probability distributions and possible extremisms; Then, we could

obtain the distribution of the evaluation result via large number of stochastic simulations based on the parameters; And at last, we can get the final evaluation value according to the result of simulation and the distribution.

The procedure of the Hypothetical Development Method improved by the Monte Carlo simulation is shown as below:

- 1) Analyze the characteristics of the evaluation object and determine the statistical regulations of the parameters.
- 2) Use a computer to conduct the stochastic simulation according to the certain distribution regulations of parameters and get the simulation result.
- 3) Establish the mathematical model of the evaluation process, which is the basic equation of the Hypothetical Development Method in this paper.
- 4) Get large numbers of sample values of variables through enough computer simulations.
- 5) Analyze the price distribution and statistics obtained from the computer simulations.
- 6) Calculate the final evaluation value according to the analysis.

3.1 Analysis of the values and distributions of parameters

We can see from the above that whether the evaluation value obtained from the improved Hypothesis Development Method is accurate and practical or not largely depends on whether the expected value and distribution comply with the future trend. Hence, this paper mainly analyzes the average house price, the inflation rate, the development costs and the development cycles collected from 2003—2010 in Beijing. And we obtain the distribution patterns and the range of values of the parameters by observing and analyzing their changing regularity.

According to the concept of the Hypothetical Development Method, we need to determine the indicators including the development cycle, the evaluation value, the completed value, the development cost, the administrative expenses, and the interest on investment, the sales taxes, the development profit and the buyer's account taxes. We don't discuss the taxes, the development profit and the administrative expenses in this paper as they could be determined accurately in general. So in this paper, we mainly analyze the values and distribution patterns of the development cycle, the completed value, the development cost and the inflation rate.

3.1.1 The development cycle

The development cycle can be divided into the development period and the sales period. Its value is always obtained by the comparison with the similar real estate in the same location. Although the government provides that developers must develop the transferred land in two years, some unexpected affairs like changes of the market circumstance, the cash flow crisis

etc. may lead to the uncertainty of the development cycle. And the uncertainty of the development cycle can cause changes of a series of parameters such as the development costs and the value after development.

The paper defines the development cycle as the period between the obtained time and the completed time. According to the 172 developed cases collected from 2003—2010 in Beijing land transfer market, we analyze the development cycle as below:

In this paper, we define the development cycle in years, and the conversion of unit is 12, that means 2.5 years can be indicated 2 years and 0.5*12 months, namely two years and six months. We can see from Table 5 that the development cycle is mainly between 1 and 5 years, accounting for 90.7% of the totals. And Figure 5 shows the histogram of Table 5.

Table 5 the development cycle of the 172 lands

Development cycle	Amount	Development cycle	Amount
$1 <= x <= 2$	35	$5 < x <= 6$	12
$2 < x <= 3$	52	$6 < x <= 7$	2
$3 < x <= 4$	45	$7 < x <= 8$	2
$4 < x <= 5$	24	> 8	0

Data source: Beijing land reserve center website and Soufun website

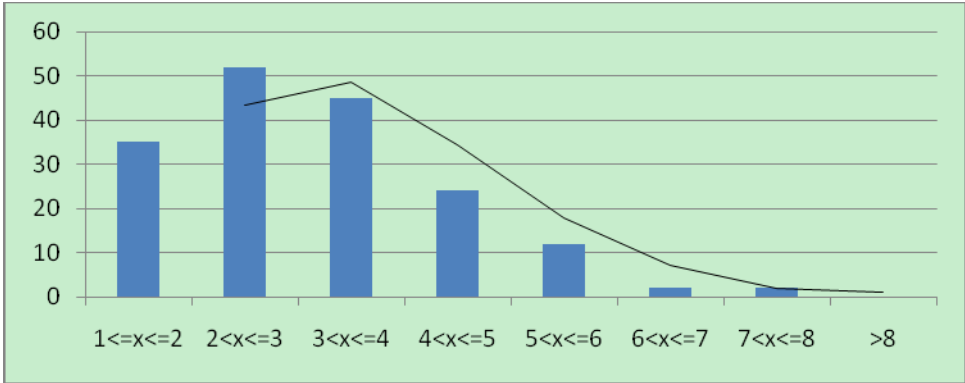


Figure 5 the development cycle distribution
Data source: Beijing land reserve center website

