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Study of Specific Assets' Investment and Resale Price-based on the Perspectives of Decreasing Return to Scale

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Abstract: In this study, we use Shleifer and Vishny (1992) analytical framework and ideas to investigate duopoly's resale price of specific assets and the optimal scale of investment in the case of variable investment model with decreasing returns to scale. We show that: (1) the firm's resale price of specific assets in distress related to the scale of investment of the another firm with not in distress in industry, (2) the value of collateral and incentive to invest of the firm in distress hinges on whether another firm under consideration is investing. The optimal investment scales of firm depend on other oligopolistic' in the industry, (3) in symmetric equilibrium, the optimal investment scales between duopoly is interactive to each other under decreasing returns to scale , the solution of optimal investment scale is a Nash equilibrium.

Key words: Asset reallocation, asset resale, decreasing returns to scale

INTRODUCTION

Generally, the possibility for the lenders to seize the borrowers' assets in the case of distress or merely to resell these assets in less strenuous times enhances the latter's borrowing capacity, so when entrepreneurs finance from investors, they will make the specific assets in crisis as collateral in order to enhance their borrowing capacity, then the investors have to assess the value of collateral, which directly determines entrepreneurs' borrowing capacity. Many scholars study the determinants of secondary market asset prices between ex ante borrowing capacity and ex post transaction prices. Eisfeldt and Rampini (2008) finds that the management layer plays a important role in capital reallocations under asymmetric information. Eisfeldt and Rampini's (2003) empirical work shows that such capital reallocations are pro-cyclical even though the gains to capital reallocation, as measured by the cross-sectional deviation of capital productivity, are countercyclical. Harford (2008) empirical work shows that firm owning plenty cash tends to acquire other firms. Anand and Singh (1997) finds that wholesale acquisitions is better than piecewise acquisitions during the recession and it is more effective to reallocate capital through the market mechanism than to integrate firm's internal capital. Maksimovic and Phillips (2001); Schoar (2002) work demonstrates that capital productivity differences between the seller and the acquirer, it is more effective for the acquirer to use the transfer capital than the seller to use it.

Using the variable investment model and asymmetric information external financing framework of Tirole (2006) and basing on Shleifer and Vishny (1992), this paper analyzes the optimal investment scale under the variable investment scale of decreasing returns to scale and the transfer prices of capital when firm is in distress. The main contribution of this paper is that financing model of decreasing returns to scale is brought into the model of constant returns to scale of Shleifer and Vishny (1992) and we get: First, under constant returns to scale and when firm is in distress, its transfer price of capital is the assured income of fixed units, different from which, under decreasing returns to scale, the transfer price is the optimal investment function of all the firms in the industry, different optimal investment scale will leads different transfer prices. Second, similarly, different from the optimal investment scale of constant returns to scale and other firms' independent of optimal investment scale in the industry, they are interactive to each other under decreasing returns to scale, the solution of optimal investment scale is a Nash equilibrium. Third, under variable investment scale of decreasing returns to scale, there is a critical value of firm' own capital, at both ends of which, the optimal investment scale of firm and others have different relationship.

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THE MODEL

We adopt the Variable-investment model, The basic assumptions are as follows:

- Participants: Two entrepreneurs and two outside investors. Where two entrepreneurs operating companies in the same industry and the two firms do not compete in the same product market
- There period: Date 0 represents ex enter period; date 1 represents intermediate period; date 2 represents ex post period
- At date 0, the entrepreneur i has a project requiring a variable investment, I_i where, $I_i \in [0, +\infty)$. The entrepreneur i initially has "assets" A_i and need to borrow I_i-A_i from investors (where, i = 1, 2).
- There are two types of firm's investment: "productive" and "unproductive". Before entrepreneurs financing, entrepreneurs can not be observed to the type of investment and at date 1 the type of investment can be observed. Suppose that a priori probability of the type of investment for participants subject to the following two points distribution:

Investment	Productive	Unproductive
Probability	x	1-x

- If both firms are productive, each manages its initial investment. Firm i's profit is either 0 R (I_i). Where $R'>0$, $R''<0$, $R'(0)>\infty$, $R'(\infty) = 0$
- If firm j is in distress, it sells its assets, which now have no internal use. We assume that potential buyers outside the industry do not have the knowledge to operate these assets. Only firm i (if it itself is not in distress) can buy it. where I = 1, 2, j = 1, 2, $i \neq j$
- Entrepreneur's moral hazard: The probability of success p is affected by the effort degree of the entrepreneur in the date 2, however the effort degree of the entrepreneur is unobservable. Behaving yields probability $p = p_H$ of success and no private benefit to the entrepreneur and misbehaving results in probability $p = p_L < p_H$ of success and private benefit $BI_i>0$. Let $\Delta p = p_H > p_L > 0$
- Under the conditions of the firm i acquire the firm j, the entrepreneur in firm i then manages I_i+I_2 units of assets and obtains private benefit 0 (if she behaves) or B (I_i+I_2) (if she does not). Firm i's profit is R (I_i+I_2) when the project is success
- There has been no initial contract that would specify the transfer price P in the case of distress. The transfer price of P is endogenous in period t = 1

Table 1: Give firm i's state, the conditional probabilities of the firm j

	Firm j is productive	Firm j is in distress
When firm i is productive	μ	1-μ
When firm j is in distress	1-v	v

- We assume that in the absence of adverse shock (x = 1), projects are viable only if the entrepreneur behaves, namely $p_H R(I) > I > p_L R(I) + BI$
- Let:

$$p_H R(I) < I + \frac{p_H BI}{\Delta p} \tag{1}$$

- The shocks affecting the demands for the two products may be correlated. We allow for an arbitrary level of correlation. The conditional probabilities (given firm i's state) that firm j is productive or in distress are stated in Table 1
- Since the firm j is productive is x, for consistency, we have:

$$x\mu+(1-x)(1-v) = x \Leftrightarrow x(1-x) = (1-x)(1-v) \tag{2}$$

- Lenders behave competitively in the sense that the loan, if any, makes zero profit
- The acquired firm's investors have full bargaining power
- Both the entrepreneur and the investors are risk neutral and the borrower entrepreneur is protected by limited liability
- Both the entrepreneur and the investors have not time preference; the riskless rate is taken to be 0

We summarize the timing in Fig. 1

OPTIMAL FINANCING CONTRACT AND EQUILIBRIUM ANALYSIS

Suppose that the financing contract between the entrepreneur i and investor i takes the following state-contingent form in the date t = 0:

$$\{I_i, (R_{bi}, R_{bi}+\delta R_{bi}, 0), (R(I_i)-R_{bi}, R(I_i+I_j-(R_{bi}+\delta R_{bi}), 0)\}$$

Where:

- The contract specifies that the optimal Investment Scale I_i
- Under the conditions of the firm i not acquire the firm j, the entrepreneur and the investor obtains, respectively R_{bi} and R (I_i)-R_b in the case of success
- Under the conditions of the firm i acquire the firm j, the investor and the entrepreneur obtains, respectively R (I_i+I_j)-R ($R_{bi}+\delta R_{bi}$) and $R_{bi}+\delta R_{bi}$ in the case of success

