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**Research on the comparison of common exotic option applications
for Alibaba and Amazon**

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for the Bachelor of Science in Finance

by

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ABSTRACT

With the globalization of the financial market, the volatility of the global financial system and the aggravation of competition, it is more important to analyze the functions of various derivatives. Because of the differences in execution prices or payment structures, exotic options are used for different customized functions of investors' needs. Therefore, it is of great significance to study the impact of different exotic options on return for underlying assets. To analyze this topic, two similar e-commerce companies, Alibaba and Amazon, are selected as the asset representatives. Meanwhile, this study will explore exotic options, including binary, lookback, and chooser options, to find whether the two assets have the same most suitable type of exotic option with the highest payoff. The research makes these four common exotic options comprehended better, and provides suggestions, especially for investors of Alibaba and Amazon.

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TABLE OF CONTENTS

Introduction

Literature Review

- Financial markets
- Common types of exotic options
- Geometric Brown Motion

Methodology and Data

- Research design
- Data and Method

Analysis and Results

- Chooser Call Options for Amazon
- Lookback Call Options for Amazon
- Binary Call Options for Amazon
- Chooser Put Options for Amazon
- Lookback Put Options for Amazon
- Binary Put Options for Amazon
- Values of Different Exotic Options for Alibaba
- Comparison between Amazon and Alibaba
- Sensitivity Analysis: The volatility of returns and risk-free interest rate

Conclusion

References

APPENDIX

Introduction

Options are an important and mature part of the financial derivatives market. In options trading, the buyer's potential profit is uncertain, but the loss is limited and the biggest risk is certain; on the contrary, the seller's profit is limited, but the potential loss is uncertain. As a result, options are popular with investors. To meet the different needs of investors, exotic options are introduced because they have different characteristics and profit-making methods, compared with ordinary options. Most exotic options are traded over-the-counter, which are often developed by financial institutions according to the specific needs of customers. The flexibility and diversity of exotic options are incomparable to conventional options. Do different types of exotic options have a great different effect on the return of the same asset? Is there a large payoff difference for the asset in the same industry with different exotic options?

In recent years, Alibaba and Amazon are the two most widely used e-commerce companies in the world. Amazon went public in 1997 and Alibaba went public in 2014. Although Alibaba and Amazon are different in terms of coverage area and development strategies, their main businesses are very similar, focusing on B2C e-commerce, cloud computing, digital media, innovative technology, etc. (Wu, 2018). This paper chooses these two companies because they are well-known leaders in e-commerce industry. This research can be regarded as a pretest of the application of exotic options to the whole the e-commerce industry. More specifically, this study will explore the application of four types of exotic options in two similar companies in the same industry, and calculate the value of options, to observe whether the same option type has the

highest value. As a result, investors of two assets, even all exotic option investors, can better understand the exotic option types and make a favorable choice for their investments.

Literature Review

A. Financial derivatives market

The international derivatives market is active and has developed into the most significant part of the financial market. Derivatives exchanges and over-the-counter (OTC) providers currently take the largest market share through continuous growth of product and technological innovation. With the globalization of the financial market, the volatility of the global financial system and the intensification of competition, it is increasingly important to analyze the trend of the derivatives market. The derivatives market has received more attention and many regulators have begun to consider strengthening regulation to improve the transparency and security of derivatives and other financial instruments (Motorniuk, Terebukh, Kharchuk, 2016). Futures, forwards, options and swaps are common derivatives. They are popularly used in the world because they have advantages for attracting investors. The transactions are fast and easy based on positive market liquidity. It is possible that one investor can sell underlying assets that he or she does not have. Also, there is larger leverage allowed for investors to gain or lose more (Ikpefan, 2016). As a result, derivatives can also cause investor loss easily. They require investors to understand different types of derivatives before using them as financial instruments. Options, as one of the derivatives, were traded very

early. Gradually there has been established options exchanges and options clearing companies, so an orderly market comes. Increasing uncertainty among participants is one of the main driving forces in finding new financial instruments. Meanwhile, the investment risk is also increasing. Everyone in the financial market must react abruptly to the changes and revise their investment strategy in time. Therefore, investors are looking for new opportunities to adapt to the changing market situation and gain more from investments. If derivative securities are traded with positive strategies, they can help investors improve their expected returns and minimize their risk. The option is one type of derivatives which can be used to create various investment opportunities in many ways (Martinkute-Kauliene, 2012). The normal options are called plain vanilla options, including the position of call and put for both short and long. Besides normal options, there are exotic options, which have various functions for investor use. Exotic options make differences on strike prices, expiration dates, and payment structures. Many types of exotic options are used popularly because of their different customized functions for investor needs.

B. Common types of exotic options

Lookback options: Compared with Asian options, lookback options are also depended on paths. However, the difference is that the payoff of lookback options depends on the highest or lowest price during the validity period. At the expiration date, the option holder can look back at the option and choose the best price to execute the option. Compared with vanilla options, as an exotic option, the benefit of lookback options is that this type avoids a problem that vanilla options may encounter: options perform

well in the early and middle stages of the life cycle, but tend to be detrimental to holders at the end of expiration (Fusai, 2010). Since lookback options guarantee the option holders the best possible results, he or she will never regret the return of the option, lookback options are more expensive than vanilla options with a similar return. The seller of a lookback option will price the option at or near the worst expected price gap according to past volatility and demand for the option (Wysup, 2017).

Chooser options: The chooser option is also a kind of exotic options. Since 1990, they have been traded with the initial contracts of the Bankers Trust Fund, and this type of options is also called “you-choose” or “as-you-like” options (Milian, 2014). Chooser options are related to the path: When a chooser option is purchased, the call or put is not decided until a specific point during the period to maturity. Compared with vanilla options, chooser options are suitable for financial products which are expected to fluctuate sharply, while investors are not sure about the direction of its change (Martinkute-Kauliene, 2012). If a stock price rises over a period, the option holder will choose the call option based on the value comparison, vice versa. Once a choice is made, the option will remain call or put to the expiration date.

Binary options: The binary option, also known as the digital option, is a kind of exotic options based on "all or none". Investors need to predict the direction and amount change of the price of options and buy binary options. If the price of the option reaches strike price when the binary option expires, the holder of the option will reap a fixed return that is decided when buying; if the strike price is not reached, nothing will be achieved for holders. Once the option holder obtains the binary option, the holder

cannot further decide whether to exercise the binary option, because binary options are automatically executed (Rosa, n.d.). One of the advantages of trading binary options is that the traders' risk is limited to the premium paid for a contract. The value of the proceeds is determined at the beginning of the contract and does not depend on the price changes of the underlying assets. Option holders will gain a fixed payoff. Compared with traditional options, even many financial instruments, the return rate of binary options is very high. This type of options can be traded in a short time for many underlying assets and make more money (Benjamin, 2017).

C. Geometric Brown Motion

Brownian motion is a physics related theory introduced before the 19th century. As Ermogenous said, Brownian motion is often used to explain the movement of time series variables. Meanwhile, it can also be used in finance to study the movement of asset prices (Reddy & Clinton, 2016). In Einstein's proof, water molecules are active. Similarly, the change of stock price in the financial market is also considered to follow the Brownian motion: the price of assets changes with random quantity. Based on Brown Motion Theory, a formula can be shown for pricing the asset price: $S_T = S_0 e^{(\alpha - \frac{1}{2}\sigma^2)T + \sigma\sqrt{T}}$ (Brewer, Feng, & Kwan, 2012).

