# Research and Analysis on Stock Investment of Liaoning Chemical Industry Based on Geometric Brownian Motion

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Abstract: This paper examines the feasibility of using Geometric Brownian motion models to simulate prices and how to use Geometric Brownian motion models to invest in stocks. Based on the historical closing prices of stocks from September 1, 2019, to September 1, 2022, the Geometric Brownian motion model is built using Python, based on Geometric Brownian motion 2023 prices from September 1 to October 1, future trends in Liaoning chemical industry stocks were analyzed. To verify the accuracy of the model, we used historical prices from January to February 2022 to simulate prices from February to March 2022 using a Geometric Brownian motion model. Comparing the predicted value with the real value, the error rate is less than 20%, which indicates that the model is feasible. The visualization results and data from the Geometric Brownian motion simulation data show that under the assumptions of the Geometric Brownian motion model, the future development of the Liaoning chemical industry's stock is relatively stable, the share price of Fengguang shares is on an upward trend, so investment may be considered.



## 1 INTRODUCTION

Chemical industry plays an important role in the national economy of many countries and is the basic industry and pillar industry of many countries. With the rapid development of science and technology, Liaoning 's chemical industry has made a qualitative leap, which also makes today 's chemical enterprises in full swing (Zhang, 1999). At the same time, some enterprises also stand out. This paper selects several enterprise stocks for analysis and prediction.

Some scholars predict the future development of the real estate industry through the simulation of the real estate stock price, which provides a certain direction for our research (Liu, 2018).This paper introduces the Geometric Brownian motion model into the research and analysis of stock investment in Liaoning chemical industry, and selects the stock data of representative companies of Liaoning chemical industry from 2019 to 2022 for simulation analysis.The results show that the stock investment behavior of the chemical enterprises in Liaoning province conforms to the characteristics of the geometric Brownian motion, and the proposed model can be used to simulate the development direction of the stock investment.

This paper provides data support for investors on how to investment goals such as maximizing returns under established risks or maximizing cumulative returns. According to this data analysis, we can effectively allocate existing funds, so as to avoid the huge risks in the financial market, maximize the benefits, and allow investors to have a clear vane when buying stocks, so as to optimize investment and make proper trade-offs.

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# 2 RESEARCH AND ANALYSIS OF GEOMETRIC BROWNIAN MOTION MODELS

In order to simulate the stock price and analyze the future development trend of Liaoning chemical industry stock, we chose the geometric Brownian motion model for numerical simulation. We collected the stock closing price data from 2019 to 2022, and then we built a geometric Brownian motion model using Python. A method to simulate the exponential evolution of the stock market in 2020 with geometric Brownian motion is proposed in the literature, where the drift and diffusion are determined by taking into account two economic connection states (economic states), namely, the non-crisis state and the financial crisis. Based on this result, we find that the GBM model can very well describe the future evolution process of the stock index, and it is a suitable model for the prediction of the stock index value(Brătian, 2022). After evaluating the model, we simulated the stock price using the historical data from 2019 to 2022.

## 2.1 Data Preparation

In order to analyze the stocks of Liaoning Chemical Industry, we selected five representative stocks for research. We refer to the literature and choose to use Python to collect data through the tushare data interface and then we process the data because the closing price is the standard of the current market and the basis of the next trading day's invoicing price (Si, 2020). The closing price can predict the future stock market, so we choose the closing price of the stock as the data of the model.

The ticker codes are as follows: '301100', '300758', '300082', '000818', '000881'. We obtained the data of five stocks from September 1, 2019 to September 1, 2022. Finally, after importing the data into an excel sheet, the original data collection is complete.

## 2.2 Establishment of Geometric Brownian Motion Model

### 2.2.1 The Introduction of GBM

GBM is a continuous-time stochastic process in which the logarithm of a random variable follows English surname's Geometric Brownian motion. This Geometric Brownian motion has applications in financial mathematics. The purpose of our research is to study the future trend of the stock investment of Liaoning chemical industry. Considering the simulation of the future stock price, we choose to use Python to realize the future trend of the stock price based on the Geometric Brownian motion model, and through the final presentation of the results to the stock investment.

