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An Experimental Study of Leniency Programs

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An Experimental Study of Leniency Programs*

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Abstract

Antitrust authorities of many countries have been trying to establish appropriate competition policies based on economic analysis. Recently an anti-cartel policy called a “leniency program” has been introduced in many countries as an effective policy to dissolve cartels. In this paper, we studied several kinds of leniency programs through laboratory experiments. We experimentally controlled for two factors: 1) cartel size: the number of cartel members in a group, small (two-person) or large (seven-person), 2) schedule of reduced fine: the number of firms that are given reduced fines. The experimental results showed that (1) an increase in the number of cartel members in a group increased the number of cartels dissolved, (2) changing the coverage of reduced fine had no significant effect both in two-player case and in seven-player case.

JEL Classification: C92, D43, K21, K42

Keywords: Leniency programs, Cartels, Collusion, Antitrust law, Experiment.

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Introduction

Cartels, collusions among competing firms, harm the social welfare of consumers by restricting competition in markets. Such market restrictions include entry barriers, market-dividing activities, price fixing, and volume controlling. The major role of antitrust authorities (referred to hereafter as AA) is to restrain cartels. For example, the Japan Fair Trade Commission (JFTC) made recommendations for 15 cases of price fixing cartels and bid riggings in fiscal year 2003. Surcharge orders, which are legal means to confiscate excessive profits created by cartels, were imposed on 468 firms and the total amount of the surcharges amounted to 3.9 billion yen in fiscal year 2003. Between fiscal years 1994 and 2003, JFTC took formal actions in 279 cases with a total of 5798 firms. An international trend is one of strengthening fines and surcharges. For example, JFTC submitted a major amendment to the Japanese Antimonopoly Act to the Diet in 2004. The essential features of the revisions are that the basic surcharge rate shall be increased from 6% to 10% and that a leniency program shall be introduced to the surcharge system.¹ Lowe describes EU's future fine policy as follows:

The trend is clearly one of increasing fines, in order to achieve a genuine dissuasive effect on firms. In 2001, the heaviest individual fine yet, 462 million euros, was imposed against Hoffman-LaRoche in the *Vitamins* case. In 2002, the second highest amount ever, 250 million euros, was imposed against Lafarge for its participation in the *Plasterboard* cartel. Other significant fines were those imposed on the BPB, also in *Plasterboard*, 139 million euros and 118 million

¹ According to the JFTC's annual reports. A formal action means recommendations or surcharge payment orders without cease and desist orders preceding.

euros for Degussa for its role in the *Methionine* conspiracy.²

In order to raise the probability of detecting cartels, the leniency program has been implemented in many countries, such as the EU, the US, Canada, Australia, Korea. They have proven that the program is a very effective device to detect cartels. In the EU, between 1996 and 2002, more than 80 firms cooperated with the EC Commission under the leniency scheme and out of a total of 24 decisions imposing fines, firms in 17 cases cooperated with the Commission under the leniency scheme.³ That is, the number of cartels caught has increased dramatically under the leniency program.

A typical leniency program is carried out in the following way. If a member of a cartel group resigns from the cartel and reports himself to the AA with sufficient evidence of his cartel activity sooner than other cartel members, then his firm will be given full leniency and will be exempted from paying a fine at all. Many countries' AAs give "moderate leniency" (reduced fine) to firms that were not the first reporters so that the authorities can get more hidden cartel information from those cartel members, too. By introducing the program, cartel members might compete with each other to reveal the evidence of their illegal activity to the AA to get the highest leniency. If this is true, then the leniency program has the advantage of increasing the probability of finding cartel activities without increasing enforcement costs.

Although there are some theoretical studies on various kinds of leniency programs using repeated game theory (e.g. Motta and Polo (2003), Hinloopen (2002)), to our knowledge, Apesteguia et al. (2003) is the only paper based on laboratory experiments.

Hinloopen (2002) theoretically analyzed European style leniency programs. In the

² See Lowe (2003).

³ See Monti (2002).

European style leniency programs, a fine is considered to be proportional to gross annual sales of a firm (maximum fine up to 10% of total sales). Hinloopen showed that it is highly unlikely for a cartel member to report information to the AA unless the probability of detection and/or a fine are unrealistically high. Brisset and Thomas (2002) obtained very similar results in the simplified first price auction settings.

Compared with the European leniency program, Spagnolo (2000) proved that courageous leniency programs, which give reward to self-reporting firms, may deter collusion completely and costlessly.

Apestequia et al. (2003) investigated leniency programs in a one-shot Bertrand competition framework theoretically and experimentally. They compared several variations of leniency programs including courageous leniency program proposed by Spagnolo, and found that the rate of cartel formation was the highest in the case that a reward was provided for the action of reporting, which contradicts the theoretical predictions.

