The research of enterprise alliance's benefit distribution mechanism based on modified Pig' s Payoffs model

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Abstract

Through analyzing the existing problems in large and small corporations' operation, and the modification of Pig's Payoffs model, alter the benefit distribution mechanism of the resource sharing among large and small member enterprises, helping enterprise alliance to find better ways to share resources. By quantifying the linkage between the quota of benefit distribution and the contribution rate in joint operations, find out the minimum condition of joining joint operations to solve the "free-rider" issue and enhance the efficiency of enterprise alliance.

Keywords

Pig's Payoffs, Axiomatization, Resource-sharing, Benefit Distribution.

1. Introduction

The survival environment of small and medium-sized enterprises is deteriorating, lots of corporations, with early finished capital accumulation and successful industrial operation, face new issues when they reach certain scale. Firstly, the shortage of capital is a widespread problem. Especially when bank financing retrenched, how can businesses strategically find financing channels. Secondly, the cost of corporate operation is rising, such as cost of raw materials, cost of energy, cost of transportation and cost of labor force, and the risk of operation is also rising. Thirdly, how to combine the resources from the outside and the inside? Under the new circumstances, how to combine outside resources to achieve expansion with lower cost is a new task that many small and medium enterprises must face. In many industries, joint operation has solved many problems that businesses cannot solve by themselves.

The resource-sharing cooperating relationship between large enterprises and small businesses in a consortium is similar to the relationship between big pigs and small pigs in the game theory of "Pig's Payoffs". Combining with the analysis of "Pig's Payoffs" model, large enterprises are the big pigs and small businesses are the small ones. Resource-sharing activities like the control panel. Under traditional pattern, when large enterprises cooperate with small businesses, large enterprises always pay a higher price and take more responsibility, however, small businesses have always been the easy beneficiary and become a "free-rider" in the resource-sharing relationship, eventually, the positivity of large enterprises is depressed and the efficiency in a consortium decreases. Therefore, how to distribute benefit, to make both large and small companies positively share their resources, is a worth studying topic.

2. The "Pig's Payoffs" model

In the Game Theory, "Pig's Payoffs" is a famous example of the Nash Equilibrium. One big pig and one small pig are put in a pigpen with a special control panel at one end and a food dispenser at the other end , when a pig presses the panel, at a utility cost of 2 units, 10 units of food are dispensed at the dispenser, if the big pig gets to the dispenser first, he will get 9 units, the other pig will only get 1 unit, if, instead, the small pig is at the dispenser first, he eats 4 units, and even if they arrive at the same time the small pig gets 3 units. Premising both pigs are wise, the small pig will choose to wait.

In economics, this model is used to reveal the competitive and cooperative activities between large firms and small firms. Original models of game theory are widely applied in management, but all draw analogies between the conclusions of this model and the real-life issues. All "conclude" to the capable work and the weak feast. The research method is illogical and impractical. Although the Pig's Payoffs theory is valued by economic and management circle, it lacks scientific and systematic theory and mechanism to support. With further study of the Pig's Payoffs model, it has broad prospect and application value in controlling the "free-rider" phenomenon in political and economic social problems.

We now presume the control panel and dispenser are on the two ends of the pigpen. Two pigs, one big and one small. With one press on the panel, "q "unit food comes out but it costs "c" unit.

If big pig press the panel, he gets "b" unit, if they both press, big pig gets "t" unit, if the small pig press, the big pig gets "s" unit.

Form 1 The payoff matrix

		Small pig	
		PRESS	**WAIT**
Big pig	**PRESS**	**t-c, q-t-c**	**b-c, q-b**
	WAIT	**s, q-s-c**	**0, 0**

The basic hypotheses of The Pig's Payoffs theory:

Hypotheses 1, once the panel is pressed, food comes out simultaneously;

Hypotheses 2, two pigs can get food at the same dispenser, once the food comes out, the first arriver can eat them;

Force cost hypotheses, $0 \leq c < q-s$;

Small pig's willing to press, $q > s$;

For the convenience of study, assuming in the resource-sharing alliance, there are two companies, A is a big firm and B is the small one. The result of this analysis can be analogized to a game theory with n number of participants. Assuming all the participating firms are rational and meet the conditions mentioned above, and the "free-rider" phenomenon exists in the alliance, this states the rationality behind the existence of Pig's Payoffs equilibrium in corporation alliance. The Axiomatic parameter of the sharing alliance is set as follow: "q" stands for the benefit can be obtained from the project, "c" stands for the cost to execute the project.

3. Model analysis and benefit distribution mechanism design

3.1 Model analysis

The Pig's Payoffs model inspires the small businesses in a consortium that free-riding is the best strategy. However, small businesses should not free ride for too long, otherwise, large enterprises would lose their incentive and the consortium would collapse. The reason to build a long-lasting

cooperating group is that through designing a benefit distribution mechanism, let both small and large companies be proactive to devote themselves to resource-sharing activities.

In the Pig's Payoffs game theory model, supposing the food dispenser gives q unit of food at one time and pressing control panel will cost c unit of energy. If no pig presses the panel, they won't get any food.

Now discuss the net benefit each pig can get under three circumstances: the big pig press the panel, both pigs press and only the small pig press.

