VSB – TECHNICAL UNIVERSITY OF OSTRAVA

FACULTY OF ECONOMICS

DEPARTMENT OF FINANCE

# Aplikace metod reálných opcí při ocenění společnosti BAIDU

# Application of the Real Option Methods in BAIDU Company Valuation

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Description:

1. Introduction
2. Description of Real Option Valuation Methods
3. Economic and Financial Characteristic of BAIDU Company
4. BAIDU Company Valuation with Real Option Methods
5. Conclusion

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List of Abbreviations
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The declaration

"Herewith I declare that I elaborated the entire thesis, including all annexes, independently."

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# Contents

# 1. Introduction

As the internet grows in popularity worldwide, more and more internet enterprises change the way people living, working and also entertaining. There are many big internet enterprises occupy large market share, and also some small internet companies bankrupt. In this situation, how to assess the value of internet enterprise objectively has become the focus not only in finance field, but also in social economic field. In comparison with traditional industry, internet enterprise has characteristics of high risk, high return and high uncertainty. The traditional method of discounted cash flow underestimates the value of the flexibility and ignores the chance brought by uncertainty in internet enterprise. Therefore, we apply a real options method to evaluate the internet enterprise.

In the diploma work, the objective is to employ the application of real options method in exploring the value of Baidu, one Chinese internet company. During estimation, we collect data from public sources. Baidu's official annual reports are the main sources of database, and we adopt information from the financial statements during the time between 2009 and 2013.

The second chapter of this paper is brief introduction of real options methods. Real options method views investment opportunity of managerial flexibility as a series of options that can achieve returns or avoid losses on investment. The basic idea of theory part is adopted from Schwartz and Trigeorgis (2004). Firstly, we point out the shortage of traditional methods, with Discount Cash Flow method as example. And then, basic parameters in real options are introduced. Next we classify real options into several types. And at last, we present how to compute real options according to the binomial model and Black-Scholes model.

The third chapter is written to introduce basic information about Baidu's economic and financial characteristics. We summarize the overview of Baidu at first,

as well as its services and market position. And then we analyze the internet industry in China. What kind of people are using internet? Is it possible to keep grow in the future? How about the market structure? After answering these questions, we use SWOT and Porter's Five Force method to discuss Baidu's market potential. And then, we adopt common size analysis and financial ratio analysis to measure Baidu's ability in profitability, management, solvency and liquidity.

In the fourth part, we employ real options approach to analyze the flexibility value of Baidu. First at all, we discuss why real options method is more efficient in internet enterprises. And then we estimate parameters and input data. After that we use four scenarios to analyze expand option, contract option and multiple options of Baidu.

In the end, we summarize the results of application computation in chapter 4, and analyze the procedure. Then, we give some recommendations to real options method application. We hope to make a useful exploration of Chinese internet company's valuation system.

# 2. Description of real options valuation methods

Options are financial derivatives, whose prices are determined by underlying assets. Real options, as its name implies, use options theory to evaluate real assets or sectors. And it can be considered as a right to make financial decisions, such as to receive a cash income from selling or buying a real asset. In this chapter, we will introduce what is real options valuation and how to calculate real options. The theory is adopted from Schwartz and Trigeorgis (2004), Koller and Goedhart (2010), Hitchner (2011) and Shockley (2007).

## 2.1 Difference between traditional valuation methods and real options methods

By contrast, discounted cash flow (DCF) method as a traditional valuation theory, assumes single static decisions. And the investments are often undervalued, because they did not properly value important strategic considerations. Traditional DCF method, including net present value (NPV) analysis, would discount the company's expected cash flows using the expected rate of return as discount rate. This risk-adjusted discount rate may not changing economic environment or changes specific to the project's risk profile that happen during the company's life. Therefore, DCF method cannot be used in operating options, because of their dependence of on future events that are uncertain at the time of the initial decision. At the same time, DCF method does not consider of flexibility. Hitchner (2011) mentions that traditional valuation methods assume that a project will proceed as planned even if future expectation are not met, and it does not incorporate the flexibility a manager has to alter strategic decisions over the project's economic life.

As the traditional valuation method has such inherent limitation, real options valuation gives the financial executives the flexibility to handle uncertainty and to make certain strategies in improving the value of the option before management exercises that option. Here, flexibility is defined as the possibility to make future decisions by the active management. And these decisions are considered as options,

which have value and can be quantified. It's possible to write the company and investment value as following equation:

$$\textit{Expanded value} = \textit{passive value} + \textit{flexibility value} \qquad (2.1)$$

This approach considers flexibility value reflects value of active management, and such probabilities are not taken into account when using traditional financial approaches.

## 2.2 Parameters of real options

The basic idea of real options is similar to financial option. Therefore, we can employ and understand parameters of real options from parameters of financial option. We assume that equity value of the firm is expressed as equity holder's call option value on firm assets. Therefore, the firm is regards as an investment project generating cash flow.

When we consider of an influence on underlying assets value and consequently on option value, it seems impossible in financial option, because underlying assets in financial option is market value. However, it seems possible for real options, because the underlying assets value of real options can be influenced by option exercising. And when we consider of sharing options, it also seems impossible for financial option, but possible for real options. The reason is that exercise of financial option is possible by owner only, and others who don't own the option cannot exercise. Whereas every can exercise. Meanwhile financial options are mostly plain vanilla options and European options, but real options are mostly compound options and American options. It's not necessary for real options to exercise at maturity day, and it's allowed to exercise at any time before maturity.

We compare the basic parameters of financial option on a stock and real options on a company's equity in Table 2.1.

Table 2.1 Relationship in financial option theory (on a stock) and real options theory (on a company's equity) [Schwartz and Trigeorgis (2004)]

| Parameter | | Financial option on a share | | Real options on firm equity |
|---|---|---|---|---|
| Underlying asset | $S_t$ | Spot share market value | $A$ | Firm assets market value |
| Maturity | $T$ | Maturity of contract | $T$ | Life of the firm |
| Exercise price | $X$ | Underlying asset price | $D$ | Debt face value |
| Risk free rate | $R_F$ | Risk free rate | $R_F$ | Risk free rate |
| Underlying asset volatility | $\sigma$ | Share price volatility | $\sigma_A$ | Assets value volatility |
| Intrinsic value | $IV$ | $IV_T=max(S_T-X, 0)$ | $IV$ | $IV_T=max(A_T-D, 0)$ |
| Option value | $c$ | Option price | $V_E$ | Firm equity value |

When we deal with real options in detail, there are some changes in parameters. For example, if we want to analysis real options on a expand project, we need to use exercise price, which is called Investment outlay to expand, $I_{exp}$, and option price is named flexibility value, $V_{exp}$.

### 2.3 Categories of common real options

In analyzing uncertainty and a financial executives flexibility, there are some different ways to classify real options. It can be distinguished in growth option future options and disinvestment options from the strategic point of view. And from future decisions and the financial management, there are operating and financial options. And operating options includes input options, which is used to choose supplier; process options, which is used for production aggregates; output options, which is used to determine the structure of the production. And financial real options includes some decision makings in liability and equity, such as options on the capital structure mix determination, share issuing and debt restructuring. And there are also some other

classify ways according to the impact on firm balance sheet

Here, we introduce the real options according to the type of active decisions. And in this way, real options is segmented in option to defer, option to abandon, option to contract, option to switch.

### 2.3.1 Option to defer

If a project is highly uncertain and risky, and it's possible to defer the starting of project to get profit at a certain time in the future, we can use option to defer the project. For example, management holds an option to buy a valuable land. It can wait several years to see if output prices justify constructing a building or plant. This method is very useful in all natural resource extraction industries, real estate development, farming and paper products.

The option to defer a project is similar to a European call option, which requires waiting until the value of the underlying asset exceeds the strike price before exercising. That means managers defer the project with investment cost *I*, if project's NPV is higher compared with its immediately starting.

Figure 2.1 Decision tree with an option to defer [Copeland and Koller (1994)]

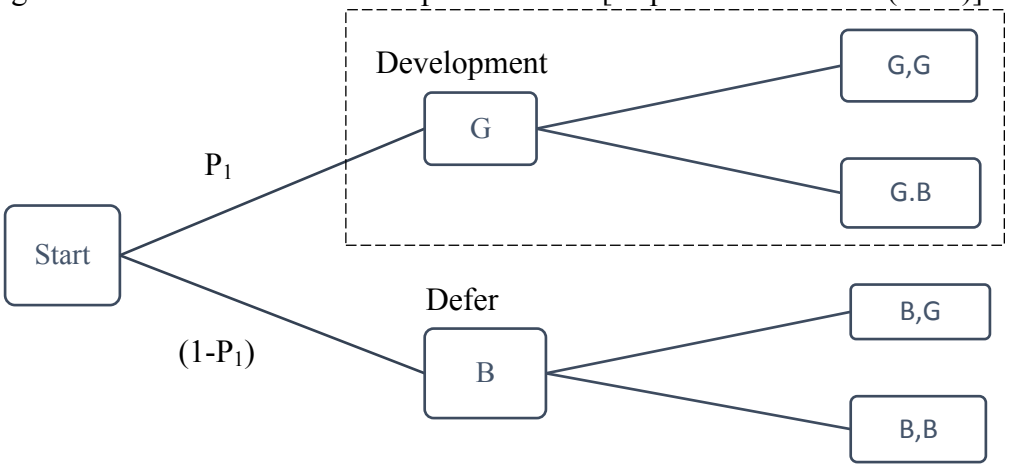



Figure 2.1 illustrates the option to defer a project. Because the manager has the right, or not an obligation, to defer the project, the project to be deferred is worth than the project to be developed immediately. Here, *B* means bad condition and *G* represents good condition.

Function of intrinsic value option, *IV*, can be formally written as follow,

$$IV = \max[V_0 - I_0, \frac{I}{(1+r)^t} \cdot (V_t - I_t)] \tag{2.2}$$

Here $V_t$ is the gross project value, which can be defined as present value of subsequent cash flow discounted back to the time *t*.

Decision function can then be written in this way,

$$F = \begin{cases} 1 \ for \ (V_0 - I_0) < \frac{I}{(1+r)^t} \cdot (V_t - I_t) \\ 0 \ for \ (V_0 - I_0) > \frac{I}{(1+r)^t} \cdot (V_t - I_t) \end{cases} \tag{2.3}$$

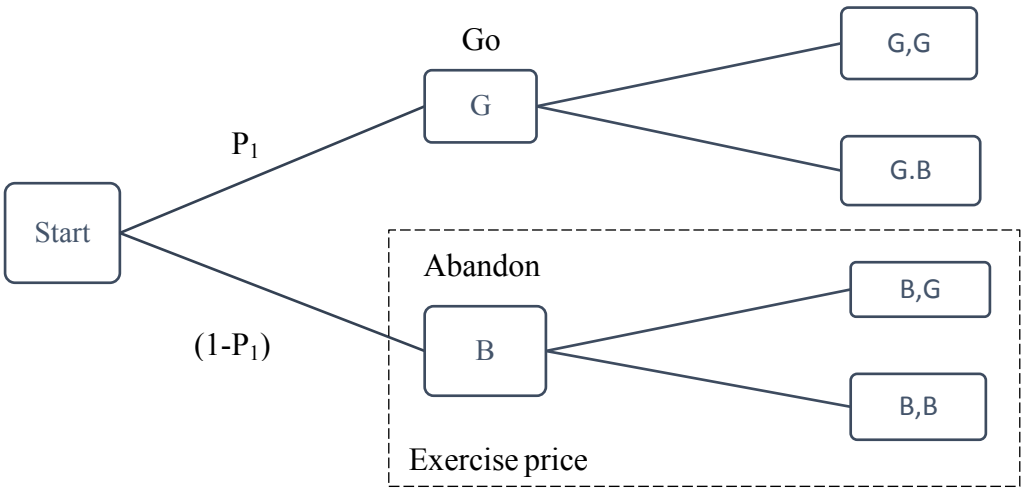
Here 1 means to defer the project, and 0 means to start the project immediately. In option to defer a project, it's important to consider the opportunity costs.

### 2.3.2 Option to abandon

If market condition decline severely, such as changes of government policies or financial crisis, manager has the possibility to abandon current operations or current projects permanently according to option to abandon the project. And then manager can realize the resale value $A_t$ of the capital equipment and other assets in secondhand market to get profit.

The option to abandon the project is always used in capital intensive industries, such as airlines and railways, financial services and new product introductions in uncertain markets.

Figure 2.2 Decision tree with an option to abandon [Copeland and Koller (1994)]




From Figure 2.2, we can find that if the bad outcome turns up at the end of the first period, the manager may decide to abandon the project and realize the expected

resale value.

An option to abandon a project looks like a put option. If the investment decision has produced results lower than expected, manager may decide to abandon the whole project and sell at a liquidation value. Therefore, manager has a put option on the gross value of the project $V_t$ when exercise price equals to resale value, which can be written as:

$$IV_t = max\ [V_t\ ,\ A_t - V_t\ ] \qquad (2.4)$$

Here $A_t$ is the resale value and is also called salvage value.

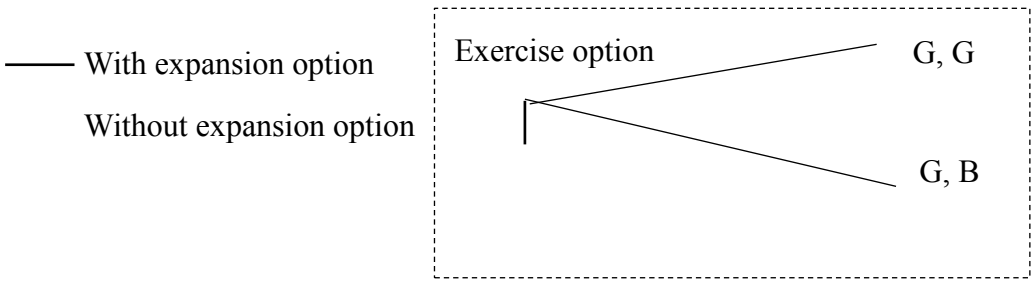
If the resale price at time $t$ is higher than the subsequent cash flow from continuing the project discounted back to the time $t$, manager should abandon the project. If the resale price at time $t$ is lower than the subsequent cash flow from continuing the project discounted back to the time $t$, manager should continue the project. Decision function of the firm can be written as,

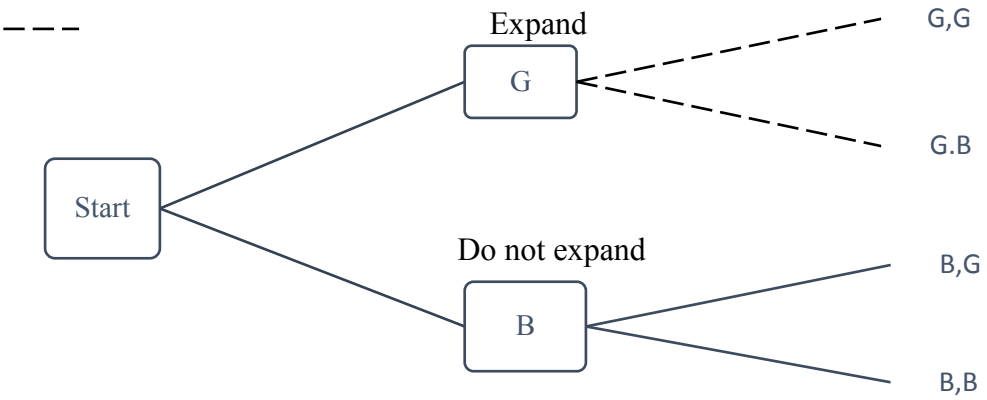
$$F = \begin{cases} abandon\ \ if\ V_t < A_t \\ maintain\ the\ operation\ \ if\ V_t > A_t \end{cases} \qquad (2.5)$$

### 2.3.3 Option to expand

If the market condition is very good and even over expectation, such as positive national policies, or good investment environment, manager has the possibility to expand the scale of project. The option to expand a project is main used in natural resource industries such as mine operations, facilities planning and construction in cyclical industries, fashion apparel, consumer goods and commercial real estate.

Figure 2.3 Decision tree with an option to expand [Copeland and Koller (1994)]






In Figure 2.3, we can find that the expansion option gives management the right to make additional follow-on investment when the project conditions turn out good, and the project that can be expand is worth more than the same project without the flexibility to expand.

The option to expand can be used as European option, in that case, project can be expanded only at a certain date in the future. And it can also be used as American option, which allowed expanding project at any time during the project's life.

Function of intrinsic value *IV* can be formally written as follows,

$$IV_t = max\,[V_t,\ x \cdot V_t - I_{exp}\ ] \tag{2.6}$$

Here $I_{exp}$ means the investment cost for project expanding at time *t* and *x* is the possibility of the scale expanding of the basic project. If the expanded project value by paying the additional cost is higher than the gross project value with the basic scale of project, manager can expand the project. Otherwise, manage should keep the initial scale. Decision function is presented as follows,

$$F = \begin{cases} expand\ \ if\ \ V_t < x \cdot V_t - I_{exp} \\ maintain\ the\ initial\ scale\ \ if\ \ V_t > x \cdot V_t - I_{exp} \end{cases} \tag{2.7}$$

### 2.3.4 Option to contract

If the market condition is not good and even be less favorable than expected, for example, powerful competitor appears, market share contraction or financial crisis happens, manager may reduce the scale of operations. The option to contract is used to reduce the loss in investment. And similar to option to expand, option to contract is also used in natural resource industries such as mine operations, facilities planning

and construction in cyclical industries, fashion apparel, consumer goods and commercial real estate.

