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The Valuation Research of Steel Industry Enterprise in Mergers and Acquisitions

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Abstract
Iron and steel industry as a traditional pillar industry of the national economy in our country, is a basic industry in the national economy and people's livelihood, in the modernization process of China's industry has played an irreplaceable role. In the context of "cut overcapacity", more merger, acquisition and reorganization will be happened in the area of iron and steel industry. In this process, industrial concentration situation will be changed, and more concentrated. As pricing is the core of the acquisition and m&a process, has attracted more and more attention. But the current m&a pricing method is not perfect, in order to solve that, real option method in the uncertain environment is proposed in this paper. There are fair value and the real option value in mergers and acquisitions, and we also put forward the synergistic effect coefficient to describe the synergistic effect in mergers and acquisitions. Considering variable operating cost of the iron & steel industry enterprises, assuming enterprise product price follows geometric Brownian motion, when the optimal production quantity in certain cases, the final profit streams must depend on the product price, so the profit streams also follows geometric Brownian motion. This paper puts forward the pricing method of iron and steel industry mergers and acquisitions.

Key words: Real options; Mergers and acquisitions (m&a); Dixit-Pyndick model; Synergistic effect

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INTRODUCTION
The iron and steel industry as the pillar industry in traditional industries, is a capital-intensive industries. Industry depends on the resources such as iron ore, coke, energy, transportation and so on, and it has barriers to entry and exit. Rappaport (1986) using the discounted cash flow method to determine the highest acceptable value method of m&a in 1986. Traditional discounted cash flow method takes the process of m&a as a one-time thing without considering the real option value in the process of m&a. For the first time the concept of real options was put forward by Myers in 1977. He thinks that the value of a company is divided into two parts, one is the present value of the assets of enterprises and the other one is the growth value conceals in the process of m&a, the main difference of the two parts the main difference is that the value of assets can be regarded as call options or not. Kester (1984) studied the growth option strategy and the corresponding competition. Gamba and Trigeogris (2002) put forward the conceptual framework of real options, and made the value of subsequent investment. Based on the B-S method, Geske (1979) adopted the method of risk neutral pricing to get a simple compound of European option pricing formula, provided a foundation for subsequent compound option pricing research. Alvarezl and Backa (2011) came up with the splitting options, they believed that after the merger acquirers will consider splitting the main business of the target firm. Split and mergers respectively constitute the company's spin-off and m&a options, and the optimum time to execute the real option to make acquisitions or to split is not at the same time. Dixit and Pindyck (2002) regarded investment as a much more compound options after considering the influence of the uncertainty, the dynamic programming method and camera rights analysis method was adopted to establish pricing partial differential equation and got the value of each option and the critical value under the conditions of certain boundaries.

Yu and Xu (2011) under the condition of uncertainty studied m&a pricing dynamic decision process by introducing a synergistic effect coefficient and Rubinstein bargaining model, however they thought the operating cost is constant, which not satisfied with the reality, especially for the iron and steel industry. So this paper introduces Cobb-Douglas production function which has variable costs and we also introduce production technology coefficient to describe the production function of steel industry enterprise. Under the background of variable operating costs, this paper present value formula of mergers and acquisitions in the steel industry.

1. FAIR VALUE OF THE TARGET FIRM IN IRON AND STEEL INDUSTRY

Under the background of "cut overcapacity", the steel industry's mergers and acquisitions will occur frequently and the m&a which occurs in iron and steel industry is full of horizontal mergers and acquisitions, basically. So the industry technical barriers are lower compares to other industry, and as a traditional industry, in the short term it is difficult to occur substantial technical progress to increase production. Therefore, in the proposed model, we assume that:

a) In the report period the technology to produce iron and steel product remain unchanged as **A**. Because of the iron and steel industry is capital-intensive industries;
b) This paper argues that the target firm of mergers and acquisitions in steel industry has certain flexibility in actual operation, allowed the change of operating costs by changing the raw materials uses, and the unit cost **c** of raw materials in probationary period is constant at any time, we can only change the operating costs by changing input quantity of the raw materials. This is because in order to maintain the continuity of production process, the raw material cost per unit between purchasing stays the same as **c**.;
c) In the process of m&a does not exist any irreversible agreement.

