Study of Game Theory on Enterprises' First-round Financing Based on Valuation Adjustment Mechanism

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Under the Valuation Adjustment Mechanism (VAM), enterprises confront with complicated Game problems during the first round (Series A) financing. Therefore the paper uses Game Theory to analysis the decisions of enterprise, Series A investor when facing different collusion condition. The paper also investigates the influence of stringency of the target and the efforts level of the enterprises on enterprises earnings and aims to define the enterprise tactics.

1. Introduction

During the financing stage of Series A, the enterprise invested in, Series A investors could not ascertain the valuations and future growth of the financing enterprises because of the information asymmetry. Consequently, financing enterprises and Series A investors usually consult with the uncertainties in the future based on the future performance and other conditions by signing the Valuation Adjustment Mechanism (VAM). According to the previous studies, the direct reason for the failure of financing enterprises' valuation adjustment is that the targets are unreasonably set when signing the Valuation Adjustment Mechanism (VAM). To be specific, when the targets are too high, the enterprises have to pay more effort costs, which might not necessarily increase the expected return, but may put the enterprises at risk. It could be observed that the target setting of the Valuation Adjustment Mechanism (VAM) as well as the degree of the enterprises' efforts will greatly influence the enterprise' expected return. Adopting the game theory as the methodology, this paper gave a thorough discuss of the decision behaviours between the financing enterprises and the first round investment, analysing the influence of the stringency of the targets of valuation adjustment and the degree of the enterprises' efforts on the enterprises' expected return, to reveal the potential risks of the Valuation Adjustment Mechanism (VAM).

2. Literature review

To better understand the characters of Valuation Adjustment Mechanism on Enterprises' First-round Financing, Cline et al. (2015) investigated the role of lockup agreements by separately examining the valuation of primary and secondary market investors. Deer and Song (2013) applied a financial valuation approach to estimate the direction and the broad extent of recent international financial adjustments on China's international balance sheet. Chen et al. (2013) investigated whether joint ventures and strategic alliances create value for bondholders by examining the bond market's reaction to announcements of these two types of cooperative business activities. Bengtsson and Sensoy (2013) studied the evolution and renegotiation of the cash-flow rights that venture capitalists (VCs) obtain in their portfolio companies. Kim et al. (2015) examined the risks and returns of venture capital investments using the Fama-French factor model and cash flow data. Ewens and Rhodes-Kropf (2014) investigated whether individual venture capitalists have repeatable investment skill and the extent to which their skill is impacted by the venture capital (VC) firm where they work. Giot (2014) explored whether private equity firms that are new to the industry take excessive risks relative to funds from established firms. Chemmanur (2013) analyzed how corporate venture capital (CVC) differs from independent venture capital (IVC) in nurturing innovation in entrepreneurial firms. Cestone (2002) developed a theory of the joint allocation of control and cash-flow rights in venture capital (VC) deals. Lahr and Mina (2014) explored the determinants of the stage distribution of European venture capital investments from 1990 to 2011. Sensoy et al. (2014) evaluated the performance of limited partners' (LPs') private equity investments over time. Reber (2014)

proposed cascade neural networks to estimate the model parameters of the Cox-Ross-Rubinstein risk-neutral approach. Park and Steensma (2014) explored factors determining board membership of venture capitalists (VCs) in a syndicate in privately held entrepreneurial ventures. Bhattacharya and Guriev (2013) considered an incomplete contracting model of bilateral trade in intellectual property (IP) with sequential investments in its quality and with financial constraints.Dahiya and Ray (2012) showed staged financing is efficient because Staging lets investors abandon ventures with low early returns, and thus sorts good projects from bad.

