UNLIMITED LIABILITY OF JOINT VENTURES

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ABSTRACT

Many researchers view joint ventures as a panacea for winning work and reducing risk. They argue that the advantages of forming joint ventures are numerous in an overseas context, with improved technology transfer and potential risk reducing being two of the most important aspects to consider. Many others also argued that the motivations behind international construction joint ventures formation include: market access, technology transfer, risk sharing, and conforming to host government policies. Almost all the literatures about motivations of joint ventures viewed risk-sharing as an important motivation. There are some researchers tried to find whether joint ventures can decrease the risks of each partner. Johnson et al. (2000[8]) tested the motivations of joint ventures by a gross sample of 191 joint ventures, of which 85 (45%) are horizontal ventures and 106 (55%) are vertical ventures, and 345 simple contracts. They found no evidence supporting a risk-sharing motive for joint ventures. They tested this motive by examining the differences in the level of supplier risk (a volatility measure defined as the standard deviation of first differences in operating income for the four years preceding the sample year, scaled by mean assets for that period) and diversification (firms in fewer lines of business are likely less diversified and thus might want to share investment risks with another party) across joint ventures and simple contracts form. They also found horizontal joint ventures elicit wealth gains that are positively correlated across the partners. In vertical joint ventures, only suppliers experience positive excess returns, and buyer's and supplier's wealth changes are uncorrelated. Karen et al. (2006[3]) test the risk sharing motivation of joint ventures and examined the risk and consequent wealth effects of joint venture activity for U.S. public firms by using a sample of 271 joint ventures events between 1989 and 1997. They found that a statistically significant 96% of the sample does experience a change in risk in response to engaging in joint venture activity and they also found that firms which engaged in joint ventures appear to decreases in systematic risk, and increases private risk. In their research they use the same definition of the system risks and private risks as the one Aharony et al. (1980[1]), and Unal (1989[16]) defined. System risks and private risks are denoted by the variance of returns of securities of the joint venture partners and the variance of the market portfolio. There is little literature which is theoretical research on the topic whether joint ventures can decrease the partner's *risk, or under which conditions partners set up a joint venture to decrease their risks or to share risks. In this paper, the problem that under which conditions partners will choose joint ventures to undertake a project when there is a background risk and project risks or if a contractor wants to find a cooperator to set up a joint venture for a project, which kinds of companies are suitable to cooperate from the viewpoint of risk sharing is analyzed. It is different from the one Hennart (1997[7]), they only did empirical analysis the choice made by Japanese investors into the United States between full acquisitions of U.S. firms and joint ventures between Japanese and American firms. They did not build any model to analyze the choice problem. In this paper, the problem if there are project risks and a background risk, under which conditions contractors can set up a joint venture for a project is analyzed.*

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1. RISKS IN CONSTRUCTION JOINT VENTURES

It is widely accepted that construction activity is particularly subject to more risks than other business activities because of its complexity. A wide range of risks related to construction business have been identified. Shen classified the risks as technical risks, management risks, market risks, legal risks, financial risk and political risks (1997[14]). In this paper, a different classification of risks in construction activities is given. The risks are called as: background risks (or system risks) and project risks.

2. DEFINITION OF BACKGROUND RISK

About background risk, there is no clear definition. Many definitions can be found in previous literatures. For example, background risk is an exogenous risk cannot be insured (Gollier, 2001[5]) and non-tradable (Franke et al., 2006[6]). Background risk which could be associated with labor income or holdings of non-marketable assets is noninsurable (Franke et al., 1998[4]). Arrondel et al. (2002[2]) defined background risk as an uninsurable component of individual income, which is exogenous given. Background risk is therefore the type of risks which cannot be controlled by the party who faces it, and cannot be insured or hedged. The existing of background risks can change the behaviors of the decision maker. Luciano et al. (2001[10]) showed that if loadings are not too high, positively correlated background risk increases insurance with respect to the case in which no background risk exists. Negatively correlated background risk decreases it, since in this case background risk is itself a hedge, even though the effect depends on the exact relationship between the two risks. It can lead to no insurance at all. The development of portfolio choice theory with incomplete markets has forced researchers to take into account the statistical properties of the uninsurable component of individuals' income risk in explaining the demand for risky assets (Arrondel et al., 2002[2]). The existing of the background risk will change the behaviors of the relevant parties. The background risk is defined as the type of risks which cannot be controlled by the party who faces them, and cannot be insured or hedged. In the construction industry, the background risk can be looked as the external risk which is defined by Li et al. (1999[9]). These risks may include risks such as the fluctuations of the price of the materials and the exchange rate of currency, the changes of the country's policy about joint ventures, conflicts due to cultural differences and so on. The risks that should be undertaken by the joint venture are defined in the main contract, which is the contract between the owner and the joint venture. For simplifications, the rules that what risks should be undertaken by the owner and what risks should be undertaken by the joint venture are assumed as some kind of some international rules, such as FIDIC. Under this condition, the background risks are the risks which should be undertaken but cannot be controlled or be insured or hedged by the joint venture partners. When one partner of the joint venture undertakes the whole project, the background risks means that the risks should be undertaken by him according to the main contract. All the background risks cannot be controlled, be insured or hedged. For the same project the background risk is assumed as the same whether it is undertaken by one contractor or by a joint venture company. For simplification, here the background risk is assumed to be independent with other risks of the project and it affects the whole project. Project risks are defined as all the risks which are specific to the given project, at the same time they should be undertaken by the partners of the joint venture according to the main contract between the joint venture and the client. Project risks can be viewed as the risks which is defined by Li et al. (1999[9]) as project-specific risks. But here the risks which are related the joint venture partners are excluded, such as the one defined as poor project relationship in Li et al. (1999[9]). The project risks are defined as the risks everyone has to face with as long as he undertakes the project.