Note: net benefit equals unit of food gained minus unit of energy.

1). Big pig press the panel: big pig's net benefit is b-c and small pig's net benefit is q-b;

2). Both pigs press: big pig's net benefit is t-c and small pig's net benefit will be q-t-c;

3). Only the small pig press: big pig's net benefit is s and small pig's net benefit will be q-s-c;

The "free-rider" behavior of the small pig can be reduced by changing the parameters (q,c,u,v,d) in the matrix which will shift the Nash Equilibrium, from (PRESS, WAIT) to (WAIT, PRESS) or (PRESS, PRESS), and eventually the small pig is motivated to devote. By distributing more benefit to the one who presses the panel, can achieve a result that both pigs press.

3.2 Designing the benefit distribution mechanism

Through analyzing the Pig's Payoffs model, the key to minimize the small businesses' "free-rider" behavior is whether the core index in the game theory is set properly. For instance, to what extent does companies, who choose to share, can get a higher benefit allocation. In order to achieve the goal of higher resource-sharing efficiency, Consortium should alter those participants' behavior by changing the rules of game theory and reduce the "free-rider" phenomenon. And eventually the final goal will be achieved, which is all the member businesses being active to share their resources, and the Nash Equilibrium will be (SHARE, SHARE).

Next, the key problem is the extent to which the benefit is better distributed. Assuming that after companies are united, the incremental benefit is m. The big and small companies' devotion are α and 1-α respectively ($0 < \alpha < 1$), and those member businesses, who share on their own initiative, get extra benefit distributed of αm and (1-α)m, and the rest conditions remain the same.

Adding extra benefit distribution will modify the game theory (Form 2): to get a result of both big and small companies' best strategy being actively share resources, move the effective Nash Equilibrium in the game theory matrix to (SHARE, SHARE), parameter m's value range can be calculated.

Form 2 The distribution model considering the rate of devotion

		Small Pig	
		PRESS	**WAIT**
Big Pig	**PRESS**	t+a(m-c), q-t=(1-a)(m-c)	b-c, q-b
	WAIT	S, q-s-c	0, 0

Assume that the incremental benefit because of joint operation is m and other parameters (q, c, u, v, d) remain unchanged. The sufficient condition for the effective Nash Equilibrium in Pig's Payoffs game theory is $m>s-b+c$ and $0<b<t<s$.

To get the optimal Nash Equilibrium of (PRESS, PRESS), which means when both pigs press, both pigs can get higher net benefit than other two circumstances. Following conditions should be met:

$$t+\alpha(m-c)>b-c \quad (1)$$

$$t+\alpha(m-c)>s>0 \quad (2)$$

$$q-t+(1-\alpha)(m-c)>q-s-c \quad (3)$$

$$q-t+(1-\alpha)(m-c)>q-b>0 \quad (4)$$

solve: $m>S-b+C$且$0<b<t<S$.

If the known parameters satisfy the conclusion above, then by testing can get Nash Equilibrium (PRESS, PRESS).

Therefore, to make all members in the business alliance actively share resources, the incremental benefit (m) because of the union should satisfy m-c>s-b and 0<b<t<s. And allocating the incremental benefit according to their rate of devotion, results in more pay for more work and by this means, optimal Nash Equilibrium (PRESS, PRESS) will be facilitated under the conditions that joint benefit q, cost c, work efficiency u, ability to gain v and work load d stay fixed. Through effective benefit distribution mechanism, small businesses would be driven to give up "free-riding" strategy. In the meantime, the proactivity of large enterprises would be stimulated and achieve the true purpose of forming the consortium.

This article is helping management to decide under what conditions they should form a consortium, and how to allocate the incremental benefit from forming the consortium to attract and encourage members' positivity and enhance alliance efficiency and stability. At initial stage of resource-sharing, alliance must follow the principle of "efficiency first". By designing the benefit allocation mechanism, to the greatest extent reduce the "free-riding" behavior. For example, the administration of the alliance should distribute benefit to members according to the amount of resources they share and fully utilize the effect of different kinds of benefit distribution mechanism by stimulating and encouraging small businesses to share more resources and mobilize the large enterprises in the alliance to share more.

4. Conclusion

The precondition to form an operation alliance in an industry is that after the alliance is founded, its incremental net benefit should be bigger than any individual company's free-riding benefit and bigger than the benefit they get deducting their cost and the benefit snatched by those "free-riders" when they operate alone. When building a consortium, when it comes to institution arrangement, sharing security system should be established and enhanced and all members are motivated to share their resources, in the meantime, the system should give full play to the effectiveness of benefit distribution, encouraging member businesses to share more resources. The management of a sharing alliance should not only mobilize those large enterprises in the group to share more resources and provide convenience to small-business members, but put certain constraint on small-business members to avoid "free-riding" behavior and increase their devotion in resource-sharing activities. Eventually, unification with effectiveness and fairness will be realized, which requires effective benefit allocation quota being implemented to attract all business members to share resources. This article is suggesting that mobilizing large and small business members to share resources and enhance the stability of a cooperating alliance by the means of adjusting benefit allocation quota according to each members' rate of devotion.

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