In this paper, we also studied the enforcement of competition policy against collusion under two kinds of leniency programs in laboratory settings. Since only unilateral deviations from the equilibrium are to be considered according to the Nash equilibrium concept, the equilibrium predictions in the two-person game models used in previous studies can be applied to the case where the game consists of more than two players, and the case where the coverage of reduced fine is limited only to the first reporting firm. However, we are not sure whether these predictions are true in real situations. If every firm involved in a cartel activity can give legally sufficient cartel information to the AA, the cartel can be dissolved easily just by prosecuting one firm. That might make each cartel member rely less on collusion as the number of cartel

members increases. In addition, cartels might be dissolved much faster with the leniency program than without it, since if a firm reports the cartel information to the AA, they can avoid a considerable fine when the cartel is detected by the AA. Furthermore, such a deviation from collusion could be accelerated if only the first reporting firm can avoid the fine and others get a penalty.

To investigate these institutional design issues, we must consider what are the crucial variables that the AA can manipulate to prevent firms from forming cartels. The variables the AA can control but firms can not are the probability of investigation and the level of the surcharge or fine. Those variables can influence the incentive of firms for cartel formation greatly. If the probability of being caught and the fine are very low (or high), firms believe that the expected profits that they could gain from the cartel would be greater (or smaller) than the expected losses from being caught.

Based on the considerations above, we experimentally controlled the following two factors to compare several institutional designs of leniency programs in a simplified oligopoly market:

- (1) Cartel group size: the number of cartel members in a group is either small (two members) or large (seven members),
- (2) The schedule of reduced fine: the number of firms that are given reduced fines is either only the first reporter or all firms that report the cartel information.

The model in our experiments is as follows. First, the probability of being investigated by the AA is common knowledge among firms. Each cartel member colludes in an N-person prisoners' dilemma game first, and then, they voluntarily and

independently decide whether or not to report the cartel information to the AA. If at least one player in a group reports the information, then their collusion in the prisoners' dilemma is revealed to the AA with certainty, and all but the players who reported the information suffer the full fine (F), and the players who reported the information suffer only a reduced fine ($R < F$). Even if no one in a group reports the cartel information, the collusion is detected by the AA with the probability (p), and every member of the group suffers the full fine if the collusion is detected.

Although it is very important to investigate whether people would collude in the beginning under the leniency programs, the issue we deal with here is limited only to how the leniency program works under the situation where firms already collude with each other.⁴ To make our subjects understand that sustaining a cartel is the most profitable for them, they experienced the mutually cooperative outcome of the prisoners' dilemma game for a sufficient number of periods. Then, we ran two treatments with leniency programs.

The experimental results showed that (1) the large size cartel is more easily dissolved than the small size cartel; (2) the schedule of leniency (all reporters can get leniency or only the first reporter can) does not affect the likelihood of cartel formation. The organization of the paper is as follows. The theoretical model we used in our experiment is explained in the next section. Our experimental design and procedures are explained in section 3, and experimental results are discussed in section 4. Finally, conclusions are given in section 5.

⁴ There is a vast number of experimental studies on the prisoners' dilemma. Whether people are cooperative or not in the game is not the issue we deal with here. What we focus on in this study is whether firms which already commit themselves strongly to a cartel activity would really use the leniency program or not.

2. Model

In our experiment, we used the following two-person prisoner's dilemma repeated game as a baseline game that represents a simple oligopoly market. Table 1 shows the payoff matrix. The N-person case is analogous to the two-person case.

Table 1 is here

In the prisoner's dilemma game, each player receives π_C when they mutually cooperate (play Cooperate) and π_D when they mutually defect (play Defect). The player who defects receives π_{DC} when the counterpart cooperates and the counterpart receives π_{CD} . The condition, $\pi_{DC} > \pi_C > \pi_D > \pi_{CD}$, guarantees that mutual defection is the only equilibrium (the dominant strategy) in the one-shot game.

Now we introduce the leniency program into the baseline game above by introducing the antitrust authority (AA). The AA investigates each player to find evidence of collusion. We assume that the AA monitors each player with probability, p . When the AA discovers evidence of collusion, both players suffer the full fine, F . If the leniency program is available to the players, each player can report voluntarily and independently the collusion information to the AA. If one player reports the information, the other player suffers the full fine, F , and the player who reported suffers a reduced fine, $R < F$. Once the collusion is detected, both players fall under the AA's control, and they are not allowed to collude anymore.

In our experiment, all players were forced to mutually collude with each other in the first stage of the prisoner's dilemma game. Then they decided voluntarily and

independently whether they would like to report the collusion information to the AA or not.