We can see from Figure 5 that the distribution of the development cycle follows one of the distributions in Poisson distribution, Normal distribution or Lognormal distribution. And it differs from the Poisson distribution according to the sample mean (3.20) and sample variance (1.64). By the ratio result of the inter-quartile range (IQR) and the standard deviation (1.36) which is approximated to 1.3, we can conclude that the development cycle follows a Normal distribution. And based on the law of large number, we determine the mean and the standard deviation of the development cycle as 3.2 and 1.3. Under the 90% confidence interval, we

determine the value range between 1 and 5 years.

3.1.2 The residential real estate value after development

Generally, we use Market Comparison Approach and Long-term Trends Method to estimate the real estate value after development. But there are some uncertainties in Market Comparison Approach for it is often influenced by many factors like the relationship between supply and demand, the substitution principle and the proportionality principle. So it is not well to determine the value simply by a variety of hypothesis. The paper determines the value and the distribution type of the variation rate of real estate price using the ideas of Long-term Trends Method by analyzing the monthly trends data of real estate price from 2006—2010 of Beijing and estimates the real estate value at the date of value using the ideas of Market Comparison Approach by comparing with the similar real estate around. Then we determine the real estate price after development by combining the variation rate of real estate price with the real estate price at the date of value. The way to analyze the rents is similar to the way to determine the real estate value after development.

According to the comparison of trends of lease and housing price index (Figure 6) from 1998—2009 of Beijing, we know that their trends are the same. As the mainly study of this paper is the land transaction reserve price, so we don't discuss the lease any more.



Figure 6 the trend of residential price index and rent index in 1998-2009 in Beijing
Data sources: Beijing Municipal Bureau of Statistics website

The distribution of the new residential housing sales price index (the year earlier is 100) from 2006 to November, 2010 is listed as Table 6:

Table 6 the amplitude of variation of the new residential housing sales price index in 2006-2010.9 (%)

	2006	2007	2008	2009	2010
January	-	8.9	17.2	0.4	16
February	-	8.8	16.5	0.1	16.9
March	7.1	9.3	16.9	-0.8	19
April	-	9.4	16.1	-0.6	21.5
May	8.2	9.6	15.7	-0.6	22
June	10.1	9.5	14.3	-0.4	21.5
July	9.8	10.4	13	0.8	20.1
August	9.9	12.1	11.7	2.1	18.6
September	9.5	13.3	8.7	3.6	18.2
October	9.5	15.1	6.9	4.3	17.5
November	9.4	14.9	4.2	8	14.3
December	9.5	15	1.4	13.2	-

Data sources: Beijing Municipal Bureau of Statistics website

We can't use the data of the first half of 2009 for the downturn of real estate market in that period is specific with the influence of the global financial crisis and real estate control policy of China government (Chen Jie, 2010). So we distribute the data from 2008 to 2010 equally on the hypothesis that the real estate market develops balanced in these three years and Table 7 shows the adjusted result.

Table 7 the amplitude of variation of the new residential housing sales price index in 2006-2010.9 (% , after distribution)

	2006	2007	2008	2009	2010
January	-	8.9	17.2	7.9	7.9
February	-	8.8	16.5	8.2	8.2
March	7.1	9.3	16.9	8.6	8.6
April	-	9.4	16.1	9.9	9.9
May	8.2	9.6	15.7	10.1	10.1
June	10.1	9.5	14.3	10.0	10.0
July	9.8	10.4	13	10.0	10.0
August	9.9	12.1	11.7	10.0	10.0
September	9.5	13.3	8.7	10.7	10.7
October	9.5	15.1	6.9	10.7	10.7
November	9.4	14.9	4.2	11.1	11.1
December	9.5	15	1.4	13.2	-