Methodology and Data

Research Design

We will use the mixed methods approach, which includes quantitative (structured) approach and qualitative (unstructured) approach. For qualitative approach, we declare the definition of three exotic options, including chooser, lookback, and binary options, and characteristics of these exotic options. For the quantitative method, we will collect the data of the underlying assets of Alibaba and Amazon from Yahoo Finance, and assume some value of data in the same way (percentage). Excel will be mainly used to do the option valuation, including simulation of payoffs, value of options, and sensitivity analysis, to find out which option is most suitable to invest.

Data and Method

Data collected: the historical daily price of Amazon and Alibaba for week days from October 1, 2018 to September 31, 2019, and risk-free interest rate.

Calculated data: historical volatility of returns (standard deviation).

Assumed data: expected return on stocks, maturity date, and strike price.

Simulation:

Use the most popular model for simulating financial asset prices called Geometric Brownian Motion (GBM) to calculate the future value of the assets:

$$S_T = S_0 e^{(r - \frac{1}{2}\sigma^2)T + z\sigma\sqrt{T}}$$

* T: Maturity date; z: Random number;

r: Risk-free interest rate;

α : Expected return on stocks; σ : Standard deviation;

S_0 : The price of the asset now; S_T : Future price of the asset.

Calculate the call and put option value at maturity for each S_T using different formulas based on functions. Regress C_T or P_T on S_T so that

$$C_T / P_T = a + bS_T$$

then the present value is

$$C_0 / P_0 = ae^{-rT} + bS_0$$

Sensitivity analysis:

Change one variable factor, such as the volatility of returns, to observe whether the factor influence the payoffs and value of various exotic options changes a lot.

Analysis and Findings

Based on the historical data of Amazon stock and Alibaba from 10/01/2018 to 09/27/2019 and calculate the daily return of the two underlying assets. The researcher calculates the volatility of these two stocks. Meanwhile, the risk-free interest rate is founded as the interest rate of 3-month government Treasury bills. Researcher assume expected return on stocks is 8%, the maturity is for one year. Meanwhile, set the last price of historical data as the strike price (K), so the K(Amazon) is \$1725 and K(Alibaba) is \$166.

Table 1.0 The information of Amazon and Alibaba.

	σ (volatility)	α (Expected Return)	Strike Price	Maturity	Risk-free Rate
Amazon	0.3545	8%	\$1725	1 year	1.84%
Alibaba	0.3550	8%	\$166	1 year	1.84%

Then, make the simulation of stock price for 1,000 times with the following equation.

$$S_T = S_0 e^{(\alpha - \frac{1}{2}\sigma^2)T + z\sigma\sqrt{T}}$$

Calculate the payoffs for Amazon and Alibaba according to features of different exotic options and make graphs to show the payoffs clearly. Here are results for the payoff calculation.

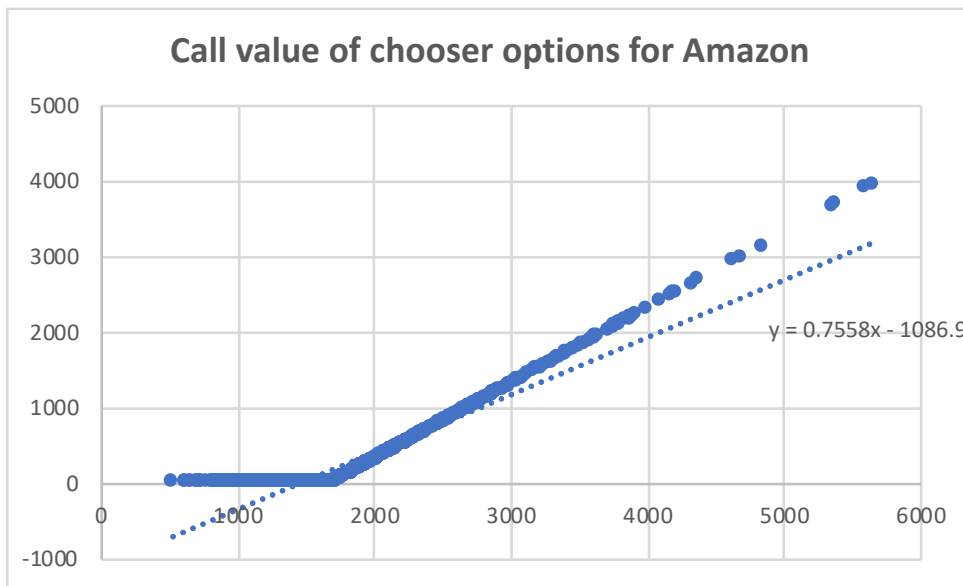
Chooser Call Options for Amazon

The first one is chooser options for Amazon at call position. According to chooser option's features, buyers can decide whether it is a call or put option as they like prior the expiration date, so when the spot price (S_T) is higher than the strike price (K), they will exercise the chooser option as call position. The equation of payoff is

$$C_T = \max(S_T - K, 0)$$

Regress C_T on S_T so that $C_T = a + bS_T$, showing as the following chart.

Chart 1.0 Call value of chooser options for Amazon



To calculate the present value, use the equation $C = ae^{-rT} + bS$. To avoid accidental events, the researcher calculated C repeatedly five times, taking the average value as the final result.

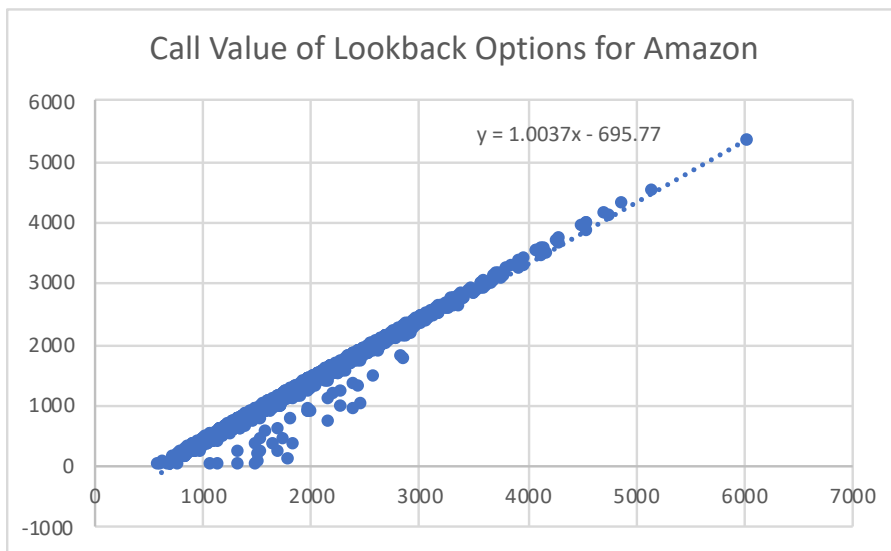
Table 2.0 Present value of chooser call options for Amazon

C0	a	b
\$237.0112	-1086.9	0.7558
\$225.2655	-1101.5	0.7573
\$228.4152	-1117.8	0.7684
\$241.5934	-1068.7	0.7481
\$236.9617	-1127.9	0.7791
Average \$233.8494		

Lookback Call Options for Amazon

The second one is lookback options for Amazon at call position. According to lookback option's features, the payoff of this types is $C_T = \max (S_T - S_{\text{MIN}}, 0)$. Regress C_T on S_T so that $C_T = a + bS_T$, showing as the following chart.