3. Establishment and analysis of game model

3.1 The hypotheses and symbol description

When there is only one venture capital firm signing the Valuation Adjustment Mechanism (VAM) with the enterprise and only one round of equity financing under Valuation Adjustment Mechanism (VAM) allowed, the game players are the investor and the financing party (enterprise). It is hypothesized that:

(1) Symbolizes the investor as I and the expected return as E_{11}; symbolize the financing party (enterprise) as F and the expected return isE_{21};

(2) When the investor enters the enterprise, the financing enterprise will be faced with a series of risks (the risk loss here does not include loss caused by the loss of control rights), such as leakage of information and technology. The loss caused by these risks is symbolized as$R$;

(3) If the investor does not enter the enterprise, since the capital owned by the investor has value (like investing in other enterprises or projects), symbolize the expected return as V;

(4) It is a dynamic game with incomplete information, hypothesis of decision order: firstly, the investor decides whether to sign the protocol; after the protocol is agreed by the two sides, in a limit time period, if the financing party has met the terms included in the protocol, the two parties implement the protocol and make further decisions, or, other decisions will be on the way.

(5) There are two strategies available to the investor: sign Valuation Adjustment Mechanism (VAM) and process venture investment, or not sign the protocol and not invest in the financing enterprises either; the financing enterprise will be confronted with two situations too, that is, having met the terms of VAM and having not. Assume that the probability of its meeting the terms of VAM is$f(\alpha, \beta) = g(\alpha) \cdot \mu(\beta)$, and thus the probability of its not meeting the terms of VAM is$1 - f(\alpha, \beta)$. Where α is continuous and$\alpha \geq 0$, which represents the effort level of financing enterprise. $\beta$is also continuous and$\beta \geq 0$, which represents the difficulty of achieving the goals of VAM signed by financing enterprises and investor. The biggerβ is, the harder it is to achieve the goals. αandβ are decision variables.

(6) Specify characters of the function from the perspective of economics based on$g(\alpha)$'s meaning:

➢ If $0 \leq g(\alpha) \leq 1$, it means that the probability of achieving goals, namely,$g(\alpha)$ under the influences of the financing enterprises' effort level is between 0 and 1;

➢ If $g'(\alpha) > 0$, it means that $g(\alpha)$ increases when the financing enterprises' effort level improves;

➢ If $g''(\alpha) < 0$, it means that compared with the unit increment of the financing enterprises' effort level,$g(\alpha)$'s increment is diminishing, which is in accordance with diminishing marginal utility.

(7) Specify characters of the function from the perspective of economics based on$\mu(\beta)$'s meaning:

➢ If $0 \leq \mu(\beta) \leq 1$ it means that the probability of achieving goals, namely,$\mu(\beta)$ under the influences of the difficulty of achieving goals is between 0 and 1;

➢ If $\beta \in [0, \theta], \mu'(\beta) > 0$; If$\beta \in [\theta, \delta]$, $\mu'(\beta) < 0$. Within limits, when β increases, that is, when it gets increasingly difficult to achieve the goals, $\mu(\beta)$ increases, which is in accordance with the deduction that under Valuation Adjustment Mechanism (VAM), reasonable goals can encourage financing enterprises. But if β continues to grow, $\mu(\beta)$ will decrease, because too ambitious goals, instead of being encouraging, will burden the enterprise more heavily and add difficulty achieving the goals;

➢ If $\mu''(\beta) < 0$, the function is in accordance with diminishing marginal utility.

(8) Assume that financing enterprises' effort costs is$\omega(\alpha)$. $\omega(\alpha)$is an increasing function ofα, namely, the effort level; Specify characters of the function from the perspective of economics based on$\omega(\alpha)$'s meaning:

➢ If $\omega(\alpha) > 0$, it means that the enterprises' effort costs is greater than zero;

➢ If $\omega'(\alpha) > 0$, it means that the more efforts the enterprises put into, the higher the costs is;

➢ If $\omega''(\alpha) > 0$, it means that compared with the unit increment of effort level, the increment of effort costs is increasing.