3. ASSUMPTIONS OF THE RISKS

The problem that when there are two kinds of risks: project risks and a background risk, under which conditions partners prefer to set up a joint venture for a project is analyzed. The two companies set up a joint venture to finish one project and both companies are risk-averse. To focus the effect of the background risk on the choice of cooperation means under different conditions, the project can be divided into two subprojects clearly. Both partners undertake their project risks which belong to their subprojects. This kind of joint ventures are called as separated type joint ventures. This kind of joint ventures can provide efficient incentive to the partners to deal with their risks. Because the partners choose their effort levels by maximizing their certainty equivalent values of the project benefit. Here the partner's certainty equivalent values of the project benefit are defined as the value of the project valued by this partner who is risk-averse. Then they will choose their optimal effort levels to maximize their certainty equivalent values.

(1) Background Risk

There is a background risk which is denoted by a stochastic variable R_0, the loss of the risk can be denoted by a normal distribution (N [φ_0, σ^2_0]). It affects the whole project. Here the influence of the background risk on the project is assumed depend on how many percent of the sum of the main contract that each subproject accounts for. In the joint venture, partners have to undertake the same share of the background risk with the share of the subprojects. The distribution of the background risk is assumed to be common knowledge for both partners. The correlation coefficient between the project risk and the background risk is denoted by ρ_{01} and ρ_{02}. For simplification, $\rho_{01} = \rho_{02} = \rho$. That means the background risk affects the whole project.

(2) Project Risk

The whole project can be divided into two subprojects: subproject 1 and subproject 2. $I_1 = \gamma I$ and $I_2 = (1-\gamma)I$ mean the benefits of each subproject, where I denotes the benefit (the sum of the contract when all the conditions realized as normal, that is to say there is no risk occurs) of the whole project, is defined by the subproject or their participant share which is exogenously defined. Each company undertakes one subproject, in the joint venture partner A undertakes subproject 1 and partner B undertakes subproject 2. Each subproject has only one project risk, the project risk of subproject 1 is denoted by R1, and the project risk of subproject 2 is denoted by R2. The project risks of the two subprojects are independent.

The cost of the subproject risk $R1 = C^A_1 + \varepsilon_1$, here $\varepsilon_1 \sim N[\varphi_1, \sigma^2_1]$ is a normal distribution. C^A_1 denotes the cost undertaken by partner A when he undertakes subproject risk R1. σ^2_1 denotes the variance of the risk loss. Similarly, The cost of the subproject risk $R2 = C^B_2 + \varepsilon_2$, here $\varepsilon_2 \sim N[\varphi_2, \sigma^2_2]$ is a normal distribution. C^B_2 denotes the cost undertaken by partner B when he undertakes the subproject risk R2. σ^2_2 denotes the variance of the risk loss.

3.1 The Model of Joint Venture

3.1.1 The Model of Joint Venture with a Background Risk

In this paper, both partners undertake unlimited liabilities and they are all risk averse. Their certainty equivalent values of the subprojects can be defined as a function of the expected values of benefit of their subproject and variances of benefit of their subproject. Here the certainty equivalent value of the subproject of the partner j can be defined as $Q_j = E - k_j\sigma^2$ [1], E is the expected value of the benefits gotten by partner j, σ^2 is the variance of benefits. k_j denotes the degree of risk-aversion of partner j, which satisfies $k_j > 0$. When the partners decided to finish the project by setting up a joint venture, and there exist these two types of risks: project risks and background risks. The certainty equivalent values of the subprojects of the two partners Q^{JH}_A and Q^{JH}_B in the joint venture can be expressed as:

$$Q_A^{JH} = \gamma I - \gamma\phi_0 - C_1^A - \phi_1 - k_A(\sigma_1^2 + \gamma^2\sigma_0^2 + 2\gamma\rho\sigma_1\sigma_0) \quad (3.1)$$

$$Q_B^{JH} = (1-\gamma)I - (1-\gamma)\phi_0 - C_2^B - \phi_2 - k_B[\sigma_2^2 + (1-\gamma)^2\sigma_0^2 + 2(1-\gamma)\rho\sigma_2\sigma_0] \quad (3.2)$$

