# To squeal or not to squeal: an experiment on leniency[1]

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*Abstract*

Competition authorities around the world have adopted leniency programs creating incentives for cartel members to come forward and provide information sufficient for cartel prosecution. We conducted a laboratory experiment simulating an infinitely repeated 4-player Bertrand game with homogeneous goods. The experiment allowed us to determine the effect of penalty reduction, extent of penalty, and detection rate on cartel formation and leniency application. The different detection and penalty combinations effectively deterred cartel formation and reduced prices. Although leniency application rates are low, there is indication that full immunity (no penalty) is more attractive than options with reduced penalties.

## 1. INTRODUCTION

Illegal agreements among firms are highly profitable and difficult to detect. The formation and stability of a cartel is dependent on a long-term repeated interaction among parties. In addition to a degree of trust among cartel members, reputational considerations and credible threats preclude a member to deviate from agreements. Knowledge on how cartel members react to the risk of being detected and the private incentives available to a member who decides to cooperate with a competition authority are useful in designing an effective leniency program (Spagnolo 2005).

Competition authorities around the world have adopted leniency programs creating incentives for cartel members to come forward and provide information sufficient for cartel prosecution. Since the introduction of the US Corporate Leniency Policy for antitrust violations in 1978, other jurisdictions have implemented their own variants of a leniency program (Spagnolo 2008). The Philippine Competition Commission (PCC), established in 2016 by virtue of Republic Act 10668 (or the Philippine Competition Act), promulgated its leniency program in December 2018.[3] Although such programs have

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[3] Under Section 35 of the Philippine Competition Act, the Philippine Competition Commission "shall develop a Leniency Program to be granted to any entity in the form of immunity from suit or reduction of any fine which

led to the crackdown of cartels, it is unclear whether some designs are systematically better than others (Colino 2017). This provides scope for experimental investigation.

Experimental evidence indicates that leniency programs are welfare-improving given the decline in average prices following leniency implementation. However, results on the impact of leniency programs on the extent of reporting and the stability of remaining cartels are mixed. In the study of Hinloopen and Soetevant (2008), participants played a repeated 3-player Bertrand game with homogeneous goods. Communication among participants was allowed but restricted to the revelation of each cartel member's minimum and maximum acceptable prices. In this setup, cartels were short-lived either due to the timing of a member reporting the cartel, or the immediate detection of the cartel activity by the competition authority. Meanwhile, Bigoni et al (2011) imposed heterogeneous goods in a 2-player duopoly Bertrand game with restricted communication. Fewer cartels were formed but those that remained persisted for many periods.

Dijkstra et al (2014) allowed unrestricted direct communication in a repeated 2-player Bertrand game with homogeneous goods and examined the attractiveness of applying for leniency conditional on the probability of conviction, i.e. where few and profound investigations increase the probability of conviction. The high likelihood of detection led to more cartels reported. However, cartels created were stable on the back of unrestricted communication among cartel members.

We implemented an infinitely repeated 4-player Bertrand game[4] with homogeneous goods designed to determine the effect of penalty reduction and detection rate on cartel formation and leniency application. The combination of detection rates, penalties, and penalty reductions were used to simulate the options available to erring firms under PCC's Leniency Program. Similar to Dijkstra et al (2014), our experimental design allowed unrestricted (but time limited) communication. However, cartel members were allowed to report at any time during each round of the experiment, thus allowing the participants to outdo each other in terms of the timeliness of reporting. The probability of conviction was explicitly stated in terms of detection rate (ranging from zero to 50 percent). Penalties if caught were either 50 percent or 100 percent of own earnings, while the reduction in the penalty conditional on leniency application ranged from 50 percent to 100 percent of own earnings.

would otherwise be imposed on a participant in an anti-competitive agreement as provided in Section 14(a) and 14(b) of this Act in exchange for the voluntary disclosure of information regarding such an agreement which satisfies specific criteria prior to or during the fact-finding or preliminary inquiry stage of the case."

