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GAME MODEL OF PAYMENT METHOD IN ACQUISITION UNDER ASYMMETRY INFORMATION

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Abstract

In this paper, we study the game of payment mode in acquisitions and the design of payment mechanism under asymmetric information. Unlike previous studies, we distinguish the high and low types of bidder and target. In the model, bidder will be assumed to provide two types of contract. We construct a unilateral private information model and innovatively study the type screening mechanism under more general bilateral private information by using game theory such as display principle and signaling. By solving the problem with the simplex method, we get the conditions of separation equilibrium and mixed equilibrium under different information mechanisms. By doing these, we give some suggestions for bidder's contract design under various information mechanisms.

Keywords: acquisitions payment, information asymmetry, signal transmission, separation, equilibrium, mixed equilibrium

INTRODUCTION

The choice of payment method is the last and most critical part of the whole company mergers and acquisitions, different payment methods contain the main information about company value. The market reaction of different payment methods is also different, which affects the short-term excess earnings of shareholders on both sides and the performance of the target company after the merger.

Due to the existence of various frictions in the real world, such as information asymmetry and taxes, different capital structure and different financing payment methods have different impacts on the value of the company. There are few studies on the classification of payment methods for company mergers and acquisitions. Recent studies have classified the payment methods for company mergers and acquisitions into four categories, namely cash, stock, mixed payment, and others. In the world of information asymmetry, if the company adopts stock as the payment method, it may represent that the company's current stock is overvalued, while cash payment is considered as a positive signal by the market ((Hansen, 1987) and (Fishman, 1989)). The model proposed by (Eckbo, Giammarino, & Heinkel, 1990) found that in the case of asymmetric information, mixed payment can achieve separation equilibrium. The model predicts that bidder value is monotonically increasing and convex in the fraction of the total offer that consists of cash. In terms of the optimal sequence of financing theory, (Smith Jr & Watts, 1992), (Jung, Kim, & Stulz, 1996) found that if enterprises have higher expected growth, they are more likely to adopt equity financing, which is a positive correlation. From the perspective of shareholders control over the company, if the control is valuable, the management or controlling shareholders who control the acquisition company are reluctant to pay in stock ((Stulz, 1988); (Amihud, Lev, & Travlos, 1990); (Jung, Kim, & Stulz, 1996)). The majority of controlling shareholders will choose more cash payment, especially when the controlling shareholders are not in absolute control. However, less attention will be paid to the issue of corporate control when the shares are highly dispersed and highly concentrated. (de La Bruslerie, 2012) proposed that full stock payment would dilute the original shareholders' equity. (Cornelli & Felli, 2012) suggested that the seller be left with the option to retain a small portion of the company's shares. By retaining a minority stake, the seller can transfer control of the company while minimizing the rent that the company sells to the buyer.Previous studies have not proposed the choice of trading media under bilateral private information, nor simplified the acquisition problem into two types of game and information transmission between buyers and sellers. This paper is divided into three parts. The first part is based on (Eckbo, Giammarino, & Heinkel, 1990). According to the assumption that the target has private information and bidder has no private information, it further proposes the choice of two types of target and bidder's payment method for acquisition. We enrich the results of previous papers. Considering the second part, in the case of only one kind of bidder and two kinds of target, the optimal strategy of the bidder is to give a pure cash contract and a pure equity contract. In the case of only one kind of target and two types of bidder, the bidder only needs to provide a contract. Next, in the third part, we innovatively put forward the choice of two types of acquisition media under bilateral private information. Whether bidder imitates each other depends on the type of bidder and target and the distribution of target type. For each choice of payment method, we have given the corresponding range of values, hoping these conclusions will provide some theoretical support for the choice of payment methods in acquisitions.

MODEL

Consider a bidder whose value is b finds an acquisition with the seller as the "target". The target value equals to t and the synergy, which depends on the types of both bidder and target, is worth $s(b,t)$ We assume a situation of asymmetric information, the bidder only knows that the value of the target is distributed over the interval $[0,t_b]$ and the probability distribution function $f(t)$ of the target value.

