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Original Paper

Real Option, Debt Agency Conflicts and Corporate Investment Decisions

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Abstract

This paper studies enterprise investment decisions under debt agency conflicts by the method of real option. It is different from the existed literatures that this paper considers not only the influence of investment goals alienation on investment decisions without bankruptcy agency, but also analyzes the investment decisions distortion under bankruptcy agency conflicts. The study result shows that enterprises with debt usually exist overinvestment; on the one hand, the overinvestment comes from excessive pursuing of the tax benefits under the investment goals alienation, on the other hand, it comes from the protection for shareholders' investment risk under strategic default bankruptcy. What's more, under the lower debt level, the former is the dominant mechanism for investment decisions distortion; while under the higher debt level, the influence of the later is prominent.

Keywords

Investment Goal Alienation, Bankruptcy Decisions Agency, Investment Behavior Distortion, Real Option

1. Introduction

In the early corperate finance literatures, debt financing is a kind of financing tools to solve the issue of financing shortage. Since Modigliani and Miller put forward the MM theory, schoolars have enriched the content of the debt financing from a number of aspects, and made the topic of corperate capital structure decision-making is full of complexity and artistry, therefore it attracts much more attention. One of the most notable theories is agency theory that put forward by Jensen and Meckling, they believed that debt financing on the one hand will ease the equity agent problem, resulting in contingent goverence effect, on the other hand, debt financing will lead to interests conflict between shareholders and creditors, thus generates inefficient in investment and business decisions, which will increase the cost of agency. Therefore, how to understand the investment decisions under the debt agency conflict is not only related to the optimization of corporate finance decision-making and debt contract design, but also is an important way to allocate social economic resource efficiently.

NPV is a crucial method for enterprise to make investment decisions, while this method ignores the flexibility of investment, which usually underestimates project value, even leads to wrong decision. In

view of the deficiency of NPV method, scholars such as Black, Scholes, Mertonhave, etc., created the theoretical method of real option, so as to provide a more scientific tool for investment and financing decision-making. Using the real option method, Brennan and Schwartz firstly analyzed the impact of debt agency conflicts on corporate investment decisions, they found that if firm's current asset profitability is low relatively, the debt will lead to investment insufficient. In response to this investment insufficient, Mauer, Parsons and Mauer Ott, etc., make a further study in a directly way. In contrast, Lelend and Satk found that under the effect of shareholders and creditors conflicts, enterprise will have motivation to make overinvestment, which confirms asset substitutions problem provided by Jensen and Meckling. Childs et al. confirmed that overinvestment or underinvestment caused by debt financing is state-dependent under the context of interaction of investment and financing decision. They found that if the investment is replacing high risk level assets with lower risk assets, shareholders will make overinvestment, while if the investment assets have the similar risk with the present risk, enterprise investment is an expansion for the present assets, and shareholders will make underinvestment. Similarly, Peng and Liu studied the expansionary investment, also found that there would be overinvestment and underinvestment in different debt level, and confirmed that if enterprise does not exist debt risk before and after the investment, then shareholders' investment decisions of the debt enterprise would meet the principle of optimal value, there would not be debating agency cost. However, all of these studies are on the condition that the decision makers for the enterprise value maximization will choose the same bankrupt policy as shareholders, even though in the same bankrupt policy, debating enterprise still exists investment goals alienation, which will cause the investment inefficient.

While, Fries et al. argued that shareholder insolvency does not meet the goal of corporate value maximization, so the indebted companies will have another agency problem, which is the agency problem of bankruptcy decision-making, by detailed analysing, they found that this agency problem will affect the optimal capital structure of the firm significantly. After discovering the agency problem of bankruptcy decision-making, Jian and LI further understood the importance of this agency problem under different debt levels, they argue that the moral risk caused by shareholders' bankruptcy decision can be neglected under a certain debt level, but this agency problem under a higher and a lower debt level is more serious relatively. Correspondingly, Liu and Li studied the enterprise value loss caused by agency problem of shareholders' bankruptcy decision, which is under different debt level. Based on this understanding, debt bankruptcy agency problem will affect enterprise operating value, and then control the project investment decision. Unfortunately, little literatures get involved into the enterprise investment decision under the bankruptcy agency, so it doesn't fully revolved the influence of debt agency on enterprise investment bahaviors, including the influence of investment goals alination and bankruptcy decision agency problems.