### 2.2.2 The Equation of GBM

In Python, to simulate that the stock price obeys geometric Brownian motion, it is necessary to use the stock price expression that obeys geometric Brownian motion after transformation by the Euler discrete method, as follows:

$$S_t=S_{(t-\Delta t)} e^{((\mu -1/2\ \sigma ^2)\Delta t+\sigma\ \varepsilon _t \sqrt{\Delta t})} \quad (1)$$

Where, "S_ T" and "S_ (t - Δ t)" represents the stock price at time "t" and time "t - Δ t" respectively, "μ" Is the expected value of stock return (annualized), "σ" Is the stock return volatility (annualized), "Δt" represents the unit time length, "ε_T" is a random number with standard normal distribution at time "t".

### 2.2.3 The Establishment of GBM

• Assumptions of the model

The assumption of the model is that in time t, the change of stock price will not be affected by the joint action of various external factors, such as economy and policy. At the same time, the superposition of various influencing factors on the stock price makes the stock price a random variable and follows a normal distribution.

• Establishment process of the model

Through the obtained data, first obtain the annual average return and annual return volatility of each stock, and then establish an initial array of stock prices simulating geometric Brownian motion. Set the simulation starting point as the stock closing price on September 1, 2022, and generate 100 random numbers at each time point. Use the difference formula of geometric Brownian motion to simulate and calculate the maximum, minimum and median of the daily closing rate of the stock.

• Range selection of analog values

By reading the literature and looking for information, we know that the accuracy of the Geometric Brownian motion model is related to the length of the set time (Agustini, 2018), and the shorter the time, the more accurate the price prediction. It is also known from the literature that the accuracy of the one-month forecast is higher than that of the one-year and one-week forecasts. We chose to forecast 2023 prices for

September to October in order to model future movements.