3.1.2 The Model of Joint Venture without Background Risk

All the conditions are same with the conditions of joint venture model when there is a background risk. Under the condition that there is no background risk, the certainty equivalent values of the subprojects of the partners $Q^{JN}{}_A$ and $Q^{JN}{}_B$ in the joint venture can be expressed as:

$$Q_A^{JN} = \gamma I - C_1^A - \phi_1 - k_A\sigma_1^2 \quad (3.3)$$

$$Q_B^{JN} = (1-\gamma)I - C_2^B - \phi_2 - k_B\sigma_2^2 \quad (3.4)$$

The effect of the background risk on the certainty equivalent values of the subprojects of partners can be clarified by comparing the two certainty equivalent values of the subprojects under the two conditions. Here Q_{AJV} , Q_{BJV} are used to denote the difference between these two certainty equivalent values.

$$Q_{AJV} = Q_A^{JN} - Q_A^{JH} = \gamma\phi_0 + k_A(\gamma^2\sigma_0^2 + 2\gamma\rho\sigma_1\sigma_0) \quad (3.5a)$$

$$Q_{BJV} = Q_B^{JN} - Q_B^{JH} = (1-\gamma)\phi_0 + k_B[(1-\gamma)^2\sigma_0^2 + 2(1-\gamma)\rho\sigma_2\sigma_0] \quad (3.5b)$$

3.2 One Partner Model

3.2.1 One Partner with a Background Risk

The whole project can be divided into the same two subprojects: subproject 1 and subproject 2. Each subproject has only one project risk, the project risk of subproject 1 is denoted by R1, and the project risk of subproject 2 is denoted by R2. The project risks of the two subprojects are independent. $I_1 = \gamma$ I and $I_2 = (1-\gamma)$I mean the benefits of each subproject respectively, where I denotes the benefit (the sum of the contract when all the conditions realized as normal, that is to say there is no risk occurs) of the whole project, is defined by the subproject or the participant share of the partner which is exogenously defined. The cost of the subproject risk R1 is denoted by $C^j{}_1+\varepsilon_1$, here $\varepsilon_1 \sim N [\varphi_1, \sigma^2{}_1]$ is a normal distribution. C_j^1 denotes the cost of dealing with the subproject risk R1. $\sigma^2{}_1$ denotes the variance of the risk loss for partner j. Similarly, the cost of the subproject risk R2 is denoted by $C_j^2 + \varepsilon_2$, here $\varepsilon_2 \sim$

N [φ_2, σ^2_2] is a normal distribution. C_j^2 denotes the cost of dealing with the subproject risk R2 for partner j. σ^2_2 denotes the variance of the risk loss. The whole project is undertaken by partners respectively. Under this condition, he certainty equivalent values of the subprojects of partner A and B denoted by Q^{wh}_A and Q^{wh}_B can be expressed as:

$$Q_A^{wh} = I - \phi_0 - C_1^A - \phi_1 - C_2^A - \phi_2 - k_A(\sigma_0^2 + \sigma_1^2 + \sigma_2^2 + 2\rho\sigma_1\sigma_0 + 2\rho\sigma_2\sigma_0) \quad (3.6)$$

$$Q_B^{wh} = I - \phi_0 - C_1^B - \phi_1 - C_2^B - \phi_2 - k_B(\sigma_0^2 + \sigma_1^2 + \sigma_2^2 + 2\rho\sigma_1\sigma_0 + 2\rho\sigma_2\sigma_0) \quad (3.7)$$

Both partners are assumed can not undertake the whole project when there is a background risk. That is to say when they undertake the whole project their certainty equivalent values would be smaller than their participation values (the participation values are defined as the amount that if the certainty equivalent values of the projects or subprojects valued by the partners is greater than it the partners agree to take part in the joint venture or to undertake the project), $Q^{wh}_A < 0$ and $Q^{wh}_B < 0$. When there is a background risk, partners have to cooperate with others to undertake the project.

3.2.2 One Partner without Background Risks

The certainty equivalent values of the partners' when they undertake the whole project under the condition there is no background risk in the same way can be calculated. When there is no background risks, partners can undertake the project themselves or cooperating with others. $Q^{wn}_A > 0$ and $Q^{wn}_B > 0$ are used to denote their certainty equivalent values.

$$Q_A^{wn} = I - C_1^A - \phi_1 - C_2^A - \phi_2 - k_A(\sigma_1^2 + \sigma_2^2) \quad (3.8)$$

$$Q_B^{wn} = I - C_1^B - \phi_1 - C_2^B - \phi_2 - k_B(\sigma_1^2 + \sigma_2^2) \quad (3.9)$$

3.3 Comparing the Two Styles

3.3.1 When there is a Background Risk

When there is a background risk, under which conditions partners will choose to set up a joint venture. Here partner A is assumed to have the right to make decision whether set up a joint venture or not. Partner A will make the decision to set up a joint venture when his certainty equivalent values of the subproject in the joint venture are greater than his certainty equivalent value of the whole project. That is to say, $Q^{JH}_A > Q^{wh}_A$ and $Q^{JH}_A > 0$.