Based on the above assumptions, in the process of merger and acquisition, the optimal output depends on the iron and steel enterprise products unit price at anytime. At any time the target firm's optimal output in the mergers and acquisitions of the steel industry depends on its moment output prices, and the final profit streams also depend on the price of steel products. Set the raw materials instantaneous input amounts as **v**, operating costs for iron and steel enterprises are $C(v)$, the unit price for steel products is P, $h(v)$ is the instantaneous supply function of the iron and steel enterprise, so the Instantaneous profit function the of target firm in iron and steel industry can be expressed as:

$$\pi(P) \equiv \max\left[Ph(v) - C(v),\ 0\right] . \quad (1)$$

In Equation (1), $C(v)=c*v$, c is the unit cost of production input factors (such as: iron ore etc.), $C(v)$ represents the total cost of the target firm. Introducing cobb-douglas production functions, so the instantaneous supply function of the iron and steel enterprise is:

$$h(v) = Av^{\theta},\ 0 < \theta < 1 . \quad (2)$$

means elastic coefficient of inputs, under the background of "cut overcapacity", $0<\theta<1$ can describe the characteristics of the steel industry more better. Combine Equation (2) and $C(v)=c*v$:

$$\pi(P) = \max\left\{ APv^{\theta} - c * v \ \middle|\ 0 < \theta < 1\right\} . \quad (3)$$

To get the instantaneous maximum profit, Inputs variable demand function of the target firm is:

$$v = \left(\frac{A\theta P}{c}\right)^{\frac{1}{1-\theta}} . \quad (4)$$

The output of the instantaneous supply function is:

$$h(v) = A\left(\frac{A\theta P}{c}\right)^{\frac{\theta}{1-\theta}} . \quad (5)$$

When the input raw material quantity to achieve the optimal value, target enterprise instant profit streams of expression of Iron and steel industry is:

$$\pi(P) = (1-\theta)\left(\frac{\theta}{c}\right)^{\frac{\theta}{1-\theta}} (AP)^{\frac{1}{1-\theta}} . \quad (6)$$

Denote Equation (6) as $\pi(P)=KP^{\gamma}$,

$$K = A^{\frac{1}{1-\theta}}(1-\theta)\left(\frac{\theta}{c}\right)^{\frac{\theta}{1-\theta}},\ \gamma = \frac{1}{1-\theta} > 1.$$

Under the presence of variable operating cost that the target firm of steel industry, we get the expression of its instantaneous profit streams. Next, we consider how to its fair value to calculate. We assume that any time in the process of the underlying business, enterprises have two choices: management or not. We make the value of all management options sequence of acquisition target enterprise, and assume that there is not in the process of merger and acquisitions irreversible agreement. But when the product price changes P on the number of inputs v have different choices. Suppose in every moment in the process of iron and steel enterprises have a fixed cost of production flow, then will there is a lower price, as long as the product price is lower than the critical value, then target enterprise's management will be put off.

In order to have the steel industry mergers and acquisitions target firm's the fair value, introduce Dixit and Pindyck' idea, the price P of acquisition targets enterprise products are assumed to be the most simple stochastic process, follows geometric Brownian motion process:

$$\mathrm{d}P = \alpha P\mathrm{d}t + \sigma P\mathrm{d}z . \quad (7)$$

α is the product price drift rate, is the variance of product price fluctuations. Also, according to the capital asset pricing model, we have:

$$\mu = r + \phi\sigma\rho_{pm} \quad . \tag{8}$$

r is market risk-free rate, ρ_{pm} is the correlation coefficient between the market portfolio and tracking targe enterprise steel's product price P; ϕ is market prices or risk. As a result of the acquisition target enterprise value V must be positive, $\mu>\alpha$ will be set up, we set $\delta=\mu-\alpha$.