### 2.2.4 Program Code

In the following section, we use the code for the Geometric Brownian motion of scenic shares:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from pylab import mpl
mpl.rcParams['font.sans serif']=['SimHei']
mpl.rcParams['axes.unicode_minus']=False
#Import Fengguang share price data
price_fengguang=pd.read_excel('FENGGUANG.xlsx',sheet_name="Sheet1",header=0,index_col=0)
#Calculate the daily rate of return of scenic shares
R_fengguang=np.log(price_fengguang/price_fengguang.shift(1))
#Deletes rows with missing values
R_fengguang=R_fengguang.dropna()
R_fengguang.describe()
#Get the annualized average yield of scenic shares and convert it into an array format
mu_fengguang=(R_fengguang.describe()).loc['mean']*252
mu_fengguang=np.array(mu_fengguang)
#Get the annualized return volatility of the landscape stock and convert it into an array format
sigma_fengguang=(R_fengguang.describe()).loc['std']*np.sqrt(252)
sigma_fengguang=np.array(sigma_fengguang)
#Import the statistics submodule stats for the SciPy module
import scipy.stats as st
#predict 23-09-10
date_fengguang=pd.date_range(start='2023-09-01',end='2023-10-01',freq='B')
N_fengguang=len(date_fengguang)
I_fengguang=100
dt=1.0/252
fengguang_GBM=np.zeros((N_fengguang,I_fengguang))
fengguang_GBM[0]=22.77
for t in range(1,N_fengguang):
    e=st.norm.rvs(size=I_fengguang)
    fengguang_GBM[t]=fengguang_GBM[t-1]*np.exp((mu_fengguang-0.5*sigma_fengguang**2)*dt+sigma_fengguang*e*np.sqrt(dt))
fengguang_GBM=pd.DataFrame(fengguang_GBM,index=date_fengguang) #Converts the simulated value into a data box with a time index
plt.figure(figsize=(9,6))
plt.plot(fengguang_GBM)
plt.xlabel(u'date',fontsize=13)
plt.ylabel(u'price',fontsize=13,rotation=90)
plt.xticks(fontsize=13,rotation=30)
plt.yticks(fontsize=13)
plt.title(u'FengGuang:The GBM simulate the full path (September to October 2023) ',fontsize=13)
plt.show()
#Simulation of the scenery of the stock maximum
max_fengguang=np.max(np.max(fengguang_GBM))
#Simulation of the scenery of the stock minimum
min_fengguang=np.min(np.min(fengguang_GBM))
#Simulation of the scenery of the stock medianmum
median_fengguang=np.median(fengguang_GBM)
print(' Maximum simulated price:',round(max_fengguang,4))
print(' Minimum simulated price:',round(min_fengguang,4))
print(' Median simulated price:',round(median_fengguang,4))egin
    Writeln('Hello World!!');
```

## 2.3 Results of Model Run

After the establishment of the model, we first need to evaluate the model. Then analyze the operation effect of the model and visualize the data, and finally summarize according to the analysis results.

### 2.3.1 Model Evaluation

To evaluate the model, we used data from January to February 2022 to predict stock prices from February to March 2022. Because the model generates 100 sets of data at random, we choose to extract one set of data from the predicted values by random sampling. Compare the real values from February to March 2022 and calculate the error rate between the predicted values and the real values. The visible error value from the data is less than 20%, so we consider the model to be valid.

Table 1: Error rate between simulated value and real value of five stocks.

| Date | 300082 | 300758 | 000818 | 301100 | 000881 |
|---|---|---|---|---|---|
| **2/7** | -2.5% | -2.4% | -1.5% | -2.4% | -1.9% |
| **2/8** | 1.4% | 0.4% | -7.8% | 2.8% | -3.1% |