For both partners if their certainty equivalent values of the subprojects are greater than 0 (the participation values of the two partners are assumed to be 0) they will take part in the joint venture. Under the condition $Q^{JH}_B > 0$ partner B will take part in the joint venture. The condition under which both partners will prefer to set up a joint venture to undertake the project rather than to undertake the whole project respectively can be clarified in the following way.

Partner A will prefer to choose to set up a joint venture to undertake the project when his certainty equivalent value of the subproject in the joint venture is greater than his certainty equivalent value of the whole project. And at the same time his certainty equivalent value in the joint venture is greater than his reservation value.

$Q_1^A = \gamma I - C_1^A - \phi_1 - k_A(\sigma_1^2 + \gamma^2\sigma_0^2 + 2\rho\gamma\sigma_0\sigma_1)$ and $Q_2^A = (1-\gamma)I - C_2^A - \phi_2 - k_A[\sigma_2^2 + (1-\gamma)^2\sigma_0^2 + 2\rho(1-\gamma)\sigma_2\sigma_0]$

are used to denote the certainty equivalent value of partner A, when he undertakes subproject 1 and subproject 2 in the joint venture respectively, or the certainty equivalent values of the two partners who have the same degree of risk-aversion and same capacity to deal with the same risk. When the background risk is positive related with the project risks or the two kinds of risks are independent with each other, the sum of the certainty equivalent values of the partners can be found to be greater than the certainty equivalent value that the partner can get when he undertakes the whole project. This is also called risk spread effect. The formula (3.6) can be rewritten as:

$$\begin{aligned} Q_A^{wh} &= Q_1^A + Q_2^A - k_A[2\gamma(1-\gamma)\sigma_0^2 + 2(1-\gamma)\rho\sigma_1\sigma_0 + 2\gamma\rho\sigma_2\sigma_0] \\ &= Q_A^{JH} + Q_2^A - k_A[2\gamma(1-\gamma)\sigma_0^2 + 2(1-\gamma)\rho\sigma_1\sigma_0 + 2\gamma\rho\sigma_2\sigma_0] \qquad (3.10) \end{aligned}$$

Because for each partner in the joint venture, he only needs to undertake part of the background risk. The background risk is shared between the partners. From the formula (3.10) the following conclusion can be obtained: When the background risk is positive related with the project risks or the two kinds of risks are independent with each other, if there are two same partners (have same capacities to deal with the same risks and same degrees of risk-aversion) the sum of the certainty equivalent values of these two partners is greater than the certainty equivalent value of partner A when he undertakes the whole project. When there is a background risk, partners can improve their certainty equivalent values by setting up a joint venture.

Partner A will take part in the joint venture if his certainty equivalent value the subproject in the joint venture is greater than his reservation value. That is to say

$Q_A^{JH} - Q_A^{wh} > 0.$

$$Q_A^{JH} - Q_A^{wh} = (\gamma - 1)I - (\gamma - 1)\phi_0 + C_2^A + \phi_2 + k_A[(1-\gamma^2)\sigma_0^2 + \sigma_2^2 + 2(1-\gamma)\rho\sigma_0\sigma_1 + 2\rho\sigma_2\sigma_0] \qquad (3.11)$$

From the formula (3.11), the following conclusion can be obtained: if partner A can choose whether to set up a joint venture or not, it is more possible for partner A to choose to set up a joint venture when the background risk is positive related to the project risks; When the background risk is negative related with the project risks, partner A may prefer to undertake the whole project. Under this condition if he undertakes the whole project, he can get the risk hedge effect by undertaking the whole project. The negative correlation between the background risk and the project risks acts as a natural hedge against uncertainty, setting up a joint venture will remove or decrease this hedge effect. When the background risk is independent with the project risks, the existing of the background risk will make the difference between the two certainty equivalent values greater. Partner A will choose to set up a joint venture, only when he can get at least the same certainty equivalent value by taking part in the joint venture as the one he can get
by undertaking the whole project. At same time he can get at least his reservation value when he takes part in the joint venture.

$$Q_A^{JH} - Q_A^{wh} > 0 \qquad (3.12)$$

$$Q_A^{JH} > 0 \qquad (3.13)$$

From the formula (3.6) and (3.10)

$$Q_2^A = (1-\gamma)I - (1-\gamma)\phi_0 - C_2^A - \phi_2 - k_A[\sigma_2^2 + (1-\gamma)^2\sigma_0^2 + 2(1-\gamma)\rho\sigma_2\sigma_0] < k_A[2\gamma(1-\gamma)\sigma_0^2 + 2(1-\gamma)\rho\sigma_1\sigma_0 - 2\gamma\rho\sigma_2\sigma_0] \qquad (3.14)$$