Assume that the capital invested is $C(C > R)$. When the financing party meets the terms of VAM, the investor can gain huge profits from the shares held because of value increment, which is symbolized as N. Financing enterprises' profits is D $(D > C$. D is the sum of capital's value increment and the rewards the investor gives to the financing enterprise); when the terms are not met, generally, the enterprise will lose and transfer its shares to the investor. Through the transferring of shares, the investor gains the corresponding control rights. Assume that the profits the control rights bring to the investor is M, in other words, the loss of financing enterprise is M too (M>C). Actually, for the investor, M is the compensation promised by Valuation Adjustment Mechanism (VAM) for the investor's failed investment; for the financing party, M is the price it has to pay for its failure of

gambling, or the punishment for its failure to meet the terms. To some extent, M's value can reflect whether the terms are harsh or not.

According to conditions mentioned above, this paper defines the expressions of $g(\alpha)$ and $\mu(\beta)$ shown below:

$$g(\alpha) = \frac{\alpha}{\alpha + 1}$$

$$\mu(\beta) = 1 - \frac{1}{9} \cdot (\beta - 2)^2$$

$$f(\alpha, \beta) = \frac{\alpha}{\alpha + 1} \cdot \left[1 - \frac{1}{9}(\beta - 2)^2 \right]$$

$$\omega(\alpha) = (\alpha + 2)^2$$

Where $\alpha \in (0,5)$, $\beta \in (0,5)$, $0 < g(\alpha) < 1$, $0 < \mu(\beta) < 1$; $g'(\alpha) = \frac{1}{(\alpha+1)^2} > 0$, $g''(\alpha) = -\frac{2}{(\alpha+1)^3} < 0$; If $\beta \in (0,2)$, then $\mu'(\beta) = -\frac{2}{9}(\beta - 2) > 0$, and if $\beta \in (2,5)$, then $\mu'(\beta) = -\frac{2}{9}(\beta - 2) < 0$; if $\beta \in (0,5)$, then $\mu''(\beta) < 0$; if $\omega(\alpha) > 0$, then $\omega'(\alpha) = 2(\alpha + 2) > 0$, $\omega''(\alpha) = 2 > 0$. It can be known that $g(\alpha)$, $\mu(\beta)$ and $\omega(\alpha)$ are in accordance with the characters of functions given above.

According to the expressions of $g(\alpha)$, $\mu(\beta)$ and $\omega(\alpha)$, conduct illustrative example analysis on the mathematical game model of Series A financing and explore the degree of difficulty on achieving the goals set in Valuation Adjustment Mechanism (VAM), the standards of effort level the enterprises should meet as well as the changing trend of expected return.

Assume C=350,000 US dollars, and set the target value of gambling as β. If the enterprises achieve the gambling goals, the investor will profit N=600,000 US dollars; if the enterprises do not achieve the gambling goals, then M=500,000 US dollars. After the enterprises win the gambling, the capital's value increment D=600,000 US dollars and the risk loss R=10,000 US dollars.

Financing enterprises' expected return is:

$$E_{21} = \frac{\alpha}{\alpha + 1} \cdot \left[1 - \frac{1}{9}(\beta - 2)^2 \right] \cdot (C + D - R) + \left\{ 1 - \frac{\alpha}{\alpha + 1} \cdot \left[1 - \frac{1}{9}(\beta - 2)^2 \right] \right\} \cdot (C - R - M) - (\alpha + 2)^2$$

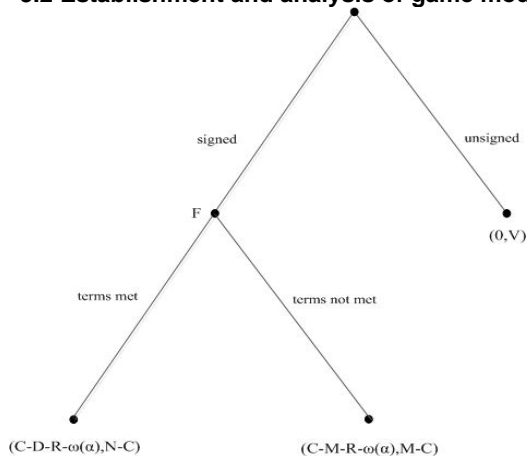### 3.2 Establishment and analysis of game model