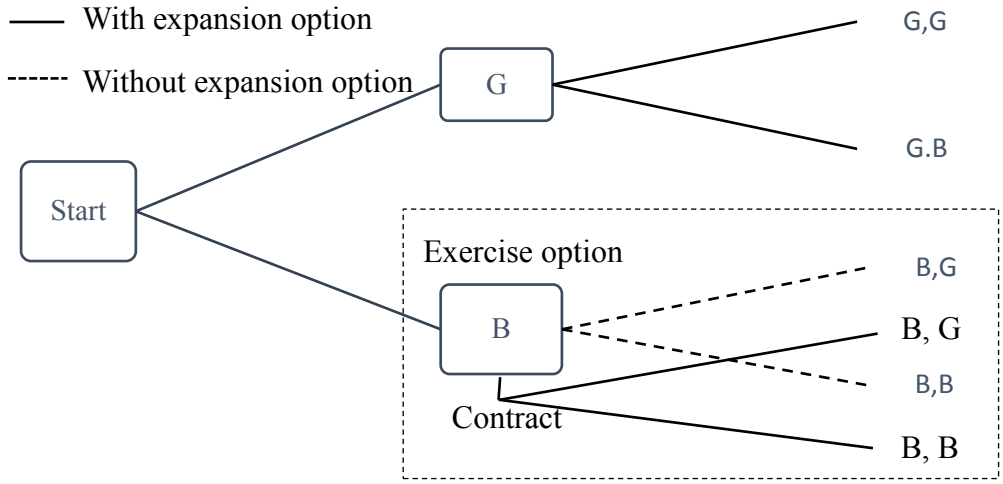
The option to contract can be used at a pre-specific time in the future, like European option, or at any time during the project's life, like American option.

Function of intrinsic value *IV* can be formally written as follows,

$$IV_t = max\,[V_t\,, I_{con} - y \cdot V_t\,] \tag{2.8}$$

Here $I_{con}$ means the investment cost for project contracting at time *t*, and *y* is the possibility of the scale contracting of the basic project.

Figure 2.4 Decision tree with an option to contract [Copeland and Koller (1994)]




If the contracted project value by paying the additional cost is higher than the gross project value with the basic scale of project, manager can contract the project and receive a part of investment cost. Otherwise, manage should keep the initial scale with gross value $V_t$. Decision function is presented as follows,

$$F = \begin{cases} contract\ \ if\ \ V_t < I_{con} - y \cdot V_t \\ maintain\ the\ initial\ scale\ \ if\ \ V_t > I_{con} - y \cdot V_t \end{cases} \tag{2.9}$$

### 2.3.5 Option to temporarily shut down and restart a project

If revenue of the project cannot cover the cost in a period time, manager have the right to shut down the project temporarily. Once the condition of the market or the project itself turns good, manager may restart the project. Therefore, operation in the given period time can be considered as a call option on the production by paying variable costs as the exercise price.

Function of intrinsic value *IV* can be formally written as follows,

$$IV_t = max(R_t - VC_t, 0) - FC_t \quad (2.10)$$

Here $R_t$ is the revenue before shut down, $VC_t$ represents variable cost as exercise price, and $FC_t$ means net of fixed cost of production.

And decision function of the company can be written as,

$$F = \begin{cases} temporarily\ shut\ down\ \ if\ \ R_t < VC_t \\ continue\ the\ operation\ \ if\ \ R_t < VC_t \end{cases} \quad (2.11)$$

## 2.4 Option valuation

In generally, people like to use financial option technology to analysis real options cases. However, in the real world, real options method is more complex than financial option. Therefore, financial option methods can provide only a rough valuation.

There are three fundamental types of models for option valuation. The first type is analytical models, and in this group, the Black-Scholes model is usually used. And the second type is numerical models, which consists of binomial model and trinomial model. And the third one belongs to simulation models, which includes Monte Carlo model.

The basic assumptions of option valuation are that the market is perfect and assets pay a known proportional yield. And it also requires constant parameters of drift, diffusion and riskless rate, unconstraint liquidity and no transaction cost.

### 2.4.1 Binomial model

Because real options are mostly the options of American type, we can introduce binomial model at first. And binomial model can be used to analysis not only American options, but also European options.

The binomial model was developed by Cox, Ross and Rubinstein (1979) as the simplification of Black-Scholes model, and it has the same logic with Black-Scholes model. Binomial model represents how the asset's value changes over a period time

with a particular volatility. During the calculation, a replication strategy for the discrete binominal model and one risky factor will be applied. And the replication strategy is based on the continuous compounding, which requires to create a portfolio consisting of the underlying assets *S* and the risk free asset *B*, and then to get derivative price $f_t$.

The portfolio value $\prod$ at any time can be defined as,

$$\Pi_t \equiv a \cdot S_t + B_t = f_t \tag{2.12}$$

There are only two possibilities during the movement in binomial model, either to go up or to go down. And in the subsequent discrete time $t+dt$ if the price moves up,

$$\Pi_t \equiv a \cdot S^u_{t+dt} + B_t \cdot e^{r-dt} = f^u_{t+dt} \tag{2.13}$$

And if the price goes down,

$$\Pi_t \equiv a \cdot S^d_{t+dt} + B_t \cdot e^{r-dt} = f^d_{t+dt} \tag{2.14}$$

Here *S* is the price of underlying asset, *a* is the amount of underlying asset, *B* is the price of riskless asset, *f* is the derivate price, *r* is risk free rate, *u* is the coefficients of upward movement in underlying asset, and *d* is the coefficients of downward movement in the underlying asset, $S^u_{t+dt}$ is the price of underlying asset if it move up, and $S^d_{t+dt}$ is the price of underlying asset if it move down.

When it reaches maturity time, the price of derivative is equal to the intrinsic value, which is also called payoff function. The function is written as follows,

$$f^u_{t+dt} = IV^u_{t+dt} \text{ , or } f^d_{t+dt} = IV^d_{t+dt} \tag{2.15}$$

By a series of calculation about *a, b,* $f_t$, we can get a general formula for derivative price valuation by the replication strategy,

$$f_t = e^{-r} \cdot \left\{ f^u_{t+dt} \cdot \left[ \frac{e^r \cdot S_t - S^d_{t+dt}}{S^u_{t+dt} - S^d_{t+dt}} \right] + f^d_{t+dt} \cdot \left[ \frac{S^u_{t+dt} - e^r \cdot S_t}{S^u_{t+dt} - S^d_{t+dt}} \right] \right\} \tag{2.16}$$

And under the consumption of risk neutral probability, the formula can also be written as follows,

$$f_t = e^{-r} \cdot \left[ f^u_{t+dt} \cdot (\hat{p}) + f^d_{t+dt} \cdot (1 - \hat{p}) \right], \text{ or } f_t = e^{-r} \cdot \hat{E}(f_{t+dt}) \tag{2.17}$$

$$\hat{p} = \frac{e^r \cdot S_t - S^d_{t+dt}}{S^u_{t+dt} - S^d_{t+dt}} \tag{2.18}$$

Here $\hat{p}$ is risk neutral probability of up-movement and $\hat{E}(f_{t+dt})$ is risk neutral expected value.

According to the geometric Brownian model, the price of underlying assets can be written as follows,

$$S_{t+dt}^{u} = S_t \cdot e^{u+c}, or\ S_{t+dt}^{u} = S_d \cdot e^{d+c} \tag{2.19}$$

Consider of formula (2.19), we can get a new expression of risk neutral probability of upward movement. The function is written as follows,

$$\hat{p} = \frac{e^{r-c} - e^{d}}{e^{u} - e^{d}} \tag{2.20}$$

And the function can be generalized after substitution of the risk neutral growth rate $\hat{g}$, which is shown as follows,

$$\hat{p} = \frac{e^{\hat{g}} - e^{d}}{e^{u} - e^{d}} \tag{2.21}$$

As for other parameters like *u* and *d*, we can get the basic function as follows,

$$u = e^{\sigma\sqrt{\Delta t}} \text{ , and } \quad d = e^{-\sigma\sqrt{\Delta t}} \tag{2.22}$$

After having a briefly understand of binominal model and risk neutral principle, we can start to introduce option pricing procedure in detail.

At first, we need to estimate the stochastic process of the underlying asset. Subjective approach in this part is based on the expert forecast and prediction. And objective in this part is based on the underlying asset by statistical estimation. General, we can use models like arithmetic, geometric Brownian motion, mean-reversion process and Ito process. We can get the coefficients of the upward and downward movement by observable volatility, and then with the function (2.22) to get the growth rate $\hat{g}$ for a given option. Therefore we can get risk neutral probability.

The second step is to simulate the evolution of underlying asset. The subject approach is also based on the expert's expectations. And the object function is based on the statistical estimation of the stochastic process of the underlying assets. Therefore we can get the price of underlying asset under function (2.19).

And the third step is to calculate option price for the end node of the binominal tree. And at the maturity day, option price should be equal to intrinsic price. And there are different ways to calculate intrinsic value according to different types of options.

In the fourth step, we work backwards from end of the binomial tree to the start to calculate option price in each node. Each node represent the state and time of option

price.

For European option, the function of price can be written as (2.17). However, it's more complex in American option, because the option can be exercise at any time before maturity. And the function is written as follows,

$$f_t = max\{IV_t^q;\ IV_t^{S+1} = e^{-r} \cdot \left[f_{t+dt}^u \cdot (\hat{p}) + f_{t+dt}^d \cdot (1-\hat{p})\right]\} \qquad (2.23)$$

Here $IV_t^q$ means the exercise the option, $IV_t^{S+1}$ means no exercise the option, symbol $q$ means choice option of process, $\hat{p}$ is the risk neutral probability and $f_t$ is the option price at time *t*. This function is from Bellman's option equation. And in real options cases, we also call it flexibility option value calculation

As we have mentioned previously, in the fifth part, the option price, $f_0$, is equal to the initial node of the binomial tree.

And in the sixth step, we can make decision on each node of the binomial tree. The decision $Q_t$ is defined as follows,

$$Q_t = \arg\max\{h(Q^1) = IV_T;\ h(Q^2) = e^{-r} \cdot \left[f_{t+dt}^u \cdot (\hat{p}) + f_{t+dt}^d \cdot (1-\hat{p})\right]\} \qquad (2.24)$$

Here $Q^1$ represents exercise the option and $Q^2$ represents no exercise the option.

Finally, if the underlying asset of the real options is not publicly traded in the secondary market, we need to make the sensitivity analysis on the input data.

### 2.4.2 Black-Scholes model

Option pricing theory developed rapidly from 1972, when Black and Scholes use a "replicating portfolio" to value dividend protected European options from their path-breaking paper. They believe that option could be priced using arbitrage principle with a risk free portfolio, and cover the need to estimate distributions of returns at all. Therefore, in their assumption, they build a replicating portfolio with underlying assets and risk free bonds. Black-Scholes model assumes that the limiting distribution is normal distribution, and price process is continues.

Contract with binomial model, in Black-Scholes model portfolio is keep risk free in a very short time, and in order to keep risk free condition, portfolio must be released

very often. And another difference is that Black-Scholes model is applied in European options.

Based on geometric Brown motion, we assume stock price *S* changes as follows,

$$dS = \mu \cdot S \cdot dt + \sigma \cdot S \cdot dz \tag{2.25}$$

Here $\mu$ is the expected return of the stock, $\sigma$ is the expected standard deviation of the returns in the pre-specific period. If *f* is a call option of the stock, we can define *f* as a function of *S* and *t*. The function can be written under Ito Lemma,

$$df = \left(\frac{\partial f}{\partial S} \cdot \mu \cdot S + \frac{\partial f}{\partial t} + \frac{1}{2} \cdot \frac{\partial^2 f}{\partial S^2}\right) \cdot dt + \frac{\partial f}{\partial S} \cdot \sigma \cdot S \cdot dz \tag{2.26}$$

Because option *f* and stock S have same characteristic in geometric Brown motion, which means they have the same $dz$ in the function, we can build a portfolio without random part of Brown motion. Therefore, we can get a risk free portfolio in a short time

$$\prod = -f + \frac{\partial f}{\partial S} \cdot S \tag{2.27}$$

There is no *dz* in the function, so the portfolio is riskless. And if the profit of portfolio is higher, arbitrager can sell risk free bond and buy the portfolio. If the profit of portfolio is lower, arbitrager will sell the portfolio and buy risk free bond. The function is presented as follows,

$$\left(\frac{\partial f}{\partial t} + \frac{1}{2} \cdot \frac{\partial^2 f}{\partial S^2} \cdot \partial^2 \cdot S^2\right) \cdot \Delta t = r \cdot (f - \frac{\partial f}{\partial S} \cdot S) \cdot \Delta t \tag{2.28}$$

And in simplified way, the function can be written as,

$$\frac{\partial f}{\partial t} + r \cdot \frac{\partial f}{\partial S} \cdot S + \frac{1}{2} \cdot \frac{\partial^2 f}{\partial S^2} \cdot \partial^2 \cdot S^2 = r \cdot f \tag{2.29}$$

Under risk neutral assumption, the price of European call option at maturity day should be shown as follows,

$$c = e^{-r \cdot (T-t)} \cdot \tilde{E}[max(S_T - X, 0)] \tag{2.30}$$

Here $\tilde{E}$ is expected price of European call option at maturity day. And $lnS_T$ is normal distribution, we can change $\mu$ to $r$ .Therefore, the function can be written as,

$$\ln S_T \sim \varphi[lnS + r - \frac{\sigma^2}{2} \cdot (T-t), \sigma \cdot \sqrt{T-t}} \tag{2.31}$$

Adapting integral method to calculate the right side of function, we can get the result of option price,

$$c = SN(d_1) - Xe^{-r(T-t)} \cdot N(d_2) \tag{2.32}$$

$$d_1 = \frac{\ln\left(\frac{S}{X}\right) + \left(r + \frac{\sigma^2}{2}\right) \cdot (T-t)}{\sigma \cdot \sqrt{T-t}} \tag{2.33}$$

$$d_2 = \frac{\ln\left(\frac{S}{X}\right) + \left(r - \frac{\sigma^2}{2}\right) \cdot (T-t)}{\sigma \cdot \sqrt{T-t}} = d_1 - \sigma \cdot \sqrt{T-t} \tag{2.34}$$

Here $N(d_1)$, $N(d_2)$ are the cumulative probability attribution function for a variable that is normally distributed with a mean of zero and a standard deviation of one. Therefore *c* can also be expressed as,

$$c = e^{-r(T-t)}[S \cdot N(d_1) \cdot e^{r(T-t)} - X \cdot N(d_2) \tag{2.35}$$

By the same logic, the price of European put option can be written as follows,

$$p = X \cdot e^{-r(T-t)} \cdot N(-d_2) - S \cdot N(-d_1) \tag{2.36}$$

During the process, the first step is to estimate $d_1$ and $d_2$, the second step is to use cumulative function and to calculate $N(d_1)$ and $N(d_2)$. The third step is to estimate present value of the exercise price by the continuous time version of the present value formulation. And the last step is to use Black-Scholes model to estimate the value of option.

# 3. Economic and Financial characteristics of BAIDU

Fundamental analysis of the company is a basic step before evaluation. In this Chapter we will introduce economic and financial characteristics of Baidu. First of all, we start with brief overview of Baidu. And then we analyze Chinese internet market, getting industry status. Next, we analyze the potential of Baidu in the market, according to SWOT analysis and Porter's Five Force analysis. At last, we end with financial analysis of Baidu.

## 3.1 Overview of Baidu Inc.

Over the past twenty years, the internet has truly transformed China. There are more than 600 million internet users in China, which indicates almost half of Chinese are living with internet. In this huge market, Baidu occupies more than 75% revenue share in the internet search market, and 30% market share in online advertising area until 2013. At the same time, it has approximately 753,000 active online marketing customers. Its online marketing customers not only be individuals, but also consist of small and medium enterprises (SMEs) throughout China, large domestic companies and Chinese divisions or subsidiaries of large, multinational companies.

Baidu is founded in 2000, at beginning it was an internet search engine website. And then with the development of technology and expansion of market scale, Baidu extended its service from simple search to mobile and cloud, location based services, consumer products and international operations. It's products includes web pages, news, images, multimedia files, music, movies and it's also the first one in China to offer Wireless Application Protocol and personal digital assistant based mobile search. Web search is the main business of the company's online productions, which may deliver the most useful and relevant search. And based on this successful service, Baidu sell advertising and get profit efficiently. Besides, it has invested in other entities, for example computer game company. Variety products successfully attracted consumer's loyalty. According to a recent survey by China Internet Network

Information Centre, there are 470 million active search internet users in China in 2013 and 86% of them identified Baidu as their favorite internet service company.

In 2005, Baidu was listed in NASDAQ (NASDAQ: BIDU) as the largest Chinese company. At the initial public day, Baidu opened at $66, more than double its initial public offering price $27, the highest price reached to $151.21 and ended at $122.54, which went up by 354%. Baidu became the IPO market's biggest splash in at least five years. In 2007, Baidu became the first Chinese company to be included in the NASDAQ-100 index.

### 3.2 Industry Analysis

No one can ignore influence of internet today. Until the end of 2013, China has had 618 million internet users, with a growth of 53.58 million compared to 2012. And mobile users in China account 500 million, with 80.09 million growth.[1]

What kind of people contribute to this huge population? Figures blow will indicate some basic attributes of China internet users.

Figure 3.1 Sex structures of internet users

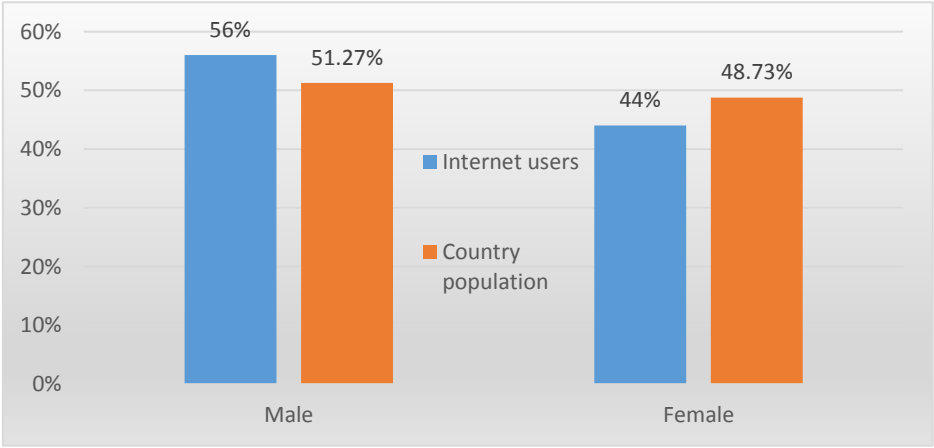



Figure 3.1 presents the sex ratio of internet ratio was 56:44 by the end of 2013, and more male like to use internet, while the country sex ratio is 51.27:48.73.

