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Study on options valuation of civilian airport infrastructure based on computer simulation

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ABSTRACT

For the options value of the civilian airport infrastructure, the paper posits that environmental uncertainty and government guarantee of the civil airport industry add to project option value. First, the author processes the option pricing problem with stochastic volatility from the Knight uncertainty perspective, and it is assumed that the asset price follows Brownian motion. Then the author obtains the optimal probability under individual Knight uncertainty, and establishes the minimum pricing model with random volatility on this probability measure, deriving the minimum pricing formula of European call option with Knight aversion. Second, the author uses MATLAB simulation calculating the impact of restricting competition on the project value by modeling, MATLAB. A case of value options of the Hongqiao business jet is studied in order to prove this formula.

KEYWORDS

Civil airports;
Infrastructure;
Knight uncertainty;
Option pricing with stochastic volatility;
Restrict competition;
MATLAB simulation.

INTRODUCTION

The greatest concern for civilian airport infrastructure investors, is to be able to get the expected economic benefits. According to the traditional decision method of cash flow, when the investment project's internal rate of return is greater than the benchmark discount rate[1], policymakers should invest right away. Cash flow in the actual operational period, however, may be inconsistent with the forecasted cash flow. When the actual value is lower than the predicted value, the original decision might lead to errors. The investment may be difficult to recover or the recovery period will be extended. from the view of the options. In addition to in the value of the project based on the time value under the traditional decision-making methods, the project also includes a flexible value from project management as well as the value of uncertainty information (ie, flexibility value of management)[2]. That the value of the project equal to the present value of cash inflows and project flexibility value[3]. Traditional decision-making methods assumes that the asset value of the investment projects will be reduced with the increased uncertainty and real options theory accounts that uncertainty will increase the value of the project if managers can make effective business decisions[4]. Civilian airport infrastructure investment has a huge one-time investment and long payback period, and project uncertainties must be fully considered, including market uncertainty, and the uncertainty of the construction costs[5]..

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OPTIONS PRICING MODELS

Existing literature only considers market visits when it involves risks and does not contain Knight uncertainty. Knight uncertainty of the real market cannot be ignored. Han treated random volatility of option pricing problems from the perspective of Knight uncertainty, and he first proved that the immediate volatility model is essentially a problem of Knight uncertainty. He used discounted relative entropy to measure Knight uncertainty, then balanced Knight uncertainty and Knight premium through a utility function, and got the optimum probability measure and the price formula of the European call option with the Knight aversion degree. Zhang studied financial markets with Knight uncertainty, and assumed that underlying stock asset follows geo metric Brownian motion, where the models of minimal pricing of European stock options are made. Moreover, the explicit solutions of the models were given by using the theories of a backward stochastic differential equation and the method of Martingale. The European call option with a stochastic volatility model based Knight uncertainty first proves stochastic volatility model can be converted to Knight uncertain model; the model also assumes that based on Knight uncertainty aversion, the individual introduces "premium Knight – the Knight uncertain utility" function to handle Knight uncertainty. In the utility function, individuals weigh knight uncertainty to make the optimal choice. Knight uncertainty in the model, however, does not take objectivity into consideration and utility functions of individuals are set to "rational economic man", Simon's theory holds that the decision-making is impossible for realizing the principle of the optimization. The minimum pricing model (Zhang) is able to compensate for this deficiency. Models from Han and Zhang are based on the financial market prices, and this paper will apply the financial model to the real options model.