Chart 1.1 Call value of lookback options for Amazon



To calculate the present value, use the equation $C = ae^{-rT} + bS$. To avoid accidental events, the researcher calculated C repeatedly five times, taking the average value as the final result.

Table 2.1 Present value of lookback call options for Amazon

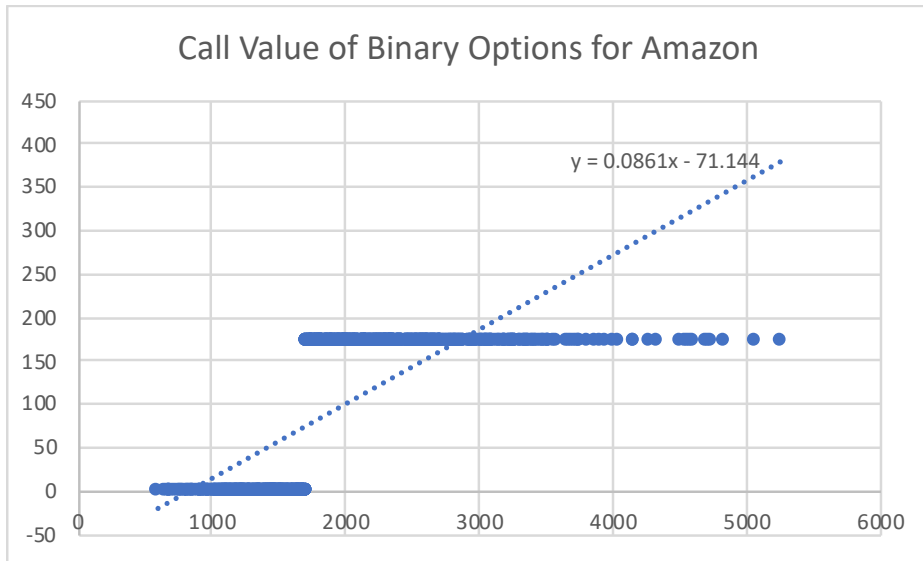
C0	a	b
\$1048.7492	-695.77	1.0037
\$1126.7788	-601.88	0.9955
\$1016.4206	-719.56	0.9985
\$1030.0957	-700.71	0.9957
\$1020.4891	-699.95	0.9897
Average \$1048.5067		

Binary Call Options for Amazon

The third one is lookback options for Amazon at call position. According to its features, call buyers can gain the fixed amount as their payoff when the spot price is higher than the strike price. As a result, the researcher set the 10% of the strike price as the fixed payoff for buyers of Amazon. Meanwhile, it is the same percentage of strike price for Alibaba.

The payoff of this types is $C_T = \text{if } (S_T - K, \$172.5, 0)$. Regress C_T on S_T so that $C_T = a + bS_T$, showing as the following chart.

Chart 1.2 Call value of binary options for Amazon



To calculate the present value, use the equation $C = ae^{-rT} + bS$. To avoid accidental events, the researcher calculated C repeatedly five times, taking the average value as the final result.

Table 2.2 Present value of binary call options for Amazon

C0	a	b
\$78.7143	-71.144	0.0861
\$76.7132	-75.467	0.0874
\$77.5651	-88.132	0.0951
\$81.2458	-74.541	0.0895
\$82.9418	-67.541	0.0865
Average \$79.4360		

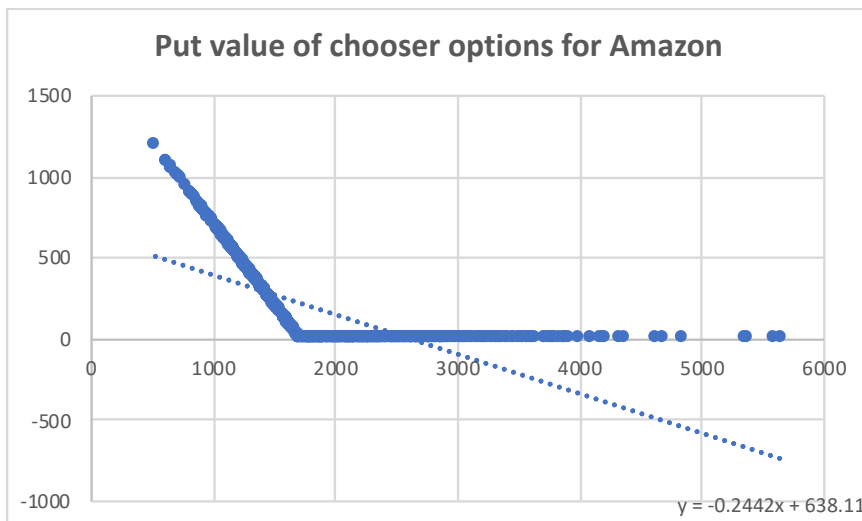
Chooser Put Options for Amazon

Here are chooser options for Amazon at put position. According to its features, when the spot price (S_T) is lower than the strike price (K), they will exercise the chooser option as put position. The equation of payoff is

$$P_T = \max(K - S_T, 0)$$

Regress P_T on S_T so that $P_T = a + bS_T$, showing as the following chart.

Chart 2.0 Put value of chooser options for Amazon



To calculate the present value, use the equation $P = ae^{-rT} + bS$. To avoid accidental events, the researcher calculated P repeatedly five times, taking the average value as the final result.

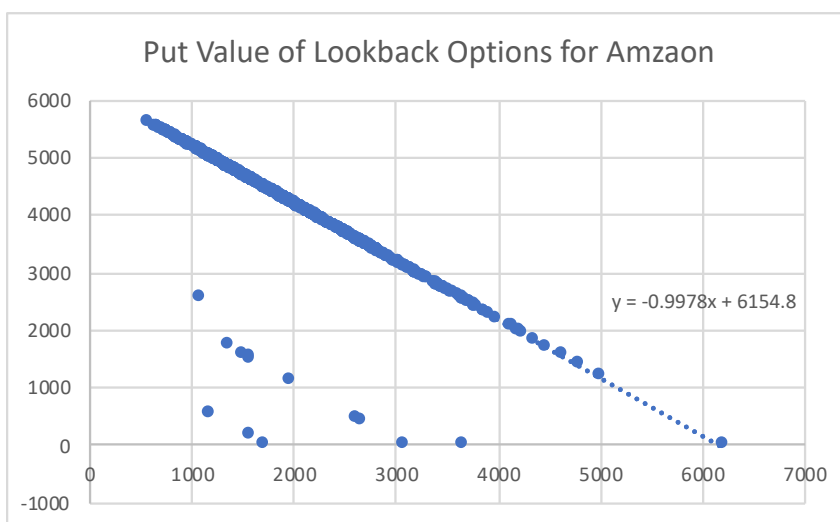
Table 3.0 Present value of chooser put options for Amazon

P0	a	b
\$205.1213	638.11	-0.2442
\$193.4051	623.54	-0.2427
\$196.5253	607.21	-0.2316
\$209.7329	656.34	-0.2519
\$205.0325	597.07	-0.2209
Average \$201.9634		

Lookback Put Options for Amazon

The other one is lookback options for Amazon at call position. According to its features, the payoff of this types is $P_T = \max (S_{MAX} - S_T 0)$. Regress P_T on S_T so that $P_T = a + bS_T$, showing as the following chart.