The formula (3.2) can be rewritten as:

$$(1-\gamma)I - (1-\gamma)\phi_0 - \phi_2 = Q_B^{JH} + C_2^B + k_B[\sigma_2^2 + (1-\gamma)^2\sigma_0^2 + 2(1-\gamma)\rho\sigma_0\sigma_2] \qquad (3.15)$$

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ubstituting (3.15) into (3.14)

$$Q_B^{JH} \le -C_2^B - k_B[\sigma_2^2 + (1-\gamma)^2\sigma_0^2 + 2\rho(1-\gamma)\sigma_0\sigma_2] + C_2^A + k_A[\sigma_2^2 + (1-\gamma^2)\sigma_0^2 + 2\rho(1-\gamma)\sigma_0\sigma_1 + 2\rho\sigma_2\sigma_0(1-2\gamma)] \qquad (3.16)$$

The inequality (3.16) means partner B's certainty equivalent value in the joint venture would not be greater than the sum of the two differences, one is the difference of partner A certainty equivalent values in the joint venture and his certainty equivalent value when he undertakes the whole project, the other is the difference between the certainty equivalent values of the two partners for project risk R2.

From (3.1) and (3.2)

$$Q_A^{JH} = \frac{\gamma}{1-\gamma}\{Q_B^{JH} + C_2^B + \phi_2] + k_B[\sigma_2^2 + (1-\gamma)^2\sigma_0^2 + 2\rho(1-\gamma)\sigma_0\sigma_2]\} \\ - C_1^A - \phi_1 - k_A[\sigma_1^2 + \gamma^2\sigma_0^2 + 2\rho\gamma\sigma_0\sigma_1] > 0 \quad (3.17)$$

Because of the inequality (3.11)

$$Q_B^{JH} \geq \frac{(1-\gamma)}{\gamma}[C_1^A + \phi_1 + k_A(\sigma_1^2 + \gamma^2\sigma_0^2 + 2\gamma\rho\sigma_0\sigma_1)] \\ - [C_2^B + \phi_2 + k_B[\sigma_2^2 + (1-\gamma)^2\sigma_0^2 + 2\rho(1-\gamma)\sigma_0\sigma_2] \quad (3.18)$$

The part in the first square bracket of the (3.18) means partner A's certainty equivalent value of risk R1. $\frac{(1-\gamma)}{\gamma}[C_1^A + \phi_1 + k_A(\sigma_1^2 + \gamma^2\sigma_0^2 + 2\gamma\rho\sigma_0\sigma_1)]$ Means the partner A's certainty equivalent value of risk R2 expressed by his certainty equivalent value of risk R1. This means when partner A undertakes the risk R2 he can get the same level of certainty equivalent value as the one he can get from undertaking subproject 1.

$$\gamma(I-\phi_0) - D_1^A = \gamma Q \quad (3.19)$$

$$(1-\gamma)(I-\phi_0) - D_2^A = (1-\gamma)Q \quad (3.20)$$

The relation between partner A's certainty equivalent values when he undertakes the two risks can be expressed as $D_1^A = \frac{\gamma}{(1-\gamma)}D_2^A$.

For partner A, to make sure he can get the same level of certainty equivalent values, his certainty equivalent values for undertaking the risks should satisfied $D_2^A = \frac{(1-\gamma)}{\gamma}D_1^A$.

Partner A's certainty equivalent value of risk R2 can also be written as $C_2^A + \phi_2 + k_A[\sigma_2^2 + (1-\gamma)^2\sigma_0^2 + 2(1-\gamma)\rho\sigma_0\sigma_2]$. That means if partner A makes a decision that he will take part in the joint venture, and he will undertake subproject 2 in the joint venture, his certainty equivalent value of subproject 2 should be at least as great as his certainty equivalent value of risk R2. The participation values of the two partners are both 0.

When partner B's certainty equivalent value of subproject 2 is less than partner A's certainty equivalent value of subproject 2, partner A's participation condition for undertaking subproject 2 can not be satisfied while partner B's participation condition can be satisfied. From the inequalities (3.16) and (3.18) the partner B's certainty equivalent value of risk R2 is in the intervals as:

$$\begin{aligned} - C_2^B - k_B[\sigma_2^2 + (1-\gamma)^2\sigma_0^2 + 2\rho(1-\gamma)\sigma_0\sigma_2] + C_2^A \\ + k_A[\sigma_2^2 + (1-\gamma^2)\sigma_0^2 + 2\rho(1-\gamma)\sigma_0\sigma_1 + 2\rho\sigma_2\sigma_0(1-2\gamma)] \\ \geq Q_B^{JH} \geq C_2^A + k_A[\sigma_2^2 + \sigma_0^2(1-\gamma)^2 + 2(1-\gamma)\rho\sigma_0\sigma_2] \\ - \{C_2^B + k_B[\sigma_2^2 + (1-\gamma)^2\sigma_0^2 + 2(1-\gamma)\rho\sigma_0\sigma_2]\} \quad (3.21) \end{aligned}$$