Data sources: Beijing Municipal Bureau of Statistics website

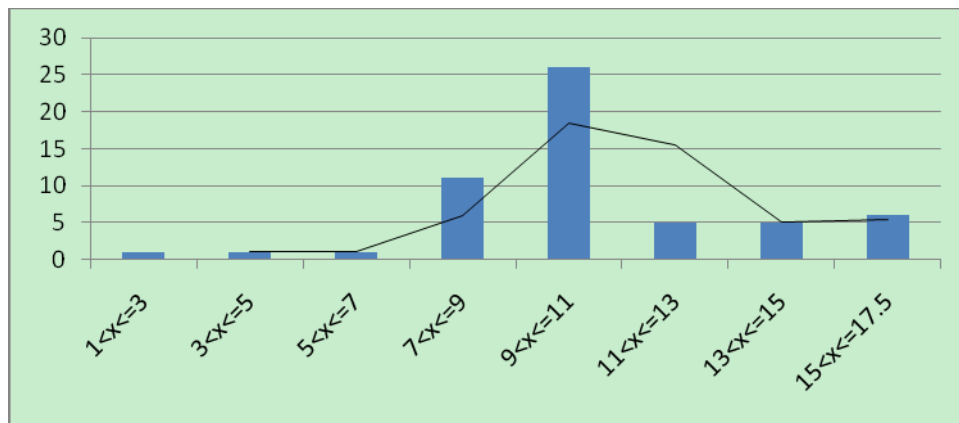


Figure 7 the amplitude of variation of the new residential housing sales price index in 2006-2010.9 (% , after distribution)

Data sources: Beijing Municipal Bureau of Statistics website

Figure 7 reflects the distribution of Table 7. According to the histogram we can suppose that the data follows a Triangular distribution or a Normal distribution. By the ratio result of the inter-quartile range (IQR) and the standard deviation (1.1) which is approximated to 1.3, we can conclude that the new residential housing sales price index (yearly) follows a Normal distribution. And it has a mean of 10%, a standard deviation of 0.03, and a range of (6%, 16%) under the 90% confidence interval.

3.1.3 The inflation rate

Generally, in a certain time, we can calculate a stable result of the development costs of a real estate with a certain type which is located in a certain position. But the result may still variable some times because of the existence of inflation. So before study the development costs of a real estate, we want to analyze the inflation rate at first.

The paper defines the growth rate of consumer price index (CPI) as the standard to describe the inflation rate and analyzes the growth rate of CPI of the Nation and Beijing separately. Figure 8 and 9 show the analysis result according to the monthly CPI from 2003 to November, 2010 (the year earlier is 100) of the Nation and Beijing.

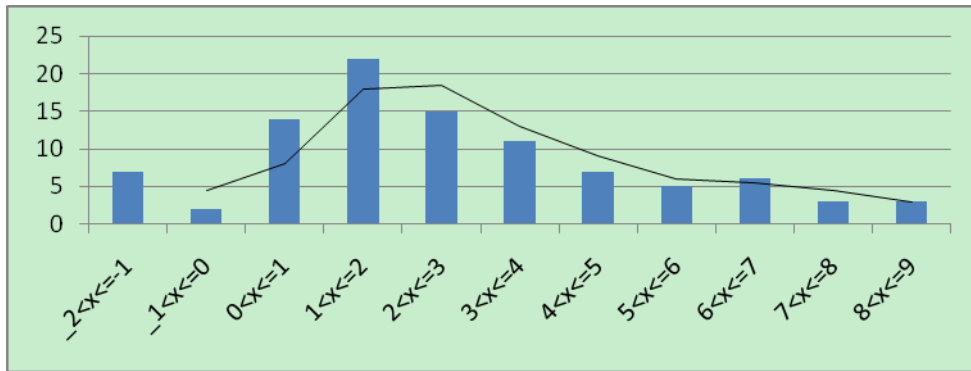


Figure 8 the amplitude of variation of the National monthly CPI in 2003-2010.11 (%)
 Data sources: The National Municipal Bureau of Statistics website