Similarly, the target only knows that the bidder value is drawn from the interval $[0,b_b]$ and the probability function $g(b)$. The distributions $f(b)$ and $g(b)$ are assumed to be common knowledge and differentiable. The offer given by bidder will consist of cash, c, and security , the proportion of which is presented by z . We consider that there can be multiple contracts provided by bidders, in which case the target will choose the offer that is most favorable to him (or reject the bidder). For simplicity, we assume that all agents are risk neutral and that the discount rate is zero. Let t_i refer to a specific target value, b_j express the specific bidder value while we assume, for ease of illustration, that $i \in \{l,h\}$.

Bidder type j discovers a synergistic opportunity with a target of unknown type. It makes an offer $\{(z_h^j, c_h^j),(z_l^j, c_l^j)\}$, $j \in \{l,h\}$.

Target shareholders revise their beliefs about $\overline{s(z,c)}$, and compute the expected payoff from accepting theoffer as

$$c_i + z\left(t_i + \overline{s(z,c)} - c_i\right) \tag{1}$$

where $\overline{s(z,c)}$ is the target's estimate of $s(b,t)$ given that the bidder has offered (z,c).

one type bidder, two type target

First, we consider the case where there is only one type of bidder type, in which case the value of the bidder is b. The purpose of the bidder is:

$$\max_{(z,c)} E\sum[s(b,t_i) + t_i - c_i - z_i(t_i + s(b,t_i) - c_i)] \tag{2}$$

satisfy: I.R:

$$\begin{cases} c_l + z_l[s(b,t_l) + t_l] \geq t_l \\ c_h + z_h[s(b,t_h) + t_h] \geq t_h \end{cases} \tag{3,4}$$

means that I.R is binding for the high type target. Here we use c_i to represent $c_i(1 - z_i)$ for the sake ofsimplicity.

I.C:

$$\begin{cases} c_l + z_l[s(b,t_l) + t_l] \geq c_h + z_h[(s(b,t_l) + t_l] \\ c_h + z_h[s(b,t_h) + t_h] \geq c_l + z_l[(s(b,t_h) + t_h] \end{cases} \tag{5,6}$$

So, the target function can be written as

$$\max_{(z,c)}\{p_h[s(b,t_h) + t_h - c_h - z_h(s(b,t_h) + t_h)] + p_l[s(b,t_l) + t_l - c_l - z_l(s(b,t_l) + t_l)]\} \tag{7}$$

Using the simplex algorithm, we can get when the target function takes the maximum:

$$\begin{cases} c_l = \max\left(t_l, \dfrac{s_l + t_l}{s_h + t_h} t_h\right) \\ z_l = 0 \\ c_h = 0 \\ z_h = \dfrac{t_h}{s_h + t_h} \end{cases} \tag{8}$$

It can be seen that in the offer list provided by the bidder, one offer is pure cash, the target is a low-typecompany; the other is pure equity, and the target is a high-type company.

two type bidder, one type target

Let's consider the case where only bidder has private information. Bidder has two types, $b \in \{b_h, b_l\}$, whereas target has only one type t. Assumed b_h's contract is (c_h, z_h), b_l's contract is (c_l, z_l). For t, when there is no additional information, he evaluates the bidder type as (p_h, p_l), where $p_h + p_l = 1$.

When the contract given by the bidder is received, target corrects his belief and evaluates the bidder's type as $(p_h(z,c), p_l(z,c))$, it is the function of z and c . At this point, the target's participation constraint

I.R is $p_h(z,c)\{c_h + z_h[s(b_h,t)+t]\} + p_l(z,c)\{c_l + z_l[s(b_l,t)+t]\} \geq t$ (9)

The objective function of b_h is:

$$\max_{z_h, c_h}(1-z_h)[s(b_h,t)+t] - c_h \quad (10)$$

The objective function of b_l is:

$$\max_{z_l, c_l}(1-z_l)[s(b_l,t)+t] - c_l \quad (11)$$

The separation equilibrium of the game is analyzed below. Since b_h and b_l do not imitate each other, their given contract uniquely determines their type. So when the target receives the bidder's contract, he can determine whether the bidder is b_h or b_l . At this point his participation constraint is

$$\begin{cases} c_l + z_l[s(b_l,t)+t] \geq t \\ c_h + z_h[s(b_h,t)+t] \geq t \end{cases} \quad (12)$$

when (12) take the equal, the function of b_h and b_l reach the most. In addition, under separation equilibrium

$$\begin{cases} (1-z_h)[s(b_h,t)+t] - c_h \geq (1-z_l)[s(b_h,t)+t] - c_l \\ (1-z_l)[s(b_l,t)+t] - c_l \geq (1-z_h)[s(b_l,t)+t] - c_h \end{cases} \quad (13)$$