Because we assume that the underlying enterprise in m&a pricing decision investigation period the unit cost of inputs to keep into c, and from Equation (7) we know iron and steel enterprise product price follows geometric Brownian motion. Because of the fair value of the enterprise $V(P)$ mainly reflects on the future cash flows, and changes with the change of time, we assume that the fair value of $V(P)$ is the price of the product P and time parameter t's joint decision. Therefore, m&a target enterprise's fair value can be represented as:

$$V=V\ (P,t)\ , \tag{9}$$

on the basis of Ito's Lemma and the characteristics of the risk-free portfolio, combine (8) and (9), we get the target enterprise fair value's Bellman equation:

$$\frac{1}{2}\sigma^2P^2V''(P) + (r-\delta)PV'(P) + V'(t) - rV(P) + \pi(P) = 0 \quad . \tag{10}$$

Equation (10) is one of the most core equations in this paper, this is a second order binary partial differential equation.

In order to obtain the best enterprise merger and acquisition pricing under the situation of P follows geometric Brownian motion. We need to solve (10), but the closed-form solution of partial differential equations and has no fixed form. In this case there are only two kinds of solutions:

a) Using numerical method.

b) Assuming that m&a target enterprise duration is the "eternal life", to take advantage of this hypothesis, simplify (10) can get its analytical form.

This article will use the second option, we assume that the m&a target enterprise is the "eternal life", means that the fair value of the enterprise and the calendar time t is relatively independent. So variables related to time t is simplified, A fair value of the enterprise transformation from $V = V(P, t)$ to $V(P)$. (10) can be simplified as:

$$\frac{1}{2}\sigma^2P^2V''(P) + (r-\delta)PV'(P) - rV(P) + \pi(P) = 0 \ . \tag{11}$$

Equation (11) also need to satisfy the boundary conditions $V(0)=0$, Means that when the enterprise product price of the steel industry is 0. The target firm does not have fair value, there is no value of mergers and acquisitions.

In order to satisfy the boundary conditions $V(0)=0$. Then the second order linear ordinary differential Equation (11) has the solution as:

$$V(P) = BP^{\beta} \quad . \tag{12}$$

B is the undetermined coefficients, β is decided by and.

For Equation (11), first, we slove the general solution combine Equation (12) with ordinary differential Equation (10), get:

$$V'(P) = B\beta P^{\beta-1}\ , \tag{13a}$$

$$V''(P) = B(\beta-1)P^{\beta-2}. \tag{13b}$$

Then, combine Equations (13a) and (13b), get the quadratic equation which has the beta coefficient:

$$\frac{1}{2}\beta(\beta-1)\sigma^2 + \beta(r-\delta) - r = 0\ . \tag{14}$$

Equation (14) has two root:

$$\beta_1 = \frac{1}{2} - \frac{r-\delta}{\sigma^2} + \sqrt{\left(\frac{r-\delta}{\sigma^2} - \frac{1}{2}\right)^2 + \frac{2r}{\sigma^2}} > 1\ , \tag{15a}$$

$$\beta_2 = \frac{1}{2} - \frac{r-\delta}{\sigma^2} - \sqrt{\left(\frac{r-\delta}{\sigma^2} - \frac{1}{2}\right)^2 + \frac{2r}{\sigma^2}} < 0\ . \tag{15b}$$

The general form of solution of Equation (11) can be expressed as: $V(P)=B_1P^{\beta1}+B_2P^{\beta2}+H(P)$, combine $\pi(P)=KP^{\gamma}$ with Equation (11), get the differential equation of target enterprise fair value:

$$\frac{1}{2}\sigma^2P^2V''(P) + (r-\delta)PV'(P) - rV(P) + KP^{\gamma} = 0\ . \tag{16}$$