This paper attempts to use Real Option Method (ROM) to make a further study of enterprise investment decision under debt agency conflicts. Different from the existed literatures, this paper argues that the decision makers who maximize the enterprise value will hold the goal of value maximization not only in the investment decision but also in the bankruptcy decision, through the comparism with the shareholders benefits maximization, this paper also analyzes the inefficient investment that caused by shareholders' investment goals alienation and bankruptcy decision agency, which will deepened the understanding of the relationship between debt agency conflicts and enterprise investment decision.

2. Hypothesis Development

Considering an enterprise with risk neutral, there is an investment opportunity that is exclusive, and enterprise do not need to consider competitors to seize investment opportunity that will cause the possible of losing partial market when waiting for investment, so enterprise can choose to make investment appropriately based on its own condition. Once enterprise decides to make investment, there will be fixed investment cost I to configure relevant production equipment, and the cost of the unit product produced by this equipment is C. We assume that the price of the product is P_t in the time point t, which follows the Geometric Brownian Motion

$$dP_t = \mu P_t dt + \sigma P_t dW_t \tag{1}$$

μ and σ are constants, which represent the excepted growth rate and fluctuation rate of the price respectively, dW_t is the increment of the Stand Wiener Process under the risk neutral.

In order to get partial investment funds, we assume enterprise can get perpetual debt financing L from external market when making investment. In order to get the corresponding credit funds, shareholders must commit to pay interests R to creditors in per unit time. Due to the imperfection of the debt contract, creditors can not limit shareholders' investment decisions effectively, but in order to maximize their own interests, they can only expect the shareholders' business policy reasonably at the time of signing the contract and provide the corresponding loans at the level of payed interests. Assuming there is no information asymmetry between creditors and shareholders, creditors can understand shareholders' operating policy completely after making investment, which makes creditors can estimate the intrinsic value of the debt funds at the time of debt happenning. Accordingly, creditors will provide debts that value equal with the investment to ensure the equity of the borrowing price, so enterprise debt financing L is equal to the debt value at the time of investment. If the debt financing L that provided by creditors is lower than the investment cost I, then the shortfall may be made up by shareholders' own founds. If the L is larger than I, the excess will be paid to shareholders as dividends. Because of the debt existing, shareholders will choose an appropriate chance to make bankruptcy. As long as the bankruptcy is not carried out, shareholders must pay for the debt interests with operation earning or its own funds. If making bankruptcy, shareholders do not to pay for the interests, but have to transferred the tangible assets to creditors, at this time, shareholders value will be zero. Put it simply, we assume the model as following: firstly, we assume there is none cost in bankruptcy, and creditors will get all of the tangible assets value; secondly, all the interests after tax will be dividends paid to shareholders, there is none returned earning in the enterprise; thirdly, the operation lose can deduct tax forward or backward indefinitely, unless bankruptcy, or the enterprise will own all the tax benefits of the current debt; finally, we assume that the manager can represent the interests of shareholders' totally, there is not agent problem between managers and shareholders.

3. Maximize Investment Decision of Shareholder's Interests

Assuming managers can represent the interests of shareholders fully, so enterprise will make investment decisions with the standard of maximizing shareholders' interests. Set E is the value of shareholders after the investment, it is a function of time t and P_t. After a certain period of time, the expected value of the stock right changed with time can be expressed as $E(dE)$. Once the investment

option is carried out, the enterprise will generate cash inflow $(1-\pi)(P_t - C - R)$ in per unit time, π is the corporate income tax rate. Therefore, the expected variation of equity value after unit time is $(1-\pi)(P_t - C - R)dt + dE$. Considering the risk neutral, in order to avoid arbitrage, the variation of equity value should equal to shareholders' risk free return $rEdt$, r is the risk free rate (to get the limited value, we assume $r > \mu$). Therefore, the equity value after investment can be expressed by the following differential equation:

$$0.5\sigma^2 P^2 E_{PP} + \mu P E_P + (1-\pi)(P - C - R) = rE \tag{2}$$

In addition, the equity value must meet three conditions: condition (3) shows that when the price tends to infinitely great, there is no bankruptcy risk in enterprise, the equity value is the present value of the enterprise's expected value after tax; condition (6) shows that under the mechanism of limited liability, shareholders will choose the best price P_d^S to make bankruptcy, then the ownership of the enterprise transferred to creditors, the equity value becomes zero; (5) is the first-order optimization conditions for the bankruptcy.

$$\lim_{P\to\infty} E = (1-\pi)\left(\frac{P}{r-\mu} - \frac{C+R}{r}\right) \tag{3}$$

$$E(P_d^S) = 0 \tag{4}$$

$$\left.\frac{\partial E}{\partial P}\right|_{P=P_d^S} = 0 \tag{5}$$

Simultaneous equation (2) and these 3 conditions, the equity value can be shown as equation (6). In equation $P_d^S = \beta_2(r-\mu)(C+R)/[r(\beta_2 - 1)]$, β_2 is the solution when the characteristic equation $0.5\sigma^2\beta(\beta-1) + \beta\mu - r = 0$ is small than zero.

$$E(P) = (1-\pi)\left(\frac{P}{r-\mu} - \frac{C+R}{r}\right) - (1-\pi)\left(\frac{P_d^S}{r-\mu} - \frac{C+R}{r}\right)\left(\frac{P}{P_d^S}\right)^{\beta_2} \tag{6}$$

Set bond value after investment is B, which is similar to equity value, it can be present as differential equation (7), and there are constrain conditions (8) and (9),

$$0.5\sigma^2 P^2 B_{PP} + \mu P B_P + R = rB \tag{7}$$

$$\lim_{P\to\infty} B = R/r \tag{8}$$

$$B(P_d^S) = V^U(P_d^S) \tag{9}$$

Condition (8) shows that when the price tends to infinitely great, shareholders will not carry out bankruptcy, creditors will receive a sustainable interest income; Condition (8) indicates that when the price trends to bankruptcy threshold P_d^S, creditors obtain all of the tangible assets, now the debt value is equal to the value of debt-free enterprise at the point of bankruptcy. So, the creditors' rights value

after investment can be present as equation (10):

$$B(P) = R/r + (V^U(P_d^S) - R/r)(P/P_d^S)^{\beta_2} \tag{10}$$

$V^U(P_d^S)$ is the debt-free enterprise value at the point of bankruptcy threshold P_d^S after investment. Similar to the previous analysis, $V^U(P)$ for the value of debt-free enterprise after investment can be obtained from equation (11) and its three constrain conditions. Condition (12) indicates that when the price tends to infinitely great, enterprise is going-concern and the enterprise value is sustainable present value of the profit after tax. (13) indicates that when the price falls to the breakeven point P_a, enterprise will withdraw from business, and (14) is the first-order optimization condition for the enterprise to withdraw from business. It is worth noting that if the bankruptcy threshold point is smaller than the break-even point P_a of the debt-free enterprise, which indicates that there is none business value for creditors to own the enterprise after bankruptcy, at this point, the debt value is zero. After calculating, $P_a = (r-\mu)\beta_2 C/[(\beta_2 - 1)r]$, P_a is smaller than P_d^S obviously, the enterprise took over by creditors still has going-concern value after bankruptcy, and the debt value is more than zero.