| **2/9** | 1.9% | -7.9% | -7.7% | 3.4% | -4.4% |
| **2/10** | 2.9% | -1.7% | -6.1% | 0.2% | 2.4% |
| **2/11** | 5.8% | -1.8% | -2.8% | 5.6% | 5.7% |
| **2/14** | 8.4% | -0.1% | -0.6% | 3.4% | 8.3% |
| **2/15** | 1.2% | 2.6% | 1.3% | 1.8% | 7.1% |
| **2/16** | 6.5% | 5.7% | -1.9% | 5.9% | 3.9% |
| **2/17** | 4.6% | 8.1% | 0.1% | 5.1% | 3.0% |
| **2/18** | 5.1% | 7.8% | 0.9% | 7.6% | 5.7% |
| **2/21** | 9.9% | 8.8% | 4.3% | 7.9% | 7.4% |
| **2/22** | 10.5% | 17.3% | 10.0% | 6.0% | 10.2% |
| **2/23** | 7.3% | 5.5% | 10.4% | 6.3% | 12.6% |
| **2/24** | 11.1% | 5.4% | 8.3% | 6.2% | 18.8% |
| **2/25** | 12.8% | 7.6% | 7.9% | 8.2% | 14.3% |
| **2/28** | 14.6% | 8.9% | 8.0% | 10.5% | 16.4% |
| **3/1** | 18.6% | 12.6% | 9.9% | 7.3% | 13.8% |

### 2.3.2 Liaoning Chemical Industry Stock 2023

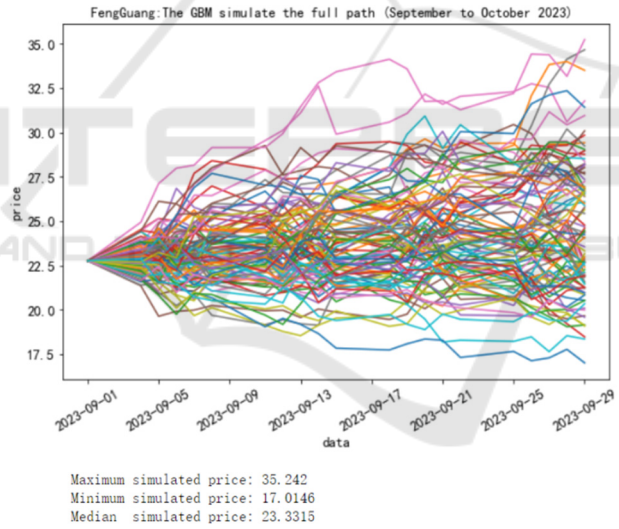


Figure 1: FengGuang: The GBM simulate the full path (September to October 2023).

Fengguang shares (301100) is a global polymer materials to provide core additives and high-tech support suppliers. The company is mainly engaged in the production and r & D of high-efficiency rubber and plastic additives, and provides one-stop solution of polymer additives for customers. Group is a state-level high-tech Enterprises, with a special research laboratory. Fengguang is a high-tech enterprise specializing in the research, development, production and sales of chemical additives for polymer materials. It belongs to the chemical additives sub-industry in the fine chemical industry, and in principle belongs to the chemical materials cycle stock, the market share of products is relatively high

From the simulation results of Fengguang shares, we can see that the maximum value of Fengguang shares is 35.242 yuan, and the minimum value is only 17.0146 yuan. The difference between the two is nearly two times, the median price was 23.3315 yuan, up from the initial 22.77 yuan (closing price on Sept. 1, 2022). As a result, when the shares follow the Geometric Brownian motion, there is an overall upward trend in the simulated share price.

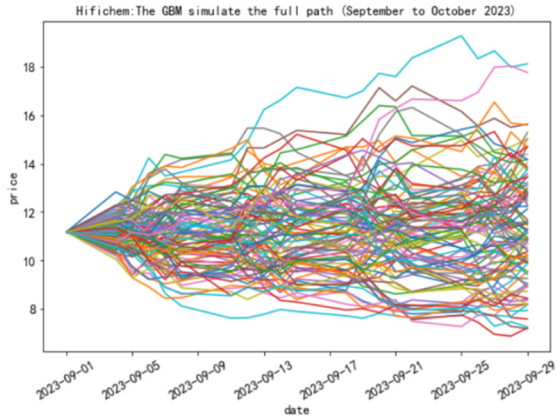


Figure 2: Hifichem: The GBM simulate the full path (September to October 2023).

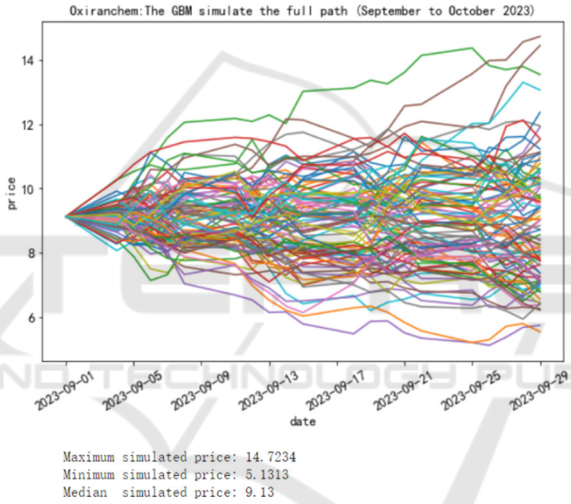


Figure 3: Oxiranchem: The GBM simulate the full path (September to October 2023).

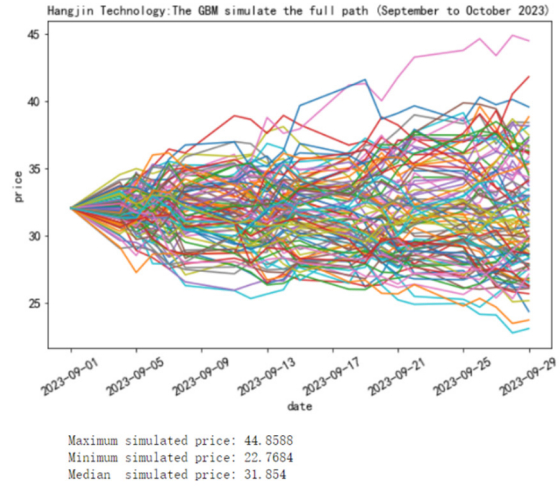


Figure 4: Hangjin Technology: The GBM simulate the full path (September to October 2023).

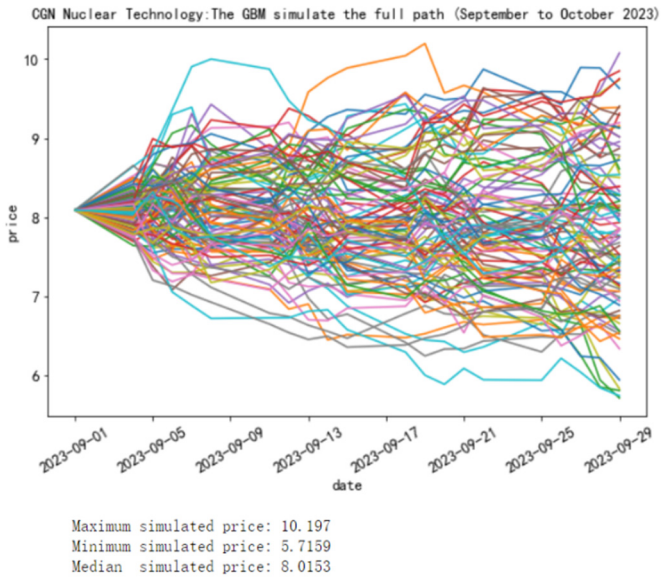


Figure 5: CGN Nuclear Technology: The GBM simulate the full path (September to October 2023).

Next to the other four companies of the simulation chart analysis, can be seen in the simulation results of Hangjin Science and technology, the median share price is 32.03 yuan, equal to the initial 32.03 yuan (September 1,2022 closing price), as a result, the stock price of technology is unchanged. The median price of Hifichem was 11.18 yuan, close to the initial value of 11.18 yuan, which closed Sept. 1,2022. The median price of Oxiranchem shares is 9.13 yuan, close to the initial value of 9.13 yuan (the closing price of 9.1 in 2022). The median share price of CGN Nuclear Technology was 8.0153 yuan, close to the initial value of 8.09 yuan (the closing price on September 1, 2022).