Equation (16) has a special solution K_1P^{γ}, we slove K, and get special solution:

$$\frac{KP^{\gamma}}{r-(r-\delta)\gamma - \frac{1}{2}\sigma^2\gamma(\gamma-1)}\ . \tag{17}$$

Equation (16) is the expected present value when profit streams is KP^{γ}:

$$\frac{KP^{\gamma}}{r-(r-\delta)\gamma-\frac{1}{2}\sigma^2\gamma(\gamma-1)}=\frac{KP^{\gamma}}{\delta'}\ . \quad (18)$$

The fair value of the enterprise in steel industry mergers and acquisitions can be expressed as: $(P)=B_1P^{\beta_1}+B_2P^{\beta_2}+\frac{KP^{\gamma}}{\delta'}$, in it $B_1P^{\beta_1}+B_2P^{\beta_2}$ is speculative bubble from the perspective of economics. In order to simplify the calculation, we have target enterprise's fair value form which rules out with speculative bubbles. So the fair value of the target enterprise is:

$$V(P)=\frac{KP^{\gamma}}{\delta'}\ . \quad (19)$$

From the Angle of reality, to make the fair value of m&a target enterprise have realistic significance, $\delta'>0$ must be met. So $B(\gamma)<0$, γ must be between the two roots, especially, $\gamma<\beta_1$.

2. REAL OPTION VALUE OF THE TARGET FIRM IN IRON AND STEEL INDUSTRY

Traditional value evaluation model directly regard the target enterprise fair value as its m&a valuation, and as the pricing in m&a. But in fact enterprise m&a process valuation not only contains its fair value, also includes real option value and synergy value in its m&a process. According to the rules of real options in mergers and acquisitions, the goal to make decisions is maximization of real option value. We adopt the method which is the same as the previous section to get real option value, can be expressed as:

$$F(P)=A_1P^{\beta_1}+A_2P^{\beta_2}\ . \quad (20)$$

A_1 and A_2 are undetermined constants, $\beta_1=\frac{1}{2}-\frac{r-\delta}{\sigma^2}+\sqrt{\left(\frac{r-\delta}{\sigma^2}-\frac{1}{2}\right)^2+\frac{2r}{\sigma^2}}>1$, undetermined.

In order to satisfy the boundary conditions $F(0)=0$, $A_2=0$ is the logical result. Therefore, the real option value of the steel industry in mergers and acquisitions is:

$$F(P)=A_1P^{\beta_1}\ . \quad (21)$$

By the value-matching and smooth-pasting conditions:

$$F(P^*)=V(P^*)-I\ , \quad (22)$$

$$F'(P^*)-V'(P^*)=0. \quad (23)$$

I is initial investment cost required, Equation (22) can be interpreted as: When the enterprise product prices for the critical value of the steel industry is, the acquisition target enterprise mergers and acquisitions are an optimal choice, to perform this real options is best. Hence, acquisition target enterprise's fair value by performing a merger that exists in the real option to get, this is the value matching conditions.

$F(P)$ is a continuous function, the critical point is smooth when product value. This condition is to ensure the effectiveness of mergers and acquisitions at point P^*, that is smooth-pasting conditions.

(22) and (23) turn into (24) and (25):

$$A_1(P^*)^{\beta_1}=\frac{K(P^*)^{\gamma}}{\delta'}-I\ , \quad (24)$$

$$A_1\beta_1(P^*)^{\beta_1-1}=\frac{K\gamma(P^*)^{\gamma-1}}{\delta'}. \quad (25)$$

K is already known,

$$K=A^{\frac{1}{1-\theta}}(1-\theta)\left(\frac{\theta}{c}\right)^{\frac{\theta}{1-\theta}},\gamma=\frac{1}{1-\theta}>1,$$

therefore, through the above two formulas, we can get A_1 and P^*. The critical value P^* of target enterprise steel product prices to m&a is:

$$\frac{A^{\frac{1}{1-\theta}}(1-\theta)\left(\frac{\theta}{c}\right)^{\frac{\theta}{1-\theta}}(P^*)^{\gamma}}{r-(r-\delta)\gamma-\frac{1}{2}\sigma^2\gamma(\gamma-1)}(\beta_1-\gamma)-I\beta_1=0\ . \quad (26)$$

While in the case of certain coefficient to obtain the best m&a point value, but it is hard to explain its give appropriate economics.