$$0.5\sigma^2 P^2 V_{PP}^U + \mu P V_P^U + (1-\pi)(P-C) = rV^U \tag{11}$$

$$\lim_{P\to\infty} V^U = (1-\pi)\left(\frac{P}{r-\mu} - \frac{C}{r}\right) \tag{12}$$

$$V^U(P_a) = 0 \tag{13}$$

$$\frac{\partial V^U}{\partial P}\Big|_{P=P_a} = 0 \tag{14}$$

Based on the valuation of equity and creditors' rights after investment, next we will analyze the optimal investment policy P_e^S of shareholders. Set the option value before investment is F, it can express as equation (15), and meet three conditions (16)-(18):

$$0.5\sigma^2 P^2 F_{PP} + \mu P F_P = rF \tag{15}$$

$$F(0) = 0 \tag{16}$$

$$F(P_e^s) = E(P_e^s) - (I - L) \tag{17}$$

$$\frac{\partial F}{\partial P}\Big|_{P=P_e^s} = \frac{\partial E}{\partial P}\Big|_{P=P_e^s} \tag{18}$$

Condition (16) indicates that when the price drop to zero, the option value of the investment is zero; (17) is the value matching condition of the investment decision in the case of maximizing shareholders interests, indicating that at the critical point, the option value is equal to equity value subtracts investment cost $I - L$ for shareholders. (18) is the first-order optimization of investment conditions. Since the enterprise debt financing L is equal to the debt value at the time of investment, so the condition (17) can also be expressed as equation (19). Obviously, according to the above equations, we can get the investment threshold P_e^S :

$$F(P_e^s) = E(P_e^s) - (I - B(P_e^s)) \tag{19}$$

4. Investment Decisions for Enterprise Value Maximization

In order to test the inefficiency investment of shareholders, we consider the investment decisions for enterprise value maximization. Set V^F as the enterprise value after investment, obviously, it can be represented by differential equation (20), and must satisfied the conditions (21)-(23).

$$0.5\sigma^2 P^2 V_{PP}^F + \mu P V_P^F + (1-\pi)(P - C - R) + R = rV^F \tag{20}$$

$$V^F(P_d^f) = 0 \tag{21}$$

$$\frac{\partial V^F}{\partial P}\Big|_{P=P_d^f} = 0 \tag{22}$$

$$\lim_{P\to\infty} V^F = (1-\pi)\left(\frac{P}{r-\mu} - \frac{C}{r}\right) + \frac{\pi R}{r} \tag{23}$$

Condition (21) represents enterprise whole value is zero at price P_d^f, at price P_d^f enterprise will carry out bankruptcy in order to maximize the whole value of shareholders and creditors. Condition (22) is the first-order optimization condition for bankruptcy; Condition (23) shows enterprise value when the price trends to infinitely great and there is risk-free for bankruptcy. According to these conditions, enterprise value after investment can present as equation (24):

$$V^F(P) = \left(\frac{P}{r-\mu} - \frac{C}{r}\right)(1-\pi) + \frac{\pi R}{r}\left[1 - \left(\frac{P}{P_d^f}\right)^{\beta_2}\right] - \left(\frac{P_d^f}{r-\mu} - \frac{C}{r}\right)(1-\pi)\left(\frac{P}{P_d^f}\right)^{\beta_2} \tag{24}$$

For $P_d^f = \frac{\beta_2(r-\mu)[C(1-\pi)-\pi R]}{r(\beta_2-1)(1-\pi)}$, obviously, if $C(1-\pi)-\pi R \le 0$, so $P_d^f \le 0$, which represents enterprise will not make bankruptcy forever (Note 1). To ensure the bankruptcy price meet the real economic characteristic that is non-negative, this paper only consider the condition $C(1-\pi)-\pi R > 0$.

Comparing P_d^f and P_d^S, we find that as long as R is bigger than zero, then the later will bigger than the former constantly, which indicates decision makers who maximize the shareholders' benefits will choose bankruptcy at a higher price point, when comparing with enterprise value maximization.