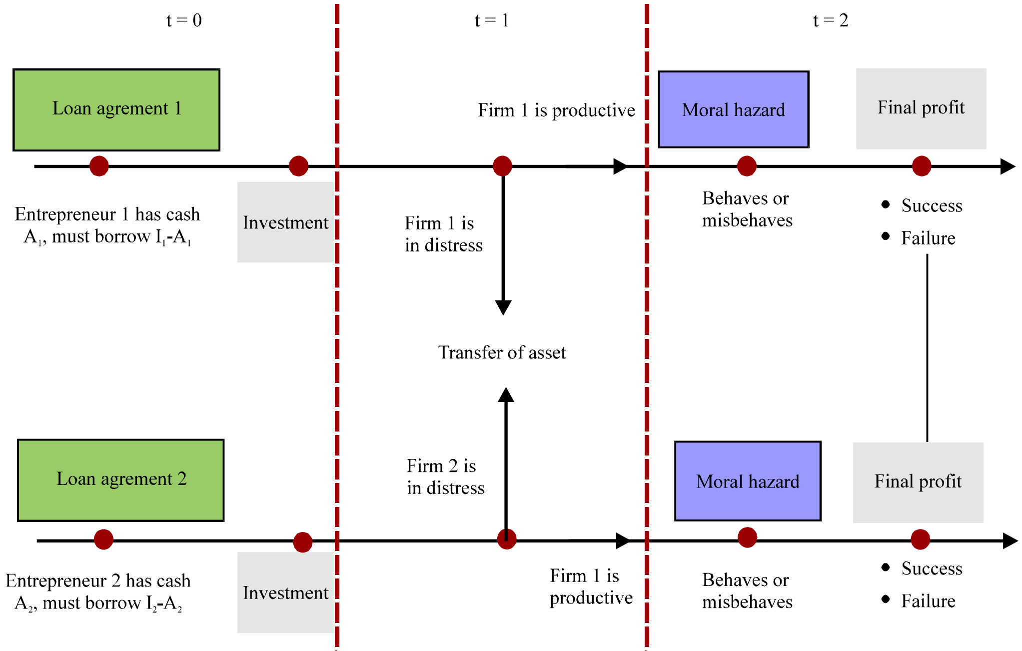

Fig. 1: Figure of the timing

- If firm i 's assets are unproductive or the project is failure in date t = 2, the entrepreneur and the investor obtains 0

Two remarks are in order here. First, the other parties (lender j and entrepreneur j, $j\neq i$) in equilibrium anticipate correctly the loan agreement, even though they do not observe it. Second, it can be checked that entrepreneur I and lender i cannot sign better contracts than those which will be considered here.

As the industry exists only two oligopolistic firms,if both firms are in distress (which has probability (1-x) v), the four participants (entrepreneurs, lenders) receive no ex post revenue. If neither is in distress (which has probability x), no sale occurs. So let us consider the more interesting case in which firm 1, say, is in distress and firm 2 is not. We then assume that lender 1 makes a take-it-or-leave-it offer to lender 2. Let P denote the per-unit price demanded by lender 1.

Proposition 1: In the case of firm 1 is unproductive and firm 2 is productive, the firm 1's resale price of the asset is:

$$P_1 = p_H\,[R\,(I_1\text{-}I_2)\text{-}R\,(I_2)]/I_1\text{-}p_H\,B/\Delta p$$

and M and A makes entrepreneur 2's rent increases by p_H BI/Δp. Similarly, in the case of firm 2 is unproductive and firm 1 is productive, the firm 2's resale price of the asset is:

$$P_2 = p_H\,[R\,(I_1\text{-}I_2)\text{-}R\,(I_1)]/I_2\text{-}p_H\,B/\Delta p$$

and M and A makes entrepreneur 1's rent increases by $p_H\,BI_2/\Delta p$.

Proof : First, Since firm 2 acquisition of firm 1 will increase in the scale of investment for firm 2 and therefore for the increased entrepreneur 2's private benefit from not behaving (now equal to B (I_1+I_2) instead of BI_2). So lender 2 must adjust entrepreneur 2's incentive scheme to account for the increased investment and make entrepreneur 2 prefer behaving in date 2. Under the condition of a purchase, lender 2 must raise entrepreneur 2's income in the case of success by δB_{b2}. Where δB_{b2} satisfy the following incentive compatibility constraint:

$$p_H\,(R_{b2}+\delta R_{b2})\geq p_L\,(R_{b2}+\delta R_{b2})+B\,(I_1+I_2)$$

The incentive compatibility constraint can be rewritten as:

$$\Delta p\,(R_{b2}+\delta R_{b2})\geq B\,(I_1+I_2) \tag{3}$$

In the Variable-investment model, the entrepreneur's incentive compatibility constraint is binding in the absence of a purchase $\Delta pR_{b2} = BI_2$.Which actually turns out to be optimal. Then Eq. 3 can be rewritten as $\delta R_{b2}\geq BI_1/\Delta p_2$. Thus can be inferred that:

$p_H\,(\delta R_{b2}) \geq [p_H B/\Delta p]I_1$

Because firm 1 has the bargaining power, lender 2 actually gains nothing from firm 1's distress. So there is:

$$p_H[R(I_1+I_2)-R(I_2)]-P_1 I_1 = p_H\frac{BI_1}{\Delta p}$$

Thus can be inferred that:

$$P_1 = \frac{p_H[R(I_1+I_2)-R(I_2)]}{I_1}-\frac{p_H B}{\Delta p}$$

Similarly, there is:

$$P_2 = \frac{p_H[R(I_1+I_2)-R(I_1)]}{I_2}-\frac{p_H B}{\Delta p}$$

Proposition 1 show that transfer price is related to firm 1 and firm 2's ex-investment. Firm 1 and firm2's ex-ante investment in a jointly determine the transfer price of firm of in distress. By the Eq. 1:

$$\frac{p_H R(I_i+I_j)}{I_i+I_j}-\frac{p_H B}{\Delta p}<1$$

We have:

$$\frac{p_H[R(I_i+I_j)-R(I_j)]}{I_i}-\frac{p_H B}{\Delta p}<1$$
$$\Leftrightarrow \frac{p_H R(I_i+I_j)}{I_i+I_j} > \frac{p_H[R(I_i+I_j)-R(I_j)]}{I_i}$$
$$\Leftrightarrow R(I_j)(I_i+I_j)-R(I_i+I_j)I_j \geq 0$$

Let F (x) = R (I_j (I_i+I_j)-R (I_i+I_j)I_j). We have F (0) = 0, F (x)$\geq$0.

So:

$$P_i = \frac{p_H[R(I_i+I_j)-R(I_j)]}{I_i}-\frac{p_H B}{\Delta p}<1$$

Proposition 2: Given the optimal investment I_j* of the entrepreneur j:

- If $A_i \geq \bar{A}_i$, the entrepreneur i 's optimal scale of investment I_i* satisfy the following expression:

$$xp_H\frac{\partial R(I_i^*)}{\partial I_i^*}+(1-x)(1-v)p_H\frac{\partial R(I_i^*+I_j^*)}{\partial I_i^*} = (1-x)(1-v)\frac{p_H B}{\Delta p}+1 \tag{4}$$

Where:

$$\bar{A}_i = [(1-(1-x)v)\frac{p_H B}{\Delta p}+1]I_i^* - xp_H R(I_i^*) - (1-x)(1-v)p_H[R(I_i^*+I_j^*)-R(I_i^*)]$$

- If $A_i < \bar{A}_i$, the entrepreneur i's optimal scale of investment I_i* satisfy the following expression:

$$I_i^* = \frac{xp_H R(I_i^*)+\beta+A_i}{[1-(1-x)v]p_H B/\Delta p+1} \tag{5}$$

Where:

$$\beta = (1-x)(1-v)p_H[R(I_i^*+I_j^*)-R(I_j^*)]$$

Proof: The capital market is perfectly competitive, which makes outside investors can only get zero-profit. Suppose entrepreneur i maximizes her net utility. Since the entrepreneur receives the full surplus associated with investment, so entrepreneur i 's expected net income can be written as:

$$U_{bi} = x\mu p_H R(I_i)+x(1-\mu)[p_H R(I_i) + \frac{p_H B}{\Delta p}I_j]+(1-x)(1-v)P_i I_i - I_i \tag{6}$$