Substituting the bidder revenue maximization condition into the above formula,

$$\begin{cases} 0 > z_l[s(b_l,t) - s(b_h,t)] \\ 0 > z_h[s(b_h,t) - s(b_l,t)] \end{cases} \quad (14,15)$$

(15) is invalid. There is no separation equilibrium in the game.

The mixing equilibrium is discussed below. As we know from the discussion above, b_l has a tendency to imitate b_h . Under the mixed equilibrium condition, the contracts given by b_l and b_h are identical, (z_h, c_h). The target's participation constraint is

$$p_h\{c_h + z_h[s(b_h,t)+t]\} + p_l\{c_h + z_h[s(b_l,t)+t]\} \geq t \quad (16)$$

Maximize (10), we can get:

$$\begin{cases} z_h = 0 \\ c_h = t \end{cases} \quad (17)$$

That is, under mixed equilibrium conditions, both bidders acquire the target in pure cash.

bilateral private information

Next, we will consider the situation of bilateral private information. This is a more general scenario. Because in the market environment, bidder's acquisition cost and target's estimate of acquisition income are all private information, which is difficult to obtain. Both parties know only the probability distributionof the type (p_{b_h}, p_{b_l}) and (p_{t_h}, p_{t_l}). And b_h gives the contract $\{(c_{hl}, z_{hl}), (c_{hh}, z_{hh})\}$, b_l gives the contract.When the target receives the corresponding contract, he will correct his belie (p'_{b_h}, p'_{b_l}), and choose the contract that is most beneficial to him (or to reject). According principle of display, there should be four contracts of direct display mechanism provided by bidder torealize the correspondence of four participants.

Among them, the contract given by the bidder satisfies the I.C:

$$\begin{cases} c_{ll} + z_{ll}[t_h + s(b_l, t_h)] \le c_{lh} + z_{lh}[t_h + s(b_l, t_h)] \\ c_{lh} + z_{lh}[t_l + s(b_l, t_l)] \le c_{ll} + z_{ll}[t_l + s(b_l, t_l)] \\ c_{hl} + z_{hl}[t_h + s(b_h, t_h)] \le c_{hh} + z_{hh}[t_h + s(b_h, t_h)] \\ c_{hh} + z_{hh}[t_l + s(b_h, t_l)] \le c_{hl} + z_{hl}[t_l + s(b_h, t_l)] \end{cases} \quad (18)$$

I.R:

$$\begin{cases} p_{b_l}\{c_{ll} + z_{ll}[t_l + s(b_l, t_l)]\} + p_{b_h}\{c_{hl} + z_{hl}[t_l + s(b_h, t_l)]\} \ge t_l \\ p_{b_l}\{c_{lh} + z_{lh}[t_h + s(b_l, t_h)]\} + p_{b_h}\{c_{hh} + z_{hh}[t_h + s(b_h, t_h)]\} \ge t_h \end{cases} \quad (19)$$

The objective function of b_h is:

$$\max_{z_{hl}, c_{hl}, z_{hh}, c_{hh}} p_{t_l}\{(1 - z_{hl})[s(b_h, t_l) + t_l] - c_{hl}\} + p_{t_h}\{(1 - z_{hh})[s(b_h, t_h) + t_h] - c_{hh}\} \quad (20)$$

The objective function of b_l is:

$$\max_{z_{ll}, c_{ll}, z_{lh}, c_{lh}} p_{t_l}\{(1 - z_{ll})[s(b_l, t_l) + t_l] - c_{ll}\} + p_{t_h}\{(1 - z_{lh})[s(b_l, t_h) + t_h] - c_{lh}\} \quad (21)$$