Combine (21) and (19), without considering synergistic effect get the enterprise value $G(P)$ in m&a is:

$$G(P)=V(P)+F(P)=\frac{KP^{\gamma}}{\delta'}+A_1P^{\beta_1}\ . \quad (27)$$

$G(P)$ is the value of the target of iron and steel industry, but it did not consider the synergistic effect in m&a, which is clearly not appropriate. Next we will make the introduction of the synergistic effect coefficient model, get the final value of the target enterprise.

3. VALUATION OF THE STEEL INDUSTRY TARGET FIRM IN M&A AFTER CONSIDERING SYNERGISTIC EFFECT

Synergy is the objective reason of the increasing competitiveness after the merger, after m&a synergy effect is of great strategic value, if you can't achieve synergies, means that both sides of the resources and capabilities are not shared, so to achieve synergies is the basic goal of m&a.

To study the synergistic effect of the steel industry mergers and acquisitions to solve the final acquisition price, we get variable coefficient of the synergistic effect which changes by the change of t, apply to throughout the duration of the enterprise.

In general, synergy in mergers and acquisitions play a positive role, that is 1+1>2, this means that the synergistic effect coefficient $\lambda(t)>1$. on the contrary, after the merger of a running-in period due to information asymmetry, management and other reasons there are many barriers between the merger parties, synergies between the two parties is weak, $0<\lambda(t)<1$ can be established within a very short time, after the merger. In addition, from the perspective of reality, $\lambda(t)\leq 0$ is impossible.

In order to describe synergies in acquisition, we assume. $\lambda(t)=\lambda \mathrm{In}(1+t)$, $\lambda>0$, $t>0$. This curve describes in a short period of time after the merger, due to information asymmetry and barriers to management is serious, synergistic effect improve faster; and after this period, information asymmetry and barriers has been solved, so the synergies speed gradually slow down. In conclusion, taking into account the synergistic effect of target enterprise, the value of it can be expressed as:

$$G(P)=\lambda(t)\big(V(P)+F(P)\big)=\lambda In(1+t)\left(\frac{KP^{\gamma}}{\delta'}+A_1P^{\beta_1}\right). \tag{28}$$

Because this article studies the pricing process of the steel industry mergers and acquisitions, and iron and steel industry belongs to the traditional enterprise, from the perspective of internal environment, the products is the industry enterprise's homogeneity is high, and have technical convergence, similar inputs, etc. from the perspective of external environment, in the background of "cut overcapacity", after completion of the steel industry mergers and acquisitions in the run-in time period is shorter than the general type of enterprise m&a, even they can quickly through the period under the common effect on the internal and external factors. Suppose the period of time t after the mergers and acquisitions completion is too small to calculate, we can define $t\to 0$, (28) can be simplified as:

$$G(P)=\lambda(t)\big(V(P)+F(P)\big)=\lambda\left(\frac{KP^{\gamma}}{\delta'}+A_1P^{\beta_1}\right). \tag{29}$$

The steel industry mergers and acquisitions valuation formula of target enterprise is (29).

4. NUMERICAL SIMULATION OF THE MODEL

From the value-matching and smooth-pasting conditions, we can get the best point P^* of the prices of iron and steel industry's m&a target enterprise. Here we adopt the method of numerical simulation for mergers and acquisitions in the iron and steel products best point P^* analysis. Set=0.026, σ=0.2, r=0.04, ϕ=0.04, P_{pm}=0.7, I=100, c=5, θ=0.2. The results of numerical simulation is shown in Figure 1.