Let us consider the incentive conditions for sustaining the collusion. Although all players are forced to collude in the first stage (prisoners' dilemma game) in our settings, we explain the incentive structure including the case that players can defect in the first stage. There are two kinds of deviations from mutual cooperation. One is a deviation in the first stage (not colluding) and the other is a deviation in the second stage (reporting the collusion information to the AA). We assume that both players employ the following trigger strategy: each player maintains collusion (first stage and second stage) as long as the other player does so. However, if one player deviates from the collusion either in the first stage or in the second stage, the other player will never collude with that player again. Based on this trigger strategy, we can calculate the expected payoffs for four possible strategies: (1) colluding and not reporting, (2) colluding and reporting, (3) not colluding and not reporting, (4) not colluding, and reporting. We can examine what the incentive conditions are for sustaining the collusion in an ordinary repeated game analysis. In the following discussion, we examine whether a player has an incentive for unilateral deviation by comparing expected payoffs of the four cases above under the condition that his counterpart chooses the strategy of colluding and not reporting.

(1) The expected payoff for the colluding and not reporting strategy (π_{CNR})

In this case, a player does not defect in both the first stage and the second stage. However, if the pair is investigated by the AA with probability p , both players suffer the full fine F and they can not collude again any more in all the periods thereafter. On the

other hand, if the pair is not investigated by the AA (the probability= $(1 - p)$), they can continue to collude in the next period, too. Therefore, the expected payoff for this strategy with the discount factor $\delta(0 < \delta < 1)$ is as follows.

$$\begin{aligned} \pi_{CNR} &= p[(\pi_C - F) + \delta \cdot \pi_D + \delta^2 \cdot \pi_D + \dots] + (1 - p) \cdot [\pi_C + \delta \cdot \pi_{CNR}] \\ &= p \left[(\pi_C - F) + \frac{\delta \cdot \pi_D}{1 - \delta} \right] + (1 - p) \cdot [\pi_C + \delta \cdot \pi_{CNR}]. \end{aligned}$$

Rearranging,

$$\pi_{CNR} = \frac{p}{1 - \delta + p\delta} \left[\pi_C - F + \frac{\delta \cdot \pi_D}{1 - \delta} \right] + \frac{1 - p}{1 - \delta + p\delta} \pi_C \dots \dots \dots (1)$$

(2) The expected payoff for the colluding and reporting strategy (π_{CR})

In this case, a player defects in the second stage. Even if the pair is investigated by the AA, the defecting player receives a reduced fine, R, while the other player suffers the full fine, F. The pair can not collude in all the periods thereafter. Therefore, the expected payoff with the discount factor $\delta(0 < \delta < 1)$ in this case is as follows.

$$\pi_{CR} = (\pi_C - R) + \delta \cdot \pi_D + \delta^2 \cdot \pi_D + \dots = (\pi_C - R) + \frac{\delta \cdot \pi_D}{1 - \delta} \dots \dots \dots (2)$$

(3) The expected payoff for the not colluding and not reporting strategy (π_{NCNR})

In this case, no collusion occurs. Therefore, the expected payoff in this case is as

follows.

$$\pi_{NCNR} = \pi_{DC} + \delta \cdot \pi_D + \delta^2 \cdot \pi_D + \dots = \pi_{DC} + \frac{\delta \cdot \pi_D}{1 - \delta} \dots \dots \dots (3)$$

(4) the expected payoff for the not colluding and reporting strategy (π_{NCR})

In this case as well, no collusion occurs. Therefore, the expected payoff is the same as equation (3).

$$\pi_{NCR} = \pi_{DC} + \delta \cdot \pi_D + \delta^2 \cdot \pi_D + \dots = \pi_{DC} + \frac{\delta \cdot \pi_D}{1 - \delta} \dots \dots \dots (4)$$

From the all the calculations above, $\pi_{CNR} \geq \pi_{CR}, \pi_{NCR}, \pi_{NCNR}$ are the necessary and sufficient conditions for each player to sustain the collusion (colluding and not reporting) if the other player also chooses the same strategy. In our experimental setting, π_{CNR} equals about 157, π_{CR} equals about 115, π_{NCNR} and π_{NCR} equal about 140. Since only unilateral deviation from equilibrium is considered according to the Nash concept, these conditions can be applied to not only the game which consists of two people but also the game which consists of more than two people. In addition, the conditions can be applied to the case that the schedule of coverage of reduced fee is limited to only the first reporting player.

In our experiments, we set the parameters so as to satisfy the condition that sustaining the collusion is an equilibrium. Therefore, in our experiment, we can expect subjects to use the colluding and not reporting strategy in both two-person and

seven-person cases.⁵ The following is the first null hypothesis to be investigated in our experiment.

Hypothesis 1: The colluding and not reporting strategy is observed in the two-person case as frequently as in the seven-person case.