[4] Fonseca and Normann (2012) showed that the marginal benefit of communicating is maximized with 4 players relative to games with 2, 6, or 8 players. In addition, Bos and Harrington (2010) argued that in the context of an infinitely repeated capacity-constrained price game, a necessary condition for any *(n-1)* firms to meet competitive demand, if demand is linear, is that *n* must be greater than 3.

Our results show that the various options under the Leniency Program can significantly deter cartel formation. However, only the full immunity option appears to be attractive to participants who remain in cartels: leniency application is likely under immunity (no penalty) relative to options with reduced penalties, while immunity with higher penalty (if detected) does not significantly increase the probability of leniency application.

The rest of the paper is organized as follows: section 2 discusses the model, section 3 describes the experimental design, section 4 shows the results, and section 5 concludes. Appendices are provided at the end of the paper.

## 2. THEORETICAL MODEL

Our leniency experiment is based on the theoretical model described below, following the work of Dijkstra et al (2014), and Motta and Polo (2003).

### A. Model

Four firms denoted by $N = \{1,2,3,4\}$ play a Bertrand game. Each firm $i \in N$ produces the same homogenous product, has the capacity of producing a maximum of 50 units, and for simplicity supplies to consumers at zero production cost. The firms interact repeatedly over an infinite, discrete time horizon.

There are 120 consumers who each demand one unit of the good up to the reservation price of $p^{max} = 12$. In each period, firms choose prices $p_i \epsilon \{1,2,\dots,15\}$[5] simultaneously to maximize the present value of the profit stream with a common discount factor $\delta \in [0,1)$. A firm's resulting profits for each round depends on one's own price choice and on the price chosen by her competitors. At the end of the experiment, the resulting profits is the average of the earnings in all the rounds.[6]

Each firm produces to meet demand up until its capacity. Consumers buy first from the firm offering the lowest price until its capacity has been exhausted. In case more than one firm charges the same low price, the firms equally share the quantity demanded.

[5] Prices above consumers' reservation price were included to identify players who either do not follow instructions or have the tendency to overprice.

[6] We assumed a discount factor equal to 1, which means that the weight attached to earnings is equal across the periods given that the time for rival firms to respond to an episode of defection is short.

B. Without antitrust

Absent the possibility of collusion, while there exist multiple Nash equilibria, our benchmark is the payoff dominant equilibrium in which all firms set a price of $p^N = 1$. This yields a competitive profit of $\pi^N = \frac{120(P^N)}{n} = \frac{120}{4} = 30$. Thus, if firms play the competitive strategy in each period, the expected payoff of each firm is $V_N = \pi^N + \delta\pi^N + \delta^2\pi^N + \cdots = \frac{\pi^N}{1-\delta}$.

However, firms can coordinate prices above the competitive level by forming a cartel. In each period, firms have to simultaneously decide if they want to form a non-binding cartel which consists of at least 2 firms (partial cartel). Firms then simultaneously select a price $p_i \epsilon \{1,2, \ldots, 15\}$ but are not obliged to follow the agreed-upon price (if any) and therefore could subsequently undercut the cartel.

The joint profit maximizing price is the consumers' reservation price of $p^{max} = 12$, which yields a collusive profit of $\pi^C = \frac{120(P^{max})}{n} = \frac{120(12)}{4} = 360$. Thus, if firms collude in each period, the expected payoff of each firm is $V_C = \pi^C + \delta\pi^C + \delta^2\pi^C + \cdots = \frac{\pi^C}{1-\delta}$.

A cartel member, however, might defect from the cartel arrangement. If a cartel member decides to do so, then it will optimally set a price that is slightly lower than the agreed-upon price (which in this case = 11). Given that each firm is capacity constrained at this price further lowering the price is unprofitable. This is consistent with the model developed by Bos and Wandschneider (2013).

Assume that the formation of a cartel is sustained by means of a *grim-trigger strategy* where any deviation from the collusive price by a cartel member leads to each firm thereafter playing a static Nash equilibrium strategy. This implies that the deviating firm will gain a one-shot deviation profit of $\pi^D = 50(11) = 550$, followed by reversion to the competitive equilibria. Thus, the payoff associated with the unilateral deviation is: $V_D = \pi^D + \delta\frac{\pi^N}{1-\delta}$.