The separation equalization is discussed below. Under the condition of separation equilibrium, the targetcan be distinguished by b_h and b_l according to the contract, so his participation constraint degenerates to:

$$\begin{cases} c_{hl} + z_{hl}[t_l + s(b_h, t_l)] \ge t_l \\ c_{ll} + z_{ll}[t_l + s(b_l, t_l)] \ge t_l \\ c_{hh} + z_{hh}[t_h + s(b_h, t_h)] \ge t_h \\ c_{lh} + z_{lh}[t_h + s(b_l, t_h)] \ge t_h \end{cases} \quad (22)$$

Use (22) and (18) to do the linear programming of (21) (20):

$$\begin{cases} c_{hl} = \max\left\{t_l, \dfrac{s(b_h, t_l) + t_l}{s(b_h, t_h) + t_h} t_h\right\} \\ z_{hl} = 0 \\ c_{hh} = 0 \\ z_{hh} = \dfrac{t_h}{s(b_h, t_h) + t_h} \end{cases} \qquad \begin{cases} c_{ll} = \max\left\{t_l, \dfrac{s(b_l, t_l) + t_l}{s(b_l, t_h) + t_h} t_h\right\} \\ z_{ll} = 0 \\ c_{lh} = 0 \\ z_{lh} = \dfrac{t_h}{s(b_l, t_h) + t_h} \end{cases} \quad (23)$$

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Whereas under separation and equilibrium conditions:

$$\begin{cases} p_{t_l}[(1-z_{hl})\Omega_{hl}-c_{hl}]+p_{t_h}[(1-z_{hh})\Omega_{hh}-c_{hh}] \geq p_{t_l}[(1-z_{ll})\Omega_{hl}-c_{ll}]+p_{t_h}[(1-z_{lh})\Omega_{hh}-c_{lh}] \\ p_{t_l}[(1-z_{ll})\Omega_{ll}-c_{ll}]+p_{t_h}[(1-z_{lh})\Omega_{lh}-c_{lh}] \geq p_{t_l}[(1-z_{hl})\Omega_{ll}-c_{hl}]+p_{t_h}[(1-z_{hh})\Omega_{lh}-c_{hh}] \end{cases} \quad (24)$$

in which $\Omega_{ji} = t_i + s(b_j + t_i)$.
Put (23) to the above, we can get:

$$\begin{cases} \dfrac{\Omega_{hl}\Omega_{lh}-\Omega_{hh}\Omega_{ll}}{\Omega_{lh}(\Omega_{hh}-\Omega_{lh})} \geq \dfrac{p_{t_h}}{p_{t_l}} \geq \dfrac{\Omega_{hl}\Omega_{lh}-\Omega_{hh}\Omega_{ll}}{\Omega_{hh}(\Omega_{hh}-\Omega_{lh})} \\ \dfrac{\Omega_{hl}}{\Omega_{hh}} t_h \geq \dfrac{\Omega_{ll}}{\Omega_{lh}} t_h \geq t_l \end{cases} \quad (25)$$

or

$$\begin{cases} \dfrac{\Omega_{hl}t_h-\Omega_{hh}t_l}{t_h(\Omega_{hh}-\Omega_{lh})} \geq \dfrac{p_{t_h}}{p_{t_l}} \geq \dfrac{\Omega_{lh}(\Omega_{hl}t_h-\Omega_{hh}t_l)}{\Omega_{hh}t_h(\Omega_{hh}-\Omega_{lh})} \\ \dfrac{\Omega_{hl}}{\Omega_{hh}} t_h \geq t_l \geq \dfrac{\Omega_{ll}}{\Omega_{lh}} t_h \end{cases} \quad (26)$$