In the previous theoretical literature, only two-person games are considered. Under the leniency program, however, one may expect that the larger the number of colluding members, the larger the probability that at least one member of the group deviates from the collusion, even if such a probability for each member is small. Further, such a deviation from the collusion could be accelerated if only the first member who reports the collusion information is given a reduced fine because each player may rush to get a reduced fine. To pursue such an institutional design issue, we compared different schedule types of reduced fine. One schedule is that only the first reporter can get a reduced fine. The other schedule is that all members that report the collusion information are given a reduced fine. Therefore, the next null hypothesis is as follows.

Hypothesis 2: The rate of collusion is not significantly different between the case that only the first reporting player is given a reduced fine and the case that all reporting players are given a reduced fine.

⁵ These incentive conditions cannot exclude other equilibria. Our game can be reduced to a kind of stag-hunt game in which both “colluding and reporting” and “colluding and not reporting” are equilibria. We set payoffs in the first stage prisoner’s dilemma game so that not reporting is a payoff-dominant *and* risk-dominant equilibrium and reporting is not a risk-dominant equilibrium. Therefore, colluding and not reporting is considered as a plausible equilibrium in our experiment.

Based on this theoretical model and these behavioral hypotheses, we conducted a series of experiments. The details of the experiments are explained in the next section.

3. Experiments

Four sessions were conducted at Kyoto Sangyo University in 2004. One session is for the case with two player groups and three sessions were for the case with seven player groups. In each session, three treatments were ran sequentially. The first session consisted of eight periods of prisoners' dilemma game to make subjects understand that sustaining collusion is the most profitable outcome (players had to collude). Each treatment of the following two treatments consisted of five games that include various numbers of periods (each game was continued with probability of 0.8). Twenty eight subjects participated in each session (fourteen groups for the session of two-person groups and twelve groups for the three sessions of seven-person groups). Subjects were paid individually in cash according to their experimental results. No subject participated in more than one session. Our experimental subjects were recruited from various majors at Kyoto Sangyo University.

The experimental procedures were programmed and conducted on z-Tree (Fischbacher (1999)) with computers with a network connection. Subjects were randomly assigned to a booth with partitions in front and on both sides of the desk in the laboratory. It was impossible for them to make direct contact, i.e., by talking, making eye contact, with other subjects during the session.

The instructor distributed the written instructions to the subjects and read them aloud to make all the parameters and rules of the experiment common knowledge

among subjects.⁶ To make subjects understand the instructions clearly, practice periods were run before the actual experiment started.⁷ Before the actual session started, subjects practiced clicking their mouses according to the experimenter's directions to get used to how to manipulate the computers and how to understand the information shown on the screen for their decision making. They were not allowed to make any free decisions until the actual period started. Table 2 summarizes all the treatments.

Table 2 is here

At the beginning of each session, subjects were told that they were going to experience three kinds of treatments and the result of the first treatment would be paid for certain but only one of the results of the other two treatments would be paid by choosing one of them by lottery at the end of all three treatments. The experimenter read the instructions for each treatment at the beginning of each treatment, so subjects were not aware of the details of each treatment until just before the treatment began. Therefore, there was no incentive for subjects to sacrifice their profits in one treatment in order to make higher profits in a later treatment.⁸ All subjects were restricted to colluding in the first stage in the second and third treatments. In the second stage of the treatments, they decided whether to report the colluding activity to the AA. At the end of each period, individual decisions of intra-group members were revealed to each

⁶ The experiment instructions are available upon request.

⁷ A practice treatment was run before the second and the third treatments since the first treatment is not complex at all.

⁸ However, since subjects could learn how cooperative others are in the second treatment, the result in the third treatment is not completely independent from the result of the previous treatment in a rigorous sense. We assume they can be treated as independent data in our analysis.

player, plus whether the collusion activity in their group was found by the AA or not.⁹ However, the identities of subjects and where they sat were kept confidential to guarantee anonymity among subjects.

The second treatment was the case that all players who report the information could get a reduced fine. In this treatment, subjects played with the same group members for five sessions in sequence.

The third treatment was the case that only the first player who reported the information could get a reduced fine. As in the second treatment, subjects played with the same partner (two-person group case) or same group members (seven-person group case) for five sessions in sequence. Within each session, the number of repetitive periods was not known beforehand since each session was ended with probability of $\delta = 0.8$.

All sessions lasted about two hours. During the experiments, subjects' earnings were represented by points. They were told in the instructions that one point would be exchanged for five yen at the end of the experiment. The average payment for subjects in the two-person group experiment was 4,972 yen (about 45 US dollars), and the average payment in the seven-person group experiment was 3,490 yen (about 32 US dollars) approximately.