If the right side of the inequality (3.21) is greater than 0, partner B's participation condition is satisfied. Partner B will take part in the joint venture. The right side of the inequality (3.21) is greater than 0 means that partner B's certainty equivalent value of risk R2 should be less than partner A's certainty equivalent value of risk R2. Otherwise partner B's participation condition can not be satisfied. If partner B's reservation value is not 0, but Q^R_B is greater than 0. If the Q^R_B is greater than the left side of the inequality (the upper-limit of the certainty equivalent value), partner B will never agree to take part in the joint venture.

$$\begin{aligned} C_2^B + k_B[\sigma_2^2 + (1-\gamma)^2\sigma_0^2 + 2(1-\gamma)\rho\sigma_0\sigma_2] \\ \leq C_2^A + k_A[\sigma_2^2 + (1-\gamma)^2\sigma_0^2 + 2(1-\gamma)\rho\sigma_0\sigma_2] \quad (3.22) \end{aligned}$$

If the equation (3.22) is satisfied, partner B takes part in the joint venture.

3.3.2 Analysis

(1) Partners with Same risk-aversion Degree and Same Capacity of Dealing with Risk

For simplifications, the two partners are same with each other. That is two say, $k_A = k_B = k$. The two partners can deal with the same risk at the same cost, that is to say ($C^A_2 = C^B_2$). Under this condition the two sides of the inequality (3.22) are equal. When the partners have the same degree of risk-aversion and same capacities to deal with the same risk, if partner A's participation condition can not be satisfied, partner B's participation condition can be satisfied either. Then they can not set up a joint venture, because none of the partner's participation condition can be satisfied. The conclusion can be found that joint ventures can not be set up by the partners who have the same degree of risk-aversion, same capacity to deal with the same risk and same reservation values. When the reservation values of the two partners are different the partner whose reservation value is higher can find other contractors whose reservation values are relative lower to set up a joint venture. From (3.16) and (3.21), the following inequality can be obtained.

$$C_2^A + \phi_2 + k_A[\sigma_2^2 + \sigma_0^2(1-\gamma)^2] - \{C_2^B + \phi_2 + k_B[\sigma_2^2 + (1-\gamma)^2\sigma_0^2]\} \leq Q_B^J < C_2^A + k_A[\sigma_2^2 + (1-\gamma^2)\sigma_0^2] - C_2^B - k_B[\sigma_2^2 + (1-\gamma)^2\sigma_0^2] \quad (3.23)$$

The inequality (3.21) can be simplified as

$$0 \leq Q_B^{JH} < 2k\gamma(1-\gamma)\sigma_0^2 \quad (3.24)$$

Proposition 1

If a contractor wants to set up a joint venture to undertake a project he should not choose a partner who has the same degree of risk-aversion and same capacity to deal with the same risk when their reservation values are also same with each other. When the reservation values of the two partners are different the partner whose reservation value is higher can find other contractors whose reservation values are relative lower to set up a joint venture.

(2) Partners with Same Risk-aversion Degree and Different Capacity of Dealing with Risk One of the partners can deal with the risks in a less costly way than the other and both partner have the same degree of risk-aversion ($k_A = k_B = k$). Here partner B is assumed can deal with the project risk of subproject 2 at a lower cost than partner A.

Under this condition, if partner B can deal with the risk at lower cost relative to partner A, the participation condition of partner B is satisfied while partner A's participation condition can not be satisfied. Partner B will agree to set up a joint venture with partner A and undertakes subproject 2. A contractor can find the other contractors who can deal with the risks at lower cost to set up a joint venture for a project even they have the same degree of risk-aversion. This result can also be explained as cost-decreasing motivation of joint ventures. It is also same as the risk allocation principle that it is efficient to allocate the risks to the one who can deal with them at lower cost.

Proposition 2

When both partners are risk-averse and they have the same degree of risk-aversion, joint ventures can be set up between the contractors who are technology superior at different tasks or risks.