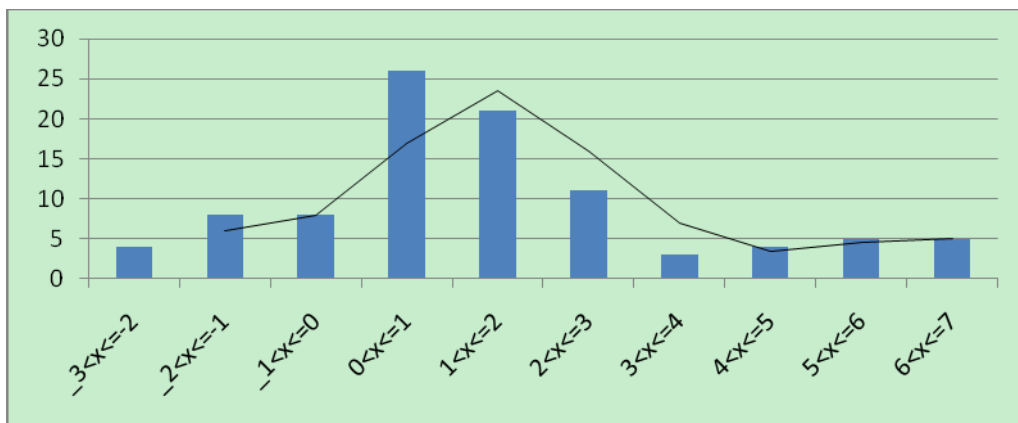


Figure 9 the amplitude of variation of the Beijing monthly CPI in 2003-2010.11 (%)
 Data sources: Beijing Municipal Bureau of Statistics website

We could suppose that both the growth rate of CPI of the Nation and Beijing follow a Normal distribution according to the figures presented above. So we calculate the ratio of the inter-quartile range (IQR) and the standard deviation of the Nation and Beijing. The result (1.24 the Nation, 1.07 Beijing) indicates that Normal distribution is appropriate for them. And the mean and the standard deviation of the growth rate of CPI of the Nation are 2.69% and 0.024. The outcomes of Beijing are 1.46% and 0.021. By comparing the result of the Nation and Beijing, we determine that the growth rate of consumer price index of Beijing follows a Normal distribution which has a mean of 2% and a standard deviation of 0.02. The range of the inflation rate under the 90% confidence interval is (-2%, 6%).

3.1.4 The development costs

The development costs are the expenses and taxes the developers need to develop the land and build the construction after obtaining the land. It is consisted of direct costs and indirect

costs. The direct costs are the expenses to employ workers and buy building materials. And the indirect costs are the expenses that needed for the construction but not included in the construction contracts. And generally, we divide the costs into construction costs, installation costs, the fee for gardens virescence and the costs for supporting buildings in urban area.

According to the calculation, we determine the construction and installation costs in Beijing for high-rise residential in 2003 as 2300 Yuan per s.m and other costs are 10 percent of the construction and installation costs. That is the total costs in Beijing for high-rise residential in 2003 are 2530 Yuan per s.m. We analyze the development costs combining the costs in 2003 with the trends of the inflation rate.

And other variables including the administrative expenses, the sales taxes, the interest on investment and the development profits are related to the real estate value after development and the development costs. For instance, the administrative expenses are always 4% of the value after development and the sales taxes are also some percents of the transaction price (the ration is determined by the government). So we can infer the former if the latter is determined.