Where, the first term in brackets in the expression of U_{bi} corresponds to the case in which distress sales are impossible. The second term represents the expected windfall gain from firm j's distress. The third term comes from lender i 's revenue from the sales of assets if only firm i is in distress. The firm i 's initial investment is I_i. Simplification of Eq. 6, the expression of U_{bi} can be rewritten as:

$$U_{bi} = xp_H R(I_i)+(1-x)(1-v)p_H[R(I_i+I_j) - R(I_j)]+x(1-\mu)\frac{p_H B}{\Delta p}I_j - [(1-x)(1-v)\frac{p_H B}{\Delta p}+1]I_i$$

Based on the above analysis, the entrepreneur i and her investors' optimal compensation contract is then the solution to the following maximization problem:

$$\begin{cases} \max\limits_{R_{bi},I_i} U_{bi} \\ \text{s.t (1)}\ \ x\mu p_H R_{bi} + x(1-\mu)p_H(R_{bi} + \delta R_{bi}) \\ \qquad \ge x\mu(p_L R_{bi} + BI_i) \\ \qquad + x(1-\mu)[p_L(R_{bi} + \delta R_{bi}) + B(I_i + I_j)] \\ \quad (2)\ \ x\mu p_H(R(I_i) - R_{bi}) + x(1-\mu)\cdot \\ \qquad \{p_H[R(I_i + I_j) - (R_{bi} + \delta R_{bi})] - P_j I_j\} \\ \qquad + (1-x)(1-v)P_i I_i \ge I_i - A_i \end{cases} \tag{7}$$

where, constraint (1) and constraint (2), respectively representative entrepreneur's incentive compatibility constraint and out investors' individual rationality constrain and:

$$\delta R_{bi} = \frac{BI_j}{\Delta p}$$

$$P_i = \frac{p_H[R(I_i + I_j) - R(I_j)]}{I_i} - \frac{p_H B}{\Delta p}$$

$$P_j = \frac{p_H[R(I_i + I_j) - R(I_i)]}{I_j} - \frac{p_H B}{\Delta p}$$

Simplification of the optimization model (7), we have:

$$\begin{cases} \max\limits_{R_{bi},I_i} U_{bi} \\ \text{s.t (1)}\quad p_H R_{bi} \ge p_L R_{bi} + BI_i \\ \quad (2)\ \ xp_H(R(I_i) - R_{bi}) + (1-x)(1-v)P_i I_i \\ \qquad \ge I_i - A_i \end{cases} \tag{8}$$

So, we have:

- When the conditions Eq. 8 are established, a necessary and sufficient condition for the entrepreneur I to receive financing is:

$$xp_H(R(I_i) - \frac{BI_i}{\Delta p}) + (1-x)(1-v)P_i I_i \ge I_i - A_i$$

By first-order conditions of the objective function, U_{bi} can be taken to the maximum when:

$$xp_H \frac{\partial R(I_i)}{\partial I_i} + (1-x)(1-v)[p_H \frac{\partial R(I_i + I_j^*)}{\partial I_i^*}] - (1-x)(1-v)\frac{p_H B}{\Delta p} + 1 = 0$$

So, when $A_i \ge \bar{A}_i$, the entrepreneur i 's optimal scale of investment I_i* satisfy the following expression:

$$xp_H \frac{\partial R(I_i^*)}{\partial I_i^*} + (1-x)(1-v)[p_H \frac{\partial R(I_i^* + I_j^*)}{\partial I_i^*}] = (1-x)(1-v)\frac{p_H B}{\Delta p} + 1$$

- When $A_i < \bar{A}_i$, the entrepreneur i 's optimal scale of investment I_i* is given by constraint (2) of Eq. 8 is binding. So we have:

$$I_i^* = \frac{xp_H R(I_i^*) + \beta + A_i}{[1-(1-x)v]p_H B/\Delta p + 1}$$

Where:

$$\beta = (1-x)(1-v)p_H[R(I_i^* + I_j^*) - R(I_j^*)]$$

Proposition2 only show that the entrepreneur i 's optimal scale of investment I_i* under given the optimal investment I_j* of the entrepreneur j. Similarly, given the optimal investment I_i* of the entrepreneur i , we can obtain the entrepreneur j 's optimal scale of investment I_i*. Consider the symmetric equilibrium $A_i = A_j = A$, we have:

- If $A_i \ge \bar{A}$, the entrepreneur i and entrepreneur j 's optimal scale of investment satisfy the following expression:

$$xp_H \frac{\partial R(I^*)}{\partial I^*} + (1-x)(1-v)[p_H \frac{\partial R(2I^*)}{\partial I^*}] = (1-x)(1-v)\frac{p_H B}{\Delta p} + 1$$

Where:

$$\bar{A} = [(1-(1-x)v)\frac{p_H B}{\Delta p} + 1]I^* - xp_H R(I^*) - (1-x)(1-v)p_H[R(2I^*) - R(I^*)]$$

- If $A < \bar{A}$, the entrepreneur i and entrepreneur j 's optimal scale of investment satisfy the following expression:

$$I^* = \frac{xp_H R(I^*) + \gamma + A}{[1-(1-x)v]p_H B/\Delta p + 1}$$

Where:

$$\gamma = (1\text{-}x)(1\text{-}v)\, p_H\, [R(2I^*) - R(I^*)]$$

RESULTS

First, If A_i is large enough, the entrepreneur i 's optimal scale of investment I_i (A_i) remains unchanged with the increase of A_i; If A_i is small enough, according to Eq. 5, I_i (A_i) is increasing in A_i.

Second, According to Eq. 4 and 5, when the entrepreneur j 's investment I_j* was given exogenously, the entrepreneur I 's investment I_i* will reduce with the I_j* increasing. Analogously, the transfer price a firm in distress can get for its assets is lower, the higher the level of existing investment by the other firm. That is, investment externalities could become negative.

Three, according to the expression of P_i, P_i is decreasing with the increase of I_j*. That is, The increased level of investment in other firm will reduce the resale price in distress in the case of decreasing returns to scale. Similarly, the lower of the I_i*, the higher the selling price in the event of in distress.

CONCLUSION

Consider the symmetry of conditional probability distribution, we assume that the benchmark parameters are R (I) = $4I^{1/2}$, p_H = 0.75, p_L = 0.25, x = 0.6, B = 0.1. Thus, we have $\bar{A}$ = 0.143. Table 2 shows that the numerical results about different parameters A_i and A_j.

Table 2: The numerical results about different parameters

A_i	A_j	P_i	P_j	I_i*	I_j*
0.05	0.2	1.08325	2.26189	0.00075	1.47900
0.07	0.2	1.08310	2.24053	0.00146	1.47900
0.09	0.2	1.08291	2.21925	0.00241	1.47900
0.11	0.2	1.08267	2.19860	0.00357	1.47900
0.13	0.2	1.08238	2.17837	0.00494	1.47900
0.15	0.2	0.87179	0.87179	1.47900	1.47900
0.17	0.2	0.87179	0.87179	1.47900	1.47900
0.19	0.2	0.87179	0.87179	1.47900	1.47900
0.21	0.2	0.87179	0.87179	1.47900	1.47900
0.23	0.2	0.87179	0.87179	1.47900	1.47900
0.05	0.1	1.42087	1.42970	0.61386	0.63070
0.07	0.1	1.40317	1.40831	0.63291	0.64309
0.09	0.1	1.38625	1.38791	0.65187	0.65529
0.11	0.1	1.37004	1.36842	0.67075	0.66730
0.13	0.1	1.35451	1.34979	0.68953	0.67914
0.15	0.1	2.20911	1.08279	1.47900	0.00295
0.17	0.1	2.20911	1.08279	1.47900	0.00295
0.19	0.1	2.20911	1.08279	1.47900	0.00295
0.21	0.1	2.20911	1.08279	1.47900	0.00295
0.23	0.1	2.20911	1.08279	1.47900	0.00295

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