From the above value assessment, we can solve the optimal investment threshold P_e^f. Similarly, we get the option value before investment from equation (15), and must satisfy equation (16), differently, at the investment critical point, the value matching condition and its smoothing condition is (25) and (26). We use these conditions can get the optimal investment decisions for enterprise value maximization

$$F(P_e^f) = V^F(P_e^f) - I \tag{25}$$

$$\left.\frac{\partial F}{\partial P}\right|_{P=P_e^f} = \left.\frac{\partial V^F}{\partial P}\right|_{P=P_e^f} \tag{26}$$

5. The Influence of Debt Agency Conflict on Corporate Investment Decision

The above analysis shows that the optimal investment policy of the shareholders is P_e^S, while the investment threshold for maximization of enterprise value is P_e^f, so there will be non-optimization problems of shareholders' decisions that caused by debt agency conflicts.

First, as references in, for the projects after investment, decision makers for maximize shareholders' benefits will choose non-optimization bankruptcy policy, which will lead to enterprise value losing. Since the valuation of investment projects is based on the expected bankruptcy policy, so the agency problems in bankruptcy decision-making will disturb enterprise investment policy. In order to test the impact of this agency problem, it is assumed that shareholders must choose a bankruptcy policy P_d^f in accordance with the rules of maximizing enterprise value after the project is invested. At this time, there is no agency problems for the bankruptcy decisions, shareholders can re-get the value estimation after investment, which can be equations (2), (3) and (16), and finally represent as equation (17). In addition, by comparing P_d^f and P_a we find that for the R greater than zero, then P_d^f less than P_a always, which shows that the enterprise owned by creditors has been under the break-even point after bankruptcy, at this time, enterprise will not have any value, so, $B(P_d^f)$ is zero. According to this constraint condition and combine equation (5) and equation (8) we can get the debt value at this point is equation (18). We set shareholders' investment decision policy is $P_e^{S(f)}$ under the bankruptcy policy P_d^f for enterprise value maximization, which can be get by equations (15), (27), (28) and conditions (16), (17), (18). Comprising P_e^s and $P_e^{S(f)}$, we can get the influence of agency conflicts of bankruptcy decisions on enterprise investment behavior.

$$E(P_d^f) = 0 \tag{27}$$

$$E(P) = (1-\pi)\left(\frac{P}{r-\mu} - \frac{C+R}{r}\right) - (1-\pi)\left(\frac{P_d^f}{r-\mu} - \frac{C+R}{r}\right)\left(\frac{P}{P_d^f}\right)^{\beta_2} \tag{28}$$

$$B(P) = R/r - (R/r)(P/P_d^f)^{\beta_2} \tag{29}$$

Secondly, as the references have studied, even if the decision-makers who maximize the enterprise value choose the same bankruptcy policy with shareholders, but shareholders will focus on their own interests and try to maximize it when making optimized investment decisions, which will ignore creditors' benefits and cause debt value losing, so shareholders' decisions still deviate from the enterprise value optimization. Therefore, even if shareholders choose the bankruptcy policy P_d^f that

will maximize the enterprise value, and there is not agency problems for bankruptcy policy, but influenced by investment goals alienation, there are still inefficient in shareholders investment decisions. Comparing the differences between P_e^f and $P_e^{S(f)}$, we can get the inefficient for shareholders' investment decisions caused by investment goals alienation in the situation of none bankruptcy agency problems. Because we can not get the analytical expression of P_e^S, $P_e^{S(f)}$, and P_e^f, this paper will further use numerical examples to study the influence of enterprise debt agency conflicts on enterprise investment behavoir.

Table 1 lists enterprise investment policy under different debt levels and the option value $F(P_0)$ of corresponding projects under various investment operating policies. The data in the table shows that for all enterprises with liabilities bigger than zero, shareholders will choose investment decisions that deviate from enterprise value maximization. For example, when R is 0.1, shareholders' investment threshold P_e^S is 2.131, at this time, the optimal investment threshold P_e^f is 2.1456, that is, if you want to achieve the goal of enterprise value maximization, enterprise should make investment till price is up to 2.1456. Therefore, shareholders will make overinvestment under debt financing, and the overinvestment level will increased with debt level (see Table 2). In addition, from the point of bankruptcy decision-making, the debt corporate shareholders will choose strategic default bankruptcy when price is higher than bankruptcy threshold P_d^f that is the point of enterprise value maximization, which will cause bankruptcy decision agency problems. The data show that the gap between P_d^S and P_d^f will increase with the liabilities, which indicates that the higher of the liabilities the more serious of the agency problems of bankruptcy decision. Obviously, due to the impact of these agency issues, enterprises have produced the agency costs $F^f(P_0) - F^S(P_0)$.