(3) Partners with Different Risk-aversion Degree and Same Capacity of Dealing with Risk Here the problem is analyzed under the condition that the risk-aversion degrees of the two partners are different, and their capacities of dealing with risks are same. The inequality (3.22) is then changed to:

$$(k_A - k_B)[\sigma_2^2 + (1-\gamma)^2\sigma_0^2] \geq 0 \qquad (3.25)$$

The following conclusion can be obtained: with the risk-aversion degree of partner A increasing or the risk-aversion degree of partner B decreasing, it is easier for the above inequality to be satisfied with. That is to say, if partners B is less risk-averse, it is easier for partner B's participation to be satisfied while partner A's participation condition can not be satisfied. If one partner is less risk-aversion than the other, joint ventures can be set up between these two contractors. Because when the contractor whose degree of risk a version is relative higher and hi participation condition can not be satisfied the other contractor whose participation condition can be satisfied. A joint venture can be set up by the partner whose degrees of risk-aversion are different, even if they have the same capacities to deal with risks.

Proposition 3

When the partners have different attitudes toward risks, the partner who is more risk-averse can set up a joint venture with other partners whose degree of risk-aversion is relative lower.

(4) Partners with Different Risk-aversion Degree and Different Capacity of Dealing with Risk

Here the problem is analyzed when the risk-aversion degrees of the two partners are different. At same time, they have different capacities to deal with risk. Partner A can set up a joint venture with partner B successfully only when the following inequality is satisfied.

$$C_2^A + k_A[\sigma_2^2 + (1-\gamma)^2\sigma_0^2] \geq C_2^B + k_B[\sigma_2^2 + (1-\gamma)^2\sigma_0^2] \qquad (3.26)$$

The following conclusion can be obtained: With the partner B's cost of dealing with risk becoming lower and his risk-aversion being less, the more possible it is for partner B's participation to be satisfied while partner A's participation condition can not be satisfied. At the same time, with the partner A's cost of dealing with the same risk being higher and his risk-aversion being more the more possible it is for partner B's participation condition to be satisfied. In other words when the difference of the cost of dealing with the same risk being more and the difference of the degree of risk-aversion being more, it is more possible for these two partners to set up a joint venture to undertake a project. Because when one partner's participation condition can not be satisfied the other partner's (who is less risk-averse or who can deal with the risk at lower cost) participation condition can be satisfied.

3.3.3 When there is No Background Risk

The participation values of the partners are assumed as 0. When there is no background risk, joint ventures would be set up when the following conditions are satisfied.

$$Q_A^{JN} - Q_A^{wn} > 0 \qquad (3.27)$$

$$Q_A^{JN} > 0 \qquad (3.28)$$

$$Q_B^{JN} > 0 \qquad (3.29)$$

The certainty equivalent value of partner A when he undertakes the whole project himself can be rewritten as:

$$Q_A^{wn} = Q_A^{JN} + [(1-\gamma)I - C_2^A - \phi_2 - k_A\sigma_2^2] \qquad (3.30)$$

The party $\{(1-\gamma)I-[C_2^A+\phi_2]-k_B\sigma_2^2\}$ in the formula (3.30) can be seen as the certainty equivalent value of partner A when he undertakes subproject 2 in the joint venture. If the partners have the same degree of risk-aversion and same capacities to deal with the risks, the certainty equivalent value of the partner when he undertakes the whole project can be looked as the sum of the certainty equivalent values of the two same partners in the joint venture, one undertakes subproject 1 and the other undertakes subproject 2. It is different from the relation showed in the formula (3.10). Compared with the sum of the certainty equivalent values of the partners in the joint venture under the condition with a background risk and without a background risk, when there is a background risk the sum of certainty equivalent values is greater than the sum of values without background risk. In the similar way as before, the conditions under which partners will prefer to set up a joint venture to undertake the project can be found.

$$C_2^A + k_A\sigma_2^2 - C_2^B - k_B\sigma_2^2 \geq Q_B^{JH} \geq C_2^A + k_A\sigma_2^2 - (C_2^B + k_B\sigma_2^2) \qquad (3.31)$$

The left part of the inequality (3.31) means partner B's certainty equivalent value in the joint venture would not be greater than the sum of the two differences, one is the difference of partner A certainty equivalent values in the joint venture and his certainty equivalent value when he undertakes the whole project, the other is the difference between the certainty equivalent values of the two partners for project risk R2. The right side of the inequality (3.31) means partner B's certainty equivalent value in the joint venture should be smaller than the difference between their certainty equivalent value of project risk R2 of the two partners. If partner B's reservation value is greater than the left side of the inequality (3.31), partner B would never agree to take part in the joint venture.

3.3.4 Analysis

When there is no background risk, if the partners are same with each other, they will not set up a joint venture to undertake a project. Because one partner's participation condition can not be satisfied, the other partner's can not be satisfied too. Joint ventures can only be set up by partners who are different with each other.

(1) If $k_A = k_B$ and $C_A^2 = C_B^2$, the right part of the inequality (3.31) can be simplified as:

$$Q_B^{JH} \geq C_2^A + k_A\sigma_2^2 - (C_2^B + k_B\sigma_2^2) = 0 \quad (3.32)$$

If partner A's participation condition can not be satisfied, partner B who is same with partner A will not take part in the joint venture. Joint ventures can not be set up by partners who are same with each other. Under this condition if partner B's reservation value is smaller than partner A's, then partner B would agree to take part in the joint venture, because his participation condition is satisfied.