From the forecast results, we can see that the future development of Liaoning chemical industry stock tends to be stable. The chemical industry has been a big contributor to revenue and profits, take Hangjin Technology for example. In the past, Aijin Technology's annual report was not very eye-catching. However, in recent years, Aijin Technology's performance has continued to rise. On the one hand, the price of chemical products is at a high level, while on the other hand, military and civil electronics have continued to contribute to the performance, it can be said that the current aviation brocade technology gradually entered a new round of growth cycle. Therefore, in the analysis of stock investment, but also with the development of the industry to carry out a systematic analysis.

### 2.3.3 Research and Analysis on Stock Investment of Chemical Industry in Liaoning Province

In order to analyze the stock investment of Liaoning chemical industry, we chose to use the same industry analysis method in addition to the Geometric Brownian motion model. We compare Liaoning chemical industry's stock with industry leader Wanhua Chemical. We can see that the total market value, net assets and net profit of Wanhua chemical are much higher than those of Fengguang shares, but the net interest rate of Fengguang shares is higher than Wanhua Chemical. Therefore, we can introduce, in the investment of stocks, to consider many aspects. Although Fengguang shares listed for a short time, but the overall company's product gross profit and net profit are relatively high, so there is a lot of room for the development of Fengguang shares, the future development prospects are also worth watching.

We used a Geometric Brownian motion model to simulate the stock price. From the 2023 analysis of the Liaoning chemical industry stock simulation data visualization, we can see that the stock price of Fengguang shares shows an upward trend, after considering all the factors, we think we can give priority to Fengguang shares when we invest in Liaoning chemical industry

# 3 CONCLUSIONS

In the course of adopting Geometric Brownian Motion to simulate stock prices, when Monte Carlo method is used to simulate random numbers,if more data samples are generated, the test effect will be better. On the contrary, fewer simulation data samples will result in poorer prediction effect.

The premise of adopting Geometric Brownian Motion for modeling is that the stock prices conform to normal distribution, but the real stock prices usually do not conform to normal distribution. So there exists certain deviation between the simulation prediction results and the real prices.

Our conclusion is that Fengguang is preferred for investment in the stock pool of Liaoning chemical industry. If we use Brownian Motion to describe the intraday high-frequency movement of stock price, each sample trajectory has enough randomness. Stock price is more likely to fluctuate around the opening price, rather than stay above or below it; Moreover, with the passage of trading time, the stock price at time t will not deviate too far from the standard deviation of the price movement (Nándori, 2022). In this paper, we use the Geometric Brownian motion model to simulate future trends and use the predicted results as a reference for stock investing. The limitation is that the Geometric Brownian motion model results under certain assumptions, it is not a complete reference, and that's something we should address in the future.

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