Research Article
The Analysis of Several Models of Investment Value of Logistics Project Evaluation

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The study of the logistics project evaluation model features reviews the traditional value evaluation model. On the basis of this, using the fuzzy theory, we establish several logistics project evaluation models under fuzzy environment. The analysis of the respective characteristics and the comparison of the calculated results of the three models show that these models are important methods of investment value of logistics evaluation.

1. Introduction

With the use of information technology and e-commerce and other modern technology, the investment in logistics industry has high uncertainty, irreversibility, and fuzziness. The application of NPV and other traditional methods of logistics project valuation is easy to cause the enterprise objective and actual value deviation. Giving full consideration to market volatility, uncertainty, irreversibility, and real option is of great practicality. The application of the real option to evaluate logistics project investment value is widely used. Schwartz and moon [1] believe that real option in venture capital evaluation can make better explanation. Dayanik [2] and so forth solved the one-dimensional diffusion process of optimal stopping problems, and the results for American option pricing, control, and so on are suitable. At the same time, in view of logistics project investment also having the characteristic of fuzziness, fuzzy factors with real option theory to carry on the research is very important. Carlsson and fuller [3] considered the rates of fuzzy-relation-fuzzy-option formula and used the optimization theory to build the project investment decision model of R&D optimization. The fuzzy process, mixing process, and uncertain process proposed by Liu [4] can well explain the fuzzy financial market. Qin and Li [5] also presented the option pricing problem under fuzzy environment. Although most of the distribution function of a random variable can be obtained by statistical method, but in actual, because of the incomplete logistics project information and prior knowledge, we often fail to accurately collect and measure these data and cannot depict or control the various factors of the logistics project, which increase the logistics project management fuzzy. Thinking about these factors of the logistics project completely, many scholars are considering the classical option pricing theory on how to be improved. This paper reviews the logistics project evaluation model under traditional situation, then, on this foundation, it puts forward a few other value evaluation models and discusses and finally compares by numerical calculations.

2. Traditional Logistics Project Evaluation Methods

2.1. Method of NPV. From time \( t \) to time \( T \), we can get the net present value flow of the whole logistics project with investment opportunities at the time of \( T \):

\[
\Phi(t) = A(t) e^{-\alpha(T-t)} - I(t) e^{-\beta(T-t)} - I_0,
\]

where \( A(t) \) is logistics project asset value, \( I(t) \) is the capital spending, where \( \alpha \) is instantaneously the expected growth rate of \( A(t) \), \( \beta \) is instantaneously expected growth rate of \( I(t) \), and \( I_0 \) is the initial investment.
2.2. A Kind of Simple Method about Net Present Value under the Random Environment. If in the risk neutral world, logistics project asset value $A(t)$ follows the stochastic differential equation (because of the uncertainty and other reasons of the logistics project investment, we can assume that the logistics project investment in capital spending $I(t)$ also follows the equation $[6, 7]$):

$$dA(t) = A(t)\alpha dt + A(t)\sigma_1dz_1,$$

$$dI(t) = I(t)\beta dt + I(t)\sigma_2dz_2,$$  \hspace{1cm} (2)

where $\alpha$ is instantaneously the expected growth rate of $A(t)$, $\beta$ is instantaneously the expected growth rate of $I(t)$, $\sigma_1$ is the instantaneous standard deviation of $A(t)$, $\sigma_2$ is instantaneous standard deviation of $I(t)$, $dz_1$ is the Wiener process of $A(t)$, $dz_2$ is the Wiener process of $I(t)$, and the instantaneous correlation coefficient is $\rho_{12}$: From time $t$ to time $T$, the logistics project investment opportunity to solve the problem and the threshold of implementation of investment are $(A^*, I^*, T)$; by McDonald and Siegel $[6]$ and Dixit and Pindyck $[7]$, we can get the formula of net present value flow:

$$\Phi(t) = A(t)e^{-\alpha(T-t)}N(d_1) - I(t)e^{-\beta(T-t)}N(d_2) - I_0,$$  \hspace{1cm} (3)

where

$$d_1 = \frac{\ln(A(t)/I(t)) + (\alpha - \beta)(T-t)}{\theta \sqrt{T-t}} + \frac{1}{2}\theta \sqrt{T-t},$$

$$d_2 = \frac{\ln(A(t)/I(t)) + (\alpha - \beta)(T-t)}{\theta \sqrt{T-t}} - \frac{1}{2}\theta \sqrt{T-t},$$  \hspace{1cm} (4)

where $\theta^2 = \sigma_1^2 - 2\rho_{12}\sigma_1\sigma_2 + \sigma_2^2$ and $\rho_{12}$ is the relevant coefficient of the Wiener process $dz_1$ and $dz_2$.