European options minimum pricing models

(Ω, F, P) is a complete probability space, $\{F_t\}_{0\le t\le T}$ is the domain generated by the one-dimensional standard Brownian motion, which meets the usual assumptions (completeness, monotonically increasing, right-continuous), make $F = F_t$, If one trading assets on the market is a risk-free bond, whose interest rate is constant r, another stock is to meet their price formulas (1) and (2):

$$dP_t = P_t r dt,\quad P_0 = 1 \tag{1}$$

$$dS_t = S_t(\mu dt + \sigma dB_t),\quad S_0 = s \tag{2}$$

r, μ, σ, s are constants, The following formulas can be obtained from formula (1)and (2),

$$S_t = s\exp\left\{(r - \frac{1}{2}\sigma^2)t + \sigma B_t^Q\right\},\quad 0 \le t \le T \tag{3}$$

Among formula (3), $B_t^Q = \sigma^{-1}(\mu - r)t + B_t$

make $\tau = \sigma^{-1}(\mu - r)$, $\frac{dQ}{dP} = \exp\left\{-\tau B_t - \frac{1}{2}\tau^2 T\right\}$

From the Girsanov theory, it is known that Q and P are equivalent probability measures, and $\{B_t^Q\}_{0\le t\le T}$ follows the Brownian motion.

For European options, the maturity date T, exercise price K of the call option is employed as follows: $(S_T - K)^+ = \max(S_T - K, 0)$. In order to portray Knight uncertainty on the financial markets, a viable control collection is introduced: $\Theta = \{(\theta_t)_{0\le t\le T} \| \theta| \le k,\ a.e.t \in [0,T]\}$, $k > 0$. Chen calls Θ K-ignorance, an equivalent probability measure generated by the collection of :

$$\wp^\theta = \left\{Q^\theta \left| \frac{dQ^\theta}{dQ} = \exp\left[-\int_0^T \theta_s dB_s^Q - \frac{1}{2}\int_0^T \theta_s^2 ds\right], (\theta_s)_{0\le s\le t} \in \Theta\right.\right\}$$

Knight uncertainty on the financial market is usually portrayed by the collection $\wp^\theta$, and investors do not know which probability measure should be used in the European option pricing; from a conservative point, investors will give the minimum pricing to European options,

$$C(S_T, K) = \min_{Q^\theta \in \wp^\theta}\left\{E^{Q^\theta}\left[e^{-rT}(S_T - K)^+\right]\right\} \tag{4}$$

Uniqueness of Solution for formula (4) can be proved by the following two lemmas:

Lemma1

Respectively exists $(\theta_t^1)_{0\le t\le T} \in \Theta$, which meet

$$C(S_T, K) = E^{Q^{\theta^1}}\left[e^{-rT}(S_T - K)^+\right] \tag{5}$$

The proof sees literature 6.

Lemma2

Suppose the diffusion coefficient $\sigma > 0$ in the stock price equation (2), in Lemma 1, $(\theta_t^1)_{0\le t\le T} \equiv k$, $(\theta_t^2)_{0\le t\le T} \equiv -k$, Therefore,

$$C(S_T, K) = E^{Q(k)}\left[e^{-rT}(S_T - K)^+\right] \quad (6)$$

Among the formula (6), $\frac{dQ^{(k)}}{dQ} = \exp\left\{-kB_T^Q - \frac{1}{2}k^2 T\right\}$.

Theorem

Suppose the diffusion coefficient $\sigma > 0$ in the stock price equation (2), then

$$C(S_T, K) = Se^{-k\sigma T}N(d_1) - Ke^{-rT}N(d_2) \quad (7)$$

Among the formula (7), $d_2 = \frac{\ln\frac{S}{K} + (r - k\sigma - \frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}}$, $d_1 = d_2 + \sigma\sqrt{T}$.

The proof sees literature 6. Formula (7) is the minimum pricing model of European option under Knight uncertainty environment.

