# An Economic Analysis of Coopetitive Training Investments for Insurance Agents[+]

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**Abstract.** The main purpose of this research is to investigate the effects of market demand uncertainty in the coopetitive insurance market. To that end, we build a game-theory model including training investments of insurance agents in an insurance market with demand uncertainty.

We derive the following results from our analysis. First, insurance firms undertake less training investment if it is determined competitively by insurance firms. From this result, we show how some associations in the insurance market coordinate the amount of training investment and produce a higher amount of training investment. Second, we show how the effectiveness of coopetition becomes larger when demand uncertainty is larger. We confirm from that finding that realizing the coopetitive situation is more important if the demand uncertainty in the insurance market is large and that demand uncertainty is an important element in coopetition studies.

**Keywords:** Coopetition, Insurance agent, Game theory

## 1. Introduction

It is well known that insurance can realize more efficient risk allocation and enhance efficiency.

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However, because insurance products are invisible and complex, some problems may be encountered. For example, individuals may purchase unnecessary and/or unsuitable insurance products because of their insurance agents' inappropriate activities.[1] Such activities lower consumers' confidence in insurance market, insurance firms, and the insurance industry. Thus, from the perspective of maintaining confidence, the training of insurance agents is one of the most important issues facing insurance firms.

In the real world, training of insurance agents is conducted not only by each insurance firm but also by the insurance industry as a whole. Thus, the insurance market contains both cooperative training and competitive sales systems. In other words, the insurance market is neither perfectly cooperative nor perfectly competitive, that is "coopetitive". Furthermore, every market, including insurance, has some kinds of uncertainty. For example, the amount of demand is changing every day. If the insurance market faces demand uncertainty, we examine how that affects the effectiveness of the coopetition in an insurance market. To answer the above question, this article builds a game-theory model that combines training investments for insurance agents in an insurance market with demand uncertainty.

The remainder of this article is organized as follows. Section 2 explains why game theory is a powerful tool for analyzing a coopetitive market situation. Section 3 builds the model and derives some results. Concluding remarks are presented in Section 4.

## 2. Methodology

A number of articles apply game theory to coopetition studies. For example, Brandenburger and Nalebuff (1996, 5–8) argue for the usefulness of game theory in understanding a coopetitive situation. Lado *et al.* (1997, 113) show how game theory explains behavior associated with interfirm relationships. Okura (2007, 2008, 2009a) argues that game theory can be a powerful tool to investigate coopetition. Pesamaa and Eriksson (2010, 167) describe how game theory can be a useful tool for analyzing and predicting actors' interdependent decisions. In coopetition studies, there are three advantages of use of game theory.[2]

First, game theory can analyze interactions between firms in an oligopolistic market. It is natural that coopetition cannot be realized in a monopolistic market. Also, we cannot consider coopetition in a perfectly

[1] Okura (2009b) analyzed the relationship between insurance agents' sales effort and wage schedules by a principal-agent model.
[2] The following explanations are a summary of the descriptions in Okura (2007).

competitive market because the definition of perfect competition precludes strategic choices. Thus, coopetition only arises in oligopolistic markets and game theory is the principal method used for analyzing that market structure.[3] Actually, the insurance market in many countries including Japan can be considered to be oligopolistic. For example, in the case of Japan's insurance industry, there are 83 insurance firms (43 life insurance and 40 nonlife (direct) insurance firms at the end of 2011), which means that game theory can be an appropriate tool to analyze an insurance market with coopetition.

Second, game theory is a rigorous analytical method. In particular, game theory is the primary tool for investigating a multistage process, because it can be treated as an extensive-form game, and the equilibrium of this game can be derived by the backward induction used to compute the equilibrium.

Third, game theory permits us to distinguish much more easily between the cooperative and competitive aspects in a coopetitive market. Coopetitive situations have a tendency to be complex because they contain elements of both cooperation and competition. However, game theory can be used to build a simple model by separating the cooperative and competitive aspects in a coopetitive market situation.