C. Antitrust[7] without leniency

Suppose that the competition authority may detect and prosecute collusion. Assume that in each collusive period, the probability of being caught and punished is $\alpha \in (0,1)$. If detected, each cartel member pays a fine of $F > 0$.

[7] This is discussed here albeit our experimental design does not include an antitrust treatment with no opportunity to apply for leniency.

If all firms collude in each period, each firm will expect to earn the collusive profit $\pi^C$ minus the fine $F$ with probability $\alpha$, and $\pi^C$ with probability $(1-\alpha)$. Thus, the expected payoff of each firm is $V_C = \alpha(\pi^C - F) + (1-\alpha)\pi^C + \delta V_{CR} = \frac{\pi^C - \alpha F}{1-\delta}$.

Consider a deviation. A cartel member who slightly undercuts the collusive price, will gain a one-shot deviation profit of $\pi^D$, and earn $\pi^N$ in future periods. Thus, the payoff associated with the unilateral deviation is $V_D = \alpha(\pi^D - F) + (1-\alpha)\pi^D + \delta\frac{\pi^N}{1-\delta} = \pi^D - \alpha F + \delta\frac{\pi^N}{1-\delta}$.

D. Antitrust with leniency

Consider the case where colluding firms can apply for leniency without incurring any cost for reporting. Without any leniency applicant, the competition authority discovers and penalizes a cartel with probability $\alpha$. With a leniency applicant, the competition authority discovers and penalizes a cartel for certain. Members of that cartel pay a fine $F > 0$.

Assume that only the first firm to apply obtains reduction of the penalty. Each member expects that the amount of discount it might receive due to leniency is given by $\theta \in [0,1]$, which gives the percentage of penalty reduction for the first applicant. That is, the member who first reports will pay a reduced fine equal to $(1-\theta)F$. Following Motta and Polo (2003), assume further that a cartel that has been detected and prosecuted will immediately revert to its collusive behavior.

*Collude and not report (CNR).* If firms always play collude and not report, each firm will receive the collusive profit $\pi^C$ in each period but will pay $F$ with probability $\alpha$. Thus, the expected payoff for playing CNR is $V_{CNR} = \alpha(\pi^C - F) + (1-\alpha)\pi^C + \delta V_{CR} = \frac{\pi^C - \alpha F}{1-\delta}$.

*Collude and report (CR).* Suppose a firm participates in the collusion and then reports the cartel to the competition authority. This firm will receive collusive profit $\pi^C$ less the reduced fine $(1-\theta)F$ in the first period and earns competitive profits $\pi^N$ in future periods. Meanwhile, the other cartel members will suffer the full fine $F$. Thus, expected payoff for CR is given by $V_{CR} = \pi^C - (1-\theta)F + \delta\frac{\pi^N}{1-\delta}$.

Consider a deviating firm that slightly undercuts the collusive price. This firm will gain a profit of $\pi^D$ and a competitive profit $\pi^N$ in future periods. Thus, the payoff associated with the unilateral deviation is $V_D = \alpha(\pi^D - F) + (1-\alpha)\pi^D + \delta\frac{\pi^N}{1-\delta} = \pi^D - \alpha F + \delta\frac{\pi^N}{1-\delta}$.

## 3. EXPERIMENTAL DESIGN

There are eight experiment conditions corresponding to combinations of detection rates and penalty reductions similar to options in PCC's Leniency Program (Table 1). For each treatment two sessions were conducted at the University of the Philippines (UP). Each session had 12 to 28 players and lasted for 45 to 60 minutes. The computer experiment was programmed in *Python* and implemented in *oTree*. (Chen et al 2016). Recruited participants (n=260) were advanced university students (graduating or postgraduate)[8] from various colleges in UP and nearby universities. The experiment instructions avoided any legal or economic jargon.