Stochastic volatility option model

This section assumes that the model is built under a risk-neutral conditions, and it is further assumed that r is the fixed risk-free interest rate in a risk neutral probability measure P, α and β are constants, assuming the Wiener process $dB(t)$ and $dW(t)$ are independent from each other. The underlying asset follows the following procedure:

$$dS(t)/S(t) = rdt + \sigma(t)dB(t) \quad (8)$$

$$d\sigma(t)/\sigma(t) = \alpha dt + \beta dW(t) \quad (9)$$

From formula (9), an expression for the instantaneous volatility can be:

$$\sigma(t) = \sigma(0)\exp\left[(\alpha - \frac{\beta^2}{2})t + \beta W(t)\right] \quad (10)$$

suppose, $h(t) \triangleq \exp\left[(\alpha - \frac{\beta^2}{2})t\right]$, $X(t) \triangleq \exp[\beta W(t)]$ then a new process can be:

$$dS(t)/S(t) = rdt + \sigma(0)h(t)X(t)dB(t) \quad (11)$$

Consider the following deterministic time-varying volatility: the volatility is a non-random and deterministic process that changes over time:

$$dS(t)/S(t) = rdt + \sigma(0)h(t)dB(t) \quad (12)$$

Because $X(t)$ and $dB(t)$ are independent, at the moment t, $X(t)dB(t)$ can be handled by two steps. First of all, according to the distribution of $X(t)$, $x(t)$ can be randomly selected, then the paper can get a random process with deterministic time-varying volatility that is similar to formula (12).

$$dS(t)/S(t) = rdt + \sigma(0)h(t)x(t)dB(t) \quad (13)$$

In formula (13), the value of $x(t)$ has unlimited possibilities. A different random process with different deterministic time-varying volatility can be obtained from different $x(t)$, when individuals face formula (11). He actually faces a family with random process in formula (13), in the face of possible probability distributions of $S(t)$. The individual is actually facing a Knight uncertainty problem, according to the thought of Bewley and Wang that the individual selects the reference model based on the "inertia", "belief", "status quo". Han assumed that individuals choose a conservative probability measure that is based on average estimate, and individuals know their choice of the reference model is not accurate. By disturbing probability measure P, the probability measure P can be obtained, and by the utility function $V(\tilde{P})$, the individual selects an optimal measure $\tilde{P}^*$. A reference model can be selected with the following characteristics:

$$D[x(t)dB(t)] = D[X(t)dB(t)]$$

Suppose $x(t) = e^{\beta^2 t}$, the reference probability measure can be obtained under probability measure P,

$$dS(t)/S(t) = rdt + \sigma(0)h(t)e^{\beta^2 t}dB(t) \quad (14)$$

for the individual, Formula (14) may be a conservative estimate. The reference model is not precise enough, and there may be another probability measure. If $m(t) \triangleq d\tilde{P}/dP$, $m(t)$ is a Radon-Nikodym derivative of $\tilde{P}$ to P, then expression of $m(t)$ can be written as follows:

$$m(t) = \exp\left[\int_0^t \theta(t)dB(t) - \frac{1}{2}\int_0^t \theta^2(t)d\iota\right] \quad (15)$$

Among formula (15) (suppose it is a non-random process), the following formula is satisfied:

$$E\left\{\exp\left[\int_0^t \theta^2(t)d\iota\right]\right\} < \infty \quad (16)$$

Also, the following formula can be obtained under the reference probability measure $\tilde{P}$,

$$dS(t)/S(t) = (r + \sigma(0)h(t)\theta(t)e^{\beta^2 t})dt + \sigma(0)h(t)e^{\beta^2 t}d\tilde{B}(t) \quad (17)$$

Among formula (17), the premium $\pi(t) \triangleq \sigma(0)h(t)\theta(t)e^{\beta^2 t}$ is caused due to the deviation from the model reference probability measure P. A "premium Knight - Knight uncertainty" based utility function $V(\tilde{P})$ is introduced to solve for the Knight uncertainty model, defined as:

$$V(\tilde{P}) = \tilde{K}(\tilde{P}) - \gamma \tilde{R}(\tilde{P}) \tag{18}$$

Among formula (18), $\tilde{K}(\tilde{P})$ is a premium under probability measure $\tilde{P}$, $\tilde{R}(\tilde{P})$ represents uncertainty, $\gamma > 0$ represents Knight Aversion. The individual, has to select appropriate risk neutral probability that makes the utility function $V(\tilde{P})$ maximum. Assuming the discount factor is $e^{-\delta t}$, then the cumulative discounted Knight premium is $\tilde{K}(\tilde{P})$:

$$\tilde{K}(\tilde{P}) = \int_0^\infty e^{-\delta t}\pi(t)dt = \int_0^\infty e^{-\delta t}\sigma(0)h(t)e^{\beta^2 t}dt \tag{19}$$