Figure 1: Establishment of Game Model of Series A Financing

Table 1: Players' Profits in Series A Financing

the investor / the financing party	Signed	Unsigned
Terms met	$(C - D - R - \omega(\alpha), N - C)$	$(0, V)$
Terms not met	$(C - M - R - \omega(\alpha), M - C)$	$(0, V)$

When the investor and the financing enterprise do not sign the Valuation Adjustment Mechanism (VAM) and not process any investment either, the investor's expected return E_3 and the financing party's expected return E_4 are respectively:

$$E_3 = V, E_4 = 0$$

When the investor processes the investment under Valuation Adjustment Mechanism, its expected return E_{11} is:

$$E_{11} = f(\alpha, \beta) \cdot (N - C) + [1 - f(\alpha, \beta)] \cdot (M - C)$$

If $E_{11} < V$, the investor will choose not to sign Valuation Adjustment Mechanism (VAM) with the financing enterprise and process no investment into the enterprise. When V reaches certain degree, the terms towards the financing enterprise will get harsher and harsher, and consequently, the there will be less chance of investment. In order to attract the investor, the financing enterprise is supposed to show satisfactory performance and potential; if $E_{11} = V$, since the profits of investing equals that of not investing, to process the investment or not will make no differences to the investor; if $E_{11} > V$, the investor will choose to process investment under Valuation Adjustment Mechanism (VAM).

If the investment is in consideration, according to the deductions under $E_{11} > V$ mentioned above, there will be $f(\alpha, \beta) > 1 - \frac{N-V-C}{N-M}$. Only when the probability for the terms signed in the protocol to be met is larger than $1 - \frac{N-V-C}{N-M}$, the investment will be processed.

Financing enterprises' expected return E_{21} is:

$$E_{21} = f(\alpha, \beta) \cdot (C + D - R) + [1 - f(\alpha, \beta)] \cdot (C - R - M) - \omega(\alpha)$$

A series of risks exists for the financing enterprises since they are faced with restraints from the terms of VAM (which can also be regarded as encouragement). Under Valuation Adjustment Mechanism (VAM) that takes shares as "counter", only when $E_{21} > 0$ can the financing party win the gambling.

If $E_{21} > 0$, calculations show that

$$f(\alpha, \beta) = g(\alpha) \cdot \mu(\beta) > \frac{M + R - C + D}{M + D} = 1 - \frac{D + C - R - \omega(\alpha)}{M + D} > 0$$

If the goals set by the terms of VAM are too high to achieve, to avoid investment failure, the investor may increase M, which causes the value on the right side in the formula above increasing while $\mu(\beta)$ on the left side decreasing. In order to achieve the goals, the enterprises have to pay more efforts so as to increase $g(\alpha)$ and meet the requirements for probability. At this moment, it is to some degree risky for the enterprises to adopt equity financing under Valuation Adjustment Mechanism (VAM) and the enterprises will face huge loss of control rights in case of gambling failure. Under this condition, if the enterprises want to win the gambling and achieve the goals, $f(\alpha, \beta)$ has to be pretty high, which means that only when the financing enterprises are expected to have enough confidence of meeting the terms can they avoid failures. If the enterprises are blindly confident that they can achieve the goals, it is highly possible for them to be trapped in the gambling. However, when the enterprises are endeavoring to improve their effort level, meanwhile, they should pay keen attention to avoiding increasing $\omega(\alpha)$ because of excessive efforts and thus putting heavier burden on enterprises and as a result increasing the value of $1 - \frac{D+C-R-\omega(\alpha)}{M+D}$. If this is the case, it is still quite hard for the enterprises to win the gambling.