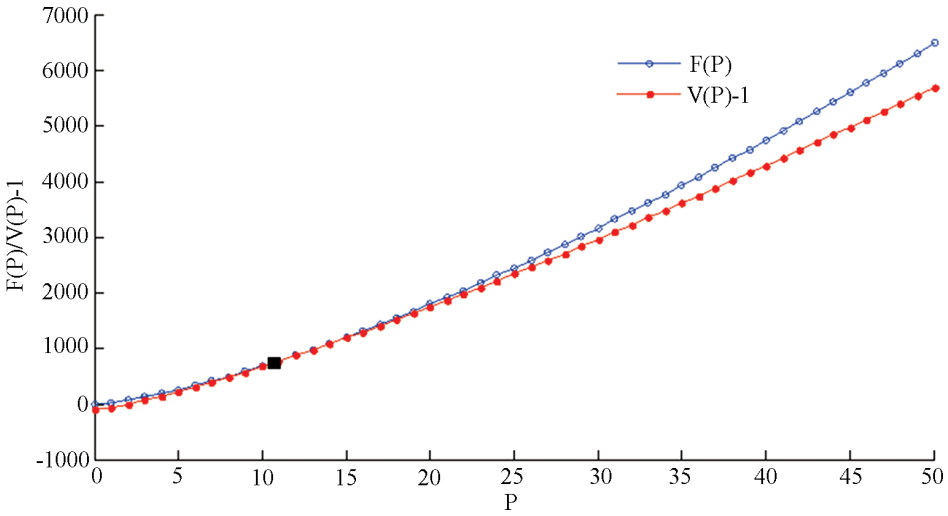

Figure 1
Numeric Simulation of $F(P)$ and $V(P)$-I to Calculate

According to the results of numerical simulation can get the best threshold for product prices. P^*=11.3661789, when the price of steel products of the target firm in mergers and acquisitions is, P^*=11.3661789, the benefit from m&a is best. And the value of the target firm in m&a is $G(P^*)$=79.3245.

Next, we research when the steel raw material's unit cost c changes, P^* how to change. Take α=0.026,σ=0.2, r=0.04,ϕ=0.04,P_{pm}=0.7,I=100,θ=0.2 remain unchanged, when the unit cost c=1,3,5,7,10. The best point of steel product prices increase with the unit cost c, that is to say, G(P^*) increase with c. We can learn this fact from Figure 2:

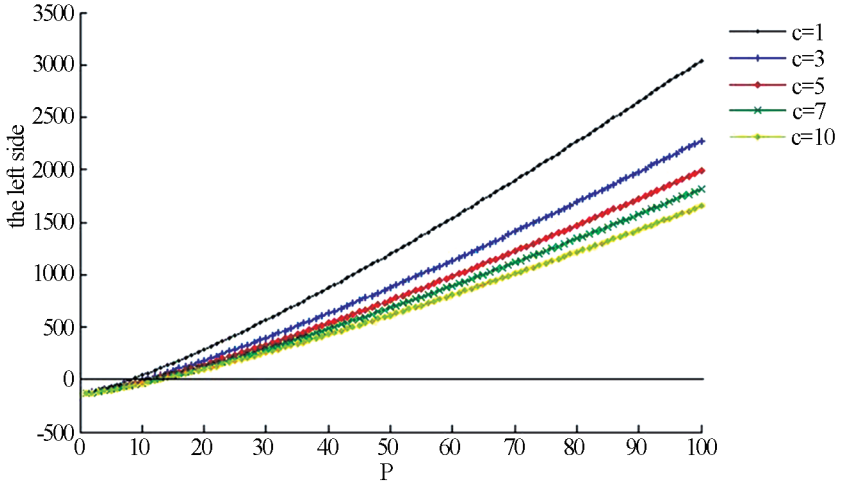

Figure 2
Variation of When Unit Variable Costs *c* Changes

Reflected in the real life, under the background of cut overcapacity, in the production of iron and steel products, raw materials (such as iron ore, etc.) unit costs rises, and iron and steel products output declines. From the perspective of the side of supply, iron and steel products production decline as the iron and steel products unit price rises, the target enterprise valuation also rises. This is the purpose of the reform to capacity supply side, cut the iron and steel industry overcapacity, improve the industry concentration, in the future of the steel industry must have high rates of merger, acquisition and reorganization.