4. Results

⁹ We did not tell subjects that the experiment was about anti-cartel policy. Instead of telling them that a cartel formation of their group was discovered by the AA, we simply told them that their group had drawn a payoff reduction lottery. We did not use any terms such as cooperation, defection, reporting and not reporting, but more neutral terms, such as A or B (in the first stage), choose C or D (in the second stage).

To verify the two hypotheses described at the end of section 2, we estimated the following logistic regression model by using data pooled from the two-person and seven-person cases.

$$Pr ob(Dissolve = 1) = F[\beta_0 + \beta_1 \cdot Group + \beta_2 \cdot Leniency + \beta_3 \cdot Game] \dots\dots\dots(5)$$

Dissolve is a response variable, which is 1 when at least one group member deviates from the collusion and 0 otherwise. *Group* is a dummy variable, which is 1 for the seven-person case and 0 for the two-person case. *Leniency* is a dummy variable, which is 1 when all who report are given reduced fines and 0 when only the first player who reports is given a reduced fine. *Game* is the number of games, and *F* is a logistic function. The estimated coefficients and other statistical information are shown in Table 3.

Table 3 is here

From Table 3, one can see that the coefficients for *Constant*, *Group* are significant ($p < 0.10$). The coefficient of *Group* is significantly positive, which indicates that the rate of cartel dissolution is significantly higher in the seven-person case than in the two-person case. Hence, Hypothesis 1 is rejected. The coefficient for *Leniency* is not significant, which means that the schedule of leniency does not have a strong impact on people's behavior in our experimental parameters. Hence, Hypothesis 2 is not rejected. From this result, we can conclude that limiting the number of firms which can enjoy the leniency program does not have significant impact on the ability of collusive firms to

maintain their collusion. The main results of our experiments are summarized below.¹⁰

Result 1: The (colluding and) not reporting strategy was observed more frequently in the two-person case than in the seven-person case.

Result 2: The rate of cartel dissolution was not significantly different between the case that only the fastest reporter can use the leniency program and the case that all reporters are allowed to use the program.

Besides these results, one can ask whether or not subject behaviors changed from game to game. Subjects could have gained enough experience and could have become familiar with our experimental environment as the games proceeded. The coefficient of *Game* is not significant, which means that there was no particular tendency or decay of collusion across games.

Figure 1 and Figure 2 show the time series data for the number of the groups sustaining collusion during the sessions in the two-person case session, and Figure 3-8 show the similar graphs for the seven-person case sessions.

Figure 1, 2, 3, 4, 5, 6, 7, 8 are here

5. Conclusions

We studied two kinds of leniency programs through laboratory experiments. It is

¹⁰ These results were confirmed by a chi-square test of independence.

expected that the larger the group, the larger the probability of cartel dissolution will be. In addition, the deviation from collusion could be accelerated if only one firm is given a reduced fine.

Based on the predictions above, under a simplified oligopoly market, we experimentally controlled the following two factors to compare several institutional designs of leniency programs; 1) group size: the number of members in a group, small group (two members) or large group (seven members), 2) schedule of reduced fine: only the first reporter of cartel information is given a reduced fine, or all reporters are given reduced fines.

The experimental results showed that (1) the larger the number of cartel members in a group is, the weaker their ability to maintain the collusion is, and (2) changing the schedule of reduced fine does not have a significant impact on firms' ability to maintain collusion: limiting the number of firms which can enjoy leniency does not make people rush to dissolve their collusion by reporting.

We can provide several policy implications from our experimental findings. The average size of a cartel in the real world consists of about six firms. Therefore the seven-player case in our experiments nearly corresponds to the real-world situation. We found that under the two leniency programs, most seven-member groups easily terminate their collusion. Therefore, we can predict that the leniency program could be fairly effective for regular size cartel groups in reality.¹¹ However, we did not run experiments for the situation without the leniency programs. By comparing the current

¹¹ Leniency programs set up in the European Union in 1996 achieved some notable successes in prosecuting cartels. (see European Union's Official Journal Legislation (OJL) (98. 1.21~03. 12.16)) From data of 31 cartels prosecuted between January 21, 1998 and December 16, 2003 we can obtain that the average number of firms forming a cartel is about six and by applying leniency programs the fines for cartel members are reduced by 10% to 100% according to evidence brought to AA.

results with the results without the leniency program, we can predict more precisely the power of leniency programs. In addition, the effect of changing the amount of a fine has not been investigated in this study. Hence, it is our future task to examine how severe a penalty is appropriate to prevent cartel formation.

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Table 1. Two-person prisoner's dilemma game

| | | Player 2 | |
|----------|-----------|----------------------|----------------------|
| | | Cooperate | Defect |
| Player 1 | Cooperate | π_C, π_C | π_{CD}, π_{DC} |
| | Defect | π_{DC}, π_{CD} | π_D, π_D |

(Note) $\pi_{DC} > \pi_C > \pi_D > \pi_{CD}$.