Figure 3.2 exhibits the age structure of internet users in China. Most portion of internet users are from 20 to 29, and these people grew up with internet development together. The second portion is from 30 to 39, which is followed by users from 10 to

[1] China Internet Network Information Center (2014)

19. The proportions of low-age and advanced-age users occupy a small part. These people don't have ability and interest to use internet. Age structure of internet users kept stable from 2012 to 2013.

Figure 3.2 Age structure of internet users

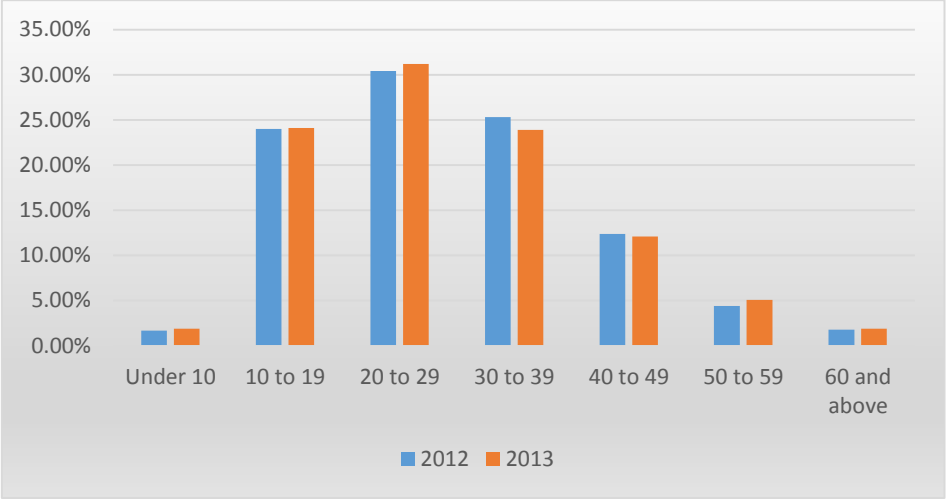
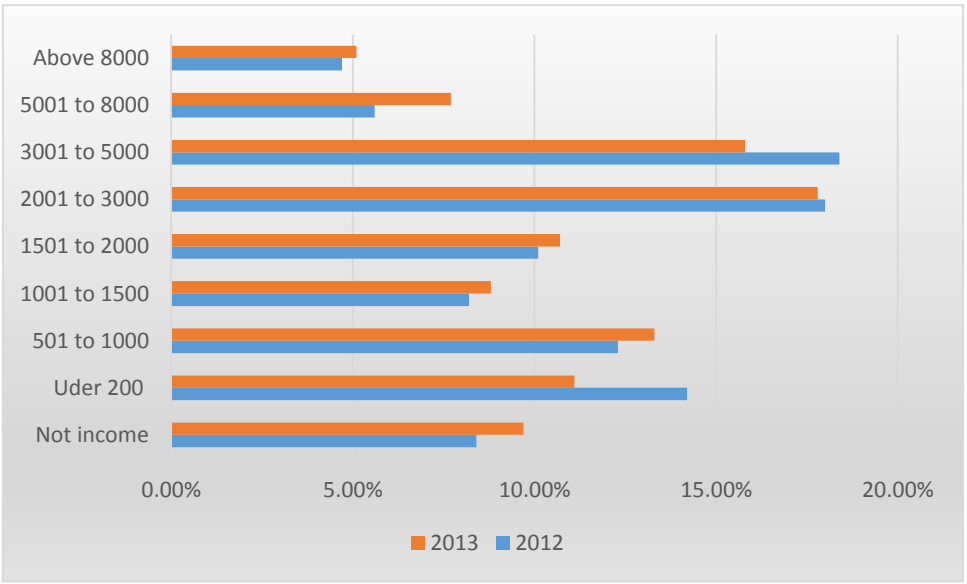



Figure 3.3 shows the structure of individual monthly income of internet users. Interest users with a monthly income 2001 CNY to 3000 CNY are the biggest part in 2013, but in 2013 the biggest size is users with 3001 CNY to 5000 CNY. Because average monthly salary in China is 4000 CNY, the base population with income from 2001CNY to 5000 CNY is large. Generally speaking, high income people take up a small part of internet users.

Figure 3.3 Structure of individual monthly income of internet users (CNY)

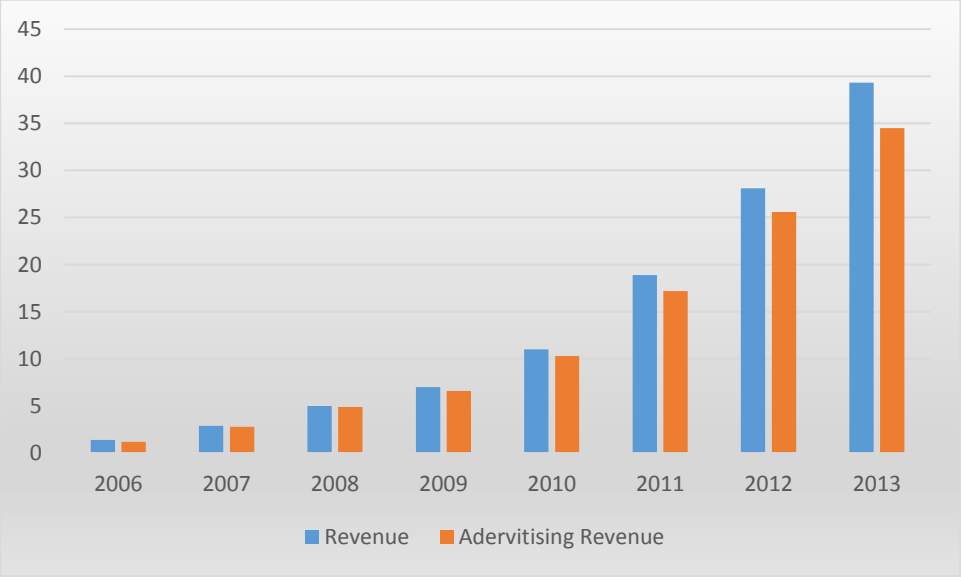



Why more and more people like to use internet? Why does Chinese internet

market develop so quickly? The first reason is supporting of national policy. Recent years, Chinese State Council issued a series policies on facilitating information consumption and expanding domestic demand, which requires to put a high value on the role of internet in the overall economy and society. And secondly, with the development of whole economy, combination of internet and traditional industry is a successful business model. People found that internet can be applied in shopping, logistics, payment and even finance. Based on such reasons, internet have gradually changed people's life style, and have had a significant impact on people's basic necessities of life.

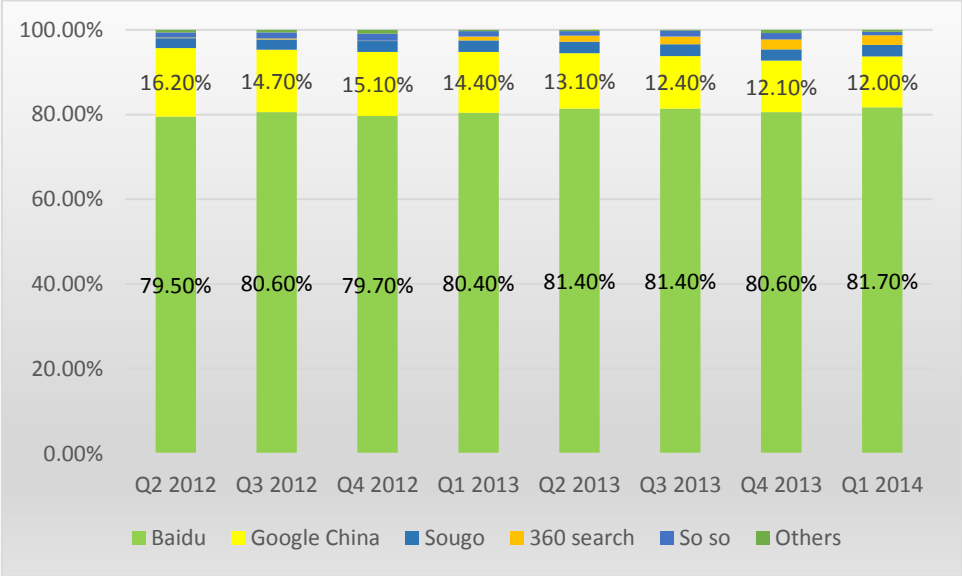
Under this positive environment, it's not difficult to understand why the US is the world's largest internet advertising market with 38% of global internet advertising revenue, but China has the largest population of users which is still fast growing. In 2013, the total revenue of China search engine market is 39.32 billion CNY, up 40.1% from 2012. And the main part of revenue, advertising revenue, increased to 34.53 billion CNY, up 34.9% from 2012. From this side, China advertising market is the fifth largest in the world after the US, Japan, UK and Germany. However growth speed of China advertising market far exceeds the US, which grows around 13% per year.

Figure 3.4 Total revenue and advertising revenue of China search engine market (million, CNY)



We can believe that Chinese search engine approaches maturity period. From historical data, even though growth rate of market revenue is the triple of the US market, the increase velocity is quiet stable. With continuous expansion of the market size, the growth slowed down to some extent.

Figure 3.5 Chinese search engine market share by total revenue




From Figure 3.5, we can find that market structure remained stable from 2012 to 2014. It's not easy for new enterprise entry into the market. Consumers have already been fostered reliance on some brand. Enterprises try to entering new markets, such like E-business or E-finance. The most common way is integrating among variety internet enterprises, and increasing their competitiveness through merger, acquisition or shareholding. With the whole search industry in the mature stage, the sustainable development of search engines in the future will also depend on the search result safety and user trust.

### 3.3 Strategic analysis of Baidu

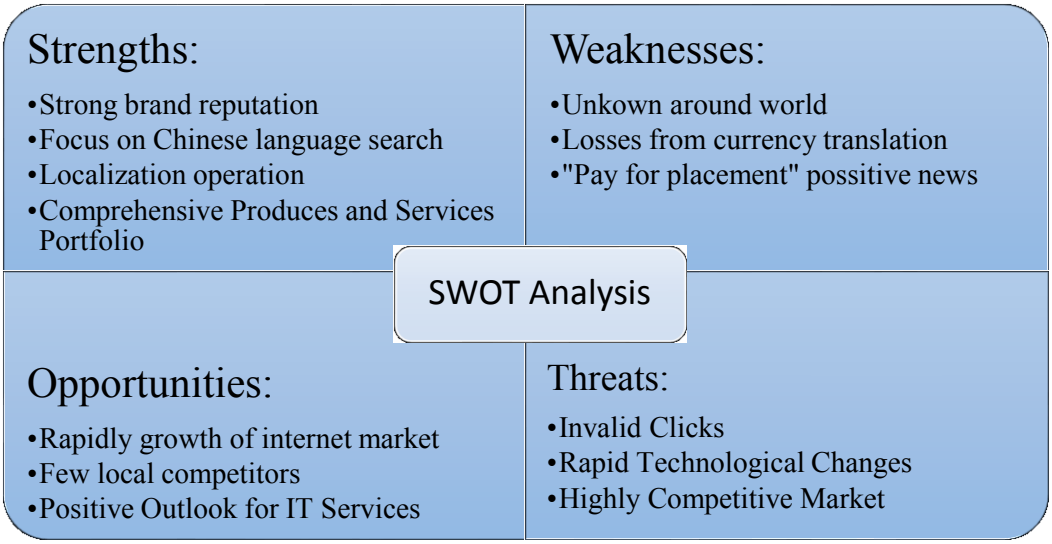
We will discuss Baidu's market situation with SWOT analysis and Porter's Five Forces Model.

#### 3.3.1 SWOT analysis of Baidu

We analyze operation strategies of Baidu from its strengths, weaknesses,

opportunities and threats. And the results are summarized in Figure 3.6.

Figure 3.6 SWOT analysis




**Strengths**

The biggest strength of Baidu is consumer's loyalty. Baidu works as leader in Chinese search engine market. When a Chinese opens an internet browser, the first step always be click Baidu.com. It's hard to change Baidu's position and internet user's preference.

Contrast with Google, Baidu focus on Chinese language search. The search engine and other services cater to Chinese hobby. And Baidu can get more support from government with localization operation. As a local company, Baidu has better understanding of Chinese cultural, Chinese law, Chinese tradition and hidden rules. That's also the reason why Google was beaten by Baidu and leave Chinese market in 2010.

Finally, based on diversified consumer, Baidu provides a comprehensive portfolio products and services, which can satisfy users variety needs from a single company. Uses can listen to music, read article, watch movies, communicate with others, and go online shopping.

**Weakness**

Every coin has two sides. In addition to advantages we have mentioned above, Baidu's concentrated geographical operation limits its international development. Its

brand recall outside of China is lesser than any other Chinese internet companies, such like Tencent and Sina.

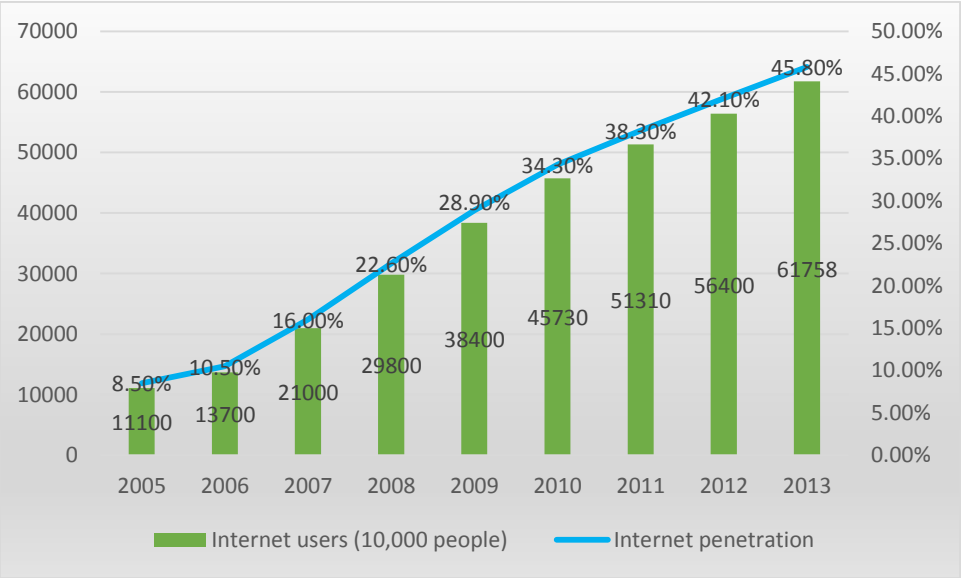
The second weakness is losses from currency translation. Baidu went public in NASDAQ in 2005. After that the company's functional currency is USD, but the company's reporting currency is CNY. The currency risk cannot be ignored in the transaction process.

The last one is "pay for placement" model. "Pay for placement" model is a kind of benefit model. Baidu arranges the position of enterprises or websites depending on payment. Enterprises and websites with higher payment to Baidu, can get a higher position when user search for related key words. People shocked of this dishonest model, when the news was exposed. Even though Baidu's clever public relation decreased the bad influence of this matter, people still hesitate about accuracy of searching results when they use Baidu.

**Opportunity**

Internet grows rapidly around the world, and especially in China. The size of internet users in China be larger and larger. Trend of market size grows up from 2005 to 2013. Baidu has enough market place and potential market to expend. It has more opportunity to concentrates on the segment of market, and make more appealing internet products.

Figure 3.7 Number of internet users in China




Because of Baidu's large part of market share, and internet user's preference,

there are few competitors for Baidu. Baidu has preferential consumers resources, which leads to an effectively cooperation in strategic partnerships.

Finally, Baidu has already built an IT infrastructure system with a positive long-term plan. Baidu takes Research and Development department seriously. As the result, hardware, software and services can be key elements in future growth.

**Threats**

As an internet information service company, Baidu gains revenue from click basis of advertisements and websites. Baidu has the ability to make a wrong high number of clicks to get more profit, which be called invalid clicks. But that would undermine company's credibility and reputation. Besides the fraudulent behavior, the company should pay more attention to make every link valuable. To explore more valuable and relevant click should be Baidu's further goal.

Rapidly growth of technology has higher requirement to internet companies. Contrast with some international internet companies such as Google and Yahoo, Baidu has limited advantage in technology. As search technology continues to develop and mobile devices and applications are increasingly used to access the Internet, manager of Baidu has been aware of its shortage in innovation. That force the company to pay more attention on technology part. For example, Baidu established the Baidu Institution of Deep Learning in 2013, which could help to develop cutting-edge speech and image recognition technologies.

The last threat is from the highly competitive market. Some competitors are from other types of advertising media, such as newspaper, TV programs and billboards. Some competitors are from internet companies, such as Google, Qihoo 360 and Alibaba. Among these competitors, some company have significant financial resources, long operating histories and are experienced in attracting and retaining users.

### 3.3.2 Porter's Five Forces Model

In essence, the job of strategist is to understand and cope with competition.

However, managers always define competition in a narrow way, as if it occurs only among direct competitors. As Michael E. Porter (2008) pointed that, competition for profits goes beyond established industry rivals to include four other competitive force as well: customers, suppliers, potential entrants, and substitute products. And the extended rivalry that results from all five force defines an industry's structure and shapes the nature of competitive interaction within an industry. Here we apply Porter's Five Force model to explain the competition of Baidu.

**Bargaining power of supplier – low**

Because Baidu benefits from advertisement, we can recognize internet user as "supplier" who drive traffic to Baidu. In this respect, the bargaining power of supplier is weak. Furthermore, Baidu gets intellectual property and copyright by way of mergers and acquisitions. In this side, suppliers of intellectual property and copyright don't have strong bargaining power.

**Bargaining power of buyers – low**

As the leader in Chinese internet search engine market, Baidu has absolute predominance in negotiation. There is no advertiser have much bargaining power over Baidu. Especially after Google's exit from China in 2010, Baidu has been reducing revenue share with advertiser.