Chart 2.1 Put value of lookback options for Amazon.



To calculate the present value, use the equation $P = ae^{-rT} + bS$. To avoid accidental events, the researcher calculated P repeatedly five times, taking the average value as the final result.

Table 3.1 Present value of lookback put options for Amazon.

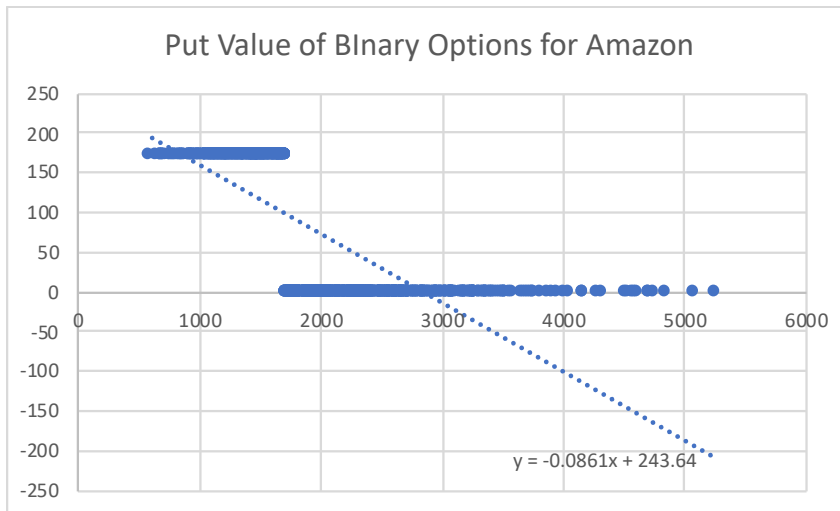
P0	a	b
\$3577.0620	5200.1	-0.8857
\$4320.9332	6154.8	-0.9978
\$3073.9873	4902.8	-1.0081
\$7868.0871	6231.4	1.0144
\$3037.5337	4861.1	-1.0055
Average \$4375.5207		

Binary Put Options for Amazon

Here are binary options for Amazon at put position. According to its features, put buyers can gain the fixed amount as their payoff when the spot price is lower than the strike price. As a result, the researcher set the 10% of the strike price as the fixed payoff for buyers of Amazon. Meanwhile, it is the same percentage of strike price for Alibaba.

The payoff of this types is $P_T = \text{if } (K - S_T, \$172.5, 0)$. Regress P_T on S_T so that $P_T = a + bS_T$, showing as the following chart.

Chart 2.2 Put value of binary options for Amazon.



To calculate the present value, use the equation $P = ae^{-rT} + bS$. To avoid accidental events, the researcher calculated P repeatedly five times, taking the average value as the final result.

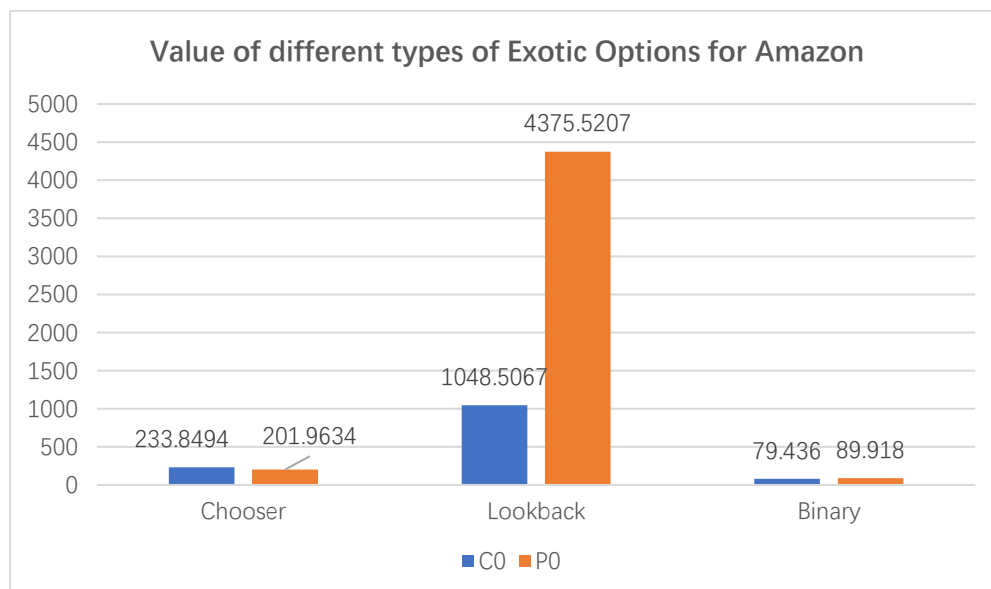
Table 3.2 Present value of binary put options for Amazon.

P0	a	b
\$90.6368	243.64	-0.0861
\$92.6447	247.97	-0.0874
\$91.7880	260.63	-0.0951
\$88.1083	247.04	-0.0895
\$86.4122	240.04	-0.0865
Average \$89.9180		

Here is a summary for the present value of different types of exotic options for Amazon.

From the chart, based on the data we have collect and created, we can see the highest payoff, no matter at call or put positions, is gained by lookback options, then the chooser options, and finally binary options. Moreover, the judge of whether it is more positive to buy a call or put cannot be found. We will discuss it later in sensitivity analysis.

Chart 3.0 Present value of exotic options for Amazon



Repeat the whole process for the second underlying assets, Alibaba. Calculate the payoffs of different types of exotic options and the value of them. The trend of the same types of exotic options for Alibaba is similar as the Amazon's, because of the feature of these exotic options, which can be seen in the appendix.