3.2 Testing the improved methodology

We still use the transferred case of Haidian District referred above to test the improved Hypothesis Development Method in this section. According to the collected data, we can know that the total opening price of this plot is 1.699 billion and the residential part is 1.1 billion; and the transaction price is 2.565 billion and the residential part is 1.7 billion. The evaluation reserve price of the residential part using the traditional Hypothesis Development Method (static) is 2.119 billion (based on the sales price in 2006) and the results based on the sales price in 2007 and 2008 are 4.171 billion and 5.838 billion separately. Hence, we can see the impreciseness of the traditional methodology through the huge gap. In this section, we use the improved methodology to reevaluate the reserve price and to test the accuracy and reliability of the improved methodology.

This paper improves the Hypothetical Development Method by the Monte Carlo simulation. And the indicators of related variables can be seen in Table 8.

Table 8 the indicators of variables

Variable	Distribution pattern	Expected value	Standard deviation	Minimum	Maximum
Development cycle	Normal distribution	3.2	1.3	1	4
Growth rate of the value of the completed real estate	Normal distribution	10.50%	0.03	7%	13%
Inflation rate	Normal distribution	2.00%	0.02	-2%	6%
Development costs	2640 Yuan per s.m				
Sales taxes	Accounting for 18% of the value of the completed real estate				
Investment profit					
Buyer's account taxes	Accounting for 4% of the evaluation value				
Planned construction area	558243s.m				
The evaluation value	V= The value of the completed real estate-Development costs- Various taxes and fees				

According to the sales price around this plot in 2006, we determine the completed value of this plot as 8200 Yuan per s.m. And we conduct 60,000 simulations using the improved methodology. The results are listed in Table 9 and 10.

Table 9 part of the simulation result

The development cycle (year)	The growth rate of the value of the completed real estate	Taxes (Yuan)	Inflation rate	The development costs (Yuan per s.m)	the value of the completed real estate (Yuan per s.m)	The unit price (Yuan per s.m)	The total evaluation value (100 million Yuan)
1.31	0.14	1760.51	0.04	2773.92	9780.60	5246.18	28.16
2.90	0.11	1984.76	0.02	2792.69	11026.46	6249.01	33.54
-0.25	0.11	1438.20	0.00	2640.58	7989.97	3911.19	20.99
4.65	0.12	2514.27	-0.02	2357.11	13968.16	9096.78	48.83
0.32	0.09	1518.25	0.01	2652.06	8434.74	4264.44	22.89
2.67	0.12	2007.13	0.03	2823.72	11150.75	6319.89	33.92
4.28	0.12	2386.12	0.02	2875.84	13256.22	7994.27	42.91
6.08	0.12	2884.84	0.06	3803.88	16026.88	9338.16	50.12

2.57	0.07	1770.73	0.01	2712.57	9837.38	5354.08	28.74
4.50	0.07	1982.41	-0.01	2492.06	11013.36	6538.90	35.10
4.15	0.10	2159.28	0.00	2671.11	11996.03	7165.63	38.46
3.22	0.05	1734.66	0.03	2889.09	9636.99	5013.24	26.91
4.84	0.15	2942.44	0.02	2854.45	16346.87	10549.98	56.63
1.15	0.07	1596.55	0.01	2665.83	8869.71	4607.33	24.73
2.57	0.06	1727.75	0.02	2796.36	9598.59	5074.48	27.24
2.61	0.12	1984.48	0.02	2786.19	11024.89	6254.22	33.57
3.44	0.12	2160.67	0.06	3175.35	12003.74	6667.71	35.79
4.02	0.07	1963.09	0.03	2968.61	10906.06	5974.36	32.07
3.32	0.12	2173.26	0.05	3138.03	12073.64	6762.36	36.30
2.72	0.07	1773.55	0.03	2854.90	9853.04	5224.59	28.04

Data sources: the process of simulation using the improved Hypothesis Development Method

Table 10 counting of the simulation result (100 million)

The range of the result	Amount	The range of the result	Amount
≤ 15	5	$65 < x \leq 75$	232
$15 < x \leq 25$	3557	$75 < x \leq 85$	68
$25 < x \leq 35$	30228	$85 < x \leq 95$	15
$35 < x \leq 45$	19284	$95 < x \leq 105$	5
$45 < x \leq 55$	5472	$105 < x \leq 115$	0
$55 < x \leq 65$	1133	$115 < x \leq 125$	1

Data sources: the process of simulation using the improved Hypothesis Development Method

The histogram according to Table 10 is graphed in Figure 10 below.