2.3. The Project Valuation Model of the Same Fluctuation Rate. In reality, the investment decision making of logistics project, often in the incomplete information condition, and their values have to be anticipated in order to determine the parameters. At the same time, the excessive pursuit of input variable accuracy of logistics project can lead to the output of results of fuzzy. From the view of fuzzy mathematics, logistics project value and the distribution of the cost of the total investment are a fuzzy number; according to the similarity of trapezoidal and normal distribution and mathematically convenient treatment, logistics project value can be expressed as a trapezoidal fuzzy number $V = [V_1, V_2, \alpha_1, \beta_1]$, and the total investment cost is $I = [I_1, I_2, \alpha_2, \beta_2]$. Trapezoidal fuzzy number $V$ lies in the interval $[V_1, V_2]$, most likely, $(V_2 + \beta_1)$ and $(V_1 - \alpha_1)$, respectively, which indicates the upper and lower bounds of the uncertain factor of the expected project profit cash flow. Similarly, the trapezoidal fuzzy number $I$ is the most likely value of the cost of logistics project investment, and it lies in the interval $[I_1, I_2, (I_2 + \beta_2)$, and $(I_1 - \alpha_2)$, respectively, which indicates the upper and lower bound of the expected investment cost. $T$ is the options of the expire time. According to Carlsson and Fullér $[3]$, we obtained the model $[8]$ based on the improved Merton formula evaluation under fuzzy environment:

$$FROV = Ve^{-\delta T}N(d_1) - Ie^{-\delta T}N(d_2)$$

$$= [V_1, V_2, \alpha_1, \beta_1] e^{-\delta T}N(d_1)$$

$$- [I_1, I_2, \alpha_2, \beta_2] e^{-\delta T}N(d_2),$$

$$V_1 e^{-\delta T}N(d_1) - I_2 e^{-\delta T}N(d_2),$$

$$\alpha_1 e^{-\delta T}N(d_1) + \beta_2 e^{-\delta T}N(d_2),$$

$$\beta_1 e^{-\delta T}N(d_1) + \alpha_2 e^{-\delta T}N(d_2),$$

where

$$d_1 = \frac{\ln(E(V)/E(I)) + (r + (1/2)\sigma^2)T}{\sigma \sqrt{T}},$$

$$d_2 = \frac{\ln(E(V)/E(I)) + (r - (1/2)\sigma^2)T}{\sigma \sqrt{T}},$$

$$\sigma = \sqrt{\sigma_1^2 + \sigma_2^2 - 2\rho_{12}\sigma_1\sigma_2},$$

where $FROV$ is the real options value under fuzzy environment, $\sigma$ is the volatility, that is, the union fluctuation rate of the logistics project value and investment cost, $N(d)$ is the probability of less than $d$ under the condition of the standard normal distribution, $\sigma_1$ is the volatility of logistics project value, $\sigma_2$ is the volatility of the cost of the logistics project investment, and $\delta$ is the value loss during the process of option. The model provides a better method for us when we make evaluation for the same logistics project under fuzzy environment.

2.4. The Evaluation Model of Logistics Project Based on Compound Option Value. We combine the Geske model with the threshold of implementation of investment $T$, the logistics project investment opportunity to solve the problem and the threshold of implementation of investment are $(A^*, I^*, T)$; by McDonald and Siegel $[6]$ and Dixit and Pindyck $[7]$, we can get the Geske $[9]$ model under fuzzy environment:

$$FROV = [V_1, V_2, \alpha_1, \beta_1] e^{-\delta T}N_2(a_1, b_1; \sqrt{t_2/t_1}) - [I_1, I_2, \alpha_2, \beta_2] e^{-\delta T}N_2(a_2, b_2; \sqrt{t_1/t_2})$$

$$- [I_1, I_2, \alpha_2', \beta_2'] e^{-\delta T}N_1(a_2),$$

where $N_2$ and $N_1$ are the normal distribution and trapezoidal distribution, respectively.
\[
\begin{align*}
V_1 e^{-\delta_1 t_2 N_2 (a_1, b_1; \sqrt{t_2/t_1})} - I_2 e^{-r t_2 N_2 (a_2, b_2; \sqrt{t_1/t_2})} - I_1 e^{-\delta_1 N_1 (a_1)} + \beta_1 e^{-\delta_1 N_1 (a_1, b_1; \sqrt{t_1/t_2})} + \beta_2 e^{-r N_1 (a_2, b_2; \sqrt{t_2/t_1})} - I_2 e^{-\delta_1 N_1 (a_2)}, \\
V_2 e^{-\delta_1 N_2 (a_1, b_1; \sqrt{t_2/t_1})} - I_2 e^{-r N_2 (a_2, b_2; \sqrt{t_1/t_2})} - I_2 e^{-\delta_1 N_2 (a_2)}, \\
\alpha_1 e^{-\delta_1 N_2 (a_1, b_1; \sqrt{t_2/t_1})} + \beta_2 e^{-r N_2 (a_2, b_2; \sqrt{t_2/t_1})} + \beta_1 e^{-\delta_1 N_2 (a_1, b_1; \sqrt{t_2/t_1})} + \alpha_2 e^{-r N_2 (a_2, b_2; \sqrt{t_2/t_1})} + \alpha_2 e^{-\delta_1 N_2 (a_2)},
\end{align*}
\]