**Threat of new entrants – low**

Internet market in China is in maturity stage now, and market structure is table. Meanwhile internet industry is technology-intensive. The barrier of entry into this market is really high. Therefore, the threat of new entrants is low.

**Threat of substitute products – medium**

Even though Baidu is very convenience to use, the segment of search engine makes substitution become possible. Qihoo 360 was a company to produce antivirus software at first, then introduced its own search engine in 2012, and secured 10% to 11% search traffic share now. Threat of substitute products is medium.

**Intensity of rivalry – medium to high**

The intensity of rivalry is between medium to high. Warren Buffett has mentioned that it is hard to predict the future winners and losers with certainty in the

technology sector. There are some U.S.-based internet search companies providing Chinese internet search engine, like Google, some China-based internet companies, like So-so, and also some internet search engine in special area, like Alibaba. These internet companies compete for both users and customers on the basis of user traffic, quality (relevance), safety and user experience of the search results, availability and ease of use of products. If anyone appears better, the user traffic could increase immediately.

## 3.4 Financial characteristic of Baidu

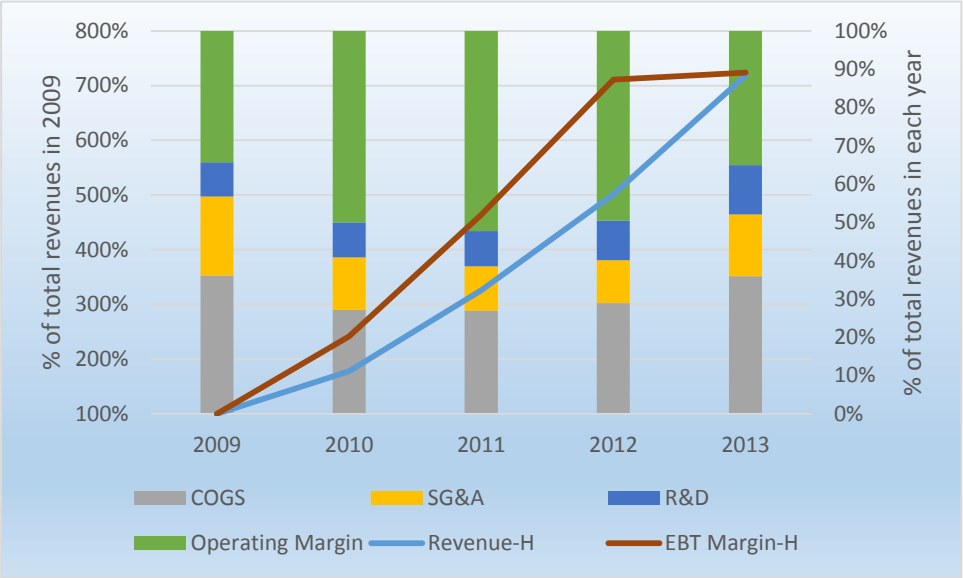
In this part, we will discuss financial situation and financial ratios of Baidu. We focus on the ability to cover company's liabilities, ability in asset management, ability of profitability and ability in further development. The primary source of data is from Baidu's annual report from 2009 to 2013, including financial statements and notes, and management commentary.

### 3.4.1 Income statement analysis

Income statement presents the performance of a business for a specific period of time. From horizontal analysis of Baidu's income statement, we found that its revenue increased 177.96%, 326.02%, 501.51% and 718.20% in 2010, 2011, 2012 and 2013, compared with the total revenue in 2009. This reflects an extremely strong growth in revenue. And Baidu's revenue is mainly from Pay for Play (P4P) business.

Figure 3.8 reflects horizontal-vertical analysis of balance sheet. The right side axis reflects percentage components of total revenue. And the left side axis reflects how each item changes by comparing with initial value of each item.

Figure 3.8 Horizontal-vertical common-size analysis of balance sheet




While the growth speed of other components declined, research and development expenses, general and administrative expenses, and cost of goods sold are still increasing with higher and higher speed. Baidu has always been committed to the research, development, new technologies, and new products. For an internet company, advanced technology is the determine factor of succeed. Technically, there are three laboratories in Baidu: Silicon Valley Artificial Intelligence Laboratory, Deep Learning Institute (IDL) and Beijing Big Data Lab.

There is a great growth of net interest income and other incomes in 2011. In 2010, Baidu's main competitor, Google, decided to leave Chinese market, and Baidu expanded its market share at this chance. At the same time, Baidu enlarged short-term investment, and the short investment gains in 2011 are very high, which reached CNY 726.4 million.

According to vertical common-size analysis, research and development expenses is the only item which kept increasing from 2009 to 2013. Other items are floating in different time period. And the whole structure of revenue keeps more stable.

### 3.4.2 Balance sheet analysis

Balance sheet presents information about financial conditions, according to measure company's obligations to lenders, creditors, and shareholders, and also the resources, which are hold and controlled by company. We start to analyze components of assets by horizontal-vertical analysis.

Figure 3.9 Horizontal-vertical common-size analysis of assets

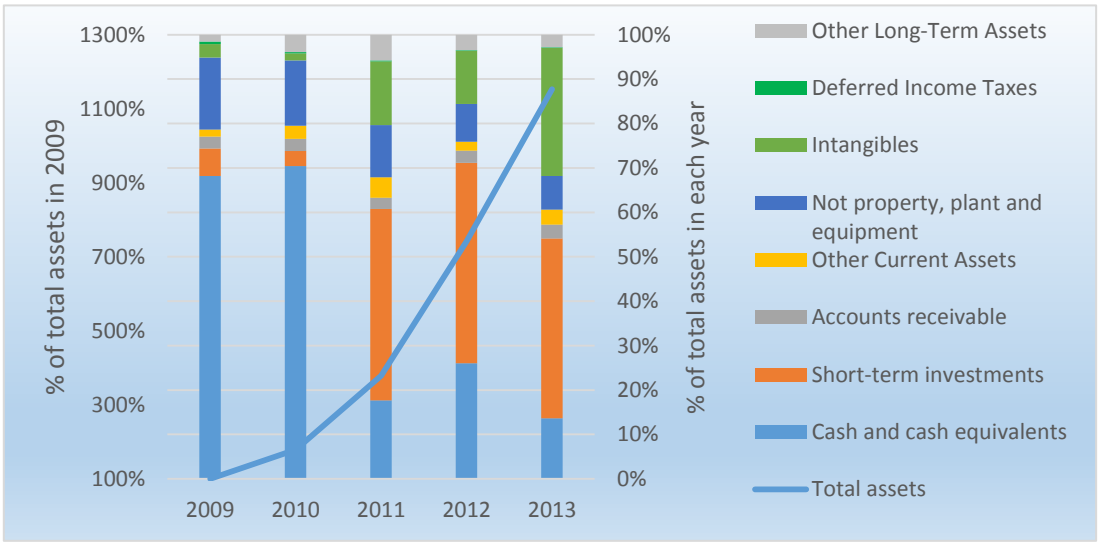



Figure 3.9 indicates a significant fluctuation in asset's structure from 2009 to 2013. Here cash and cash equivalent has a slightly increase from 68% to 70% of total assets during 2009 to 2010, after that it dropped rapidly to 18% of total revenue in 2011, and then it went up to 26% in 2012 and dropped to 13% in 2013. Studying with horizontal growth in cash and cash equivalent, we can find that it growth 185%, 98%, 283% and 231% in 2010, 2011, 2012 and 2013.

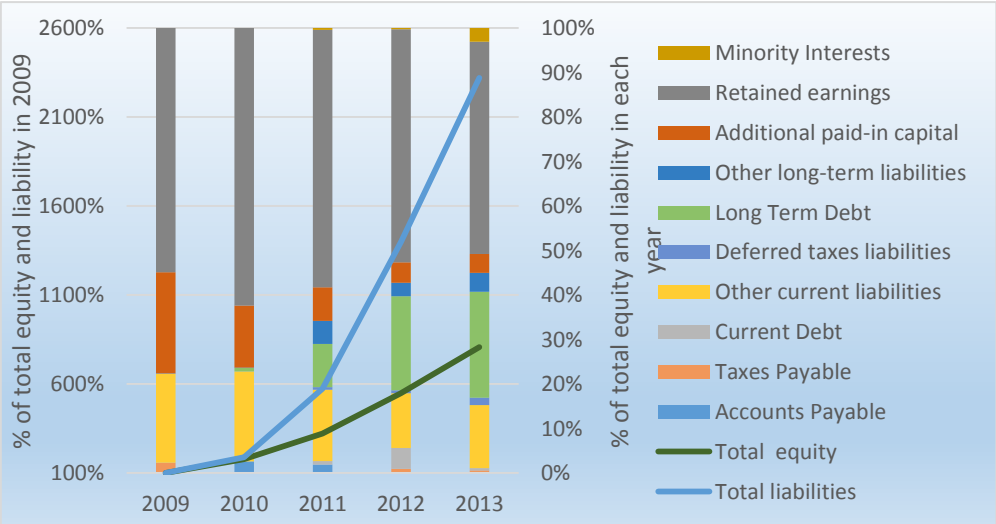
What happened in 2011? And how did this strange change occur? The one reason is that cash and cash equivalent is affected by inflation. Higher inflation caused lower amount of cash and cash equivalent. And because of financial crisis, China's inflation rate is -0.7% in 2009. And then Chinese government takes some stimulus measures to boost the economy, which contributed an increasing high inflation rate. Until 2010, inflation rate reached to the peak, 5.4%. And from 2011, it fluctuated stable around 2.6%.

And another and also the main reason is that Baidu concentrates more on short-term investment in 2011. We can see that the portion of short-term investment increased 6%, 3%, 43%, 45% and 41% from 2009 to 2013. For example, Baidu had a short-term loan negotiation with Bank of China with a credit facility of US$30 million for general corporate purpose in 2011. And it borrowed an unsecured loan of AU$105 million with Australia and New Zealand in 2012.

Intangible assets also appear a significant change in Figure 3.9. The amount of intangibles grows significantly from 2009 and 2013, and it occupies more and more portion in total assets. Baidu's intangible assets includes the trademark of "BAIDU", which is the most famous internet trademark in China, domain name asset, license and other trademarks acquired from business union or cooperation services.

Figure 3.10 appears how liability and equity changes according to horizontal-vertical analysis. There is a noticeable portion in histogram, which is retained earnings. Retained earnings are cumulative earnings which have not been paid to the owners of the company as dividends. Baidu has no dividends to shareholders, and its net income is very high, therefore its retained earnings keep a stable large portion of total liability and equity.

Figure 3.10 Horizontal-vertical common-size analyses of liability and equity




There is also a noticeable line in horizontal analysis, which is long term debt. Baidu has no long term obligations in 2009. However, the item grows up 2649%, 11271%, 20034% in 2011, 20112 and 2013, which includes big international banks' long-term

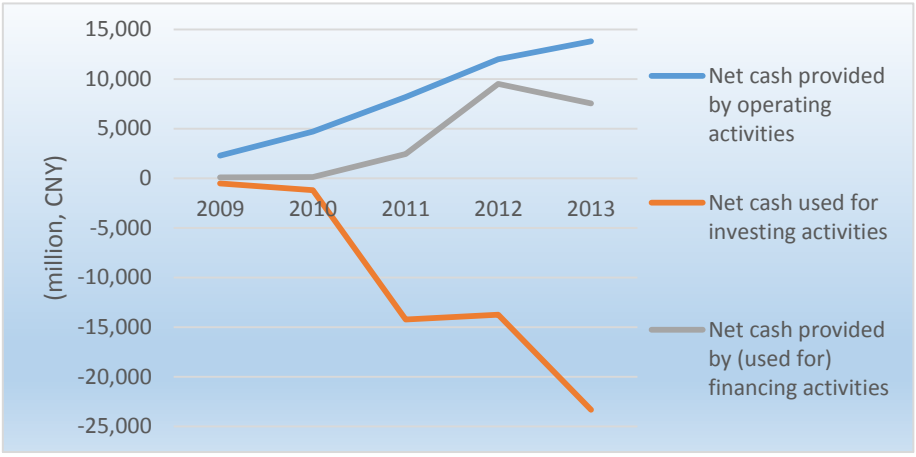
debt obligations and senior unsecured notes. The raise of Baidu brings out a good liability condition, and more international financial institutions are willing to cooperate with Baidu.

### 3.4.3 Cash flow Analysis

While cash flow from financial and operating activities are positive, cash flow of investing activities is negative, which is illustrated in Figure 3.11. The company is still in maturity stage, and it has the potential in the future development.

Therefore, Baidu uses 0.5 billion CNY, 1.2 billion CNY, 14.3 billion CNY, 13.8 billion CNY, and 23.3 billion CNY in investing activities from 2009 to 2013. During this time, the company's acquisition business included Qunar Cayman Islands Limited ("Qunar") in 2011, which is one of the biggest tourism website, and Qiyi.com, Inc. ("Qiyi") in 2012, which is a famous video website.

Figure 3.11 Line graph of growth of cash flow

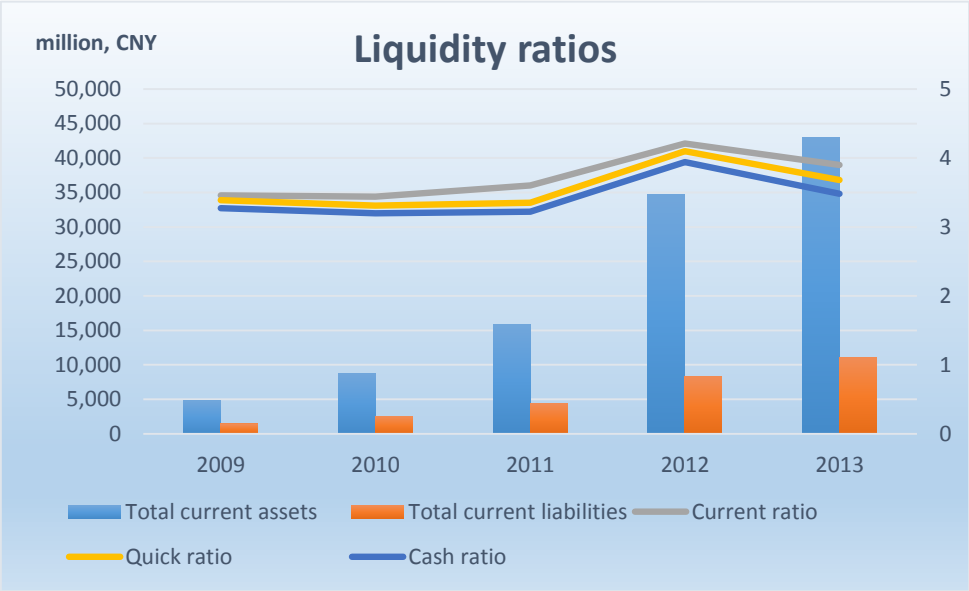



Because of the steady growth in net income, Baidu's net cash in operating activities also sustains a stable growth from 2009 to 2013. And strong cash flow from operating activities gives Baidu more opportunities to expand its business scale. There appears a general upwards trend of net cash used for financing activities in Figure 3.11. However, from 2012 to 2013 net cash provided by financing activities dropped by 2 billion CNY, and it is due to the decrease of long-term notes issued in 2013.

### 3.4.4 Liquidity ratio

Liquidity ratio measures the company's ability to meet its short term obligations. Current ratio, Quick ratio and cash ratio are applied in Figure 3.12.

Figure 3.12 Growth of liquidity ratios



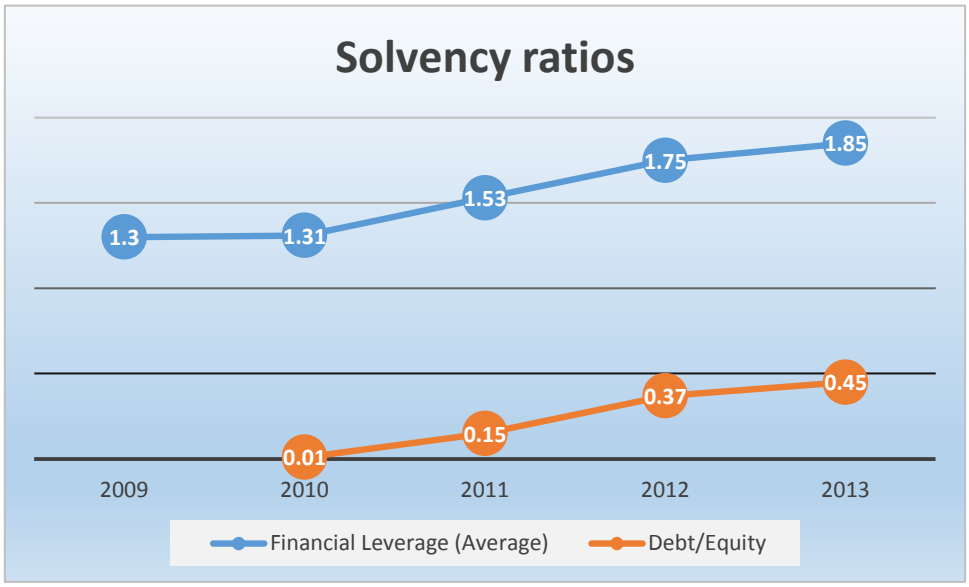

The general trends of Baidu's liquidity ratios are almost same. Over the period from 2009 to 2010, liquidity ratios remained steady around 3.3. And then they began to raise slightly, up to 4.2, 41, 3.9 in current ratio, quick ratio, cash ratio, in 2012. The dramatically growth of total cash, cash equivalent and short-term investments contribute to this increase. After that the ratio dropped back, near 3.6.

In practice, Baidu as a high technical company, meets intense market competition all the time, thus the company should keep enough current assets to ensure the smooth progress in technical research activities and high liquidity to core with unexpected expenses. And from common view, people think high technical enterprises can bring higher returns for investors, so Baidu must keep a high ability to meet its short-term obligations, which can be one of its strength to catch investors' attention.

### 3.4.5 Solvency ratios

Be similar to liquidity ratios, solvency ratios are also used to measure company's ability to cover its liabilities. But analysis of solvency ratios is focus on long-term and other obligations. Financial leverage and debt-to-equity ratio are used in Figure 3.12.