Assume that

$$\tilde{R}(\tilde{P}) = 1/2\tilde{E}\left[\int_0^\infty e^{-\delta t}\theta^2(t)dt\right] \tag{20}$$

Formulas (19) and (20) and the Euler equation shows:

$$\theta^*(t) = \frac{\sigma(0)}{\gamma}e^{(\alpha+\frac{1}{2}\beta^2)t} \tag{21}$$

By formulas (17) and (21), the price of the underlying asset is obtained following the process probability measure $\tilde{P}$:

$$dS(t)/S(t) = (r + \frac{\sigma^2(0)}{\gamma}e^{(2\alpha+\beta^2)t})dt + \sigma(0)e^{(\alpha+\frac{1}{2}\beta^2)t}d\tilde{B}^*(t) \tag{22}$$

in order to obtain European option prices for the underlying assets following formula (22), according to Shreve's argument, assume that the underlying asset European call option price for the first time under the risk-neutral conditions is as follows:

$$C(T,S(0)) = BSM\left\{T, S(0), K, \frac{1}{T}\int_0^T \tilde{r}(t)dt, \sqrt{\frac{1}{T}\int_0^T \tilde{\sigma}^2(t)dt}\right\} \tag{23}$$

Among formula (23), $BSM(S,K,\bar{r},\bar{\sigma})$ is the price of a standard European call option, the initial underlying asset price is S, exercise price is K, $\bar{r}$ is unchanged interest rates, and $\bar{\sigma}$ is unchanged volatility.

European minimum options

By Shreve's argument and European options pricing formula in section 2.2.2, the European call option formula with random volatility of the underlying asset at the initial time can be obtained:

$C^*(T,S(0),K) = BSM(T,S(0),K,\bar{r}^*,\bar{\sigma}^*) = Se^{-k\sigma T}N(d_1) - Ke^{-rT}N(d_2)$ Among the above formula,

$$\bar{r}^* = r + \frac{\sigma^2(0)}{T\gamma(2\alpha+\beta^2)}\left[e^{(2\alpha+\beta^2)T} - 1\right] \tag{24}$$

$$\bar{\sigma}^* = \sqrt{\frac{\sigma^2(0)}{T(2\alpha+\beta^2)}\left[e^{(2\alpha+\beta^2)T} - 1\right]} \tag{25}$$

S — The price of the underlying asset,
K —The cost of the underlying asset investment,
σ — Volatility of Asset value,
T — Option exercise time,
k —The parameter of Knight uncertainty,
γ —Knight Aversion.

CASE STUDIES

Project description

In Shanghai, in October 2006, Shanghai Airport Authority and Australia's Hawker Pacific Business Aviation Development Co., Ltd. which makes the Shanghai business jet base project signed a memorandum of cooperation and entered into a substantive start-up phase. Total investment of the joint venture is 175 million yuan, registered capital is 120 million yuan, the Airport Group invested 61.2 million yuan, accounting for 51%, Hawke companies invested 58.8 million yuan, accounting for 49%. According to the estimate of the feasibility study report, a one-time payment of all ground facilities lease costs and 50% of the land lease costs, the part of the rent totaling approximately 1.0255 billion; and additional 50% of the land lease fee of 53 million yuan in 20 years, accumulating approximately to 1 billion, The joint venture awarded Hawke the right to operate in Shanghai Airport and engage in the business jet terminal building and apron services; 5% of the revenue each year pays the franchise fee, and a one-time rental income equal to the total cost of the construction. In the calculation process, a one-time rental 1.0255 billion of the joint venture company was thought as the investment of the project, and the other 50% of the rental fee as operating costs allocated to 20 years' payment. According to the traditional cash flow evaluation methods, long-term bond yields as risk-free interest rate 6.15% were made. An investment net present value (NPV) of Shanghai Hongqiao business jet base is 22.8293 million yuan.