The essence of Valuation Adjustment Mechanism (VAM) is not just a "safeguarding umbrella" for one side or a cake snatched by two sides. It does not mean any investors' malicious investment but that both two sides hope to make the cake larger so that the parts owned by them will get larger. Therefore, the investor under Valuation Adjustment Mechanism also expects financing enterprises' success, since only in this way can the investor earn gains from the market, rather than looks forward to financing enterprises' failure and gaining profits only from the enterprises which should have been cooperators. Because compared with capital's value increment driven by good performance, compensation promised by Valuation Adjustment Mechanism (VAM) cannot meet the investor's expected return (that is, $N > M$). Hence, win-win is the ultimate goal of Valuation Adjustment Mechanism (VAM).

4. Conclusions

Based on the above analysis, it could be seen that a lot of detailed questions need to be considered when signing the Valuation Adjustment Mechanism (VAM). Targeting at the problem that the financing enterprises are at a disadvantaged position now, this paper proposed the following suggestions.

(1) Deeply understanding the advantages and disadvantages of Valuation Adjustment Mechanism (VAM)

At present, financing difficulty of the small and medium-sized enterprises (SMEs) in China is an irrefutable fact. When these enterprises urgently need to develop their capitals yet face the problems of the bank credit unobtainable and the procedures of going market too complicated, choosing to sign Valuation Adjustment Mechanism (VAM) with the foreign investment banks is a hopeful way for enterprise financing. Although financing by Valuation Adjustment Mechanism (VAM) could bring capitals to the enterprises quickly, its disadvantages should not be neglected, for in case that valuation adjustment fails, the enterprise would suffer great losses and even lose their control power.

(2) Deeply analysing the enterprise development strategy

Financing enterprises should deeply analyse their own development strategies, to decide whether they need to finance by accepting valuation adjustment or not. Meanwhile, they are supposed to finish capital planning and budget on the basis of the future development strategies in order to make the limited funds produce the greatest utility.

(3) Choosing the investors prudently

Investors who sign the Valuation Adjustment Mechanism (VAM) with the enterprises generally would not share hardships together with the enterprises. What they concern is just high return of investment. Therefore, to avoid the failure of valuation adjustment, financing enterprises should choose the investors prudently. The newly established enterprises are well advised to choose strategic investors as their investment partners, because they could not only bring capitals for the enterprises, but also bring rich managerial experience, which benefits the long-run development of the enterprises.

(4) Setting reasonable targets of valuation adjustment

What is gambled in the Valuation Adjustment Mechanism (VAM) is the future performance of the enterprises. When anticipating the goal of the future performance, "moderation" should be emphasized, for if the goal is too low, the investors could not be attracted; if the goal is too high, it will burden the enterprises. Therefore, when setting the targets of valuation adjustment, the enterprises should be realistic and avoid being blindly optimistic.

(5) Flexibly designing the terms of VAM

When signing the Valuation Adjustment Mechanism (VAM), financing enterprises need to analyze and weigh every term meticulously, enhance the communication with the investors, and add more flexible terms to the Valuation Adjustment Mechanism (VAM), to increase its flexibility.

(6) Making risk response plans in time

Financing enterprises should fully estimate all the possible emergencies and make corresponding response plans, for fear of lacking solutions once the risks occur and making the enterprises get into greater trouble.

(7) Trying to improve the business and management level

Only by trying hard to improve the business and management level and enhancing the abilities of resisting external risks could the enterprises grasp the initiative in the negotiation processes with the foreign investment banks.

The original intention of Valuation Adjustment Mechanism (VAM) is not that financiers and investors "scramble" for one piece of cake, but to make a greater piece of cake by the joint efforts of both sides. "Valuation adjustment" is a means and tool, while "adjusting valuation rightly" is the mutual expectation and aim of financiers and investors. Only by unifying the interests of investment and financing parties, utilizing the Valuation Adjustment Mechanism (VAM) flexibly and reasonably and jointly promoting the healthy and fair long-run development of enterprises, a real win-win could be achieved.

Acknowledgments

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