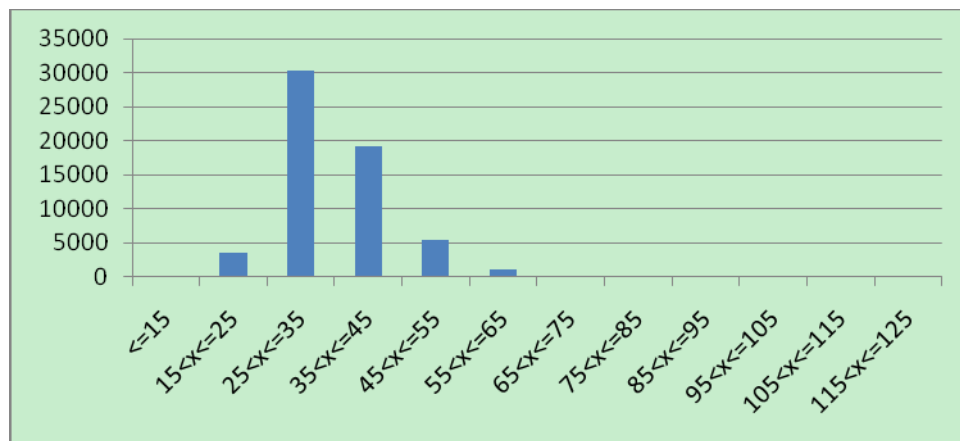


Figure 10 counting of the simulation result (100 million)

Data sources: the process of simulation using the improved Hypothesis Development Method

As the requirement of Table 8, we delete 33723 simulation results that are not fit for Table 8 and get the remained 26277 results' statistics as Table 11 shows.

Table 11 description of the statistics

mean	32.33	Skewness	0.32
Standard error	0.02	Range	20.42
Median	32.03	Minimum	24.00
Standard deviation	3.93	Maximum	44.42
Variance	15.46	sum	849449.80
Kurtosis	-0.48	Number of observations	26277.00

Data sources: the process of simulation using the improved Hypothesis Development Method

And the distribution of remained data is graphed in Figure 11.

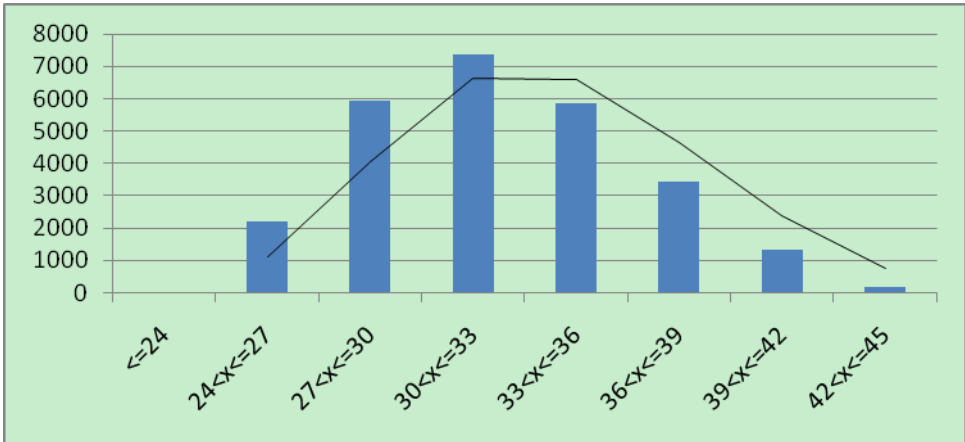


Figure 11 description of the statistics

Data sources: the process of simulation using the improved Hypothesis Development Method

We can infer that the simulation results follow a Normal distribution according to Figure 11. And the ratio result of the inter-quartile range (IQR) and the standard deviation is 1.45 which fits for the requirement of a Normal distribution. The mean of the simulation is 3.23 billion, and the standard deviation is 3.93. Then, we calculate the variation coefficient as 0.12 and get the standard error as 0.02. So we can conclude that the mean of the simulation is representative and can be determined as the final evaluation value.