From the view of traditional investment decision-making theory, NPV> 0, the investment project can be launched, but the rate of return is similar to the risk-free rate. For investors, it is not very attractive. Moreover, the operating cycle of the project is up to 21 years. For investment projects, there are many risk factors, but if investors take into account fluctuations of the PPP project cash flow into consideration, then the investment value of the project may not be so low. The paper re-evaluates the value of the project based on the minimum pricing models with the Knight uncertainty stochastic volatility.

Industry Knight uncertainty

The general aviation industry is an emerging industry in China, which mainly refers to aviation activities in addition to military, police, and customs officials. Other than air transport flight aviation activities, including those engaged in industry, include agriculture, forestry, fisheries, mining, construction and flight operations and health, disaster relief, meteorological exploration, marine monitoring, scientific experiments, remote sensing, mapping, education and training, culture, sports, and tourism. Other aspects of the flight activities, along with economic development, business aviation are the fastest growing and most important industry in general aviation. There are many problems in the development of China's business jet industry. The industry environment has a high degree of uncertainty, using the analytic hierarchy process, and the author has accesssed to the airport five experts and obtained Knight uncertainty = 0.74(TABLE 1).

TABLE 1 : Index weights table

Target layer	Criteria layer	Index layer	Weight	First	Second	Third	Fourth	Fifth
uncertainties of business jet development	Industry policy	Airspace control policy	0.246	0.8	0.8	0.85	0.9	0.7
		Approval process	0.104	0.7	0.7	0.8	0.6	0.75
		Operator accreditation	0.061	0.7	0.65	0.6	0.8	0.75
		Freedom rights impact	0.033	0.8	0.7	0.75	0.85	0.65
	Purchase tax burden	Purchase tax burden	0.0864	0.60	0.70	0.70	0.80	0.65
		Operating costs	0.0864	0.50	0.60	0.65	0.75	0.60
	Infrastructure	Number of common airport	0.148	0.80	0.85	0.80	0.85	0.85
		The number of FBO and MRO facilities	0.091	0.85	0.80	0.80	0.75	0.85
		Financing, insurance, consulting services	0.057	0.75	0.70	0.70	0.80	0.85
		Business jet operating manner	0.031	0.70	0.75	0.75	0.80	0.85
	Environment	Macroeconomic trends	0.036	0.50	0.55	0.50	0.50	0.50
		Aviation cultural and social attitudes	0.016	0.55	0.50	0.65	0.65	0.55
		Weighted average score	0.74	0.75	0.73	0.75	0.78	0.72

The determination of value

In order to estimate the civilian airport industry with Knight Aversion, the first need is to estimate the parameters of the stochastic volatility models (1) and (2), and then generate the analog data of a structural model. There are many methods of parameter estimation, such as the estimation method of moments, method of least squares, Bayesian estimation method and maximum likelihood estimation method, etc. The author uses Efficient Method of Moments (EMM) put forward by Gallant and Tauchen to estimate the parameters of the stochastic volatility model. The basic idea is based on analog technology moments matching process, using the score of the auxiliary model as the moment conditions in the structural model of expectations. The auxiliary model chosen by the EMM estimation method should be approximated to the real structure model, and the dimension of the vector of the auxiliary parameters of the model must be greater than or equal to the dimension of the vector of the estimated model parameters of the real structure. (1)According to listing date and the exercise start date that the HP company subscribes, select the appropriate trading day (20/08/2011—18/08/2012) of the

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underlying securities closing price is estimated by EMM. From the results of EMM estimates, it can be seen that the value of b is close to 1(TABLE 2, TABLE 3). (2) using the least squares method (LSM), by minimizing the square of the error and finding data matching the best function, fitting the closing price of a range HP company, the author estimates γ, the exercise price is 1.04, the exercise ratio is 1, fitting time interval is from July 21, 2012 to August 17, 2012, for the 28 trading days, the author checks that the SHIBOR interest rate of the corresponding one-year time interval is 0.0315. Setting the trading day at 252 days, it is available to estimate $\alpha=-0.174$, $\beta=0.113$. α,β is substituted into formula (24), using the LSM fitting warrants data, the paper derives that $\gamma=0.351$.