According to the previous analysis, the inefficiency of enterprise investment decisions not only comes from the direct influence of shareholders' investment goals alienation, but also because of the indirect influence of the bankruptcy decision agent problems. In order to understand the influence mechanism of these two kinds of agency problems on shareholders' investment behavior, Table 1 lists the shareholders' investment behavior with the optimal bankruptcy policy P_d^f, to make further comparison and analysis.

Table 1. Investment Policies and Relevant Enterprise Value in Different Debiting Levels

Interests payment R	Shareholder's benefits maximization			Enterprise value maximization			Shareholders' benefits maximization with policy P_d^f		
	P_e^S	P_d^S	$F^S(P_0)$	P_e^f	P_d^f	$F^f(P_0)$	$P_e^{S(f)}$	P_d^f	$F^{S(f)}(P_0)$
0	2.2183	0.4226	5.3388	2.2183	0.4226	5.3388	2.2183	0.4226	5.3388
0.1	2.131	0.4649	5.4711	2.1456	0.4018	5.4733	2.1319	0.4018	5.4732
0.2	2.0424	0.5072	5.6059	2.0729	0.381	5.6162	2.046	0.381	5.6156
0.3	1.9522	0.5494	5.7406	2	0.3602	5.7683	1.9607	0.3602	5.7669
0.4	1.8601	0.5917	5.871	1.9271	0.3394	5.9306	1.8762	0.3394	5.928
0.5	1.7656	0.634	5.9899	1.854	0.3186	6.1044	1.7924	0.3186	6.1
0.6	1.6681	0.6762	6.0849	1.7808	0.2977	6.2908	1.7096	0.2977	6.2842
0.7	1.5667	0.7185	6.1342	1.7074	0.2769	6.4915	1.6279	0.2769	6.4821
0.8	1.4595	0.7608	6.0959	1.6339	0.2561	6.7083	1.5475	0.2561	6.6955
0.9	1.3434	0.803	5.881	1.5601	0.2353	6.9433	1.4686	0.2353	6.9268
1.0	1.2106	0.8453	5.2565	1.4862	0.2145	7.1992	1.3914	0.2145	7.1787
1.1	1.0272	0.8876	3.121	1.4121	0.1937	7.4789	1.3162	0.1937	7.4545

Note. r =6%、I =5、μ =2%、σ =20%、π =0.33、C =1、P_0 =1.

Firstly, comparing P_e^S and $P_e^{S(f)}$ we can find that $P_e^{S(f)}$ will bigger than P_e^S constantly in enterprise with liability more than zero, which shows that the agency problems of bankruptcy decisions will accelerate the process of shareholders' investment decision-making, and lead to overinvestment. In fact, with the protection mechanism of limited liability, shareholders can choose bankruptcy so long as equity value is approaching to zero, without waiting to the whole value is zero, this kind of strategic default bankruptcy is somewhat provides a risk protection for shareholders investment behavior. Because shareholders believe that even if the market performance is not satisfactory in the future, they can make bankruptcy decisions when the product prices fall to P_d^S, at this time shareholders can only loose all of the previous equity investment; while when product price at P_d^f shareholders make bankruptcy decision, form the view of shareholders, the equity value is already zero, in order to make the enterprise equity value keep in non-negative situation and ensure enterprise effective operation in the process of price falling from P_d^S to P_d^f, shareholders must continue to add own funds, which will lead to shareholders bear more losses. Therefore, shareholders' strategic default bankruptcy opportunities reduce the worry in the future to face with market risk when they making investment decisions, which will show a stronger investment momentum. Because of shareholders' strategic default bankruptcy and the resulting of over-investment, enterprise will suffer the agency costs $F^{S(f)}(P_0)-F^S(P_0)$, which account for the total debt agency cost $F^f(P_0)-F^S(P_0)$ about 95% to 99% of the share.

