Research on Economic Risk Control Mechanism of Large Enterprises based on Evolutionary Game Model

Qi Gao

School of International Trade and Economics, University of International Business and Economics, Beijing, China

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Abstract: Since knowledge loss risk is pervasive in inter-enterprise knowledge sharing, a method for research on economic risk control mechanism of large enterprises based on evolutionary game model is proposed in this Article to promote the effectiveness of research on economic risk control mechanism of large enterprises. For which, enterprise knowledge sharing action is divided into reciprocal action and opportunistic action, and dynamic game theory is used to analyze the dynamic evolution of both parties involved in knowledge sharing, to discuss the effect mechanism of risk attitude of parties in knowledge sharing on their knowledge sharing action, and the measures leading to their final choice of reciprocal action, then an examples is used to explain the conclusion. The results showed that: the risk attitude of parties in knowledge sharing have towards risks has impact on their knowledge sharing action; in order to choose suitable object for knowledge sharing, enterprises shall synthetically consider risk attitude of their own and of other enterprises; in order to promote knowledge sharing, both parties finally choose reciprocal action, and enterprises shall moderately increase the compensation claimed to the party of opportunistic action.

1. Introduction

In the era of knowledge-based economy, the promotion of core competence in enterprises not only relies on integration and update of own core knowledge, but also on consolidation and absorption of external critical knowledge, which making inter-enterprise knowledge sharing become more and more common. In order to maximize own interest, enterprises might take some opportunistic actions such as knowledge imitating and embezzling, leaving other enterprises in risk of knowledge loss. Such problem has been attached with great importance in academic circles. Hamel pointed out that, enterprises consisting of alliance partners who aimed at internalizing enterprise knowledge are facing the risk of knowledge loss. Hagedoorn believed that, some enterprises participate in cooperation and innovation only for embezzling or abusing knowledge of other enterprises; while mQuintas et al thought that, when acquiring knowledge, enterprise might face with risk of core knowledge exposure caused by inter-enterprise knowledge transfer. Fitzgerald confirmed that, enterprise software development outsourcing contains the risk of knowledge theft.

However, the significance of risk attitude of enterprises in inter-enterprise knowledge sharing with pervasive knowledge loss risk has not been valued. Therefore, in this Article, starting from the view of risk attitude of enterprises, dynamic game theory is used to study the effect mechanism of risk attitude of parties in knowledge sharing on their knowledge sharing action when such parties are facing with the risk of knowledge loss caused by the party of opportunistic action, to choose knowledge sharing objects for enterprises with different risk attitudes and provide reference for enterprises to promote sincere cooperation, and to prevent and control knowledge loss risk.

2. Creation of expected return matrix

2.1 Basic assumptions

From the view of actual venture capital, there are 3 moments for venture capitalists to sign a contract to gain returns. At Moment 1, venture entrepreneurs provide initial contract to venture capital-

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ists, which, once accepted by venture capitalists, will be fed into capital I; if not, will not be fed into the same. Meanwhile, venture capitalists offer supervision and management services at cost of C_v; between Moment 1 and 2, venture enterprises have two possible natural operation status, ϕ and $\phi \in \{g, b\}$, in which ϕ_g is the good state of natural operation and ϕ_b is the poor one. At Moment 2, according to the project signal ϕ_g or ϕ_b observed, venture capitalists will negotiate on whether to re-allocate the control rights. At Moment 3, enterprises have returns, while both venture capitalists and venture entrepreneurs achieve returns. The structure of venture capital time sequence is shown in Figure 1.

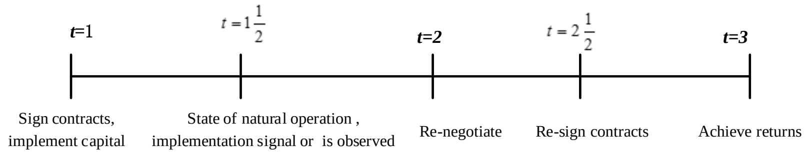

Fig. 1. Structure of venture capital time sequence

Combining with related Records and the structure of venture capital time sequence, based on research contents, following assumptions are made for allocation of control rights on venture enterprises by venture capitalists and venture entrepreneurs:

(1) There are 2 game participants with limited rationality in operation of venture enterprises—the group of venture capitalists and venture entrepreneurs, both of which repeat learning and gaming on choice of strategies.