TABLE 2 : Auxiliary model parameter maximum likelihood estimation results

Variable	Estimate	Standard Error	t value	Approx p
a'	0.0067	0.000721	4.21	<.0001
b'	0.1371	0.00038	13.47	<.0001
c'	0.8249	0.00266	83.14	<.0001

TABLE 3 : EMM parameter estimation results

Variable	Estimate	Standard Error	t value	Approx p
a	0.01764	0.000536	40.82	<.0001
b	0.97864	0.000427	2325.64	<.0001
c	0.19659	0.00026	185.46	<.0001

Option value

The following data can be obtained from the Statement of Cash Flows: (Unit: million)

So, if the present value is 12,528 million, then the author makes a five-year long-term Treasury bill rate as the risk-free rate $r=6.15\%$. It is known that $r^*=8.66\%,\ \sigma^*=9.38\%$,

$\sigma(0)=0.249,\ \alpha=-0.174,\ \beta=0.113,\ T=21$,

$$\begin{cases} d_2=\dfrac{\ln(\frac{S}{I})+(r-k\sigma-\frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}} \\ d_1=d_2+\sigma\sqrt{T} \end{cases}.$$

So it is can be obtained that $d_2=1.09,\ d_1=1.52$,

$$C=12538\times0.261\times N(1.52)-10255\times0.169\times N(1.09)$$
$$=1497\quad\text{(unit: million)}$$

GOVERNMENT GUARANTEE

Both the developed or developing countries actively explore their own infrastructure construction plan. In order to further strengthen the capacity of infrastructure supply and make up long-term serious shortage situation of investing in the construction of infrastructure finance only by government funding and government loans, the trend that the government is a guarantee people become more and more popular, he government guarantee in infrastructure projects is different from general government guarantee, which refers to the government action which gives preferential policies or guarantee on franchise business, investment return and environment conditions in order to attract non-government investors to invest in the infrastructure construction. The government guarantees means that the government must compensate to the secured party when the secured party's income is lower than the set guarantee, and the secured party are either private investors or financial institutions. With the PPP financing model used in public infrastructure projects, the important role of the government guaranteen has more and more attention (TABLE 4). Restricting competition is more common in the civil airport industry, when aircraft movements are greater than a set value. The Government has the right to build in the same geographical range second business jet base. When aircraft movements are greater than the highest limit, the second home business jet base has the right to start operations, and the original business jet base often maintains a competitive advantage in the operating period, that is embodied in the mathematical model, which means additional revenue to is extracted by the government, which is as shown as follows:

$$SF_i=\begin{cases}0, & if\ Q_t^R\le Q_t^C, \\ (Q_t^R-Q_t^C)\cdot P_t\cdot w & if\ Q_t^R\ge Q_t^C\end{cases} \quad (26)$$

The paper studies the impact of the restriction competition on project value under the initial aircraft movements, aircraft movements growth rate and other factors based on the Charles (2005) model. For investors, he has a call option. The benchmark rate of return is 7.15%, according to the feasibility study report. The calculation steps are as follows: (1) Determine the probability distribution of the initial business jet movements,