Secondly, Table 1 shows that for any enterprise with R more than zero, $P_e^{S(f)}$ will be less than P_e^f, which indicates that when we revolve the impact of bankruptcy decision agency problems, enterprise still will make overinvestment decisions under the influence of shareholders' investment goals alienation. For this result, the literature thought this is due to shareholders pursuit for tax benefits overly. In fact, based on the rational man assumption, shareholders will weigh the size of expected bankruptcy losses in the process of pursuing for tax benefits, but they are different from the decision makers for enterprise value maximization, they will neglect the bankruptcy loose for creditors, which will cause non-optimization problems for investment decisions.

Assuming that enterprise investment threshold is P_e, then the investment time t_e can be expressed as $t_e = \inf\{t \in (t_0, \infty), P_t = P_e\}$, equally, the enterprise bankruptcy time under the bankruptcy policy P_d^f can also be expressed as $t_d = \inf\{t \in (t_e, \infty), P_t = P_d^f\}$ (obviously, $t_e < t_d$), and assuming shareholders' wealth loss because of bankruptcy is SBL, creditors' wealth loss is DBL, we can get enterprise expected tax benefit is $TB = E[\int_{t_e}^{t_d} e^{-r(t-t_e)} \cdot \pi R dt]$ when making investment, shareholders' expected bankruptcy loss is $BL^S = E[e^{-r(t_d - t_e)} \cdot SBL]$, creditors' bankruptcy loss is $BL^D = E[e^{-r(t_d - t_e)} \cdot DBL]$. Therefore, the net tax benefits profit of shareholders at the time of investment is $TB - BL^S$, and for decision-makers who maximize enterprise value, the net tax benefits are $TB - BL^S - BL^D$ at this time. In order to achieve the net tax benefits maximization, at the specific bankruptcy policy P_d^f and special bankruptcy time t_d, decision makers only can choose the optional investment time t_e through adjusting investment policy. On the one hand, if the expected price increases in the future, enterprise will accelerate the process of investment, thereby increasing net value of tax benefits through decreasing t_e; on the other hand, if the price declines, the sooner of the investment, the smaller of the gap between P_e and P_d^f, and enterprise effective operating time $t_d - t_e$ will be shorter, at this time, enterprise will generate less excepted tax benefits and more expected bankruptcy loss, so decision makers will delay the investment. Because the decision makers who maximize enterprise value take into account the bankruptcy loss of both shareholders and creditors, comparing with shareholders, they will be more concern of wealth loss after price declining, so they will choose a higher investment threshold carefully, to ensure more effective operating time $t_d - t_e$ and less excepted bankruptcy loss, so $P_e^{S(f)}$ is smaller than P_e^f, on the impact of investment goals

alienation, shareholders will make overinvestment. Obviously, this over-investment behavior will lead to the agency costs $F^f(P_0)\_F^{S(f)}(P_0)$ and will account for approximately 1% to 5% of the total debt agency costs.