Each treatment consisted of two Parts. In Part 1, participants were randomly grouped into 4 (representing 4 equally sized firms) and played 5 practice rounds with the same group to help them become familiar with the tasks. After the practice rounds, participants were again randomly grouped with 3 other players who they encountered throughout Part 2. Each participant knew that her actual earnings at the end of the experiment was the average of her earnings per round in Part 2 plus a participation fee of PHP 100. Participants also knew that Part 2 may end at any round.

In Part 1, each participant was a seller who had access to 50 trinkets which could be sold at an offer price ranging from PHP 1 to PHP 12. Total supply at each round was 200 trinkets, but there were only 120 consumers who may buy only 1 trinket each per round at a maximum price of PHP 12. After all group members have submitted their offer price, consumers start buying trinkets starting from the lowest price until all the 120 lowest-priced trinkets were purchased. If participants in a group had the same offer price, a proportional rule was applied. For example, when one participant has sold all 50 trinkets and if the other 3 participants in the group had the same but higher offer price, they each sold 23 trinkets.

Before choosing an offer price at each round, a participant had the opportunity to interact with members of her group but with only those who had decided to use the time-limited chat window. Use of the chat window to discuss their offer price was free of charge and with risk of penalty (depending on the treatment). At the end of each round, the computer displayed the details of each group member's earnings. Throughout the experiment, participants had access to an on-screen calculator, a pen and paper which most players used to track prices and earnings.

[8] The experimenters opted to recruit only advanced university students on the assumption that younger students are less cunning or less likely to participate in organized crime.

The tasks in Part 2 were similar to Part 1. The participants knew that the actual number of Rounds will be randomly determined by the computer so that Part 2 may end at any time.[9] Participants decided whether to use the chat window to communicate with other players to agree on an offer price and set the individual offer price. However, in Part 2 participants knew that communicating through the chat window, regardless of the price agreement reached, may be penalized. If detected by the computer, the fine is equal to half of one's earnings in the current round. In the experiment, a (partial) cartel was formed if at least 2 of the 4 participants decided to chat. A cartel participant had the opportunity to either avoid or reduce the penalty of detection if she succeeds as the first player (or marker) in her group to self-report the use of the chat window by clicking on a report button on-screen. This action was similar to applying for leniency to a competition authority. The first marker in a group was shown a message that she was the first to self-report for that round, while other markers saw a message stating that another player has previously applied for leniency.

Below is a summary matrix of the treatments, with each condition corresponding to options available under the PCC's Leniency Program.[10]

| Conditions | Detection rate (%) | Penalty (% of earnings) | Fine reduction (%) |
|---|---|---|---|
| no chat | NA | NA | NA |
| no penalty | 0 | 0 | NA |
| full immunity | 15 | 50 | 100 |
| full penalty | 15 | 100 | 100 |
| leniency | 15 | 50 | 80 |
| reduced discount | 15 | 50 | 50 |
| high detection | 30 | 50 | 50 |
| higher detection | 50 | 50 | 50 |

Table 1. Summary of Experiment Conditions

## 4. HYPOTHESES

Hypothesis 1. Offer prices tend to be lower in the *no chat condition* relative to other conditions where players have an opportunity to coordinate with other players. The strategy to collude strongly dominates

[9] In each condition, there were at least 8 rounds each with 50% probability that the experiment will end after the 8th round.

[10] Another treatment with risk of *t+1* detection is not reported here. Under this condition, a successful immunity applicant avoids an administrative charge in period *t* but faces the possibility of a criminal charge in period *t+1*.

the strategy to compete independently and this is more pronounced when there is no possibility of penalty for coordinating.

Hypothesis 2. From the payoff values calculated (Appendix B), $V_C > V_N$ for any value of $\theta$, or penalty $F$. A cartel is likely to be formed regardless of the level of leniency discounts, or extent of penalty.

Hypothesis 3. $V_C$ decreases as the detection rate increases, ceteris paribus. Cartels are more likely to form and prices will be higher under reduced discount ($\alpha = 15\%$), followed in decreasing magnitude by high detection ($\alpha = 30\%$) and higher detection ($\alpha = 50\%$). Thus, controlling for the level of leniency discounts, higher detection rates make the formation of cartels less likely.