TABLE 4 : The content of government guarantee

Warranties	Form of expression	Existing term or condition
The minimum income guarantee	If the annual operating income is less than income as agreed in the contract, the government provides subsidy for investors.	During franchise period
The minimum amount of traffic security	If the annual traffic volume is greater than or equal to the volume of traffic as agreed in the contract, the government does not provide any subsidies; otherwise the government makes up the actual traffic volume to a certain percentage.	During franchise period
Guarantee of investment returns	Determination of the rate of return on investment rate contract, if business income exceeds the limit of rate of maximum return, the government and investors share profit according to the predetermined proportion; if business income is lower than the rate of minimum return limit, the government provides subsidy for investors.	During franchise period
Purchase guarantee	The government will ensure to buy a certain number of product prices from investors each year.	During franchise period
Preferential tax guarantee	The government provides all aspects of preferential tax for investors, including tariffs of imported equipment, tax of investors receive dividends, dividend withholding tax.	During franchise period
Foreign exchange guarantee	The government promises that operating profits can be convertible into foreign currency.	During or after franchise period
Guarantee of restricting competition	The government promises to the PPP company that the same project is no longer approved at a certain time and space.	During franchise period
The protection of intellectual property rights or other secret information	The government should take the corresponding protective measures to protect secret information and intellectual property from missing free of charge.	During or after franchise period

the probability distribution of the growth rate of aircraft movements and the probability distribution of the annual aircraft movements income. (2) Based on the above parameters, the paper simulates the distribution path of aircraft movements in the period of the concession. (3) In each path, the triggered condition of call options is set by the government guaranteed, when condition is triggered, government revenue is calculated, the paper calculates government revenue on each path. (4) To simulate multiple paths, and calculate the statistical value of government revenue.

The initial jet taking off and landing sortie probability distribution. But he initial jet taking off and landing vehicles theoretically have an important impact on the economic benefits of official machine base. But estimating jet base initial official machine movements is difficult, the paper take movements of initial official machine in feasibility report for numerical calculation (TABLE 5).

TABLE 5 : Probability distribution of official machine initial movements

Variable	Distribution	mean	Growth rate	Standard deviation
The initial movements	The lognormal distribution	movements of the first year in operation years	0	14%

As to movements estimation, according to the “feasibility study report of S jet base”, growth rate of official machine movements changes along with the time.In the first stage, because the project construction and operation time is earlier, which is an important stage for official machine development, growth rate reached 15%, after the year 2017, official machine projects construction goes into operation all over the country, although these bases are far away from each other in geographic space, but they have a certain influence on the project, so the growth rate will drop to 10%, after the year 2025, official machine movements growth goes into the stable stage because of the project design capacity.

Based on prediction of growth rate of official ma-

TABLE 6 : The growth of business jet movements

Operating years	mean	Standard deviation
2009-2016	14%	11.4%
2017-2024	8%	6.45%
2025-2029	1%	1.74%

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chine movements, during in the operation period, official machine movements, and the growth rate and the volatility of aircraft movements relevant parameters is as shown in TABLE 6.

The jet base income cannot be directly calculated through the car goods flow as well as air cargo station or highway project. The income of official machine base is divided into three parts. First, the income of FBO, the revenue of this part includes parking service, channel service, ground service and agency services, all kinds of services income can be calculated by public frame time multiplied by the service rate, but the volume of four different business services is often different, the most basic service is stopping service and channel service, after the development of these two kinds of service becomes mature, it can drive the development of ground service and agency service. Second, the income of MBO.

TABLE 7 : Official aircraft taking off and landing of annual income

Particular year	Official machine movements	Annual total Income (yuan)	The Average Income (million yuan)
2009	1200	240	0.2
2010	1368	1131	0.8268
2011	1559	1757	1.1267
2012	1777	3097	1.7420
2013	2026	4126	2.0358
2014	2311	5179	2.2416
2015	2633	6287	2.3869
2016	3002	7239	2.4108
2017	3243	7558	2.3306
2018	3502	7810	2.2299
2019	3782	8110	2.1440
2020	4085	8169	1.9997
2021	4412	8229	1.8561
2022	4765	8290	1.7398
2023	5146	8354	1.6234
2024	5558	8217	1.4785
2025	5613	8485	1.5116
2026	5725	8555	1.4942
2027	5782	8626	1.4917
2028	5898	8700	1.4750
2029	5958	8775	1.4729