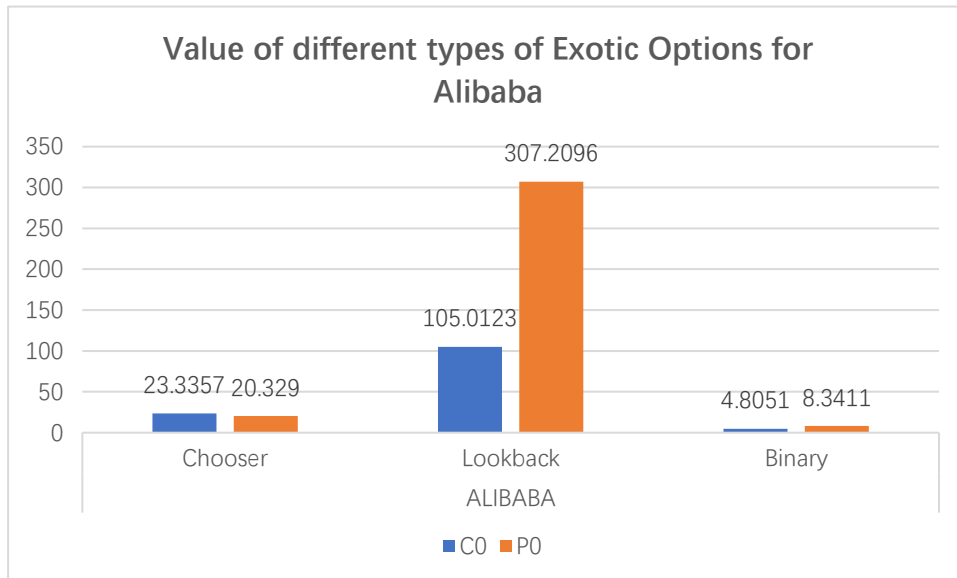
Values of Different Exotic Options for Alibaba

Here is a summary for the present value of different types of exotic options for Alibaba.

From the chart, similarly, we can see the highest payoff, no matter at call or put

positions, is gained by lookback options, then the chooser options, and finally binary options.

Chart 4.0 Present value of exotic options for Alibaba.

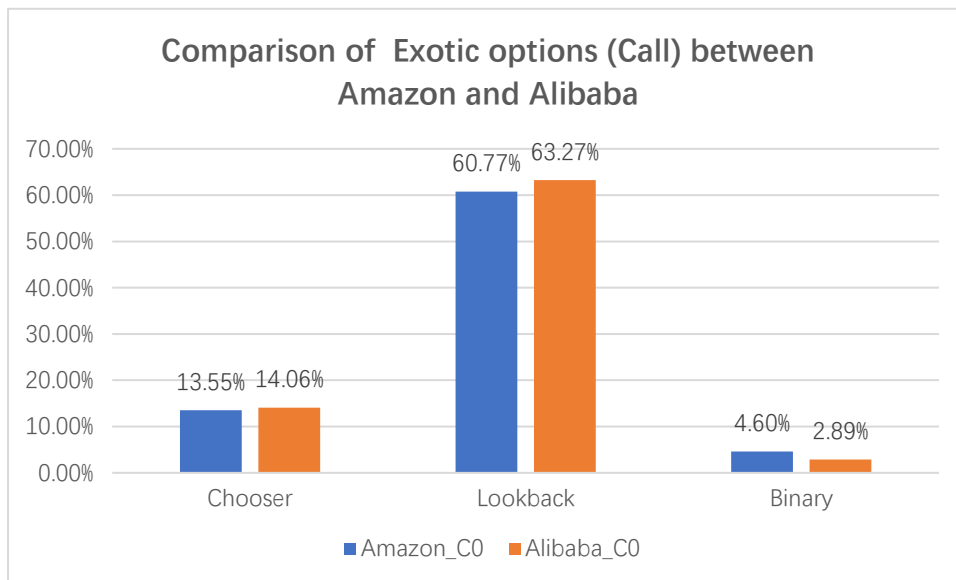


The lookback options of Amazon and Alibaba have higher value than the options and binary options. It shows that in the current situation, investment in lookback option is the most favorable choice. It depends on the different characteristics of these options. If we change the existing conditions, such as increasing the fixed return value of the binary option, the value of the binary options will be changed, which may exceed the chooser options, close to the lookback options.

Comparison between Amazon and Alibaba

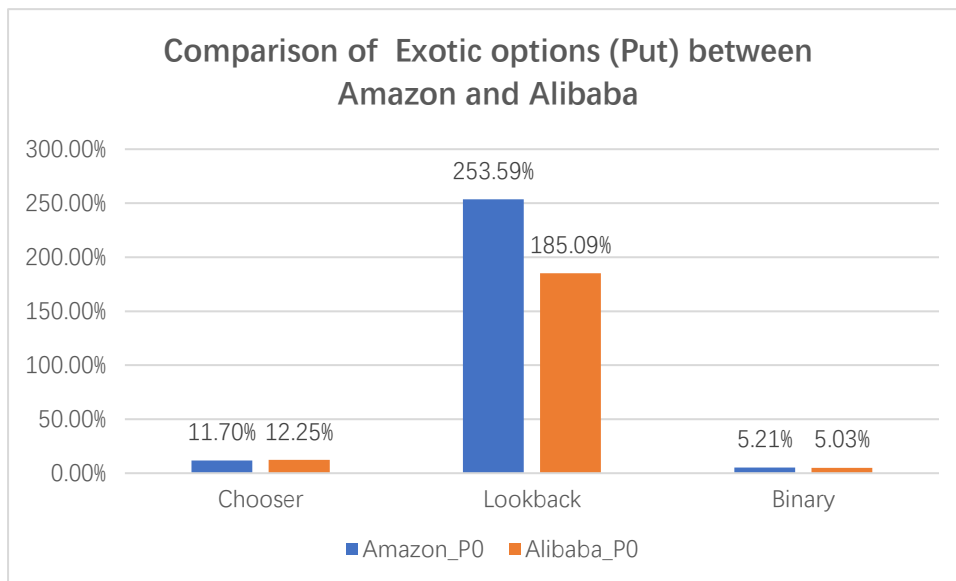
Compare the payoff returns in percentage of Amazon and Alibaba differently at call or put position, the result can be seen:

Chart 5.0 Comparison of exotic call options between Amazon and Alibaba



The present value (in percentage of spot price) of chooser options and lookback options at call position for Alibaba is higher than Amazon's. However, the present value of binary options at call position for Amazon is higher than Alibaba's. As a result, in this situation the researchers create, the investors can make an investment in chooser options and lookback options at call position for Alibaba and make an investment in binary options at call position for Amazon.

Chart 5.1 Comparison of exotic put options between Amazon and Alibaba

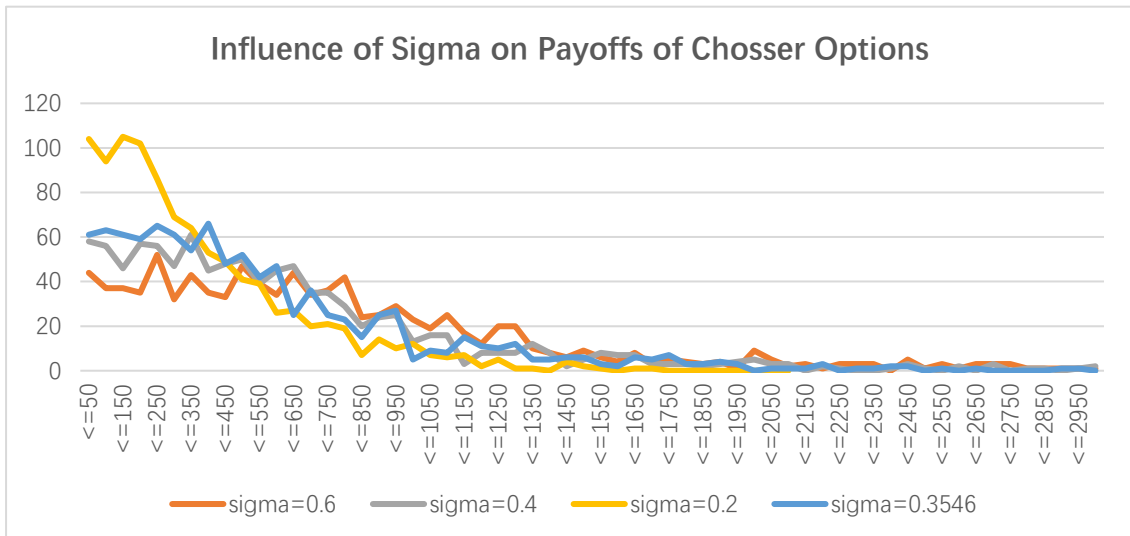


The present value (in percentage of spot price) of binary options and lookback options at put position for Amazon is higher than Alibaba's. However, the present value of chooser options at put position for Alibaba is higher than Amazon's. As a result, in this situation the researchers create, the investors can make an investment in binary and lookback options at put position for Amazon and make an investment in chooser options at put position for Alibaba.