Hypothesis 4. Cartels will be stable. Firms always have an incentive to collude across all treatments since $V_C > V_D$. The value of defection $V_D$, however, decreases as the detection rate increases, ceteris paribus That is, the number of deviations from the collusive price is highest under reduced discount ($\alpha = 15\%$), followed in decreasing magnitude by high detection ($\alpha = 30\%$) and higher detection ($\alpha = 50\%$). Also, the $V_D$ decreases as the extent of penalty increases, ceteris paribus; deviations are less likely under full penalty ($F = 100\%$) than under immunity ($F = 50\%$).

Hypothesis 5. There is no self-reporting regardless of the level of leniency discounts, since $V_{CNR} > V_{CR}$ at various levels of $\theta$. Hence, cartel members always have an incentive to keep mum about the cartel. Controlling for detection rate, such incentive is high under reduced discount ($\theta = 50\%$) followed in decreasing magnitude by leniency ($\theta = 80\%$) and immunity ($\theta = 100\%$) .

Hypothesis 6. There is no self-reporting regardless of the detection rate $\alpha$, since $V_{CNR} > V_{CR}$. The value of colluding and not reporting is highest under reduced discount ($\alpha = 15\%$), followed in decreasing magnitude by high detection ($\alpha = 30\%$) and higher detection ($\alpha = 50\%$).

Hypothesis 7. There will be no self-reporting regardless of the extent of penalty, since $V_{CNR} > V_{CR}$ at various levels of $F$. The value of colluding and not reporting is higher under immunity ($F = 50\%$) than under full penalty ($F = 100\%$).

## 5. RESULTS

The experiment sessions were participated in by university students who pre-registered online. Participants were advanced university undergraduate students (80%) and graduate students (20%); 44%

are females. Mean age is 22.6 years, with range of 19 to 47 years. 24% of the participants revealed that they have engaged in betting in the past 6 months, 11% of players do not feel constrained to engage in illegal behavior and 38% are likely to violate rules if probability of detection is low. Maximum possible earnings during the experiment is PHP 700 (~USD 13.4). Range of actual earnings is PHP 100 (~USD 1.9) to PHP 605.56 (~USD 11.6), with a mean of PHP 264.65 (~USD 5.1) and standard deviation of PHP 95.81 (~USD 1.8).

**Result 1:** Players tend to offer higher prices when there is no penalty for coordinating. The average offer price under the ***no chat*** treatment (mean=3.47) quickly drops to 2.9 by the 10$^{th}$ actual round (15$^{th}$ round overall) compared to the ***no penalty*** treatment (mean=9.37) which reaches an average offer price of 10.2 by the 10$^{th}$ actual round. This result becomes more apparent when we examine the minimum offer price under the no chat condition which falls off to 1 by as early as the 4$^{th}$ actual round (9$^{th}$ round overall) while the no penalty condition registers a minimum offer price of 5 at the same point in the game.

Figure 1. Average offer price per round

Figure 2. Minimum offer price per round

**Result 2**: Cartel formation is prevalent but the introduction of a leniency program serves as a significant deterrence. Controlling for detection rate (at 15%), cartel membership tends to be more prevalent when the reduction in penalty is less attractive. Chat window usage rate under ***reduced discount*** (mean=33.6%) relative to ***leniency*** (mean=25.0%) is statistically significant (ranksum=-2.14, p=0.03); we find a similar observation under ***full immunity*** (mean=19.7%; ranksum=-2.40, p=0.02).

Meanwhile, players tend to offer higher prices when fine reduction is higher. Ranksum test results reveal a statistically significant difference in prices between the full immunity (mean=8.42) and leniency

treatments (mean=6.71; ranksum=5.00, p=0.00), and between leniency and reduced discount (mean=5.52; ranksum=4.83, p=0.00).