The revenue and income of this part includes repair income, spare parts sales income, subcontracting income and warehouse management income. Third, managed and charter income. It can be divided into small, medium and large machine charter. Parameters calculation in TABLE 5 is based on parking services, other services can be regarded as the extension of the parking service and ancillary revenue service. During operation period, the same number of parking service brings about different service income, which is due to the different stages of development. In general, in the initial stage of development, an aircraft parking services brings about a low income, during development of later operation stage, because of the rich service content and

TABLE 8 : Simulation result of government revenue under restrict competition

Statistics	Simulation times	Mean	Standard deviation
Numerical	1000	928.81	61579

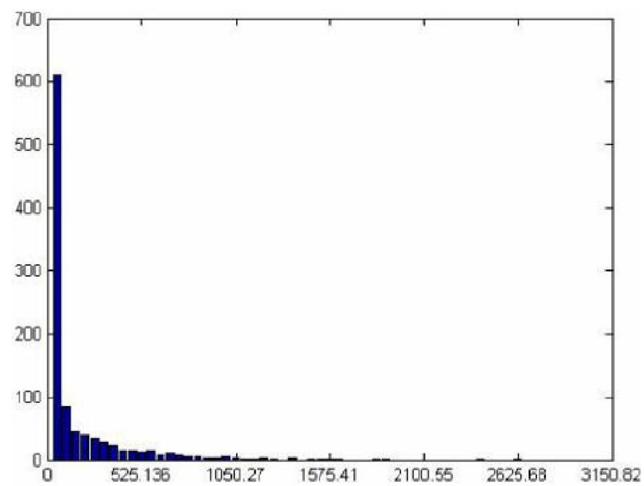

Figure 1 : Government revenue under restrict competition

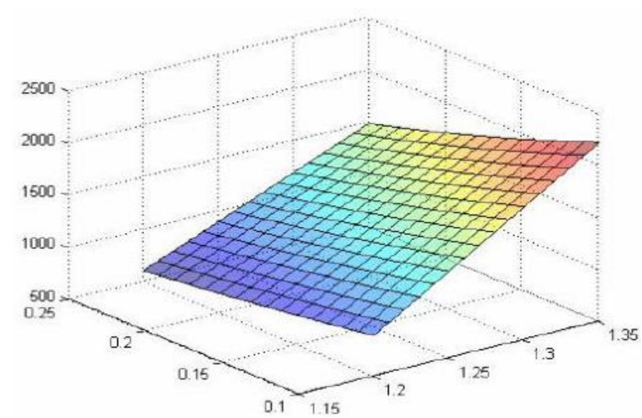

Figure 2 : The relationship of income pumping proportion and to restrict competition proportion

improved quality, aircraft income will be increased brought about by a parking service. To a certain extent, income caused by each aircraft is fixed at a certain level, but the operating

costs will rise because of various factors, the rate is as shown in TABLE 7.

In the case of restricting competition, according to the government contract pumping ratio (0.4) and government restriction on competition ratio (1.3), the government revenue is 9.2881 million yuan (Figure.1). If the government contract pumping ratio and government restrictions on competition ratio changes, the government revenue will change correspondingly (TABLE 8).

As is shown in Figure.2, under the restricting competition, the relationship is simulated on MATLAB platform between the three factors, including restricting proportion, the proportion of share and government income. It can be seen that the government guarantees or income increased with the rise of percentage of share, while decreased with the increase of competition restriction ratio. In practice, the government and investors can negotiate the percentage of share and restrict competition according to their strength, it depends on the project environment and their attitudes to risk.

CONCLUSION

The topic of the real options method investment is on the forefront of academic research in the field of decision-making in the current project. Theorists on the real options approach paper was discussed more, but less was discussed on the enterprise application level. In this paper, the author uses the Hongqiao business jet base case to prove option pricing in the enterprise. Calculation proves the method is feasible and effective.

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