In our experimental setting, $\pi_C = 40, \pi_{CD} = 10, \pi_{DC} = 60, \pi_D = 20$.

Table 2. Treatment details

| | Sessions | |
|-------------------------------------|--|--------------------|
| | Two-person group | Seven-person group |
| Treatment 1 | No leniency programs | |
| Treatment 2 (5 games) | All players can get reduced fines | |
| Treatment 3 (5 games) | Only the first player can get a reduced fine | |
| Total subjects | 28 | 84 |
| The number of groups (each session) | 14 | 4 |
| Fines (F: fine, R: reduced fine) | F=40, R=5 | |
| Discount factor | $\delta = 0.8$ | |

(Note) Discount factor means the probability that each game is continued. Subjects were told that each period in each game would be continued with probability of 0.8.

Table 3. Logistic regression on cartel dissolution

| Dependent variable: Dissolve (if a cartel is dissolved =1, otherwise=0) | | | | |
|---|--------------|-----------|-------|------|
| Number of observation =260, Log likelihood =-112.23829 | | | | |
| Variable | coefficients | Std. Err. | z | p |
| Constant | -1.24 | 0.45 | -2.78 | 0.01 |
| <i>Group</i> (two = 0, seven = 1) | 3.41 | 0.35 | 9.75 | 0.00 |
| <i>Leniency</i> (only the first one = 0, all ones = 1) | 0.18 | 0.34 | 0.51 | 0.61 |
| <i>Game</i> | -0.15 | 0.12 | -1.20 | 0.23 |

(Note) We simply assumed those groups whose cartels were dissolved by lottery could have maintained their collusion if they did not draw the payment reduction lottery, which means that the anti-trust agency investigated those firms.

Figure 1. Time series of the number of collusive groups when all players who report get reduced fines (two-person case)

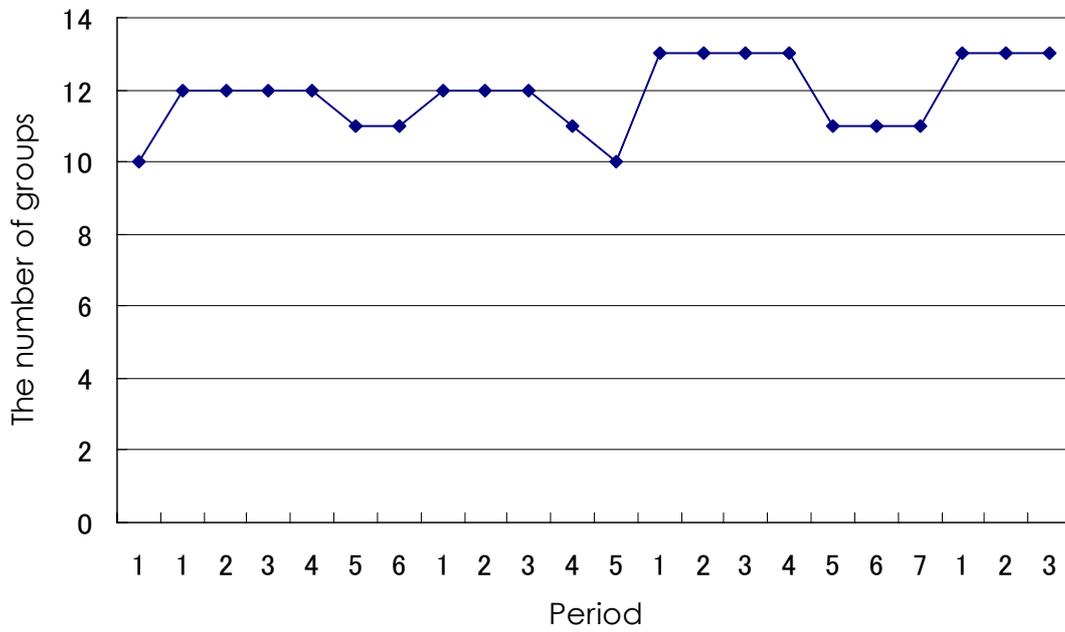


Figure 2. Time series of the number of collusive groups when only the first player who reports gets a reduced fine (two-person case)