Figure 3.12 Growth of solvency ratios



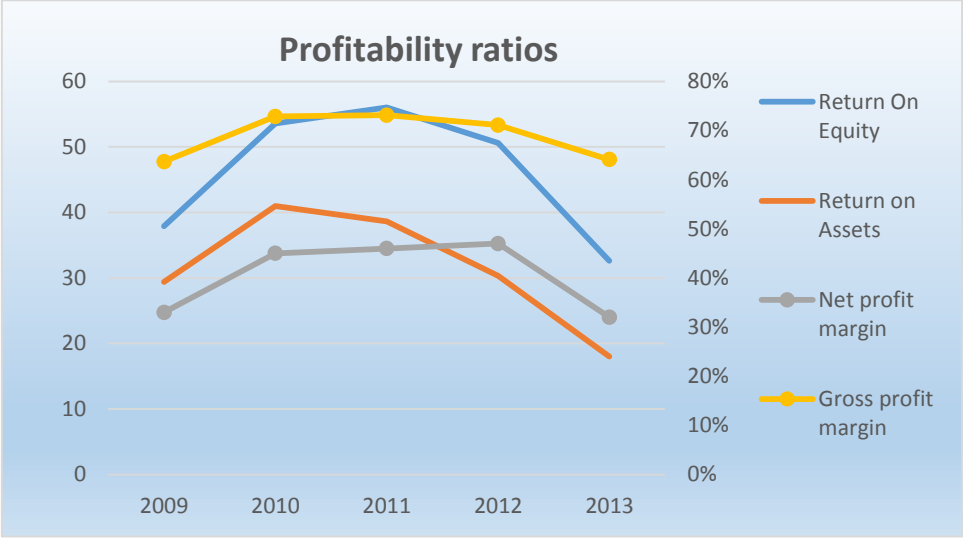

Financial leverage indicates the amount of total asset relative to total equity, and debt-to-equity indicates the amount of total debt relative to total equity. These two ratios grew up in the same trends from 2010 to 2013, and there is no debt in 2009, so the debt-to-equity ratio is zero.

Increase in total investment leads to the growth of financial leverage and debt-to-equity ratio. And long-term obligation takes up more and more share in total capital, which is a dangerous sign for company. Because it implies that total leverage of Baidu increased. Creditor provided investment agreement to Baidu because they believe Baidu has good solvency ability. But with the increase of financial leverage and debt-to-equity ratio, creditors will bear more and more risk of the company. As a consequence, manager changes capital structural and slower growth in ratios appeared in 2013.

### 3.4.6 Profitability ratios

Profitability ratios measure the company's ability to manage profits from its assets. And profitability plays an important role in market competition. Gross profit margin and net profit margin are used to analyze return on sales, meanwhile return on assets (ROA) and return on equity (ROE) are applied to analyze return on investment. Figure 3.13 indicates how these ratios changes, and the left side axis is for return on investment, while the right axis is for return on sales.

Figure 3.13 Growth of profitability ratios




Net profit margin followed the same pattern as gross profit margin, increasing from 2009 to 2010, changing smoothly from 2010 to 2012 and decline from 2012 to 2013. Baidu did a good work in coving expenses. However, Baidu's total expenses increased due to expand of business during 2013. And the significant increase are from sales tax and surcharges, traffic acquisition costs, bandwidth costs, operational costs, content costs and share-based compensation. By consider about Baidu's high growth rate in revenues, it seems a wisdom decision to invest in growth rate.

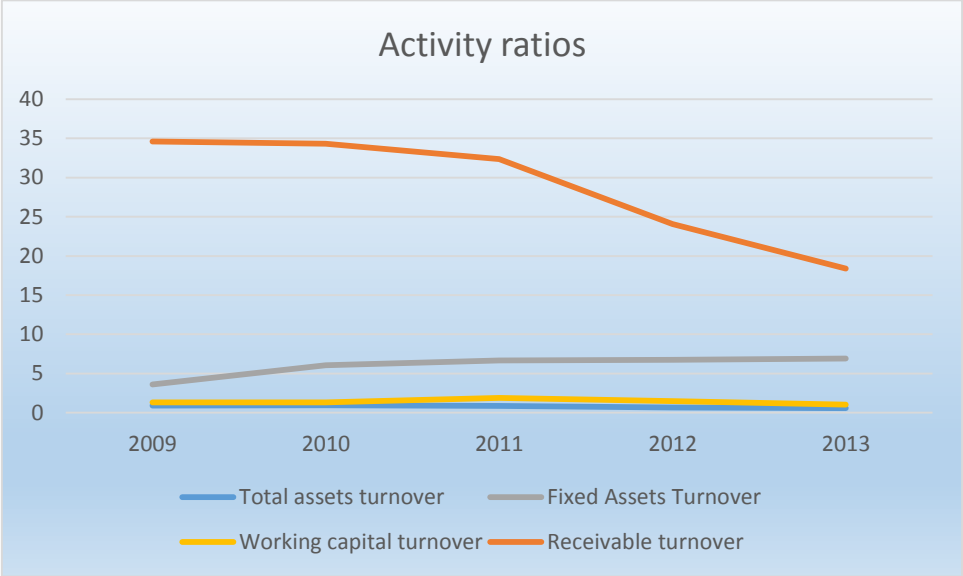
Both ROE and ROA increased in 2009, and ROA declined from 2010 to 2013, while ROE dropped from 2011. That is because equity grew slower than liabilities in recent years. By compared with Google, which had a gradual reduction in ROA from 18.1% to 12.6% and in ROE from 20.3% to 16.3% over the period from 2009 to 2013, Baidu had higher ROE and ROA. It indicates that Baidu has a better ability to earn

profit on its capital and assets.

### 3.4.7 Activity ratio

Activity ratios are used to measure how efficiently a company manages its various assets. Receivable turnover, working capital turnover, fixed assets turnover and total assets turnover is illustrated in Figure 3.14.

Figure 3.14 Growth of activity ratios




There was a slightly decrease of receivable turnover from 2009 to 1011, and after then, it dropped rapidly. Receivables are created when customer received products but has not paid for yet. Since more and more customers joined in performance-based online marketing services and time-based online advertising services, Baidu had receivable of 2.2 billion CNY, with a growth of 0.9 billion CNY compared to 2012. That would be another result caused by expansion of business.

Fixed assets turnover kept a smoothly grow from 3.6 in 2009 to 6.9 in 2013. That indicates Baidu generates revenues from its investments in fixed assets more efficient, but some new business like “Baidu cloud” have not yet operated at full capacity. Working capital turnover and total assets turnover remained steady, and are near zero. Because of large portion of cash and cash equivalent and short-term investment, working capital turnover is inefficient, which can distort overall interpretation.

# 4. BAIDU company valuation with real options methods

In contrast, internet companies are more complex to evaluate than traditional companies. Because the internet industry is still in fast development period around the world and the growth of internet companies is one of the key factors in valuation. There is too much uncertainty in internet industry, and traditional methods are unable to reflect accurate value of enterprise. And the valuation criteria of internet companies, such as customer effects, time effects, innovation effects and brand effects, are also difficult to measure.

By mapping out both uncertainties and decisions over time, real options methods provide an appropriate way to track value creation and risk profile. In many case, real options is used only if the firm actually executes the plan. If the plan proceeds unsuccessful, manager has the right to give up the decision and avoid loss. But if the plan progress goes well, manager also has the right to make optimistic decisions.

In this section, we verify possibilities to different value of Baidu with option to expand, option to contract, and option to expand or contract. In order to analyze influence of different expansion rate and contraction rate, we apply basic scenario, optimistic scenario, middle scenario and pessimistic scenario in each option. And the binomial model is used to estimate real options.

## 4.1 Parameters estimation

Even though Baidu is a Chinese company, it was listed on NASDAQ in 2005. Thus, we applied historical data from Nasdaq.com, Yahoo finance and Baidu annual reports during 2009 to 2013. We think five years period is a proper length for analyzing company's condition accurately. According to financial and economic characteristics of Baidu, we assume Baidu can operate for 5 years, in other words, Baidu's investment will stop in 2018. We employ Excel to build binomial model and discuss underlying assets of Baidu from 2013 to 2018.

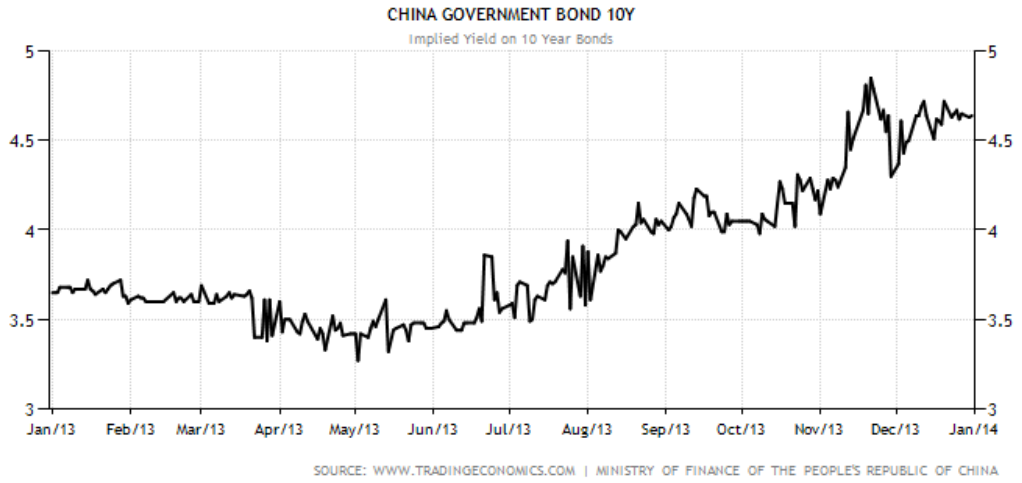
### 4.1.1 Estimation of maturity

In the traditional valuation methods, company's business life is assumed infinity. However, in the real world, it's impossible. Some big companies have hundreds years history, and some small companies bankrupt in a few years after they established. Baidu is a high technical company with highly uncertainty and risky, so we observe five years as investment maturity in real options analysis.

### 4.1.2 Estimation of risk free rate

The typical risk free rate is long term government bond. And we adopted interest rate of China 10 years government bond as risk free rate.

Figure 4.1 China 10 years government bond yield curve

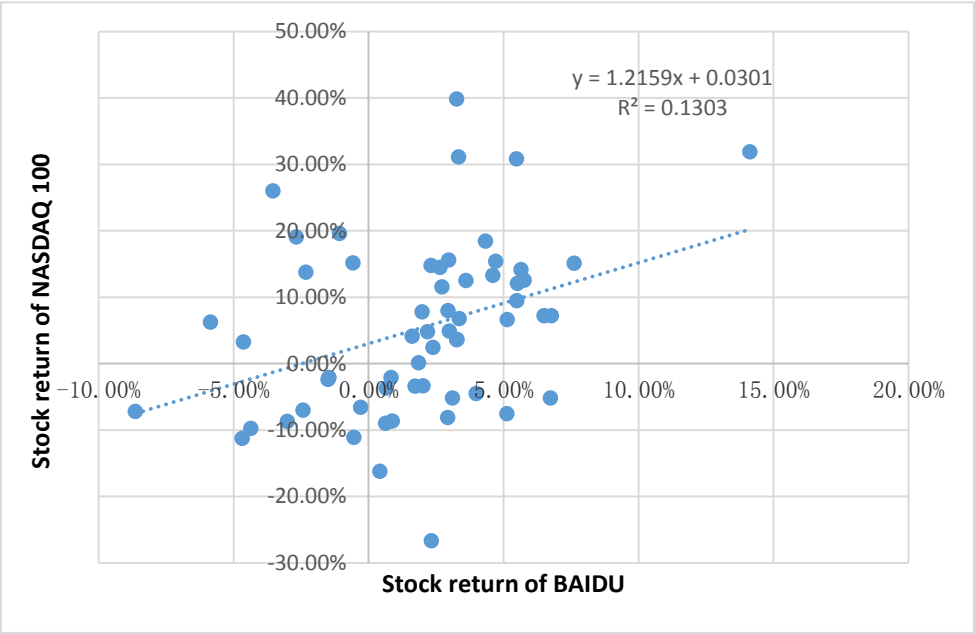



We focus on the interest rate of government bond during 2013, it increased to 4.6 percent in December from 3.3 percent in April. And because investors always prefer higher interest rates from long term government bonds, we decide to choose 4.6 percent as risk free rate, $R_f$ for prediction.

### 4.1.3 Estimation of Beta

Beta is a kind of market sensitivity, and it is also the correlation between a company's stock return and market's return. We use common regression model to build trend line between return of index and return of Baidu stock to estimate beta.

Figure 4.2 XY scatter diagram of index's return and Baidu stock's return




We choose monthly price of NASDAQ100 from 2009 to 2013 as our observation index, and adopt monthly stock price of Baidu from the same time period as independent variable. Figure 4.2 illustrates the equation *y=1.2159x + 0.0301* explains 13.03% of changes in Baidu's stock return is caused by NASDAQ100's return. And if return of NASDAQ100 increases by one percent, then return of Baidu grows up approximately by 1.21 percent. So we defined β as 1.2. Because typical betas is between 0 and 2, Baidu's stock is risker than typical stock but also has higher rewards.

### 4.1.4 Estimation of assets value

Before getting assets value, we need to calculate Baidu's free cash flow as passive state in 2013, and cost of capital. If perpetuity is assumed, we can defined Baidu's asset value ($A$) as follows,

$$A = \frac{FCF}{WACC} \tag{4.1}$$

Free cash flow can be defined as the cash flow which is generated after investment but before interest payment. Here we employed free cash to the firm. The function is written as follows,

$$FCFF = NOPAT + D\&A - \Delta NWC - Capex \quad (4.2)$$

Here FCFF represents free cash flow to the firm, NOPAT means net operating profit after tax, D&A is depreciation and amortization, ΔNWC is the change of net working capital and Capex is capital expenditures. In fiscal 2013, Baidu's operating income was 11,706 million CNY and total taxes was 1756 million CNY, as the result, its NOPAT can be counted as 9,950 million CNY. And D&A was 2,652 million CNY, ΔNWC was -914 million CNY, and Capex was 2,800 million CNY. Consequently, FCFF should be 10,716 million CNY in 2013.

We apply Capital Asset Pricing Model (CAPM model) to estimate weighted average cost of capital (*WACC*). The weighted average cost of capital is determined by cost of debt ($R_d$), cost of equity ($R_e$), income tax rate（$T$）, target level of debt to asset ($\frac{D}{A}$) and target level of equity to asset ($\frac{E}{A}$), which is written as follows,

$$WACC = \frac{E}{A} \cdot R_e + \frac{D}{A} \cdot (1 - T) \cdot R_d \quad (4.3)$$

From Baidu's annual reports and China tax policy, we have already know that corporate income tax rate is 15%. Next we will discuss estimation of other components of WACC.

Market approach is used to estimate cost of debt, which includes interest expenses in relation to debt. In 2003, interest expenses of Baidu was 447 million CNY and total debt was 16,644 million CNY. Therefore, we estimate cost of debt as 2.69%, which is shown in Table 4.1.

Table 4.1 Computation of cost of debt

| | |
|---|---|
| Interest Expenses | 447 |
| Average Debt | 16644 |
| **Cost of Debt** | 2.69% |

The cost of equity has three components: the risk free rate, the risk premium and risk adjustment. From part 4.1.1 and 4.1.2, we have already known that risk free rate is 4.6%, and risk adjustment beta is 1.2. And risk premium is calculated by the difference between the market expected return and risk free rate. Since average annual ten years return of NASDAQ100 in the end of 2014, 9.03%, is reported as

market return, we get 4.43% as risk premium. According to CAPM model, expected rate of equity return equals the risk free rate adds risk adjustment beta times risk premium, which is written as follows,

$$E(R_E) = R_f + \beta[E(R_m) - R_f] \quad (4.4)$$

Here $E(R_E)$ is expected return of security, and is also defined as cost of capital; $E(R_m)$ represents market expected return. Table 4.2 shows that, as a consequence, cost of equity is equal to 9.92%.

Table 4.2 Computation of cost of equity

| | |
|---|---|
| Risk Free Rate | 4.60% |
| Market Premium | 4.43% |
| Beta | 1.2 |
| **Cost of Equity** | 9.92% |

Target level of debt to asset and target level of equity to asset can be calculated by market debt, market equity, and market capital. However, market value of debt is difficult to estimate; here we use book value of debt in the calculation. It is written in annual report that total debt of Baidu was 166,44 million CNY in 2013. And market value of equity is also called market capitalization, which is calculated by share outstanding multiplying stock price. At December 31 2013, total share outstanding of Baidu is 350 million, and the closed price is $177.88. Consequently, market capitalization is $62,258 million. Consider of foreign exchange rate between USD and CNY, we adopt the exchange rate on December 31 2013, 6.05. Therefore the market capitalization of Baidu is 376,824.25 million CNY. And then we assume market value of capital is calculated as the sum of market value of equity and debt, which is 393,468.25 million CNY. So target level of equity to asset is 95.77%, and weight of debt is 4.23%.

Table 4.3 Computation of WACC

| | |
|---|---|
| Market Cap | 376,824.25 |
| Average Debt | 16644 |
| Total Capital | 393468.25 |
| E/A | 95.77% |
| D/A | 4.23% |
| **WACC** | 9.59% |

Finally, from Table 4.3 we can see that based on the function (4.3), WACC is 9.59%. And the asset value of our case is 111,741 million CNY.