where
\[
\begin{align*}
\alpha_1 &= [V_1, V_2, \alpha_1, \beta_1] \\
b_1 &= [V_1, V_2, \alpha_1, \beta_1] \\
\beta_2 &= [V_1, V_2, \alpha_1, \beta_2]
\end{align*}
\]

\[
\begin{align*}
\alpha_2 &= c_1 - \sigma \sqrt{t_2 - t_1}, \\
b_2 &= b_1 - \sigma \sqrt{t_2}, \\
V_{C_1} &= e^{-\delta (t_1 - t_1)} N (c_1) - E (C_3) e^{-\delta (t_2 - t_1)} N (c_2) - E (C_2) = 0,
\end{align*}
\]

\[
\begin{align*}
c_1 &= \ln \left( \frac{E (V_0) / E (V_1)}{\ln \left( \frac{a_1}{b_1} \right)} \right) + \left( r - \delta + \frac{1}{2} \sigma^2 \right) (t_2 - t_1) + \left( \frac{1}{2} \sigma^2 \right) (t_2 - t_1)^2 - \int_0^{t_1} \exp \left( \frac{\alpha \pi}{\sqrt{6} \sigma_1} \right) \frac{d \alpha}{\sqrt{3} \sigma_1} \\
c_2 &= c_1 - \sigma \sqrt{t_2 - t_1},
\end{align*}
\]

where \([V_1, V_2, \alpha_1, \beta_1]\) is the present value of cash flows produced by the logistics project promotion, \([I_1, I_2, \alpha_2, \beta_2]\) is the investment required by the logistics project R&D, and \(E (V_0)\) is the critical value of the logistics project when the first buyer's option is closed, and it can be calculated by the Black-Scholes model. In \(N_1 (a_1, b_1; \sqrt{t_2/t_1})\), the first variable is less than \(a_1\), the second variable is less than \(b_1\), and two variable correlation coefficient is the probability function of the standard normal cumulative distribution of \(\sqrt{t_2/t_1}\). \(T\) is the expiration time of compound options. The model is mainly used for the study of the investment decision of the complex logistics project.

2.5. The Logistics Project Evaluation Model under Fuzzy and Stochastic Environment. Similar to the building ways of the model under the random case, we still assume under the risk neutral world that asset value \(A(t)\) follows a fuzzy differential equation; thus, we conclude the logistics project European call option pricing formula under the fuzzy and stochastic circumstances [5]:

\[
\begin{align*}
\max (0, A (T)) &= \exp \left[ (A (T) - K_1)^+ \right] \\
&= \exp \left[ -r (T - t) \right] \\
&= \exp \left[ -r (T - t) \right] \times E \left[ \mu \left[ \left( \alpha (T - t) + \sigma z_1 \right) - K_1 \right] \right] \\
&= \exp \left[ -r (T - t) \right] \times \int_{-K_1}^{\alpha (T - t)} \exp \left( \frac{\alpha \pi}{\sqrt{6} \sigma_1} \right) \frac{d \alpha}{\sqrt{3} \sigma_1} \\
&= A (t) \exp \left[ -r (T - t) \right] \times \int_{K_1}^{\alpha (T - t)} \exp \left( \frac{\alpha \pi}{\sqrt{6} \sigma_1} \right) \frac{d \alpha}{\sqrt{3} \sigma_1} \\
&= A (t) \exp \left[ -r (T - t) \right] \times \int_{K_1}^{\alpha (T - t)} \exp \left( \frac{\alpha \pi}{\sqrt{6} \sigma_1} \right) \frac{d \alpha}{\sqrt{3} \sigma_1} \\
&= A (t) \exp \left[ -r (T - t) \right] \times \int_{K_1}^{\alpha (T - t)} \exp \left( \frac{\alpha \pi}{\sqrt{6} \sigma_1} \right) \frac{d \alpha}{\sqrt{3} \sigma_1} \\
&= A (t) \exp \left[ -r (T - t) \right] \times \left( \ln x - \alpha (T - t) \right) \frac{d \alpha}{\sqrt{3} \sigma_1} \\
&= A (t) \exp \left[ -r (T - t) \right] \times \left( \ln x - \alpha (T - t) \right) \frac{d \alpha}{\sqrt{3} \sigma_1}.
\end{align*}
\]