Sensitivity analysis

Here is the sensitivity analysis for the value or payoffs of different types of chooser, lookback, and binary options. The volatility (σ : sigma) is tested to see how the change of it influences these exotic options' value or payoffs. Amazon is selected as the example to see the influence.

Chart 6.0 Influence of sigma on payoffs of chooser options



The first one is for chooser options. Change the sigma into 0.2, 0.3546, 0.4, and 0.6, and the payoff of chooser options at call and put position changes. As the sigma goes up, the frequency of low returns increases.

Chart 6.1 Influence of sigma on payoffs of chooser call options

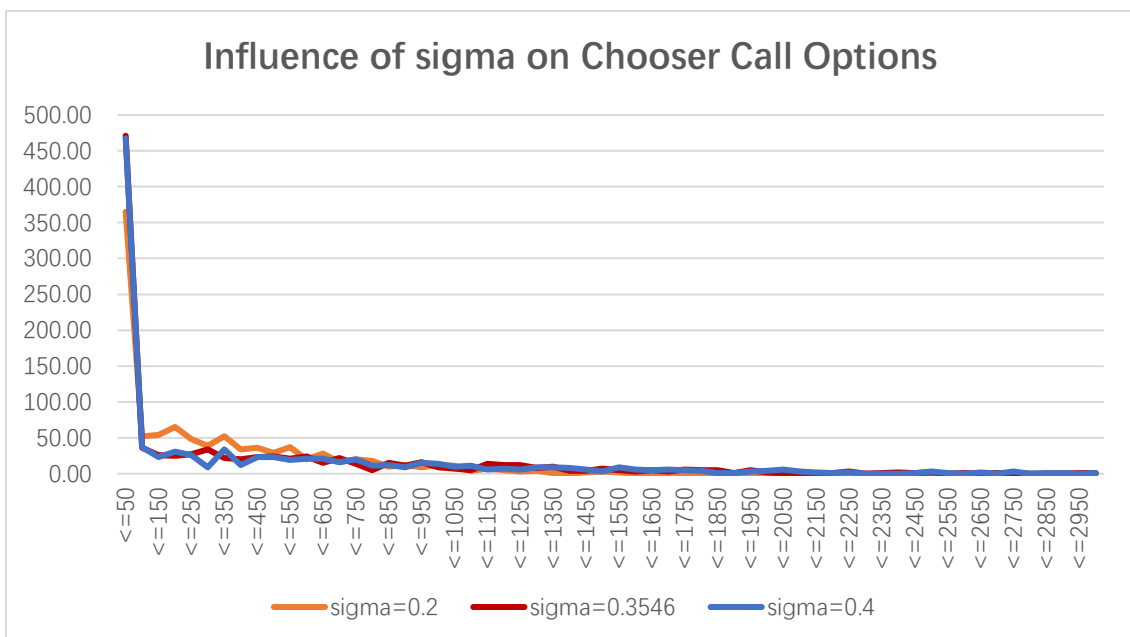
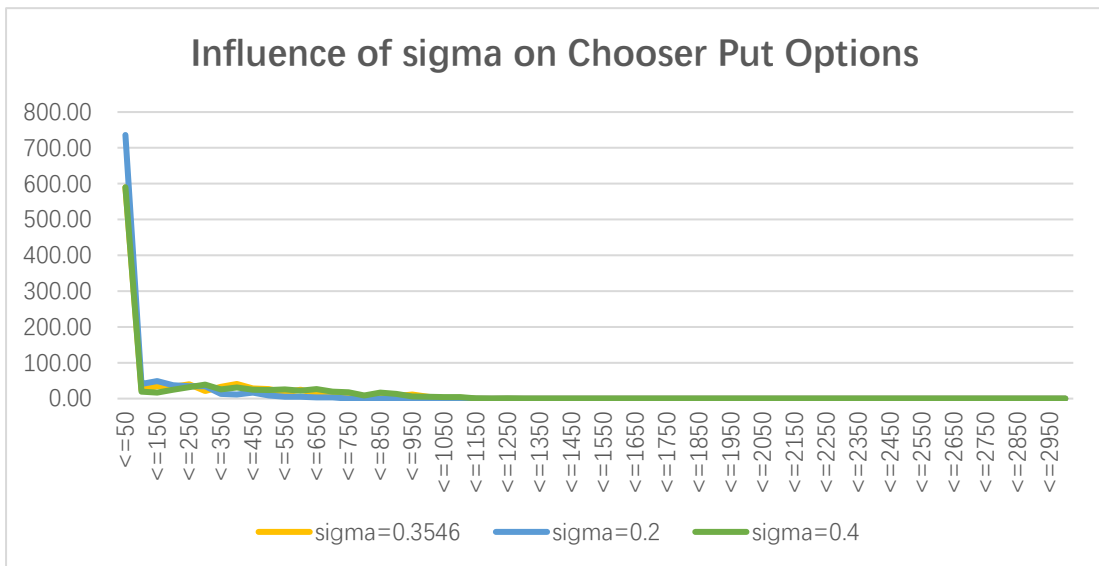


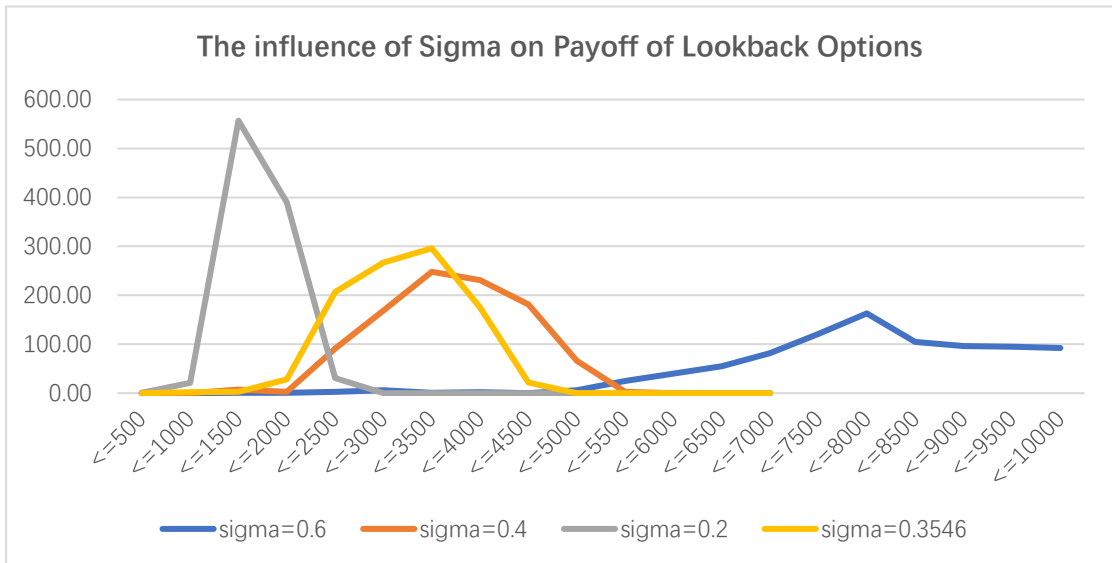
Chart 6.2 Influence of sigma on payoffs of chooser put options