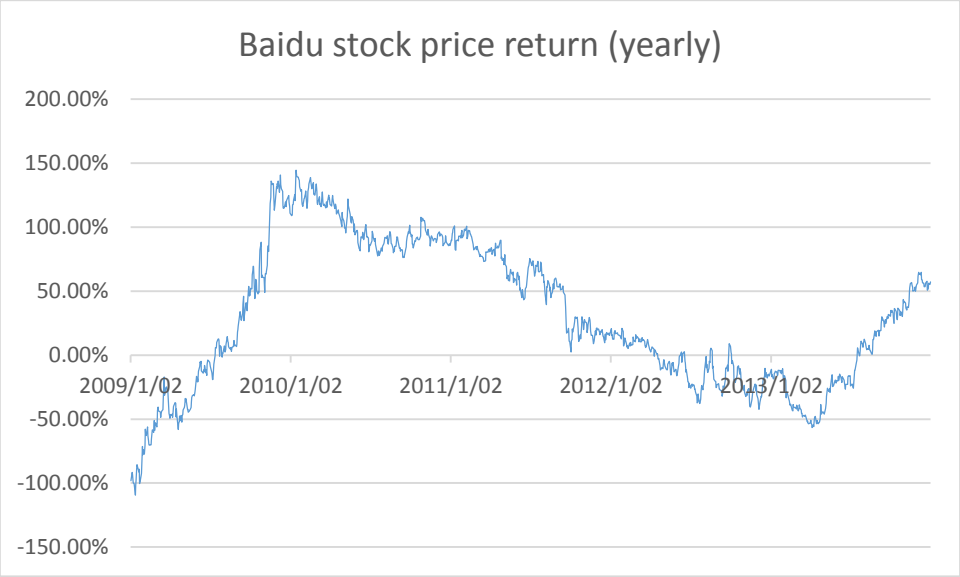
### 4.1.5 Estimation of debt

The nature of company's limited liability gives shareholders rights to decide residual value of the company. Shareholders can get the rest value after company's asset covering debt, which is similar like options. Strike price is stable regardless of the type of option and maturity time. In real options method, face value of debt is strike price. Nevertheless, Chinese bond market is not mature and complete, we decide to use book value of debt as strike price, which is 16,644 million CNY.

### 4.1.6 Estimation of volatility

There are two ways to estimate volatility, one is backward looking, and another is forward looking. Calculation of backward looking volatility depends on historical returns, and calculation of forward looking volatility depends on present value of options. Here we employ backward looking method with historical stock price of Baidu from January 1, 2008 to December 31, 2013.

Figure 4.3 Yearly return of Baidu's stock from 2009 to 2013




In order to get more accurate volatility, we compute yearly return directly, which is written as follows,

$$R_t = \ln \frac{P_t}{P_{t-1\,year}} \tag{4.5}$$

Here $R_t$ means yearly return at time *t*, $P_t$ represents daily close price of Baidu at time *t*, and $P_{t-1\,year}$ means daily close price of Baidu at one year before time *t*. Based on historical stock price, we get yearly return (logarithm) from 2009 to 2013 at first, which we can see from Figure 4.3. And then standard deviation of yearly return is computed as 49.15%. Therefore we assume that the volatility of Baidu is 49%.

### 4.1.9 Estimation of investment growth

Typically speaking, the company with high profit each year has more potential to keep high investment. In order to get growth rate of future investment, we suppose that it equals to growth rate of revenues. Based on market approach, we find total revenue of Chinese search engine companies from 2009 to 2013 at first. And then we calculate change of market revenues in each year. With the weight we assumed, we can get the change of relative market revenues 33.22%. At last by adding growth of Chinese GDP 7.67%, we get the final change of relevant market 40.89%.

Table 4.4 Changes of relative market revenues

| | Market revenue (mil.) | Δ | weight | |
|---|---|---|---|---|
| 2009 | 7000 | | | |
| 2010 | 11000 | 36.36% | 10% | 3.64% |
| 2011 | 18900 | 41.80% | 20% | 8.36% |
| 2012 | 28100 | 32.74% | 30% | 9.82% |
| 2013 | 39300 | 28.50% | 40% | 11.40% |
| SUM | | | | 33.22% |

The next step is to compare with sales of Baidu year to year, we get its market share, and growth rate in each accounting year. With the weights we assume again, we get the final result of change in market share 4.35%. Table 4.2 shows the whole process.

Table 4.5 Changes of Baidu's market share

| Year | Baidu revenue (mil.) | market share | Δ | weights | |
|---|---|---|---|---|---|
| 2009 | 4,447 | 63.53% | | | |
| 2010 | 7,915 | 71.95% | 11.71% | 10% | 1.17% |
| 2011 | 14,500 | 76.72% | 6.21% | 20% | 1.24% |
| 2012 | 22,306 | 79.38% | 3.35% | 30% | 1.01% |
| 2013 | 31,943 | 81.28% | 2.34% | 40% | 0.93% |
| SUM | | | | | 4.35% |

As a result, growth of revenue 45.24% is the sum of changes of market revenues and changes of Baidu's market share. And in our assumption, the basic growth of investment *x* is defined as 45%.

### 4.18 Estimation of other parameters

Consider the previously parameters we have already estimated, we supposed the coefficient of up movements *u* and coefficient of down movements *d*, which are based on the equation (2.22), are 1.74 and 0.56. And according to equation (2.21), we determine the risk neutral probability of up movement *p* is 0.4 and probability of down movement *q* is 0.6.

In the end, the parameters are summarized in Table 4.6.

Table 4.6 Input data

| | | | | |
|---|---|---|---|---|
| FCF | 10716 | | g | 45% |
| WACC | 9.59% | | I | 23322.82 |
| A | 111741.4 | | u | 1.632316 |
| $R_f$ | 4.60% | | p | 0.425005 |
| Volatility | 49% | | q | 0.574995 |
| T | 5 | | d | 0.612626 |

### 4.2 Valuation of real options of BAIDU Company

Generally speaking, when an internet company entry to maturity stage, its production sales goes on well, market share keeps stable, sustainable growth rate remains steady, cash flow keeps at the same level, financial risk and operation risk are significantly dropped. However, production life cycle of internet companies are

short, for example, 10 years ago, blog was the most popular discussion or informational site, but now, social media, like Facebook, Microblog and Twitter, have replaced its position. And another typical example is Happy Farm, a massively multiplayer online game. At the height of its popularity in 2009[2], there were 27 million daily active users in China. And after 2013, it lost approximately 10% of all players every month and it closed until August of 2013. In addition, there are countless copycats and variants in the internet market, such as Twitter and Google+. Because of these reasons, managers should consider to modify and update their decisions at the right time, according to market changes. That's why they need to use real options.

In what follows, we assume underlying assets value of Baidu from 2013 to 2018, by binomial method. Regardless of what kind of options we choose, the underlying assets will be unchangeable.

Figure 4.4 Binomial tree of underlying assets of Baidu

| n/t | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| 5 | | | | | | 1294898 |
| 4 | | | | | 793288.7 | |
| 3 | | | | 485989.6 | | 485989.6 |
| 2 | | | 297730.1 | | 297730.1 | |
| 1 | | 182397.3 | | 182397.3 | | 182397.3 |
| 0 | 111741.4 | | 111741.4 | | 111741.4 | |
| -1 | | 68455.73 | | 68455.73 | | 68455.73 |
| -2 | | | 41937.79 | | 41937.79 | |
| -3 | | | | 25692.19 | | 25692.19 |
| -4 | | | | | 15739.72 | |
| -5 | | | | | | 9642.566 |

Valuation needs forecast. Even though we have estimated basic parameters by financial models, we cannot be certain that results are accurate. Since the future is never truly knowable, we consider using multiple scenarios. The scenarios reflect different expansion rates and contraction rates regarding future internal or external development of Baidu. Four scenarios are used in each option, there is basic scenario, middle scenario, optimistic scenario and pessimistic scenario. Table 4.7

[2] China's Top 10 Social Games (2009)

provides expansion rates and contraction rates regarding different scenarios.

Table 4.7 Scenarios alternatives

| | | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|
| Basic scenario | Expansion rate | 45% | 45% | 45% | 45% | 45% | 45% |
| | Contraction rate | 20% | 20% | 20% | 20% | 20% | 20% |
| Middle scenario | Expansion rate | 20% | 30% | 45% | 30% | 20% | 10% |
| | Contraction rate | 30% | 20% | 10% | 20% | 30% | 45% |
| Optimistic scenario | Expansion rate | 10% | 20% | 30% | 35% | 40% | 45% |
| | Contraction rate | 45% | 40% | 35% | 30% | 20% | 10% |
| Pessimistic scenario | Expansion rate | 45% | 40% | 35% | 30% | 20% | 10% |
| | Contraction rate | 10% | 20% | 30% | 35% | 40% | 45% |

### 4.2.1 Expand option

In Baidu's future development, managers would consider to expand business scale according to market condition, for example, to develop e-finance products, new interactive entertainment business and internet value-added services. And Baidu also has the opportunity to entry into new market, such as hardware equipment market. Specifically, the option to expand is at the basis of arguments that an investment should be made because of strategic considerations or that large investments should be broken up into smaller phases. In this situation, decision maker can employ the option to expand the company.

In our assumption, expand rate of Baidu is equal to growth rate of revenues, which indicates the scale of the production can be expanded by $x=45\%$, with additional investment outlay $I_{exp} = 23,322.82$ million CNY.

Firstly, we provide basic scenario to expand option of Baidu from 2013 to 2018. We assume the company being valued faces stable market structure and smooth growth rate during observation period. Some old products still keep profitability and new products also be welcomed. Local companies are less competitive than Baidu. Therefore, expansion rate has no change, and it keeps high rate 45% for 5 years.

In Figure 4.5, we perform the computation of the option to expand with basic scenario. Intrinsic value in 2013 is 26,961 million CNY, and in 2018, the intrinsic

values are 559,381 million CNY, 195,373 million CNY, 58,756 million CNY, 7,482 million CNY, 0 CNY and 0 CNY. Because the option price equals to intrinsic value at the maturity time, it is calculated from the end. As the consequence, the flexibility value of expand option is 34,792 million CNY in 2013.

Figure 4.5 Binomial tree of expand option by basic scenario

| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Intrinsic value | | | | | | 559381.3 |
| | | | | | 333657.1 | |
| | | | | 195372.5 | | 195372.5 |
| | | | 110655.7 | | 110655.7 | |
| | | 58755.96 | | 58755.96 | | 58755.96 |
| | 26960.81 | | 26960.81 | | 26960.81 | |
| | | 7482.258 | | 7482.258 | | 7482.258 |
| | | | 0 | | 0 | |
| | | | | 0 | | 0 |
| | | | | | 0 | |
| | | | | | | 0 |
| Flexibility value | | | | | | 559381.3 |
| | | | | | 334682.8 | |
| | | | | 197378.7 | | 195372.5 |
| | | | 113599.4 | | 111681.4 | |
| | | 63669.8 | | 60762.19 | | 58755.96 |
| | 34792.20 | | 31858.16 | | 27986.48 | |
| | | 16230.82 | | 13042.52 | | 7482.258 |
| | | | 5978.4 | | 3040.153 | |
| | | | | 1235.259 | | 0 |
| | | | | | 0 | |
| | | | | | | 0 |

Secondly, we use middle scenario to expand option valuation of Baidu during the same time. We assume the macroeconomic environment, industry competition, market share and company management are not steady. Due to advantages from previous years, Baidu keeps expand rate for the first three years. However, capital of Baidu is insufficient to support expanding investment, and the expansion rate of Baidu goes down since 2016. Therefore, expansion rates from 2013 to 2018 are 20%, 30%, 45%, 30%, 20% and 10%.

In Figure 4.6, we illustrate the option to expand with middle scenario. Because

of the low expansion rate, most of options are abandon. Intrinsic value in 2013 is 0 CNY, and in 2018, the intrinsic values are 106,167 million CNY, 25,276 million CNY, and others are 0 CNY. The flexibility value of expand option is 30,312 million CNY in 2013, which is lower than option price with basic scenario.

Figure 4.6 Binomial tree of expand option by middle scenario

| | n/t | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|
| Intrinsic value | 5 | | | | | | 106167 |
| | 4 | | | | | 135334.9 | |
| | 3 | | | | 122474.1 | | 25276.14 |
| | 2 | | | 110655.7 | | 36223.19 | |
| | 1 | | 31396.37 | | 31396.37 | | 0 |
| | 0 | 0 | | 26960.81 | | 0 | |
| | -1 | | 0 | | 0 | | 0 |
| | -2 | | | 0 | | 0 | |
| | -3 | | | | 0 | | 0 |
| | -4 | | | | | 0 | |
| | -5 | | | | | | 0 |
| Flexibility value | 5 | | | | | | 106167 |
| | 4 | | | | | 135334.9 | |
| | 3 | | | | 122474.1 | | 25276.14 |
| | 2 | | | 110655.7 | | 36223.19 | |
| | 1 | | 59781.63 | | 31396.37 | | 0 |
| | 0 | 30311.98 | | 26960.81 | | 0 | |
| | -1 | | 10954.58 | | 0 | | 0 |
| | -2 | | | 0 | | 0 | |
| | -3 | | | | 0 | | 0 |
| | -4 | | | | | 0 | |
| | -5 | | | | | | 0 |

Thirdly, optimistic scenario is employed to expand option valuation of Baidu during the same time. We assume the industry competition, and company economic condition go better and better from 2013 to 2018. Because of superiority of Baidu, for example, the breakthrough in technology, or great brand awareness, Baidu raises expansion rate every year. Therefore, expansion rates are 10%, 20%, 30%, 35%, 40% and 45%.

It is illustrated the option to expand with optimistic scenario in Figure 4.7. Intrinsic value in 2013 is 0 CNY, and in 2018, the payoff values are 559,381

million CNY, 195,373 million CNY, 58,756 million CNY, 7,482 million CNY and others are 0 CNY. The flexibility value of expand option is 34,792 million CNY in 2013. It is interesting to discover that expansion rates are different between optimistic scenario and basic scenario, but the final option price is totally same.

Figure 4.7 Binomial tree of expand option by optimistic scenario

| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Intrinsic value | | | | | | 559381.3 |
| | | | | | 293992.7 | |
| | | | | 146773.5 | | 195372.5 |
| | | | 65996.2 | | 95769.21 | |
| | | 13156.64 | | 40516.23 | | 58755.96 |
| | 0 | | 10199.6 | | 21373.74 | |
| | | 0 | | 636.6853 | | 7482.258 |
| | | | 0 | | 0 | |
| | | | | 0 | | 0 |
| | | | | | 0 | |
| | | | | | | 0 |

| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Flexibility value | | | | | | 559381.3 |
| | | | | | 334682.8 | |
| | | | | 197378.7 | | 195372.5 |
| | | | 113599.4 | | 111681.4 | |
| | | 63669.8 | | 60762.19 | | 58755.96 |
| | 34792.20 | | 31858.16 | | 27986.48 | |
| | | 16230.82 | | 13042.52 | | 7482.258 |
| | | | 5978.4 | | 3040.153 | |
| | | | | 1235.259 | | 0 |
| | | | | | 0 | |
| | | | | | | 0 |

Fourthly, we apply pessimistic scenario to expand option valuation of Baidu from 2013 to 2015. We assume the internal and external condition of Baidu is not as good as manager's expectation. Competitors discover new internet products and catch user's attention successfully. Baidu losses its leading position in the market. Thus Baidu decreases expansion rate from 45%, 40% 35%, 30% and 20% to 10% during observation period.

It is illustrated the option to expand with pessimistic scenario in Figure 4.8. It seems like middle scenario, most of options are abandon. Intrinsic value in 2013 is

26,961 million CNY, and in 2018, the intrinsic values are 106,167 million CNY, 25,276 million CNY, and others are 0 CNY. The flexibility value of expand option is 26,961 million CNY in 2013, which is the lowest one among four scenario approaches and is similar to its intrinsic value at the same time.

Figure 4.8 Binomial tree of expand option by pessimistic scenario

| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Intrinsic value | | | | | | 106167 |
| | | | | | 135334.9 | |
| | | | | 122474.1 | | 25276.14 |
| | | | 80882.7 | | 36223.19 | |
| | | 49636.1 | | 31396.37 | | 0 |
| | 26960.81 | | 15786.67 | | 0 | |
| | | 4059.472 | | 0 | | 0 |
| | | | 0 | | 0 | |
| | | | | 0 | | 0 |
| | | | | | 0 | |
| | | | | | | 0 |
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| Flexibility value | | | | | | 106167 |
| | | | | | 135334.9 | |
| | | | | 122474.1 | | 25276.14 |
| | | | 80882.7 | | 36223.19 | |
| | | 49636.1 | | 31396.37 | | 0 |
| | 26960.81 | | 15786.67 | | 0 | |
| | | 6414.358 | | 0 | | 0 |
| | | | 0 | | 0 | |
| | | | | 0 | | 0 |
| | | | | | 0 | |
| | | | | | | 0 |

So far, the results are summarized in Table 4.8. In the option to expand the company approach, the flexibility values in 2013 are 34,792 million CNY in basic scenario, 30,312 million CNY in middle scenario, 34,792 million CNY in optimistic scenario and 26,961 million CNY in pessimistic scenario. The expand options in optimistic scenario and basic scenario have the highest price, and the option in pessimistic scenario has the lowest price.

Table 4.8 Flexibility values of options to expand the company (million, CNY)

| | Basic scenario | Middle scenario | Optimistic scenario | Pessimistic scenario |
|---|---|---|---|---|
| Option price | **34792** | 30312 | **34792** | 26961 |

### 4.2.2 Contract option

Due to the rapid development of technology, appearance of substitute products and some other reasons, it is possible for Baidu to face worse growth prospects and market demand shrinking. In this situation, Baidu could adopt option to contract business scale, decline expenses, and even sell part of non-main business services. The option to contract the company is used to decrease the loss in the bad market condition.

From the history of Baidu, we cannot find disinvestment sample. We assume disinvestment outlay of Baidu equals to investment outlay, and basic contraction rate is 20%, which means the scale of the production can be contracted by $y=20\%$, with additional disinvestment outlay $I_{con} = 23,322.82$ million CNY.

At first, we provide basic scenario to contract option of Baidu from 2013 to 2018. In the assumption, Baidu has no innovation which leads to be failed to fend off competitors and lost a large market share. In reality, although Baidu never stop to release new services, the company has been accused of anti-competitive conduct in manipulating search results and turning the results page into an advertisement listing for its own products. If managers have never considered to forbidden this business model, they will loss users gradually. The planned investment could be saved in the stable level. And the contraction rate is keep 20% during 2013 to 2018.