Similarly, we still can get fuzzy the European call option pricing formula:

\[
\begin{align*}
\max (0, I (t)) &= I (t) \exp \left[ -r (T - t) \right]
\end{align*}
\]
\[ \Phi(\tau) = 30 \exp(-0.03 \times 3) - 15 \exp(-0.06 \times 3) - 15 \approx 30 \times 0.9139 - 15 \times 0.8353 - 15 = -0.1125. \]
Under the random environment, we have
\[
\Phi(t) = A(t) e^{-\alpha(T-t)} N(d_1) - I(t) e^{-\beta(T-t)} N(d_2) - I(t) \Phi(t)
\]
\[
= 30 \exp(-0.03 \times 3) N(d_1) - 15 \exp(-0.06 \times 3) N(d_2) - I(t) \Phi(t)
\]
\[
\approx 30 \times 0.9139 \times N(2.434) - I(t) \Phi(t)
\]
\[
\approx 0.1175.
\]

Under the fuzzy environment, we have
\[
\Phi(t) = A(t) e^{-\alpha(T-t)} N(d_1) - I(t) e^{-\beta(T-t)} N(d_2) - I(t) \Phi(t)
\]
\[
= \max(0, A(T))
\]
\[
= A(0) \exp(-rT)
\]
\[
\times \int_{K/A(0)}^{\infty} 1 \times \left( 1 + \exp \left( \frac{\pi}{\sqrt{6} \sigma_1 T} \right) \times (\ln x - (m_1 + \alpha - \lambda_1) T) \right)^{-1} dx
\]
\[
- I(0) \exp(-rT)
\]
\[
\times \int_{K/I(0)}^{\infty} 1 \times \left( 1 + \exp \left( \frac{\pi}{\sqrt{6} \sigma_2 T} \right) \times (\ln x - (m_2 + \beta - \lambda_2) T) \right)^{-1} dx - I(T) \Phi(t)
\]
\[
= 11.3784.
\]

In order to calculate \(\exp(-rT) \int_{-\infty}^{K} C_r[(A(T) \leq u)] du\), \(\exp(-rT) \int_{-\infty}^{K} C_r[(I(T) \leq u)] du\), using MATLAB, we can get on the computer [5]:

```matlab
syms x;
y = 30 \times \exp(-0.06 \times 3) ./ (\exp((\log(x) + 0.03 \times 3) \times \pi / (\sqrt{6} \times 0.25 \times 3)))
I = quad(y,15/30,10000)
f=32.3977
syms x;
y = 15 \times \exp(-0.06 \times 3) ./ (\exp((\log(x) + 0.06 \times 3) \times \pi / (\sqrt{6} \times 0.20 \times 3)))
I = quad(y,15/15,10000)
f=6.2193.
```

As can be seen from the above, according to the traditional NPV method, the logistics project cannot be invested, but according to the random and fuzzy method, this project should be invested. Therefore, during the assessment of the logistics project, if using the traditional NPV method, we will often miss a lot of investment opportunities, easily to underestimate the sequence of the value of investment projects, so the result is that good prospects of gain project will usually be rejected.

5. Conclusions

Logistics project investment has high uncertainty, irreversibility, and the fuzziness. The NPV method usually adopted, for not considering the investment opportunity option value, it cannot reflect the actual value of the future well. In reality, we often still have no accurate evaluation or cannot expect logistics project net cash flow situation, and because of the objective factors, some logistics project variables can not use the exact data to estimate the actual situation. So, by the accurate values determining model input parameters, evaluation results often deviate from the actual. In this paper, using the real option method, in reviewing the traditional model, we establish and discuss the logistics project valuation models under fuzzy environment; these models are important basis when we make the logistics project evaluation under fuzzy environment. Of course, for its scope of application as well as the practical problems to be solved in different emphasis, each model has its own characteristics. Of course, these models are not negative on the traditional investment decision methods, but, under the original basis, a reasonable explanation of investment income of fuzziness is made, which further increases the scientific and rationality of the investment decision making. In reality, we may combine logistics project investment opportunities in the variety and complexity, using multiple models as well as from multiple perspectives analysis. Finally, as far as possible, we will not miss good project. On the further discussion and research of the logistics project evaluation, the fuzzy random variable for rough fuzzy as well as the fourth party logistics problem of real options are the next problems we will try our best to solve.

References


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