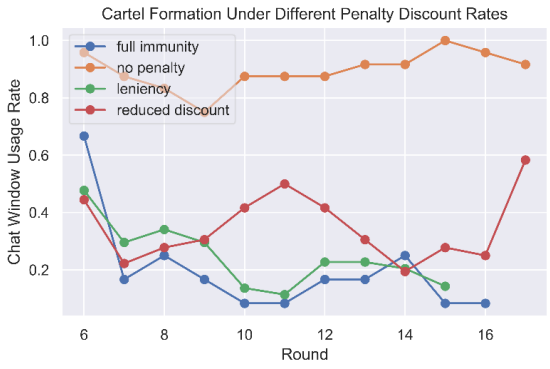


Figure 3. Chat window usage by discount rate

Figure 4. Average offer price by discount rate

No surprise that the ***no penalty*** treatment registers the highest chat window usage rate, but usage rate fails to hit 100% in most rounds (average=89.6%). Although some players opt for a strongly dominated strategy, there is indication of learning as chat window usage and average offer prices are both higher in subsequent periods.

**Result 3**: Controlling for the reduction in penalties (fixed at 50% of earnings in the current round, if caught), the downward trend in average prices observed is not significantly different across the treatments.

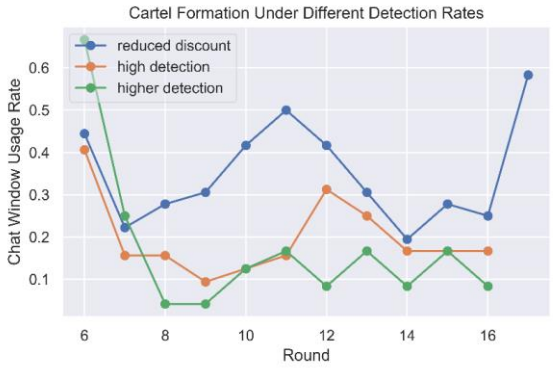


Figure 5. Chat window usage by detection rate

Figure 6. Average offer price by detection rate

However, we find that higher detection rates tend to discourage cartel formation. This is most evident under the ***higher detection*** treatment (mean=18.0%) which starts off with 67% chat window usage rate but quickly drops off to 4% by the 3rd actual round (8th round overall). The ***reduced discount*** (mean=33.6%) and ***high detection*** treatments (mean=20.1%) start off with similar chat window usage

rate at 44% and 41%, respectively. Cartel formation is consistently more prevalent under reduced discount, peaking at 50% in the 6th actual round (11th round overall).

**Result 4**: Our model suggests that firms have an incentive to collude so that cartels will tend to be stable. However, we find that deviation from the agreed action among users of the chat window is not uncommon. Controlling for fine reduction, players under the ***reduced discount*** treatment had the highest number of opportunities to defect[11] (i.e. agreed on a common price during use of the chat window) and exhibited relatively the lowest defection rates (mean=19.3%). The defection rates in the ***high detection*** (mean=34.6%) and ***higher detection*** (mean=28.0%) treatments are not statistically different (ranksum=0.41, p=0.69).

**Result 5**: The likelihood of cartel participants applying for leniency is low. Controlling for detection rate (fixed at 15%), we find the highest report rate occurs under the ***immunity*** condition followed by ***full penalty*** (i.e. immunity condition with 100% penalty if caught). The ranksum test results indicate that there is no statistically significant difference in the report rates between these two treatments (ranksum=0.29, p=0,77), suggesting that doubling the possible penalty does not significantly affect the likelihood of leniency application.