(2) If $k_A = k_B$ the right part of the inequality (3.31) can be simplified as:

$$Q_B^{JH} \geq C_2^A - C_2^B \quad (3.33)$$

Partner B will take part in the joint venture and undertake subproject 2 only when he can deal with the project risk of subproject 2 at lower cost relative to partner A.

(3) If $C^A_2 = C^B_2$, the right part of the inequality (3.31) can be simplified as:

$$Q_B^{JH} \geq k_A\sigma_2^2 - k_B\sigma_2^2 \quad (3.34)$$

The conclusion that if the two partners can deal with the risks at same cost, only when partner B's degree of risk-aversion is lower than partner A's partner B will agree to take part in the joint venture to undertake subproject 2 which partner A can not finish can be found.

(4) Partners are different with each other: different degrees of risk-aversion and different capacities to deal with the risk.

$$Q_B^{JH} \geq C_2^A + k_A\sigma_2^2 - (C_2^B + k_B\sigma_2^2) \quad (3.35)$$

With the higher the partner A's cost to deal with the risk is and the higher his degree of risk-aversion is, it is more possible the partner B's participation condition to be satisfied when partner A's participation condition can not be satisfied. With the lower the partner B's cost to deal with the risk is and the lower the degree of risk-aversion of partner B is, it is more possible the partner B's participation condition to be satisfied when partner A's participation condition can not be satisfied.

3.4 Conclusion and Future Research

3.4.1 Conclusion

In relation to the motivations of joint ventures there are many arguments, but there is little theoretical research. According to the previous literatures, risk sharing is one of the main motivations of joint ventures. Some researchers found that partners can not always decrease their risks by setting up a joint venture with others. According to the results of their researches, they found under some conditions setting up a joint venture with others can even increase the risks of the partners.

In this paper the motivation for partners to set up joint ventures are analyzed from the viewpoint of the risk sharing theoretically. There are many kinds of risks in the construction activities. The existence of these risks can change the behaviors of the relevant partners when they make decisions. In this paper two kinds of risks, project risks and background risks are focused on. The problem how the existence of these risks affects the decision-makers behaviors is analyzed. Under which condition which kinds of companies will be chosen as the cooperators by a company for a project? The conclusions can be summarized as:

If partners can choose whether to set up a joint venture or not, it is more possible for partners to choose to set up a joint venture when the background risk is positive related to the project risks. When the background risk is negative related with the project risks, partners maybe prefer to undertake the whole project. Because when they undertake the whole project, they can get the risk hedge effect by undertaking the whole project. The negative correlation between the background risk and the project risks acts as a natural hedge against uncertainty, setting up a joint venture will remove or decrease this hedge. When the background risk is independent with the background risk, the existing of the background risk will make the difference between the two certainty equivalent values greater compared with the one when there is no background risk.

(1) When partners have the same degree of risk-aversion and they have the same capacities to deal with the same risk, and they also have the same reservation value, if one partner's participation condition is not satisfied the other's can not be satisfied too.

Joint ventures can not be set up by the partners who are same with each other. If they have different reservation values even they have the same capacity to deal with the risk and they have the same degree of risk-aversion, a joint venture can be set up between them. If there is a background risk, they can improve their certainty equivalent values by setting up a joint venture.

(2) When both partners undertake unlimited liabilities, if one partner can deal with the risk in a less costly way than the other, they can set up a joint venture successfully.

(3) When the partners have different attitudes toward risks, the partner who is more risk-averse can find a contractor whose degree of risk-aversion is relative lower to set up a joint venture. From the analysis in this paper, the conclusion that background risks can affect the behaviors of the decision-maker can be concluded.

The results of this paper can be used to choose cooperators by a company. When it is not profitable for a company to undertake a project because of too many risks, the company can find another company to cooperate to undertake the project. Under this condition, he can find his cooperators who is less risk-averse or who is better on dealing with the risks than him. The cooperation between the partners who have different special knowledge or have special technologies to cooperate with each other is an efficient way to cooperate. If the risks are changed to tasks, the same conclusion can be obtained. It is optimal for the partners who have different special knowledge or have special technologies to cooperate with each other. This conclusion is same as the conclusion of transaction cost theory. Under this condition the risk sharing motivation of joint ventures can also be looked as cost decreasing motivation. When there is a background risk, risk spread effect can be realized by setting up a joint venture between the partners.

3.4.2 Future Research

In this paper both partner are assumed to undertake unlimited liabilities. In real world almost all the companies are limited liability companies. It is necessary to find when partners are limited liability companies under which condition they will choose to set up a joint venture for a project. In this paper, the moral hazard problem is neglected, it is necessary the effect of moral hazard problem when the partners make decision whether to set up a joint venture or undertake the whole project.

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