After considering c affects P^*, now we study how the elastic coefficient for raw materials affect P^* set θ=0.05,0.1,0.15,0.2,0.25 and α=0.026, σ=0.2, r=0.04, ϕ=0.04, P_{pm}=0.7, I=100, c=5 remain unchanged. Noticed that with the increase of raw material elastic coefficient, best point also increase in turn. It is shown as follows:

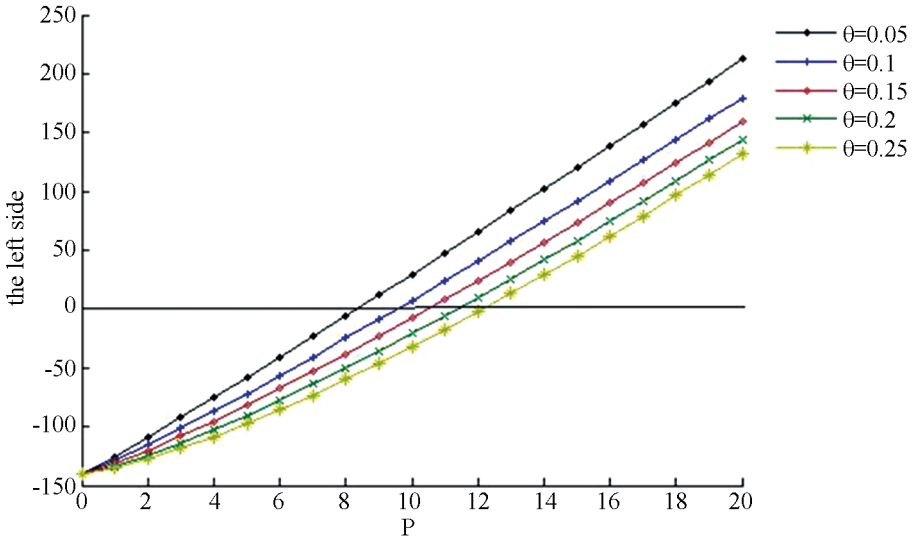

Figure 3
Variation of When Elastic Coefficient Changes

In reality most of the iron and steel industry enterprises have this feature, to improve utilization rate of raw materials is very important. Due to the steel industry is the traditional backbone industries, dispersion and size of the current industry enterprises, the production technology is also uneven, the problem of overcapacity is very severity.

Iron and steel industry mergers and acquisitions can greatly improve the status now we faces, and improve the industry concentration, after enhancing utilization rate of raw materials materials, and increase the concentration of large equipment, then the elasticity coefficient of raw materials in iron and steel enterprises will be increased significantly. It is very meaningful for the iron and steel industry.

CONCLUSION

This paper put forward the pricing model of mergers and acquisitions in iron and steel industry from the perspective of real options, and the model considering the value from three sources: the fair value, the real option value and the synergy value of the target firm. And the model based on variable operating costs which accord with the reality of iron and steel enterprises's input output situation. We can get the value of the target firm in m&a of iron and steel industry through the model presented in this paper. And we studied how the variation of changes when elastic coefficient θ or unit variable costs c changes, we found $G(P^*)$ increase with c and with the increase of raw material elastic coefficient, Best point also increase. Under the background of "cut overcapacity", horizontal m&a in iron and steel industry can improve the industry status quo. As pricing is the core of the acquisition and m&a process, mergers and acquisitions valuation model are given for the iron and steel industry enterprises in this paper, which provides reference to pricing in m&a of iron and steel industry, but this article doesn't specialize inputs which need a further research.

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