## 3. The Model

Suppose that there are two insurance firms named insurance firm A and insurance firm B, respectively, in the market. They sell their insurance products through insurance agents. Our model develops the following three-stage game.

In the first stage, both insurance firms competitively decide on the amount of their training investments for insurance agents to maintain market confidence. $k_i$ represents the amount of training investment by the insurance firm $i$ for $i \in \{A, B\}$. The amount of training investment depends on the level that maintains the confidence of the insurance market. The investment function is quadratic and is assumed to be specified by $(1/2)k_i^2$.

In the second stage, the nature determines the situation with regard to confidence in the insurance market. There are three possible cases as follows. The first case can be called the "good" confidence case in which all (potential) consumers are credible to the insurance market. In this case, the form of the demand

[3] For example, Shy (1995, 11) argued that "[…] game theory is especially useful when the number of interactive agents is small."

function is

$$p^G = a - q_A^G - q_B^G, \tag{1}$$

where superscript $G$ means the good confidence case, $a$ denotes the intercept of the demand function that represents insurance market size, $p$ represents the insurance premium, and $q_A$ and $q_B$ are the quantities of insurance products sold by insurance firm *A* and *B*, respectively. The probability of realizing the good confidence case is $k_A k_B$. The second case is the "bad" confidence case. This case indicates that the activities of the insurance agents of either insurance firm tend to lower confidence in both of them. Although not all insurance agents choose inappropriate activities, it is assumed that (potential) consumers lose confidence not just in individual agents but in the whole insurance market. Thus, the demand function in this case is

$$p^B = \lambda a - q_A^B - q_B^B, \tag{2}$$

where superscript $B$ means the bad confidence case. $\lambda \in (0,1)$ represents the degree of lowering the confidence. In other words, the insurance market is diminished by insurance agents' inappropriate activities. The probability of realizing the bad confidence case is $k_1(1-k_2)+k_2(1-k_1)$. The third case can be called the "worst" confidence case. This case indicates that the insurance agents of both insurance firms actively lower confidence in the insurance market. The demand function in this case is

$$p^W = \lambda^2 a - q_A^W - q_B^W, \tag{3}$$

where superscript $W$ means the worst confidence case. The size of the insurance market reduces more than in the bad confidence case because $\lambda \in (0,1)$. The probability of realizing the worst confidence case is $(1-k_1)(1-k_2)$.

In the third stage, after both insurance firms observe which case is realized, they simultaneously decide the quantities of insurance products. At that time, the size of the insurance market, represented by $a$, has some uncertainty but is assumed to be distributed by the normal distribution function $N(\mu, \sigma^2)$, where $\mu \equiv E[a]$ represents the mean, and $\sigma^2 \equiv [(a-\mu)^2]$ represents the variance of the size of the insurance market.

Because each insurance firm takes its decisions in the first and third stages, we analyze these stages by backward induction.

First, we consider the third stage.[4] Both insurance firms can choose their quantities of insurance products in accordance with a demand function and its uncertainty. In the good confidence case, both insurance firms are assumed to be risk neutral and their profit functions can be written as

$$\pi_i^G = p^G q_i^G - \frac{1}{2}k_i^2 = \left(a - q_A^G - q_B^G\right)q_i^G - \frac{1}{2}k_i^2, \tag{4}$$

where $\pi_i^G$ represents the profit of insurance firm $i$ in the good confidence case.

From equation (4), we derive the equilibrium quantities of insurance products as

$$q_i^{G*} = \frac{a}{3} = \frac{\mu}{3} + \frac{1}{3}(a - \mu), \tag{5}$$

where the asterisk (*) means that value is the equilibrium value. Substituting equation (5) into equation (4), the equilibrium profit of each insurance firm shows that

$$\pi_i^{G*} = \left\{\frac{\mu}{3} + \frac{1}{3}(a - \mu)\right\}^2 - \frac{1}{2}k_i^2. \tag{6}$$

From equation (6), the equilibrium expected profit of each insurance firm is

$$E\left[\pi_i^{G*}\right] = \frac{1}{9}\left(\mu^2 + \sigma^2\right) - \frac{1}{2}k_i^2. \tag{7}$$