The above analysis shows that the two kinds of agency costs $F^{S(f)}(P_0)\_F^S(P_0)$ and $F^f(P_0)\_F^{S(f)}(P_0)$ have significant differences in quantity, while because the former is not the role of the purely investment decision distortions in bankruptcy agency conflicts, but includes the impact of the bankruptcy agency conflicts on enterprise value, so their quantity differences can not be used to measure the importance of investment decisions distortion under these two agency conflicts. In order to compare the importance of these two different kinds of investment decision distortions, Table 2 describes the composition of enterprise investment decision distortions under the debt agency conflicts. The results show that, when R is less than 0.8 constantly, the investment decision distortions caused by the investment goals alienation can explain the share of the total investment distortions more than 50% under debt agency conflicts, and when the ratio is greater than or equal to 0.8, more than half of the total share is decision distortions caused by bankruptcy agency conflicts, which shows that shareholders' investment goals alienation at low debt level is the main driving force of enterprise investment decision distortions, and the influence of bankruptcy agency conflicts is more significant under high debt level. The results show that there is no high bankruptcy risk when there is a low debt level, and shareholders will make overinvestment in the purpose of pursuing tax benefits. At high debt level, influenced by high bankruptcy risk, shareholders will not make overinvestment or make investment in advance for earning more tax benefits, and the motivation for their early investment mainly comes from the risk protection for shareholders' strategic default on bankruptcy opportunities under the limited liability mechanism, because if the price is rising in the future, and most of the proceeds of their investments will be owned by themselves, and if price is falling, they will make bankruptcy in advance in order to maximize their own interests and pass on the remaining risks to creditors. Therefore, in order to control the inefficiency of shareholders' investment decisions under debt financing, low-debt enterprises should start from taxation factors, by reducing enterprise tax rate to reduce the expected tax benefits, and curbing the enthusiasm of shareholders to over-hold debt tax; for higher debt enterprises, be through the debt contract design, which will increase restrictions on shareholders' earlier bankruptcy, or through institutional arrangements increase shareholders' bankruptcy losses directly.

Table 2. The Composition of Investment Decision Distortions under Different Debt Levels

Interest Payment R	Total investment decision distortions	Investment distortions caused by investment goals alienation		Investment distortions caused by bankruptcy policy agency	
	①degree of distortion	②degree of distortion	Proportion of total distortion	③degree of distortion	Proportion of total distortion
	$P_e^f \_ P_e^S$	$P_e^f \_ P_e^{S(f)}$	②÷①	$P_e^{S(f)} \_ P_e^S$	③÷①
0.1	0.0146	0.0137	93.84%	0.0009	6.16%
0.2	0.0305	0.0269	88.2%	0.0036	11.8%

0.3	0.0478	0.0393	82.22%	0.0085	17.78%
0.4	0.067	0.0509	75.97%	0.0161	24.03%
0.5	0.0884	0.0616	69.69%	0.0268	30.31 %
0.6	0.1127	0.0712	63.18%	0.0415	36.82%
0.7	0.1407	0.0795	56.51%	0.0612	43.49%
0.8	0.1744	0.0864	49.54%	0.088	50.46%
0.9	0.2167	0.0915	42.22%	0.1252	57.78%
1.0	0.2756	0.0948	34.4%	0.1808	65.6%
1.1	0.3849	0.0959	24.92%	0.289	75.08%

6. Conclusion

This paper studies the influence of debt agency conflicts on enterprise investment behavior by using real option method. It is different from the previous literatures that this article not only considers the influence of the investment goals alienation on the investment decisions without the bankruptcy agency, but also analyzes the investment decision distortions caused by the bankruptcy agency conflicts, which makes the relationship between the debt agency conflicts and the enterprise investment decisions more comprehensive. It is found that there is an over-investment phenomenon due to the debt agency conflicts. The motivation of over-investment is partly due to shareholders excessive pursuit of tax benefits under the influence of investment goals alienation. On the other hand, it comes from the protection of strategy default bankruptcy for shareholders' investment risk, and at a lower debt level, the former is the dominant mechanism for investment decision distortions, and the impact of the latter is even more pronounced at a higher debt level. Although this paper makes quantification for the cost of debt agency caused by investment decision distortions under investment goals alienation, there should be a further study on the value quantification of pure investment decision distortions under bankruptcy agency conflicts, so as to stress the importance of these from the point of value loss. In addition, this article sets a variety of strict assumptions in the process of model constructing, such as the interests consistency of shareholders and managers, the information symmetry between creditors and shareholders, etc., gradually liberalize these assumptions should be the future study direction.

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Note

Note 1. If the tax-free clause allows enterprise to operate the loss to deduct tax forward or backward indefinitely, the enterprise does not exist the possibility of tax benefits losing, then this “business never bankrupt” situation can be objective. Because in this tax law environment, regardless of operating income, corporate interest payments can provide tax benefits of, so even if the product price dropped to zero, as long as bigger than the enterprise change cost after the tax, from the point of maximizing the enterprise value, continuing to run a business will be profitable.