In Figure 4.13, we perform the computation of the option to contract with basic scenario. Intrinsic value in 2013 is 975 million CNY, and in 2018, the intrinsic values are 21,943 million CNY, 18,184 million CNY, 9,632 million CNY, and others are 0 CNY from downwards. And the flexibility value of contraction option is 7,850 million CNY in 2013.

Figure 4.13 Binomial tree of contract option by basic scenario

| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Intrinsic value | | | | | | 0 |
| | | | | | 0 | |
| | | | | 0 | | 0 |
| | | | 0 | | 0 | |
| | | 0 | | 0 | | 0 |
| | 974.5405 | | 974.5405 | | 974.5405 | |
| | | 9631.674 | | 9631.674 | | 9631.674 |
| | | | 14935.26 | | 14935.26 | |
| | | | | 18184.38 | | 18184.38 |
| | | | | | 20174.88 | |
| | | | | | | 21394.31 |
| Flexibility value | | | | | | 0 |
| | | | | | 0 | |
| | | | | 0 | | 0 |
| | | | 1599.92 | | 0 | |
| | | 4431.114 | | 2910.49 | | 0 |
| | 7849.84 | | 6878.273 | | 5294.609 | |
| | | 11004.78 | | 10361.31 | | 9631.674 |
| | | | 14935.26 | | 14935.26 | |
| | | | | 18184.38 | | 18184.38 |
| | | | | | 20174.88 | |
| | | | | | | 21394.31 |

Secondly, we provide middle scenario to contract option of Baidu from the year between 2013 and 2018. In the assumption, the company experiences fluctuating condition. To face with the strong competition, contraction scale of Baidu raises during the first three years. However, since 2016, manager find an efficient way to improve the situation, therefore the contraction rate goes down after that. The contraction rates are 20%, 30%, 45%, 30%, 20% and 10%.

Figure 4.14 shows the computation process of the option to contract valuation with middle scenario. In 2013, the intrinsic value is 975 million CNY, and in 2018, the intrinsic values are 22,359 million CNY, 20.754 million CNY, 16,477 million CNY, 5,083 million CNY and others are 0 CNY from downwards. And the flexibility value of contraction option is 10,521 million CNY in 2013. In comparison with the contraction option price with basic scenario, contraction option with middle scenario has higher price.

Figure 4.14 Binomial tree of contract option by middle scenario

| | n/t | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|
| Intrinsic value | 5 | | | | | | 0 |
| | 4 | | | | | 0 | |
| | 3 | | | | 0 | | 0 |
| | 2 | | | 0 | | 0 | |
| | 1 | | 0 | | 0 | | 5083.09 |
| | 0 | 974.5405 | | 0 | | 974.5405 | |
| | -1 | | 2786.101 | | 2786.101 | | 16477.25 |
| | -2 | | | 4450.816 | | 14935.26 | |
| | -3 | | | | 15615.16 | | 20753.6 |
| | -4 | | | | | 20174.88 | |
| | -5 | | | | | | 22358.56 |
| Flexibility value | 5 | | | | | | 0 |
| | 4 | | | | | 0 | |
| | 3 | | | | 1536.003 | | 0 |
| | 2 | | | 4609.342 | | 2794.216 | |
| | 1 | | 7864.944 | | 7249.741 | | 5083.09 |
| | 0 | 10521.20 | | 10900.51 | | 11123.01 | |
| | -1 | | 13326.27 | | 14471.02 | | 16477.25 |
| | -2 | | | 16185.37 | | 18103.37 | |
| | -3 | | | | 18747.37 | | 20753.6 |
| | -4 | | | | | 20723.18 | |
| | -5 | | | | | | 22358.56 |

Thirdly, we provide optimistic scenario to contract option of Baidu from the year between 2013 and 2018. In this situation, Baidu develops a proprietary technological infrastructure and enlarge services, while its competitors has no innovations. Due to the success of positive management, it's no necessary to increase contraction rate. And the contraction rates are 45%, 40%, 35%, 30%, 20% and 10% during 2013 to 2018.

Figure 4.15 indicates the process of the option to contract valuation with optimistic scenario. In 2013, the intrinsic value is 0 CNY, and in 2018, the intrinsic values are 22,359 million CNY, 20,754 million CNY, 16,477 million CNY, 5,083 million CNY and others are 0 CNY from downwards. The intrinsic values in optimistic scenario are same to the value in middle scenario since 2016. And the flexibility value of contraction option is 10,531 million CNY in 2013, which is also same to the contraction option price in middle scenario.

Figure 4.15 Binomial tree of contract option by optimistic scenario

| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Intrinsic value | | | | | | 0 |
| | | | | | 0 | |
| | | | | 0 | | 0 |
| | | | 0 | | 0 | |
| | | 0 | | 0 | | 5083.09 |
| | 0 | | 0 | | 974.5405 | |
| | | 0 | | 2786.101 | | 16477.25 |
| | | | 8644.595 | | 14935.26 | |
| | | | | 15615.16 | | 20753.6 |
| | | | | | 20174.88 | |
| | | | | | | 22358.56 |
| Flexibility value | | | | | | 0 |
| | | | | | 0 | |
| | | | | 1536.003 | | 0 |
| | | | 4609.342 | | 2794.216 | |
| | | 7864.944 | | 7249.741 | | 5083.09 |
| | 10521.20 | | 10900.51 | | 11123.01 | |
| | | 13326.27 | | 14471.02 | | 16477.25 |
| | | | 16185.37 | | 18103.37 | |
| | | | | 18747.37 | | 20753.6 |
| | | | | | 20723.18 | |
| | | | | | | 22358.56 |

And then we provide pessimistic scenario to contraction option. We assume Baidu faces horrible situation, the initial strategy to simply copy competitors or acquire them has not always yielded positive results. And new products of the company are not welcomed, while competitors enlarge their platforms and service chains. At this time, Baidu should continue to contract investment, and contraction rate increases 10%, 20%, 30%, 35%, 40% and 45% in the year 2013, 2014, 2015, 2016, 2017 and 2018.

In Figure 4.16, we find the computation of option to contract by pessimistic scenario from 2013 to 2018. In 2013, the intrinsic value is 12,149 million CNY, and at the maturity time, the intrinsic values are 18,984 million CNY, 11,761 million CNY and others are 0 CNY from the downwards. And the price of contraction option is 12,149 million CNY, which is similar to the intrinsic value in 2013.

Figure 4.16 Binomial tree of contract option by pessimistic scenario

| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Intrinsic value | | | | | | 0 |
| | | | | | 0 | |
| | | | | 0 | | 0 |
| | | | 0 | | 0 | |
| | | 0 | | 0 | | 0 |
| | 12148.68 | | 0 | | 0 | |
| | | 9631.674 | | 0 | | 0 |
| | | | 10741.48 | | 6547.705 | |
| | | | | 14330.55 | | 11761.33 |
| | | | | | 17026.93 | |
| | | | | | | 18983.67 |
| Flexibility value | | | | | | 0 |
| | | | | | 0 | |
| | | | | 0 | | 0 |
| | | | 0 | | 0 | |
| | | 1087.641 | | 0 | | 0 |
| | 12148.68 | | 1978.579 | | 0 | |
| | | 9631.674 | | 3599.327 | | 0 |
| | | | 10741.48 | | 6547.705 | |
| | | | | 14330.55 | | 11761.33 |
| | | | | | 17026.93 | |
| | | | | | | 18983.67 |

The results are summarized in Table 4.9, the prices of option to contract the company are 7,850 million CNY in basic scenario, 10,521 million CNY in middle scenario and optimistic scenario, and 12,149 million CNY in pessimistic scenario. The option price in pessimistic scenario is the highest, and the price in basic scenario is the lowest.

Table 4.9 Flexibility values of options to contract the company (million, CNY)

| | Basic scenario | Middle scenario | Optimistic scenario | Pessimistic scenario |
|---|---|---|---|---|
| Option price | **7850** | 10521 | 10521 | **12149** |

### 4.2.3 Multiple options

In addition to the simple situation to expand or contract company, there is another method to combine these two choices in one option. Manager can make

decisions in simultaneously expanding, contracting, or holding the company with no changes, according to different market situations.

By applying same estimation of input data, the scale of the company can be expanded by *x=45%* with additional investment outlay $I_{exp}$ = 23,323 million CNY. In addition, the company can be contracted by $y$ = 20%, with disinvestment outlay $I_{con}$ = 23,323 million CNY.

Since the uncertainty of future development, we divide the multiple options into four scenarios: basic, middle, optimistic and pessimistic.

At first, we discuss basic scenario. In the assumption, the internal and external environments are stable. Baidu's services determine its value, and it's impossible to exceed Baidu in five years for other players in the market. Therefore, the expansion rate and contraction rate in basic scenario keep steady from 2013 to 2015.

Figure 4.17 illustrates the computation of multiple options in basic scenario. The initial intrinsic value in 2013 is 26,961 million CNY, and in 2018, the intrinsic values are 559,382 million CNY, 195,373 million CNY, 58,756 million CNY, 9,632million CNY, 18,184 million CNY and 21,394 million CNY. Because intrinsic value at the maturity day is same to flexibility value, by beginning in the final period, we can use the risk free rate and risk neutral probabilities to get the price of option 40,370 million CNY in 2013.

Figure 4.17 Binomial tree of multiple options by basic scenario

| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Intrinsic value | | | | | | 559381.3 |
| | | | | | 333657.1 | |
| | | | | 195372.5 | | 195372.5 |
| | | | 110655.7 | | 110655.7 | |
| | | 58755.96 | | 58755.96 | | 58755.96 |
| | 26960.81 | | 26960.81 | | 26960.81 | |
| | | 9631.674 | | 9631.674 | | 9631.674 |
| | | | 14935.26 | | 14935.26 | |
| | | | | 18184.38 | | 18184.38 |
| | | | | | 20174.88 | |
| | | | | | | 21394.31 |
| ilit y | | | | | | 559381.3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | 334682.8 | |
| | | | | 197378.7 | | 195372.5 |
| | | | 113956.4 | | 111681.4 | |
| | | 66080.91 | | 61411.7 | | 58755.96 |
| | 40369.8 | | 35980.42 | | 29168.03 | |
| | | 24595.13 | | 20061.44 | | 9631.674 |
| | | | 18147.36 | | 14935.26 | |
| | | | | 18184.38 | | 18184.38 |
| | | | | | 20174.88 | |
| | | | | | | 21394.31 |

Secondly, we provide middle scenario to analyze multiple options. From history performance, Baidu appears booming growth and has leading position in the market. We assume the company will keep expanding investment in the first few years, and then manager may consider decreasing investment. It's unreasonable to increase expansion rate and contraction rate at the same time. Thus the expansion rates are 20%, 30%, 45%, 30%, 20% and 10% during the year between 2013 and 2018. Conversely, contraction rates are 30%, 20%, 10%, 20%, 30% and 45%.

It's illustrated in Figure 4.18 how multiple options is computed by middle scenario. In 2013, the intrinsic value is 0 CNY, and in 2018, there is 106,176 million CNY, 25,276 million CNY, 0 CNY, 0 CNY, 11,761 million CNY and 18,984 million CNY. The flexibility value of multiple options in 2013 is 36,092 million CNY, and it's lower than the value in basic scenario.

Figure 4.18 Binomial tree of multiple options by middle scenario

| | n/t | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|
| Intrinsic value | 5 | | | | | | 106167 |
| | 4 | | | | | 135334.9 | |
| | 3 | | | | 122474.1 | | 25276.14 |
| | 2 | | | 110655.7 | | 36223.19 | |
| | 1 | | 31396.37 | | 31396.37 | | 0 |
| | 0 | 0 | | 26960.81 | | 0 | |
| | -1 | | 9631.674 | | 9631.674 | | 0 |
| | -2 | | | 19129.04 | | 10741.48 | |
| | -3 | | | | 18184.38 | | 11761.33 |
| | -4 | | | | | 18600.9 | |
| | -5 | | | | | | 18983.67 |
| | n/t | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Flexibility value | 5 | | | | | | 106167 |
| | 4 | | | | | 135334.9 | |
| | 3 | | | | 122474.1 | | 25276.14 |
| | 2 | | | 110655.7 | | 36223.19 | |
| | 1 | | 59781.63 | | 31396.37 | | 0 |
| | 0 | 36092.38 | | 26960.81 | | 0 | |
| | -1 | | 21469.97 | | 9631.674 | | 0 |
| | -2 | | | 19129.04 | | 10741.48 | |
| | -3 | | | | 18184.38 | | 11761.33 |
| | -4 | | | | | 18600.9 | |
| | -5 | | | | | | 18983.67 |

And then we discuss the multiple options in optimistic scenario from 2013 to 2018. In our assumption, market condition and company management go better and better. We defined expansion rates are 10%, 20%, 30%, 35%, 40% and 45% in the year 2013, 2014, 2015, 2016, 2017 and 2018. And simultaneously the contraction rates are 45%, 40%, 35%, 30%, 20% and 10%.

In Figure 4.19, it indicates the computation process of multiple options in optimistic scenario. The initial intrinsic value in 2013 is 0 CNY, and in 2018, the intrinsic values are 559,381 million CNY, 195,373million CNY, 58,756 million CNY, 16,477 million CNY, 20,794 million CNY and 22,359 million CNY. The price of multiple options in optimistic scenario is 42,231 million CNY, and it's higher than the option price in basic and middle scenario.

Figure 4.19 Binomial tree of multiple options by optimistic scenario

| n/t | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Intrinsic value | | | | | | 559381.3 |
| | | | | | 293992.7 | |
| | | | | 146773.5 | | 195372.5 |
| | | | 65996.2 | | 95769.21 | |
| | | 13156.64 | | 40516.23 | | 58755.96 |
| | 0 | | 10199.6 | | 21373.74 | |
| | | 0 | | 2786.101 | | 16477.25 |
| | | | 8644.595 | | 14935.26 | |
| | | | | 15615.16 | | 20753.6 |
| | | | | | 20174.88 | |
| | | | | | | 22358.56 |
| xibilit y val | | | | | | 559381.3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | 334682.8 | |
| | | | | 197378.7 | | 195372.5 |
| | | | 115093.5 | | 111681.4 | |
| | | 67993.26 | | 63480.29 | | 58755.96 |
| | 42231.17 | | 38618.75 | | 32931.1 | |
| | | 26567.73 | | 23331.96 | | 16477.25 |
| | | | 19785.7 | | 18103.37 | |
| | | | | 18747.37 | | 20753.6 |
| | | | | | 20723.18 | |
| | | | | | | 22358.56 |

The last part is about pessimistic scenario. When the investments failed and competition of Baidu is weak, we assume expansion rates decrease from 45%, 40%, 35%, 30%, 20% to 10%, and contraction rates increase conversely from 10%, 20%, 30%, 35%, 40% and 45% during the time between 2013 and 2018.

In Figure 4.20, we can find the calculation progress of multiple options in pessimistic scenario. The intrinsic value in 2013 is 26,961 million CNY, and in 2018, intrinsic values are 106,167 million, 25,276 million CNY, 0 CNY, 0 CNY, 11,761 million CNY and 18,984 million CNY, which are same to the values in middle scenarios. The front path of intrinsic value is same between two scenarios since 2016, because of the same expansion rate. And the flexibility value of multiple options in pessimistic scenario is 26,981 million CNY.

Figure 4.20 Binomial tree of multiple options by pessimistic scenario

| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Intrinsic value | | | | | | 106167 |
| | | | | | 135334.9 | |
| | | | | 122474.1 | | 25276.14 |
| | | | 80882.7 | | 36223.19 | |
| | | 49636.1 | | 31396.37 | | 0 |
| | 26960.81 | | 15786.67 | | 0 | |
| | | 9631.674 | | 0 | | 0 |
| | | | 10741.48 | | 6547.705 | |
| | | | | 14330.55 | | 11761.33 |
| | | | | | 17026.93 | |
| | | | | | | 18983.67 |
| xib ilit y val | | | | | | 106167 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | 135334.9 | |
| | | | | 122474.1 | | 25276.14 |
| | | | 80882.7 | | 36223.19 | |
| | | 49636.1 | | 31396.37 | | 0 |
| | 26960.81 | | 15786.67 | | 0 | |
| | | 12319.04 | | 3599.327 | | 0 |
| | | | 10741.48 | | 6547.705 | |
| | | | | 14330.55 | | 11761.33 |
| | | | | | 17026.93 | |
| | | | | | | 18983.67 |

So far, results are listed in Table 4.10, and the price of multiple options is 40,370 million CNY in basic scenario, 36,092 million CNY in middle scenario, 42,231 million CNY in optimistic scenario and 26,961 million in pessimistic scenario. Among these results, the highest price is in optimistic scenario, the next is in basic scenario, and the lowest option price is in pessimistic scenario.

Table 4.10 Flexibility values of options to contract or expand the company (million, CNY)

| | Basic scenario | Middle scenario | Optimistic scenario | Pessimistic scenario |
|---|---|---|---|---|
| Option price | 40370 | 36092 | 42231 | 26961 |

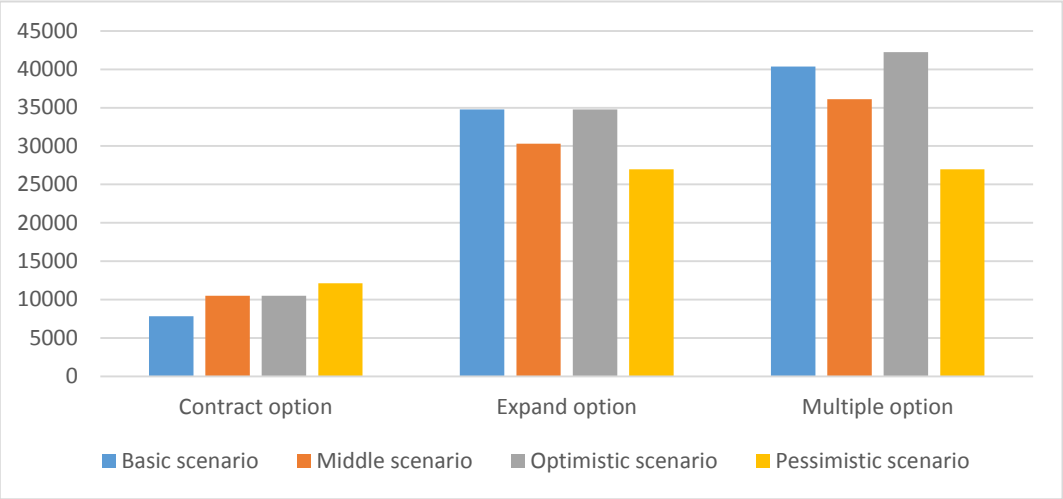
### 4.3 Comparison and discussion

Results showing the flexibility values are presented in Figure 4.12 and Table 4.11. Compared to simple options, multiple options have higher value in our case, and it's not the aggregation of each simple option. In our research, price of each scenario in multiple options is lower than the sum prices of expand option and contract option. When measuring price of multiple options, we should consider about the correlation between expand option and contract option.