In the bad confidence case, the profit function of each insurance firm can be written as

$$\pi_i^B = p^B q_i^B - \frac{1}{2}k_i^2 = \left(\lambda a - q_A^B - q_B^B\right)q_i^B - \frac{1}{2}k_i^2, \tag{8}$$

where $\pi_i^B$ represents the profit of insurance firm $i$ in the bad confidence case. From equation (8), we derive the equilibrium quantities of insurance products as

$$q_i^{B*} = \frac{\lambda a}{3} = \frac{\lambda\mu}{3} + \frac{\lambda}{3}(a - \mu). \tag{9}$$

Substituting equation (9) into equation (8), the equilibrium profit of each insurance firm becomes

$$\pi_i^{B*} = \left\{\frac{\lambda\mu}{3} + \frac{\lambda}{3}(a - \mu)\right\}^2 - \frac{1}{2}k_i^2. \tag{10}$$

From equation (10), the equilibrium expected profit of each insurance firm is

[4] The analysis in the third stage originates entirely from Sakai (1991, Chapter 3), which investigated broader cases such as the monopolistic information case.

$$E\left[\pi_i^{B*}\right] = \frac{\lambda^2}{9}\left(\mu^2 + \sigma^2\right) - \frac{1}{2}k_i^{\,2}. \tag{11}$$

Similarly, the equilibrium quantities of insurance products and expected profits in the worst confidence case can be derived as

$$q_i^{W*} = \frac{\lambda^2 a}{3}, \tag{12}$$

$$E\left[\pi_i^{W*}\right] = \frac{\lambda^4}{9}\left(\mu^2 + \sigma^2\right) - \frac{1}{2}k_i^{\,2}, \tag{13}$$

where $\pi_i^W$ represents the profit of insurance firm $i$ in the worst confidence case.

Next, let us consider the first stage. The expected profit of each insurance firm in the first stage, which is denoted by $E[\Pi_i]$, can be written as

$$E[\Pi_i] = k_A k_B E\left[\pi_i^{G*}\right] + \left\{(1-k_A)k_B + k_A(1-k_B)\right\}E\left[\pi_i^{B*}\right] + (1-k_A)(1-k_B)E\left[\pi_i^{W*}\right]. \tag{14}$$

Substituting equations (7), (11), and (13) into equation (14), we obtain

$$E[\Pi_i] = \frac{\left[k_A k_B + \lambda^2\left\{(1-k_A)k_B + k_A(1-k_B)\right\} + \lambda^4(1-k_A)(1-k_B)\right]\left(\mu^2+\sigma^2\right)}{9} - \frac{1}{2}k_i^{\,2}. \tag{15}$$

From equation (15), the optimal amount of training investment may be derived as

$$k_i^* = \frac{\lambda^2\left(1-\lambda^2\right)\left(\mu^2+\sigma^2\right)}{9-\left(1-\lambda^2\right)^2\left(\mu^2+\sigma^2\right)}. \tag{16}$$

From equation (16), the equilibrium expected profit of each insurance firm is

$$E\left[\Pi_i^*\right] = \frac{\lambda^4\left(\mu^2+\sigma^2\right)\left\{18-\left(1-\lambda^2\right)^2\left(\mu^2+\sigma^2\right)\right\}}{2\left\{9-\left(1-\lambda^2\right)^2\left(\mu^2+\sigma^2\right)\right\}} - \frac{1}{2}\left\{\frac{\lambda^2\left(1-\lambda^2\right)\left(\mu^2+\sigma^2\right)}{9-(1-\lambda)^2\left(\mu^2+\sigma^2\right)}\right\}^2. \tag{17}$$