Test the payoff at call and put position separately, and observe the impact of sigma on them. As the sigma goes up, the frequency of low payoff at call options increases, while the frequency of low payoff at put options decreases.

The second one is for lookback options. Change the sigma into 0.2, 0.3546, 0.4, and 0.6, and the payoff of lookback options at call and put position changes. As the sigma goes up, the frequency of high payoffs increases.

Chart 7.0 Influence of sigma on payoffs of lookback options



Test the payoff at call and put position separately, and observe the impact of sigma on them. As the sigma goes up, the frequency of low payoff at call options increases, while the frequency of high payoff at put options increases.

Chart 7.1 Influence of sigma on payoffs of lookback call options

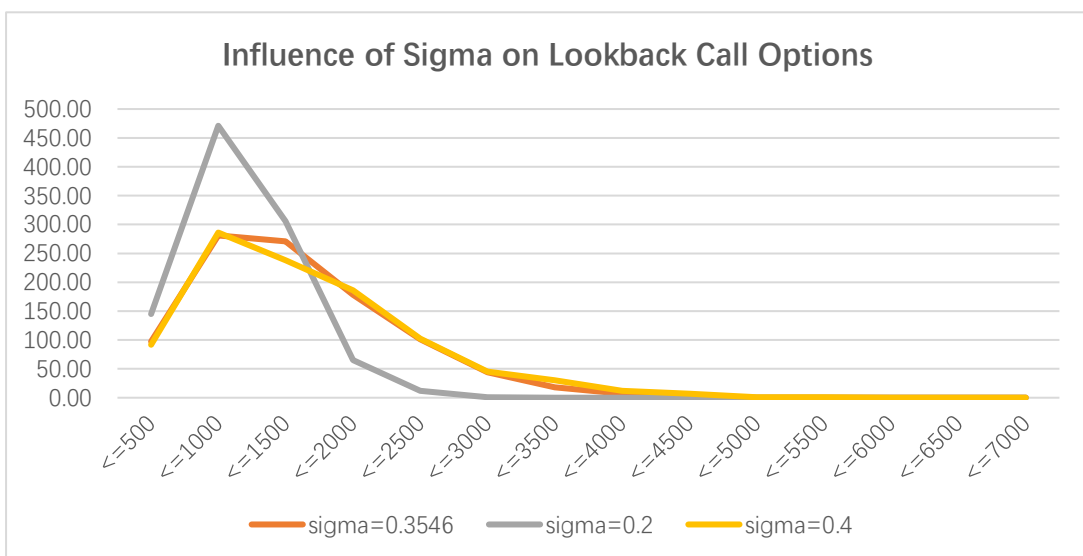
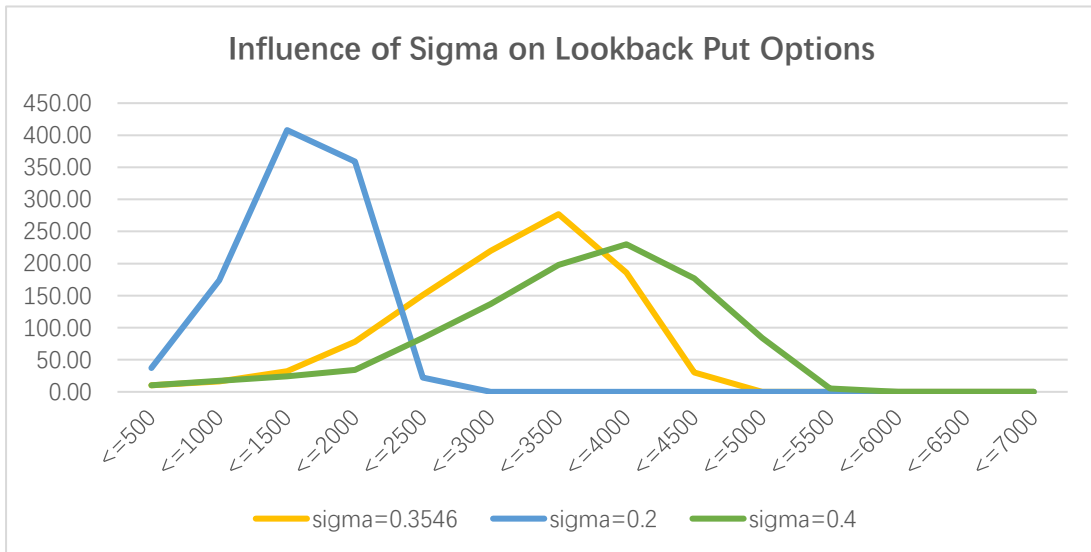
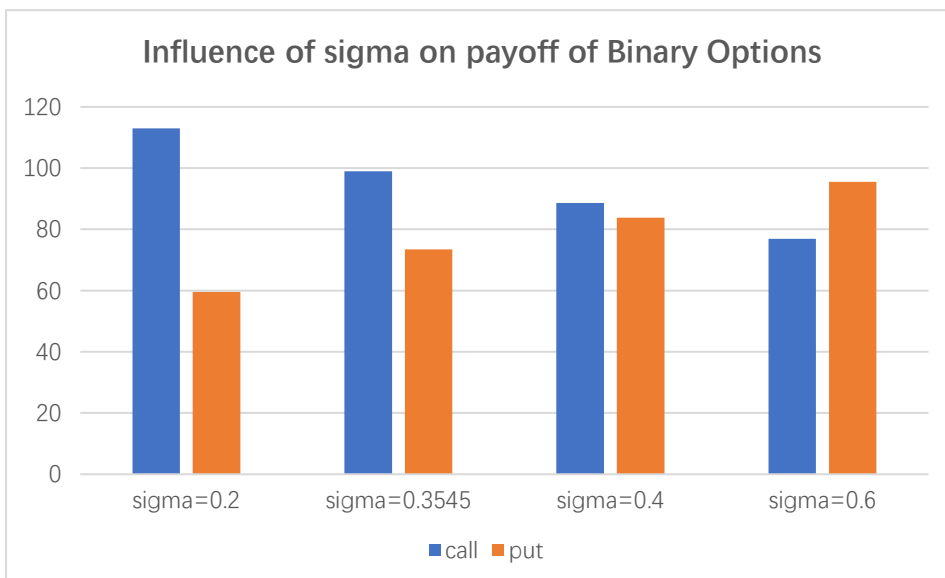


Chart 7.2 Influence of sigma on payoffs of lookback put options



The third one is for binary options. Change the sigma into 0.2, 0.3546, 0.4, and 0.6, and the payoff of chooser options at call and put position changes. However, according to the special feature of binary options, its payoff is fixed. As a result, we test the present value of call and put instead of payoffs.