Table 4.11 Option prices in different scenarios (million, CNY)

| | Basic scenario | Middle scenario | Optimistic scenario | Pessimistic scenario |
|---|---|---|---|---|
| Contract option | 7850 | 10521 | 10521 | 12149 |
| Expand option | 34792 | 30312 | 34792 | 26961 |
| Multiple options | 40370 | 36092 | 42231 | 26961 |

Figure 4.21 Results of the flexible investment in different scenarios (million, CNY)




Both Table 4,11 and Figure 4,12 illustrate that in the multiple options, the price in optimistic scenario presents the highest level, 42,231 million CNY, and the price in pessimistic scenario is the lowest, 26,961 million CNY. In the option to expand, the highest price 34,792 million CNY is located in optimistic scenario and basic scenario simultaneously, and the lowest one is in pessimistic scenario, which is 26,961 million CNY. And in the option to contract, price in pessimistic scenario, 12,149 million CNY, is the highest one, and the price in basic scenario maintains the lowest level, 7,850 million CNY.

From the results, we find that future development trend is an important factor in real options method. For example, the option to expand the project is a positive right to enlarge company's business scale and get more profit, and the option to contract the project can be seen as a negative right to cut more costs and scale back investment. Therefore price of expand option is always higher than the price of contract option.

This conclusion can be also used in scenario approach. We distinguish each scenario by different expansion rate and contraction rate. When we discuss four scenarios in expand option, it's interesting to discover there are two same results in basic scenario and optimistic scenario. In our assumption, due to the excellent investment environment, the company keeps a stable expansion rate 45% in basic scenario and an increasing expansion rate from 10% to 45% in optimistic scenario. Both of these two scenarios demonstrate the same positive develop trend in the

future, and they have the same expansion rate at maturity time by coincidence. Therefore, the final option values are same.

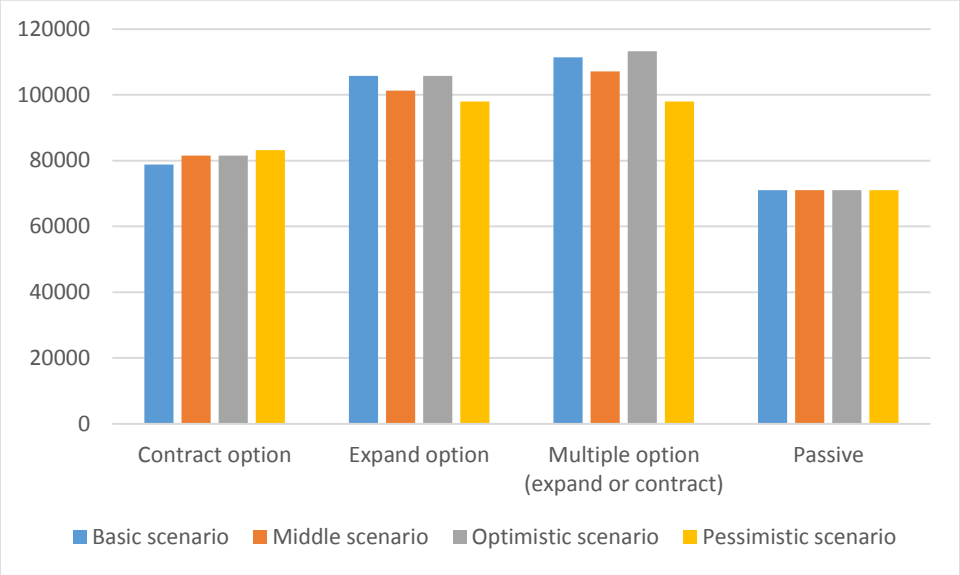
Meanwhile, there are two identical results in the option to contract, and one is from middle scenarios, and another is from optimistic scenario. Since 2016, options in these two scenarios move in the same contraction rate, which is from 30% to 10%. It indicates that after 2016, the company will contract the investment in the same trend from middle scenario and optimistic scenario. Consequently, option prices of these scenarios are same.

Due to the fact that the passive asset value of Baidu is 70,986 million CNY in 2013, the total asset values of Baidu in different flexibilities are summarized in Table 4.12 and Figure 4.22.

Table 4.12 Passive and flexibility asset valuation results (million, CNY)

| Component | | Total value | Flexibility |
|---|---|---|---|
| Passive value | | 70986 | 0 |
| Contract option | Basic scenario | 78836 | 7850 |
| | Middle scenario | 81507 | 10521 |
| | Optimistic scenario | 81507 | 10521 |
| | Pessimistic scenario | 83135 | 12149 |
| Expand option | Basic scenario | 105778 | 34792 |
| | Middle scenario | 101298 | 30312 |
| | Optimistic scenario | 105778 | 34792 |
| | Pessimistic scenario | 97947 | 26961 |
| Multiple options (expand or contract) | Basic scenario | 111356 | 40370 |
| | Middle scenario | 107078 | 36092 |
| | Optimistic scenario | 113217 | 42231 |
| | Pessimistic scenario | 97947 | 26961 |

Figure 4.22 The relationship between passive and flexible asset value of Baidu




As is exhibited in the Table 4.12 and Figure 4.22, Baidu's total asset value with flexibility is higher than the account passive value. The total asset value with the option to contract in basic scenario is 78,836 million CNY, in middle scenario and passive scenario is 81,507 million CNY and in passive scenario is 83,135 million CNY. The total asset value with the option to expand in basic scenario and optimistic scenario is 105,778 million CNY, in middle scenario is 101,298 million CNY, and in pessimistic scenario is 97,947 million CNY. And the total asset value of Baidu with the option to expand or contract in basic scenario is 111,356 million CNY, in middle scenario is107,078 million CNY, in optimistic scenario is 113,217 million CNY and in pessimistic scenario is 97,947 million CNY.

By contrast, the highest total asset value is 11,317 million CNY, with multiple options in optimistic scenario. In such a situation, Baidu will have the best environment and innovation awareness in the next five years. And the company can simultaneously continue the operation with no changes, expand or contract the project. The lowest asset value with flexibility is 78,836 million CNY, with contract option in basic scenario. In this situation, future expectations are negative and impossible to improve. Hence, expectations regarding long-term performance influence not only early growth investment, but also total asset value with real options.

# 5. Conclusion

In an uncertain environment, the firm's ability to manage projects over time is valuable. The real options framework recognizes this value, and so represents a new approach to both project evaluation and strategic management [Barnett, 2005]. In this diploma thesis, we adopted real options method to evaluate asset values of Baidu with different flexibilities in 2013. Baidu is a leading company in Chinese internet search engine market, with the strongest technology and the best development teams in the industry.

After the brief introduction of the thesis framework in the first chapter, the formal ideal of the real options method is explained in Chapter 2. The real options method is a right to make financial decisions, such as to receive a cash income from selling or buying a real asset. By compared with traditional valuation method, real options method has the better ability to deal with evaluation in the rapid change, great uncertainty, and flexibility environment. The real options method comes from financial options, just as the value of a stock option (or the investor's decision to exercise it) depends on the future stock price; the exercise decision of a real option is based on the future value of an underlying real asset, which is also called the future value of the investment project. And it also includes various types of options; we adopt and explain five of these in the thesis.

In Chapter 3, some basic information of Baidu is introduced. Baidu was established in 2000, and now it becomes the leading internet search provider in China, serving nearly 600,000 advertisers, occupying and 30% market share in online advertising and commanding 79% market share in China's internet search engine industry. Meanwhile, China has the largest population of users which is still fast growing. And the environment of internet industry in China is good for Baidu's development. Both SWOT analysis and Port's Five Force analysis indicated that Baidu has superiority in the market competition. In such a situation, we applied financial analysis of Baidu to estimate its financial characteristics. From common size analysis and ratio analysis,

performance of liquidity ratios, profitability ratios and activity ratios indicated good abilities of Baidu to meet its short-term obligations earn profits on its capital and assets and generate revenues from its investments. However, increase in total investment leads to the growth of financial leverage and debt-to-equity ratio. And long-term obligation takes up more and more share in total capital, which is a dangerous sign for the company. By considering these analyses, we defined that Baidu has a strong financial performance.

In Chapter 4, real options method is applied to evaluate Baidu's asset value. First at all, parameters and input data are estimated according to the company financial statements and stock market conditions. Based on the reality, we assumed manager of Baidu has the option to expand the company, option the contract the company and the option to expand or contract the company, from 2013 to 2018. And then, binomial model is applied to predict evolution of the underlying asset value, intrinsic value and option value. During this process, scenario approach is used to analysis different possibilities of option. According to the risky and uncertainty in the next five years from 2014 to 2018, we changed expansion rate and contraction rate in each year. Therefore, we can get four scenarios in each option, which are basic scenario, middle scenario, optimistic scenario and pessimistic scenario. Finally, we summarized option prices and total asset values in different scenarios: the highest total asset value is with multiple options in optimistic scenario, 11,317 million CNY, with the option price 42,231 million CNY; and the lowest asset value with flexibility is with contract option in basic scenario, 78,836 million CNY, with the option price 7,850 million CNY.

From the computation, it is found that expectations regarding long-term performance can influence early growth investment real options value. Better expectation will lead to a higher option price, and worse expectation will lead to a lower option price. Therefore, how to define and estimate expectation condition accurately of the company is the goal of our further study.

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## List of abbreviations

| | |
|---|---|
| CNY | China Yuan |
| USD | United States dollar |
| SMEs | Small and medium enterprises |
| P4P | Pay for play |
| GDP | Gross domestic product |
| CAPM | Capital asset pricing model |
| FCFF | Free cash flow to the firm |
| WACC | Weighted average cost of capital |
| NWC | Net working capital |
| NOPAT | Net operating profit after tax |
| D&A | Depreciation and amortization |
| Capex | Capital expenditures |

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Ostrava dated 23.4.2015 .....

JUNYAN GUO

## List of Annexes

1. Adjustment income statement of Baidu from 2009 to 2013
2. Adjustment balance sheet of Baidu from 2009 to 2013
3. Adjustment cash flow of Baidu from 2009 to 2013

Annex 1 Adjustment income statement of Baidu from 2009 to 2013 (million, CNY)

| | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|
| Revenue | 4,447.78 | 7,915.07 | 14,500.79 | 22,306.03 | 31,943.92 |
| Cost of Revenue | 1,616.24 | 2,149.29 | 3,896.88 | 6,448.55 | 11,471.84 |
| **Gross Operating Profit** | **2,831.54** | **5,765.79** | **10,603.90** | **15,857.48** | **20,472.09** |
| Research and development | 422.62 | 718.04 | 1,334.43 | 2,304.83 | 4,106.83 |
| Sales, general and administrative | 803.99 | 1,088.98 | 1,692.81 | 2,501.34 | 5,173.53 |
| Total Operating Expenses | 1,226.60 | 1,807.02 | 3,027.24 | 4,806.16 | 9,280.37 |
| **Operating income before interest and taxes** | **1,604.94** | **3,958.77** | **7,576.66** | **11,051.32** | **11,191.72** |
| Non-operating income | 78.18 | 102.4 | 232.52 | 914.12 | 993.3 |
| Income before income taxes | 1,683.12 | 4,061.16 | 7,809.18 | 11,965.44 | 12,185.02 |
| Provision for income taxes | 198.02 | 536 | 1,188.86 | 1,574.16 | 1,828.93 |
| Net income from continuing operations | 1,485.10 | 3,525.17 | 6,620.32 | 10,391.28 | 10,356.09 |
| **Net Income** | **1,485.1** | **3,525.1** | **6,638.64** | **10,456.0** | **10,519.0** |
| Net income available for common shareholders | 1,485.10 | 3,525.17 | 6,638.64 | 10,456.03 | 10,518.97 |
| **Earnings per share** | | | | | |
| Basic | 4.3 | 10.13 | 19.03 | 29.93 | 30.07 |
| Diluted | 4.27 | 10.1 | 18.99 | 29.89 | 30.02 |

Annex 2 Adjustment balance sheet of Baidu from 2009 to 2013 (million, CNY)

| | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|
| Assets | | | | | |
| Current Assets | | | | | |
| Cash, cash equivalents, and short-term investments | | | | | |
| Cash and cash equivalents | 4,200 | 7,782 | 4,127 | 11,881 | 9,692 |
| Short-term investments | 381 | 376 | 10,052 | 20,604 | 28,735 |
| **Total cash, cash equivalents, and short-term investments** | **4,581** | **8,158** | **14,179** | **32,485** | **38,427** |
| Accounts receivable | 164 | 297 | 600 | 1,253 | 2,221 |
| Other Current Assets | 98 | 327 | 1070 | 936 | 2382 |
| **Total current assets** | **4843** | **8782** | **15848** | **34674** | **43029** |
| Non-Current Assets | | | | | |
| Not property, plant and equipment | 998 | 1622 | 2744 | 3888 | 5370 |
| Intangibles | 186 | 179 | 3348 | 5465 | 20495 |
| Deferred Income Taxes | 34 | 31 | 52 | 53 | 98 |
| Other Long-Term Assets | 96 | 433 | 1348 | 1588 | 1994 |
| **Total non-current assets** | **1314** | **2266** | **7492** | **10995** | **27957** |
| **Total Assets** | **6157** | **11048** | **23341** | **45669** | **70986** |
| Liabilities and stockholders' equity | | | | | |
| Liabilities | | | | | |
| Current Liabilities | | | | | |
| Accounts Payable | - | 295 | 452 | - | - |
| Taxes Payable | 148 | - | - | 425 | 429 |
| Current Debt | - | - | 172 | 2171 | 344 |
| Other current liabilities | 1252 | 2256 | 3782 | 5640 | 10260 |
| **Total current liabilities** | **1400** | **2552** | **4407** | **8237** | **11033** |
| Non-current liabilities | | | | | |
| Deferred taxes liabilities | - | - | 132 | 289 | 1200 |
| Long Term Debt | - | 86 | 2278 | 9693 | 17229 |

| | | | | | |
|---|---|---|---|---|---|
| Other long-term liabilities | 4 | 5 | 1233 | 1394 | 3098 |
| **Total non-current liabilities** | **4** | **91** | **3642** | **11377** | **21528** |
| **Total Liabilities** | **1404** | **2643** | **8049** | **19614** | **32561** |
| Stockholders' equity | | | | | |
| Common stock | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Additional paid-in capital | 1426 | 1557 | 1772 | 2095 | 3056 |
| Retained earnings | 3441 | 6966 | 13604 | 24038 | 34525 |
| Minority Interests | - | - | 98 | 127 | 2240 |
| **Total stockholders' equity** | **4753** | **8406** | **15292** | **26055** | **38425** |
| **Total liabilities and stockholders' equity** | **6157** | **11048** | **23341** | **45669** | **70986** |

Annex 3 Adjustment cash flow of Baidu from 2009 to 2013 (million, CNY)

| | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|
| **Cash Flows From Operating Activities** | | | | | |
| Net Income | 1,485 | 3,525 | 6,620 | 10,391 | 10,356 |
| Depreciation and amortization | 317 | 441 | 885 | 1,515 | 2,652 |
| Deferred income taxes | -11 | -74 | -65 | -59 | 331 |
| Accounts receivable | -59 | -227 | -434 | -1,133 | -774 |
| Inventory | - | - | - | - | - |
| Account payable | - | - | - | 340 | 2 |
| Other working capital | 465 | 973 | 1,026 | 1,574 | 1,739 |
| Other non-cash items | 81 | 62 | 146 | -633 | -513 |
| **Net cash provided by operating activities** | **2,279** | **4,700** | **8,179** | **11,996** | **13,793** |
| **Cash Flows From Investing Activities** | | | | | |
| Investment in property, plant and equipment | -450 | -963 | -1,866 | -2,340 | -2,769 |
| Acquisitions Net | -12 | 0 | -1,946 | -822 | -13,461 |
| Purchases of investments | -782 | -2,903 | -11,462 | -33,201 | -84,713 |
| Sales/Maturities of investments | 708 | 2,662 | 1,497 | 22,829 | 78,510 |
| Purchases of intangibles | 0 | -13 | -476 | -227 | -912 |
| Other investing activities | 0 | 0 | 2 | 10 | 23 |
| **Net cash used for investing activities** | **-536** | **-1,218** | **-14,251** | **-13,750** | **-23,323** |
| **Cash Flows From Financing Activities** | | | | | |
| Common stock issued | 55 | 0 | 0 | 100 | 1,397 |
| Dividends | - | - | - | - | - |
| Other financing activities | 40 | 125 | 2,426 | 9,418 | 6,144 |
| **Net cash provided by (used** | **95** | **125** | **2,426** | **9,519** | **7,542** |

| for) financing activities | | | | | |
|---|---|---|---|---|---|
| Net Change in Cash | 1,838 | 3,602 | -3,654 | 7,753 | -2,189 |
| Cash at beginning of period | 2,362 | 4,180 | 7,782 | 4,127 | 11,881 |
| Cash at end of period | 4,200 | 7,782 | 4,127 | 11,881 | 9,692 |
| **Free cash in flow** | | | | | |
| Operating Cash Flow | 2,279 | 4,700 | 8,179 | 11,996 | 13,793 |
| Capital Expenditure | -450 | -976 | -2,342 | -2,566 | -3,681 |
| Free Cash Flow | 1,829 | 3,724 | 5,836 | 9,430 | 10,112 |