(2) There are 3 ways for allocation of control rights on venture enterprises, unilateral control, camera control and joint control. In which unilateral control means the game player wholly owns control rights on venture enterprises; camera control means venture entrepreneurs own all control rights first, followed by re-allocation of the same as determined by the enterprise operating signal observed. At meanwhile, for choice of financial instruments, venture capitalists can choose convertible bonds, and not convert it if the enterprise natural operating signal is $\phi_b \left(\phi_b \in [0, 0.5]\right)$ and still implement bond investment; if the enterprise natural operating signal is $\phi_g \left(\phi_g \in [0.5, 1]\right)$, convert and implement equity investment. Joint control means both venture capitalists and venture entrepreneurs own proportional control rights first, and adjust such proportion according to development conditions of the enterprise, to control the enterprise jointly. Under method of unilateral control and joint control, venture capitalists implement equity investment both.

2.2 Expected return matrix

We assume that a venture entrepreneur holds a new project requiring investment of K, its own funds is A, and $A < K$. A venture capitalist invests the fund I, and $I = A - K$; at meanwhile, venture capitalist offers supervision and management services at cost of C_v. The probability of project success is measured to be $P_H \left(P_H \in [0,1]\right)$ after statistical analysis, and the probability of project failure is $P_L \left(P_L \in [0,1]\right)$, the probability of project success is affected by the degree of venture entrepreneur efforts e positively, while probability of project failure is affected by the degree of venture entrepreneur efforts e negatively. The return is $\pi \left(\pi > 0\right)$ in case of project success, and 0 in case of failure. But, since venture capitalist is entitled to priority in claiming residual value of project in investment, in order to simplify the calculation, we assume in this Article that the residual value T in case of project failure is solely owned by venture capitalist, and $T < I$. In case of project success, the remaining claiming rights on project returns entitled to venture capitalist is $\omega, \omega \in [0,1]$, so project returns available to be allocated by venture capitalist is $\omega\pi$, while by venture entrepreneur, it is $\omega, \omega \in [0,1]$. If venture capitalist uses convertible bonds, before conversion and in case of project success, the project returns available to be allocated by venture capitalist is R, while by venture entrepreneur, it is $\pi - R$. Generally, venture capitalist implements equity investment to maximize its interest, and the return on equity obtained is expected to be higher than fixed income from bond investment, so $\omega\pi > R$ is considered. Whether to implement the convertible bonds is determined by the natural state of venture enterprises observed. Implementation is made if in good state and not if in poor state.

3. Evolutionary game model based on front-end comparison

3.1 Optimal performance in specific case

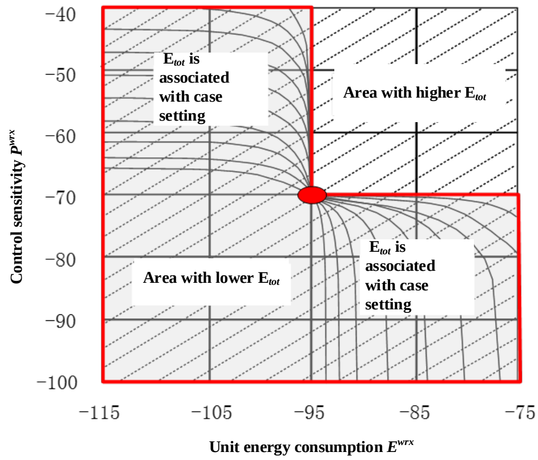

Fig. 2. Selection of single risk control operating point

Figure 2 shows the several operating points selected, Table 1 gives economic risk control data on such operating points. Replace E^{wrx} in Formula (6) with each risk control indicator at front end, we assume that, as compared with risk control, the risk control indicators of large enterprises are ignored. Research in this Article aims to find economic risk controls that can obtain optimal performance of risk control energy in existing solutions. Graphical method is used and the calculation consists of two steps:

Step 1: Calculate case parameter Γ according to Formula (8), draw corresponding line of balance in given parameter and case.

Step 2: Start along lower left corner of the line of balance, until to the first risk control, which can provide minimum indicator parameter for specific risk control.

In the two sample cases mentioned above, illustrate how to choose optimal economic risks in risk control of large enterprises by examples, with corresponding data of Figure shown in Table 1. Firstly, add the line of balance corresponding to each case in Figure 2 (solid and dotted line).

Search for operation of economic risk control at (red) point 2.4 (nearest to point 2.4) starting from lower left side, obtain operating point[10]; while for Case 2, search for operation of economic risk control at (blue) point 780-950 (nearest to point 780-950) starting from lower left side, obtain operating point [14].