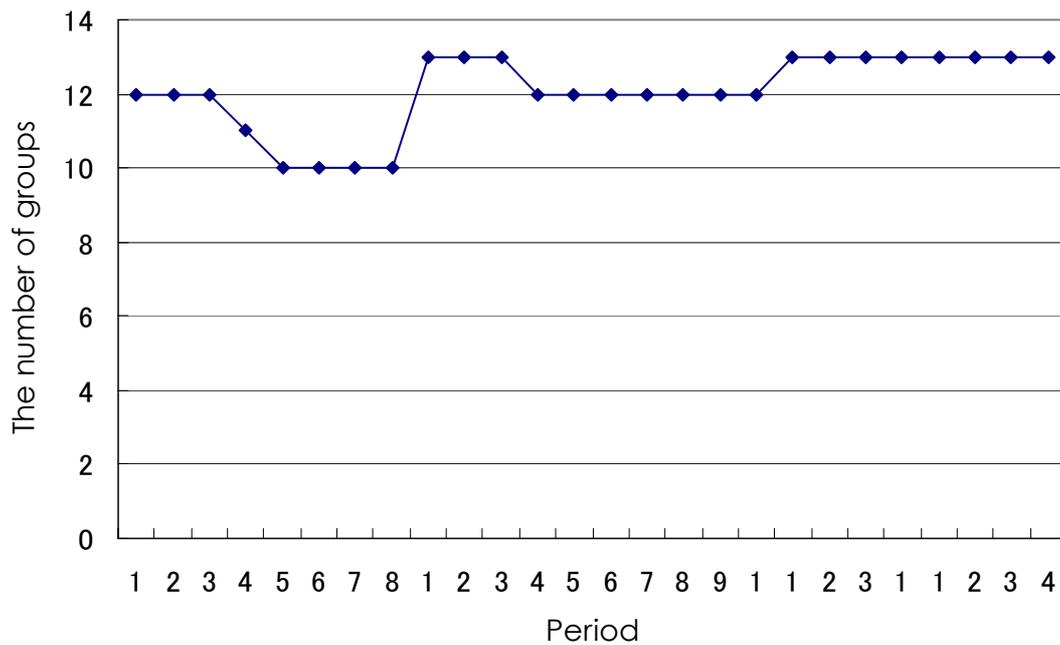


Figure 3. Time series of the number of collusive groups when all players who report get reduced fines (seven-person case) -session 1

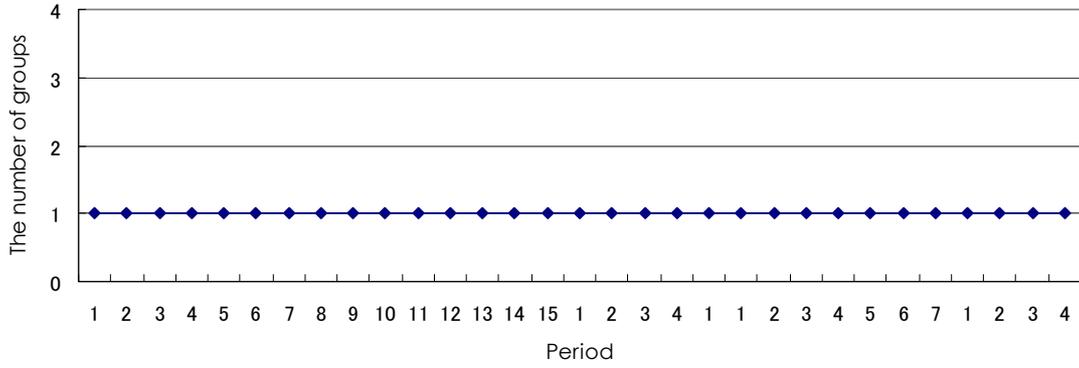


Figure 4. Time series of the number of collusive groups when all players who report get reduced fines (seven-person case) -session 2

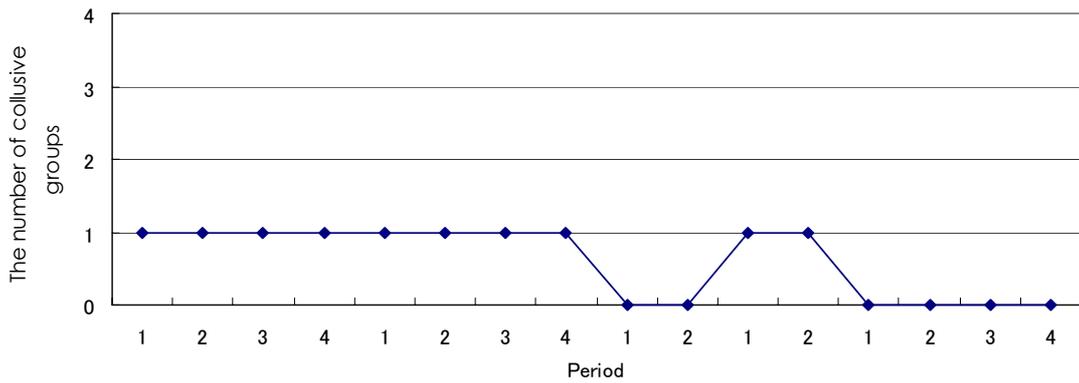


Figure 5. Time series of the number of collusive groups when all players who report get reduced fines (seven-person case) -session 3