That is the conditions for the separation equilibrium of the game. When this mechanism is satisfied, thebidder's optimal strategy is (23), and the target will uniquely distinguish the type of bidder. The following discussion of mixed equalization. From the above discussion we know that b_l will imitate b_h when one of the following 4 conditions are met:

$$\begin{cases} \dfrac{\Omega_{ll}}{\Omega_{lh}} t_h > t_l \\ \dfrac{\Omega_{ll}}{\Omega_{lh}} > \dfrac{\Omega_{hl}}{\Omega_{hh}} \end{cases} \quad \begin{cases} t_l \geq \dfrac{\Omega_{ll}}{\Omega_{lh}} t_h \\ t_l \geq \dfrac{\Omega_{hl}}{\Omega_{hh}} t_h \end{cases} \quad \begin{cases} \dfrac{p_{t_h}}{p_{t_l}} > \dfrac{\Omega_{hl}\Omega_{lh}-\Omega_{hh}\Omega_{ll}}{\Omega_{lh}(\Omega_{hh}-\Omega_{lh})} \\ \dfrac{\Omega_{hl}}{\Omega_{hh}} t_h \geq \dfrac{\Omega_{ll}}{\Omega_{lh}} t_h \geq t_l \end{cases} \quad \begin{cases} \dfrac{p_{t_h}}{p_{t_l}} > \dfrac{\Omega_{hl}t_h-\Omega_{hh}t_l}{t_h(\Omega_{hh}-\Omega_{lh})} \\ \dfrac{\Omega_{hl}}{\Omega_{hh}} t_h \geq \dfrac{\Omega_{ll}}{\Omega_{lh}} t_h \geq t_l \end{cases} \quad (27)$$

In this case, I.R.

$$\begin{cases} p_{b_h}(c_{hl}+z_{hl}\Omega_{hl})+p_{b_l}(c_{hl}+z_{hl}\Omega_{ll}) \geq t_l \\ p_{b_h}(c_{hh}+z_{hh}\Omega_{hh})+p_{b_l}(c_{hh}+z_{hh}\Omega_{lh}) \geq t_h \end{cases} \quad (28)$$

I.C.

$$\begin{cases} p_{b_h}(c_{hl}+z_{hl}\Omega_{hh})+p_{b_l}(c_{hl}+z_{hl}\Omega_{lh}) \leq p_{b_h}(c_{hh}+z_{hh}\Omega_{hh})+p_{b_l}(c_{hh}+z_{hh}\Omega_{lh}) \\ p_{b_h}(c_{hh}+z_{hh}\Omega_{hl})+p_{b_l}(c_{hh}+z_{hh}\Omega_{ll}) \leq p_{b_h}(c_{hl}+z_{hl}\Omega_{hl})+p_{b_l}(c_{hl}+z_{hl}\Omega_{ll}) \end{cases} \quad (29)$$

Use the above two equations to do linear programming for (20), we can get:

$$\begin{cases} c_{hl} = \max\left\{t_l, \dfrac{p_{b_h}\Omega_{hl}+p_{b_l}\Omega_{ll}}{p_{b_h}\Omega_{hh}+p_{b_l}\Omega_{lh}} t_h\right\} \\ z_{hl} = 0 \\ c_{hh} = 0 \\ z_{hh} = \dfrac{t_h}{p_{b_h}\Omega_{hh}+p_{b_l}\Omega_{lh}} \end{cases} \quad (30)$$

Similarly, we can get that b_h will imitate b_l when the following conditions are met:

$$\begin{cases} \frac{p_{t_h}}{p_{t_l}} < \frac{\Omega_{hl}\Omega_{lh} - \Omega_{hh}\Omega_{ll}}{\Omega_{hh}(\Omega_{hh} - \Omega_{lh})} \\ \frac{\Omega_{hl}}{\Omega_{hh}} t_h \geq \frac{\Omega_{ll}}{\Omega_{lh}} t_h \geq t_l \end{cases} \quad (31)$$

or

$$\begin{cases} \frac{p_{t_h}}{p_{t_l}} < \frac{\Omega_{lh}(\Omega_{hl} t_h - \Omega_{hh} t_l)}{\Omega_{hh} t_h (\Omega_{hh} - \Omega_{lh})} \\ \frac{\Omega_{hl}}{\Omega_{hh}} t_h \geq t_l \geq \frac{\Omega_{ll}}{\Omega_{lh}} t_h \end{cases} \quad (32)$$

At this point, the optimal contract form of b_l is similar to (30). These are the optimal strategies for bidders in the game under mixed equilibrium conditions. The bidder who maximizes personal income will choose to pay as little equity as possible to low target, and the rest will be paid in cash. But bidder also guarantees that the equity payment is greater than zero. Further, for high-type bidders, fewer shares will be transferred to target than to low-type bidders.