Table 1 Economic risk control case design in risk control

Reference Operating Points	Sensibility	Control Indicators	Control Rate	E^{wrx}
[15] Operating Point [15]	-87	45.5	50	-55.4
[7] Operating Point [7]	-50	65	40	-67.9
[8] Operating Point [8]	-72	52	100	-32.7
[10] Operating Point [10]	-56	7.4	100	-10.3
[11] Operating Point [11]	-53	19	50	-42.8
[12] Operating Point [12]	-65	10	100	-30.1
[14] Operating Point [14]	-45	0.161	12.5	-15.3

3.2 Optimal front end selection scheme

The form of optimal indicator parameter operating line shown in Figure 1-2 is level and smooth, mainly because specific location for risk control of large enterprise and other information is not considered, making operating line impossible to have nodes for risk control, results are that risk control fails, or the selected group of nodes is not the optimal when moving operating line evenly for risk control.

For this purpose, in order to simplify optimal front end selecting method, the range ($(-\infty,\infty)$) of variation Γ is used to choose optimal economic risk control. Two cases are chosen for illustration: (1) selection of common single risk control operating point, as shown in Figure 2, (2) selection of multiple risk control operating points, as shown in Figure 3.

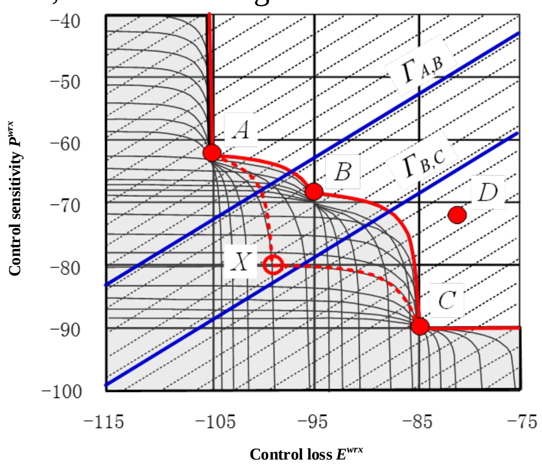

Fig. 3. Selection of multiple risk control operating point

3.3 Algorithm calculation steps

Algorithm steps for risk control node selection mechanism based on front end priority as mentioned above are shown in pseudocode.

Pseudocode: Comparison of Risk Control Mechanism with Front End Priority

Input: Worst control loss $L_{p,\max}$, network size N, control interval $(1/\lambda)$, control delay demand average value D^{req}, WB risk control indicator W, control efficiency factor η, and WB data length Z_{wb}.

Output: Simulation front end for risk control of large enterprises

1. for i=1:N do
2. $W=(1/\lambda)/2KZ_{wb}T_b$ (2)
3. $K=(1/\lambda)/2D^{req}$ (3)
4. $P^{tx}=P_s^{wrx}L_{p,\max}/\eta$ (4)
5. $E^{wrx}=P^{wrx}T_b$ (5)
6. $E_{tot}=\frac{D^{req}L_{p,\max}}{\eta Z_{wb}}P_s^{wrx}+N\frac{1/\lambda}{2D^{req}}E^{wrx}$ (6)
7. endfor
8. Use the parameter values to obtain total control loss/risk control horizontal curve in Figure 1
9. $\Gamma=N+\eta+Z_{wb}+(1/\lambda)-2D^{req}-3-L_{p,\max}[dB]$ (8)

$\Gamma=N+\eta+Z_{wb}+(1/\lambda)-2D^{req}-3-L_{p,\max}[dB]$ (formula 8)

10. $P_s^{wrx}=E^{wrx}+\Gamma[dB]$

$P_s^{wrx}=E^{wrx}+\Gamma[dB]$ (formula 7, for calculation of line of balance)

11. Draw line of balance, search from left lower side to right upper side along the line of balance
12. Collect the first risk control operating points on all lines of balance
13. Select optimal risk control operating points for different boundary area
14. Control all optimal risk control operating points to obtain the optimal simulation front end

The network size involved in above algorithms is N, we can see from pseudocode steps that, during above process, only single cycle execution structure is contained, thus the calculation complexity is $\mathcal{O}(N)$.

4. Conclusions

Risk attitude by both parties in knowledge sharing affects their knowledge sharing action: if there is no party of risk preference but of risk aversion, both parties finally choose reciprocal action; if there is no party of risk aversion but of risk preference, both parties finally choose opportunistic action; if both parties are in risk neutral, they might finally choose opportunistic action, or reciprocal action, and if the risk attitude of both parties approaches to each other, the probability of choosing reciprocal action is higher; if the parties are in risk aversion and preference respectively, they finally have no stable knowledge sharing action.

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