So according to the statistical analysis, we determine the final evaluation value as 3.23 billion. Integrating the simulation process introduced above, we can get the basic evaluation equation as below:

$$V = \{ [p((1 + r_1)^t - d_1) - c(1 + r_2)^t] / (1 + d_2) \} * S \tag{3}$$

V : the total evaluation value, p : the price after development at the date of value (unit value), c : the development costs, r_1 : the yearly growth rate of real estate value, r_2 : the inflation rate, t : the development cycle, d_1 : the ratio of taxes and profits account for the price after development, d_2 : the ratio of taxes and expenses account for the transfer value, S : the planned construction area.

The p, c, d_1 and d_2, S are determined according to the circumstance at the evaluation date and others have been determined above. And according to the characteristics of the parameters, we can get the evaluating equation in Excel Form as below:

$$V = \{ [p[(1 + \text{norminv}(\text{rand}(), 0.105, 0.03))^{\text{norminv}(\text{rand}(), 3.2, 1.3)} - d_1] - c(1 + \text{norminv}(\text{rand}(), 0.02, 0.02))^{\text{norminv}(\text{rand}(), 3, 2, 1.3)}] / (1 + d_2) \} * S$$

4

According to Equation 3 and 4 and characteristics of the distribution of the related variables, we conclude that the final simulation results also follow a Normal distribution. And after a large number of testing, we find that the mean of the simulation value is representative and can be used as the final evaluation value.

Seen from the process of testing above, we still need to determine the values of the parameters when use the improved methodology. And what the superiority is that we not only provide an evaluation value, but obtain the statistical data such as the mean, the standard deviation and the distribution etc. as well with large numbers of simulations. Based on the statistical data obtained from the simulations, the evaluator can find an evaluation value of maximum likelihood (the mean of the eligible simulation results). And it makes the improved methodology much more reliable and accurate.

4. Conclusion

In summary, the evaluation process using the improved Hypothesis Development Method by the Monte Carlo simulation based on the Excel Form is:

- 1) Determine the distribution types, the mean, the standard deviations and the ranges of value under certain confidence interval according to the historical data and expert advice etc.
- 2) Determine the mathematical model to evaluate the real estate value according to the characteristics of parameters analyzed above.
- 3) Get large numbers of simulation results by combining the basic equation of the Hypothetical Development Method with the function *NORMINVE (RAND (), mean, stand_dev)* in the Excel Form.

- 4) Determine the final evaluation value by combining the analysis of the simulation results in Step 3 with the consideration of the reality.

So by conducting the Monte Carlo simulation we can get large numbers of simulation results, and the government can determine the reasonable reserve price according to the improved Hypothesis Development Method. And according to the analysis above, we can know that using the improved methodology can make the evaluation value more reliable and accurate. And in this paper, we mainly study the statistical features of the development cycle, the variation rate of new residential housing sales price index, the inflation rate and the development costs. By analyzing the simulation results, we find that the mean of the eligible simulation results has ideal representative and can be chosen to be the final evaluation value.

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BIOGRAPHICAL NOTES

Weidong Qu has gotten his degree of Dr.-Ing at the Geodetic Institute of University of Hanover in Germany at the end of 2000.and received his. From Jun. 2001 to Feb. 2002 he worked in department of real estate valuation in North German States Bank (NORD/LB). Since Mar. 2002, he has been pursuing his career of teaching and researching an associate professor at the Department of Land & Real Estate Management, School of Public Administration in Renmin University of China.

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