CONCLUSION

Generally speaking, we establish a mathematical model for the choice game of payment mode in acquisitions and assume that bidder can provide multiple contracts. This model is an extension of previous studies and more realistic. We systematically describe the game between two parties and the phenomenon of signal transmission under this information asymmetry model and provide suggestions for bidder's contract design.

Specifically, in the case of only one kind of bidder and two kinds of target, bidder's optimal strategy is to give a pure cash contract and a pure equity contract. Among them, cash contracts are for low-type targets, while equity contracts are for high-type targets. In the case of only one kind of target and two types of bidder, the bidder only needs to provide a contract. At this time, there is no separation equilibrium, and low-type bidders tend to imitate high-type bidders to obtain higher returns because by imitating high-type companies they can give less equity. At this time, the best strategy for high-type bidders is to adopt a pure cash strategy. The intuitive explanation is that because the target cannot determine whether the other party is of a high or low type, the requirement for equity acquisition will be raised. Originally, high-type bidders can use cash or equity buyouts, but they are more likely to use cash buyouts to maximize returns. Finally, in the case of bilateral private information, there exists both separation equilibrium and confusion equilibrium. When conditions (25)(26) are satisfied, they have separation equilibrium, that is, they give their respective contracts and do not imitate each other. Looking back at formula (23), we can see that obviously $z_{lh} > z_{hh}$, while the relationship between c ll and c hl is uncertain. If $c_{ll} > c_{hl}$, then b_l obviously tends to imitate b_h , because disguising himself as b_h can succeed at a lower price regardless of the type of target. If $c_{ll} < c_{hl}$, the distribution of target type should be considered. If the amount of t_h is more than t_l to make the pure equity contract the main final contract, then b_l will imitate b_h ; otherwise, b_h will imitate b_l if the pure cash contract becomes the main final contract. If the probability ratio of t_h to t_l is appropriate, they will not imitate each other. Conditions (25) (26) describe this situation. These are our descriptions of the game process of acquisition mode selection under information asymmetry. We innovatively put forward more realistic contract mode, and also give suggestions for bidder’s choice under different information structures. We hope these inferences can provide some constructive suggestions for company mergers and acquisitions.

References

1. Amihud, Y., Lev, B., & Travlos, N. G. (1990). Corporate control and the choice of investment financing: The case of corporate acquisitions. The Journal of Finance, 45(2), pp. 603-616.
2. Cornelli, F., & Felli, L. (2012). How to sell a (bankrupt) company. International Review of Finance, 12(2), pp. 197-226.
3. de La Bruslerie, H. (2012). Corporate acquisition process: Is there an optimal cash-equity payment mix?
4. International Review of Law and Economics, 32(1), pp. 83-94.
5. Eckbo, B. E., Giammarino, R. M., & Heinkel, R. L. (1990). Asymmetric information and the medium of exchange in takeovers: Theory and tests. The Review of Financial Studies, 3(4), pp. 651-675.
6. Fishman, M. J. (1989). Preemptive bidding and the role of the medium of exchange in acquisitions. The Journal of Finance, 44(1), pp. 41-57.
7. Hansen, R. G. (1987). A theory for the choice of exchange medium in mergers and acquisitions. Journal of business, pp. 75-95.
8. Hege, U., Lovo, S., Slovin, M. B., & Sushka, M. E. (2008). Equity and cash in intercorporate asset sales: Theory and evidence. The Review of Financial Studies, 22(2), pp. 681-714.
9. Jung, K., Kim, Y.-C., & Stulz, R. M. (1996). Timing, investment opportunities, managerial discretion, and the security issue decision. Journal of Financial Economics, 42(2), pp. 159-185.
10. Koessler, F., & Skreta, V. (2016). Incentive compatibility in signaling games with a continuum of types.
11. Journal of Economic Theory, 165, pp. 456-471.
12. Smith Jr, C. W., & Watts, R. L. (1992). The investment opportunity set and corporate financing, dividend, and compensation policies. 32(3), pp. 263-292.
13. Stulz, R. (1988). Managerial control of voting rights: Financing policies and the market for corporate control. Journal of financial Economics, 20, pp. 25-54.