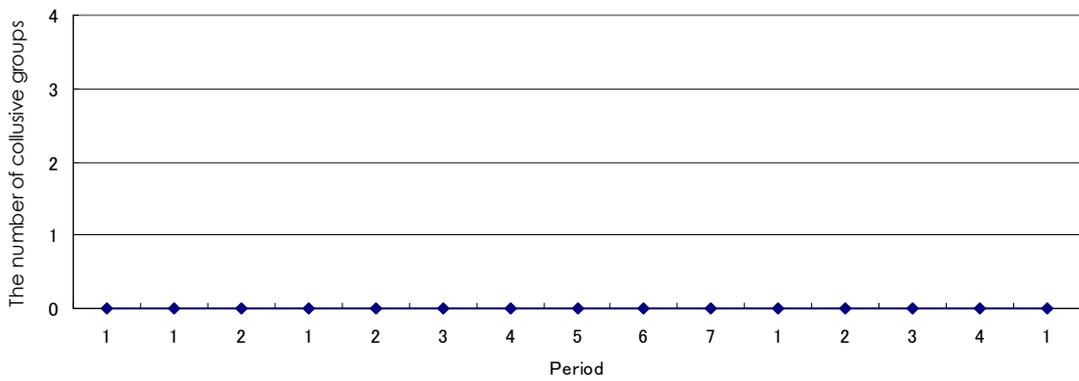


Figure 6. Time series of the number of collusive groups when only the first player who reports gets a reduced fine (seven-person case) - session 1

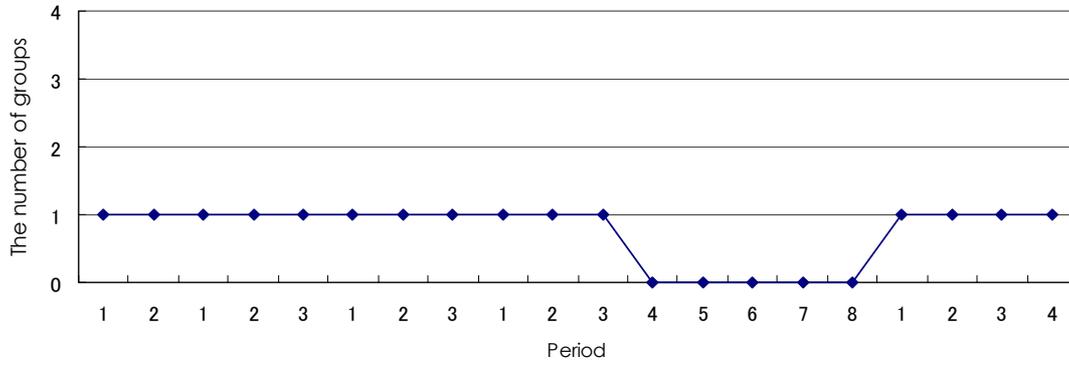


Figure 7. Time series of the number of collusive groups when only the first player who reports gets a reduced fine (seven-person case) - session 2

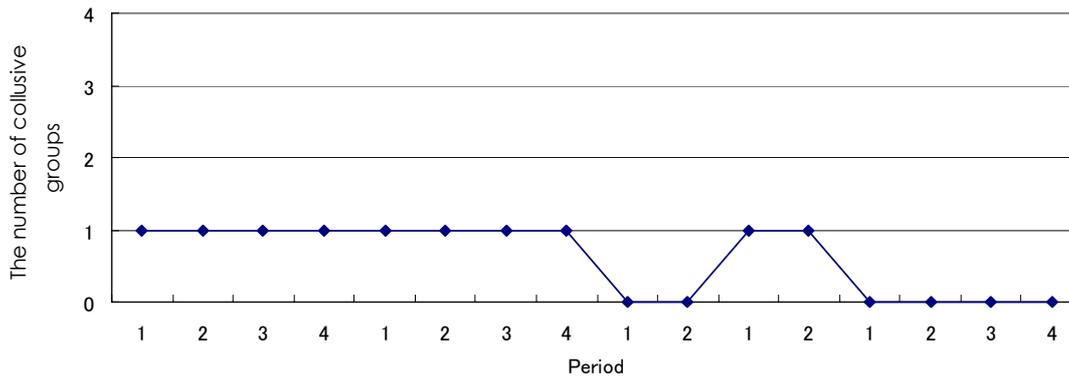


Figure 8. Time series of the number of collusive groups when only the first player who reports gets a reduced fine (seven-person case) - session 3