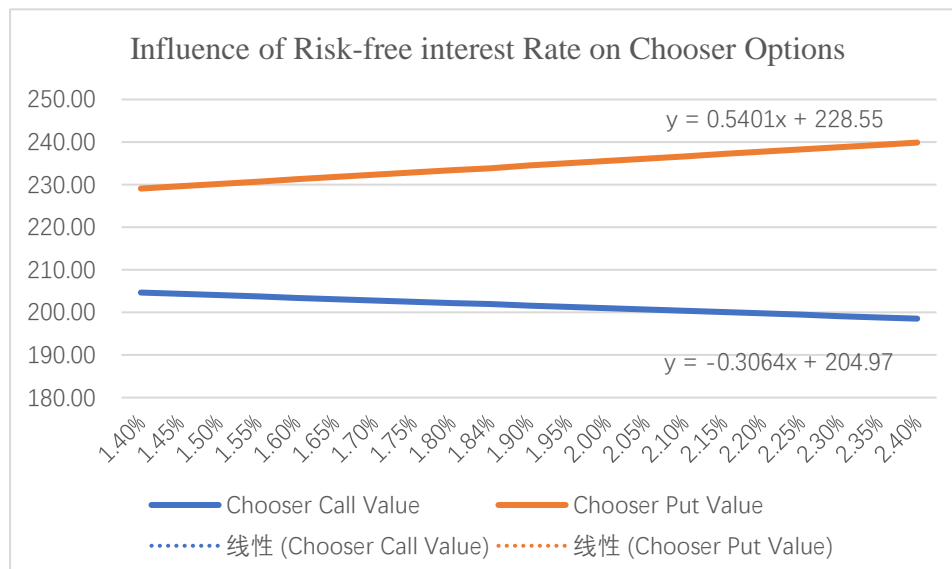
Chart 8.0 Influence of sigma on payoffs of binary options



As the sigma goes up, the value of call options decreases, while the value of put options increases. It can be seen that when the volatility becomes large, whether it's chooser options, look back options, or binary options, the payoffs and value of call options will decrease and the payoffs and value of put options will increase.

Based on the formula: $C_0/P_0 = ae^{-rT} + bS_0$, it can be seen that risk-free interest rate influence the call and put value. Researchers change the risk-free interest rate to see the influence on call and put value with chooser options for Amazon as an example. We only need test one example is because that the value of these options is calculated with the same formula with different payoffs.

Chart 9.0 Influence of risk-free interest rate on payoffs of chooser options



From the graph above, we can conclude that the increase of risk-free interest rate leads to the increase of call options and the decrease of put options.

Conclusion

This paper discusses the common application of exotic options in Alibaba and Amazon, focusing on the payoffs and value of these exotic options. Based on the conditions set by the researcher and the characteristics of various options, compared to the same company, lookback options bring the highest payoff and value. When the strike price of chooser options and the fixed payoff amount of binary options are changed, their payoff and value values will be changed. There might be different exotic options which are the most profitable.

When comparing the two companies, different call or put options have different payoff returns. For call options, the payoff returns of choose options and lookback options for Alibaba are higher than that of Amazon, but the payoff return of binary options for Amazon is higher than that of Alibaba. As a result, when investors choose to invest in chooser and lookback call options, Alibaba has more advantages, but when they invest in binary call options, Amazon has more advantages.

For put options, the payoff return of binary options and lookback options for Amazon is higher than that of Alibaba, but the return of chooser options for Alibaba payoff is higher than that of Amazon. As a result, when investors invest in binary and lookback call options, Amazon is more advantageous, but when they invest in chooser call options, Alibaba is more advantageous. These results help investors of these two assets make better decisions when they invest.

Changes in some conditions will cause changes in the value of these options. When the volatility is changed, the payoff and value of all call options are reduced, and the payoff

and value of put options are increased. The change of volatility has different influences on different options, especially on lookback options.

Therefore, the findings of this research are beneficial for both investors and financial institutions, because, for investors, this study discusses exotic options from their perspective to understand the characteristics of various types: researcher does not only simulate the specific return for exotic options but also analyzes the impact of different factors on specific options. This helps investors make better decisions when they invest. For financial institutions, through the application of different options in the same asset, it assists them to understand and analyze the characteristics of this asset, so that they can develop more appropriate exotic options for this asset.

However, there are limitations to this study. The main limitation of this study lies in the assumption of conditions. To compare the value of different exotic options under the same conditions, the simulation is carried out in the ideal state set by the researchers: it is assumed that the expected return on stocks and standard deviation are constant when σ changes with time. However, in reality, the change of these two factors may have different effects on the value of different options. Another limitation is that the amount of historical data and simulated samples in this research is not large. Statistical tests usually need large samples to determine the accuracy of regression. Later researchers can calculate the value of different options in a more realistic situation, considering the changes in expected return and standard deviation. In addition, researchers can further study the application of different exotic options in the whole e-commerce industry, not limited to two companies.

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APPENDIX

Table 1.0 Present value of chooser call options for Alibaba.

C0	a	b
\$23.0813	98.925	0.7242
\$23.5448	101.31	0.7411
\$24.0314	96.013	0.7127
\$23.4352	95.234	0.7045
\$22.5855	102.49	0.7423
Average \$23.3357		

Table 2.0 Present value of lookback call options for Alibaba.

C0	a	b
\$100.9926	65.704	0.9971
\$106.6607	60.032	0.9977
\$103.2603	63.411	0.9972
\$101.9151	65.001	0.9985
\$112.2327	55.354	1.0036
Average \$105.0123		

Table 3.0 Present value of binary call options for Alibaba.

C0	a	b
\$7.5254	8.0576	0.093
\$7.5535	8.7391	0.0972
\$7.6323	8.9124	0.0987
\$7.4761	9.3251	0.1002
\$6.1621	7.8319	0.0092
Average \$4.8051		

Table. 4.0 Present value of chooser put options for Alibaba.

P0	a	b
\$297.9495	469.62	-0.9827
\$257.4004	427.76	-0.9794
\$385.5857	560.27	-0.9909
\$298.8783	474.37	-1.0052
\$296.2341	466.03	-0.9718
Average \$307.2096		

Table 5.0 Present value of lookback put options for Alibaba.

P0	a	b
\$297.9495	469.62	-0.9827
\$257.4004	427.76	-0.9794
\$385.5857	560.27	-0.9909
\$298.8783	474.37	-1.0052
\$296.2341	466.03	-0.9718
Average \$307.2096		

Table 6.0 Present value of binary put options for Alibaba.

P0	a	b
\$7.1524	23.008	-0.093
\$8.6456	25.239	-0.0972
\$8.5665	25.412	-0.0987
\$8.7230	25.825	-0.1002
\$8.6182	24.332	-0.092
Average \$8.3411		