To evaluate the equilibrium amount of training investment that is denoted in equation (16), the optimal amount of training investment when both insurance firms cooperatively choose their amount of training investment is derived by maximizing total expected profit, defined as

$$E\left[\tilde{\Pi}^*\right] = E\left[\Pi_A^*\right] + E\left[\Pi_B^*\right], \tag{18}$$

where tilde (~) means that value is derived in a cooperative training investments situation. From equation (18), the equilibrium training investment of each insurance firm are derived by

$$\tilde{k}_i^* = \frac{2\lambda^2\left(1-\lambda^2\right)\left(\mu^2+\sigma^2\right)}{9-2\left(1-\lambda^2\right)^2\left(\mu^2+\sigma^2\right)}. \tag{19}$$

By comparing equations (16) and (19), it is easy to derive

$$\tilde{k}_i^* > k_i^*. \tag{20}$$

This equation (20) implies that both insurance firms choose a lesser amount of training investment when they are in competition. In other words, the equilibrium amount of training investment runs into the "prisoners' dilemma" situation because both insurance firms want to be free riders on their rival's training investment when acting competitively. To avoid realizing such Pareto-inferior outcome, it is better if each firm cooperatively chooses its training investments. Thus, in practice, insurance firms train their insurance agents not only for themselves exclusively, but in effect for all the other insurance firms. For example, Japanese insurance agents cannot sell some kinds of insurance products that are risky and complicated unless they have had some training and pass the examination required to demonstrate knowledge of the insurance laws and products. Such training for insurance agents is conducted by some insurance associations such as The Life Insurance Association of Japan and The General Insurance Association of Japan. Moreover, "educational activities" and "enhancement of quality of agents and solicitors" are listed in the activities of The Life Insurance Association of Japan and The General Insurance Association of Japan, respectively.[5] Thus, from the results of our analysis, these associations can be evaluated as "coordinators" seeking to avoid the prisoners' dilemma situation. Because both insurance firms in our model are clearly competitive in the third stage, the game including a coordinator contains both competitive and cooperative aspects. In other words, the existence of insurance associations promotes a coopetitive insurance market and increases incentives to raise training investments by all insurance firms.

Furthermore, we analyze whether such coopetition becomes more effective when demand uncertainty become large. To know how the effectiveness of coopetition changes in accordance with changes in demand uncertainty, we define the following measure, which represents the effectiveness of coopetition in the insurance market.[6]

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[5] These main activities can be confirmed from each association's website. See http://www.seiho.or.jp/english/about/objective/ and http://www.sonpo.or.jp/en/about/activity/ (accessed April 30, 2012).

[6] The following results are the same if the effectiveness of the coopetition in the insurance market is defined

$$\theta \equiv \frac{\tilde{k}_i^*}{k_i^*} = 1 + \frac{9}{9 - 2(\mu^2 + \sigma^2)(1 - \lambda^2)^2} . \tag{21}$$

In the equation (21), $\theta > 1$ is always satisfied, and means the effectiveness of coopetition is larger if $\theta$ is larger.

To investigate the effect of demand uncertainty on the effectiveness of coopetition, by partially differentiating equation (21) with respect to $\sigma^2$, we obtain

$$\frac{\partial \theta}{\partial \sigma^2} = \frac{18(1 - \lambda^2)^2}{\left\{9 - 2(\mu^2 + \sigma^2)(1 - \lambda^2)^2\right\}^2} > 0 . \tag{22}$$

Equation (22) implies that effectiveness of coopetition in the insurance market becomes larger when demand uncertainty increases. This result shows that realizing the coopetitive situation is more important if demand uncertainty in the insurance market is large. From that perspective, we find that demand uncertainty is an important element in coopetition studies.

## 4. Concluding Remarks

This article considered training investments for insurance agents in terms of coopetition. We derived the following results from our analysis. First, insurance firms undertake less training investment if it is determined competitively by insurance firms. From this result, we showed how some associations in the insurance market coordinate the amount of training investment and produce a higher amount of training investment. Second, we showed how the effectiveness of coopetition becomes larger when demand uncertainty is larger. We confirmed from that finding that realizing the coopetitive situation is more important if the demand uncertainty in the insurance market is large. Also, we concluded that demand uncertainty is an important element in coopetition studies.

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