Leniency application under ***immunity*** is also not significantly different from the ***leniency*** condition (ranksum=0.76, p=0.45) and ***reduced discount*** condition (ranksum=0.75, p=0.45). We note that about half of the reporting instances occurred on the sixth round (or at the start of Part 2). Given the novelty of the *red button*, curiosity rather than the desire to retaliate may have triggered the clicking of the red button.

| Treatment | Report Opportunities[12] | Actual Number of Reports | Report Rate (%) |
|---|---|---|---|
| Full Immunity | 26 | 3 | 11.5 |
| Full Penalty | 53 | 4 | 7.6 |
| Leniency | 106 | 2 | 1.9 |
| Reduced Discount | 137 | 3 | 2.2 |

Table 2. Leniency application by reduction in penalty

**Result 6**: As predicted by the model, self-reporting is unlikely under detection rate of 15 to 50 percent. Controlling for the discount on penalty (fixed at 50%), the likelihood of having a leniency applicant is highest under the ***higher detection*** condition, corresponding to a situation where a competition authority

[11] A player is defined as having the *opportunity to defect* when they use the chat window with more than one other player. A player is defined to have *defected* when she has had the opportunity to defect in a particular round and the offer price in that round is lower than the agreed common price.
[12] Only players who used the chat window during Part 2 are identified as having the opportunity to report.

is in the advanced stage of its investigation. However, we find that leniency application under higher detection is not significantly different from the ***high detection*** condition (ranksum=0.28, p=0.78) and ***reduced discount*** condition (ranksum=0.26, p=0.79).

| Treatment | Report Opportunities | Actual Number of Reports | Report Rate (%) |
|---|---|---|---|
| Reduced discount | 137 | 3 | 2.2 |
| High detection | 61 | 1 | 1.6 |
| Higher detection | 41 | 2 | 4.9 |

Table 3. Leniency application by detection rate

Model simulations indicate that a significantly higher detection is required to induce self-reporting. Under full immunity and full penalty, detection rate must be at least 69 percent. When discount of penalty is reduced at 80 percent, a higher detection rate of 74 percent may induce self-reporting.

Despite deviations from the agreed common price, participants do not use the leniency program to retaliate, unlike in Hinloopen and Soetevent (2008) where they showed that application for leniency is likely in groups where deviation has occurred. We also note that these report rates are very low relative to the leniency application rates found by Dijkstra et al (2014) and Bigoni et al (2012) where participants deviated and reported.

## 6. CONCLUSION

The introduction of an antitrust regime with a leniency program, regardless of detection rate or extent of discount on penalty, deters cartel formation and lowers offer prices. However, the likelihood of self-reporting is low across the combinations of detection rate, extent of penalty, and discount rates. Among participants who remain in cartels, there is indication that full immunity is more attractive relative to options with reduced penalties. A high probability of detection (at least 69 percent) is necessary to induce self-reporting. Considering the impact of leniency application on the stream of earnings and reputation, as pointed out by members of chambers of commerce and law practitioners in the Philippines, self-reporting is unlikely unless the probability of cartel detection is high.

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APPENDIX A: INSTRUCTIONS (IMMUNITY TREATMENT)

## Part 1 Instructions

Welcome to today's experiment on decision-making. Please fill in the consent form on your desk.

Turn off your mobile phones and other devices, as they may not be used during today's session. Refrain from talking to other participants during the experiment. If you have a question, please raise your hand and one of the experimenters will come and answer it privately.

Each of you will earn PHP100 for participating in today's session. You will have the opportunity to earn an additional amount of money which will depend on a series of decisions you will make and the decisions of other participants. You will receive your earnings privately before you leave today.

This experiment has two Parts. Part 1 consists of 5 practice rounds to help you become familiar with the computer screens. In Part 2, the actual number of Rounds will be randomly determined by the computer. Only your earnings in Part 2 will be paid to you in cash. Your actual earnings in this experiment will be your average earnings in Part 2 plus a show-up fee of PHP100. We will describe your tasks in Part 2 after we complete Part 1.

### YOUR TASKS

In this experiment, you will play the role of a seller. In every Round, you will have access to 50 trinkets. You will decide at what offer price, ranging from PHP 1 to PHP 15, you are willing to sell all your trinkets.

At the beginning of Part 1, the computer will randomly group you with 3 other participants in this room or in the other room. They will be the same people you will encounter throughout Part 1.

In every Round, there are 200 trinkets that are available for sale. However, there are only 120 consumers who buy only 1 trinket each per Round at a maximum price of PHP 12. This means that it is not possible for all 4 members of your group to sell all their trinkets.

### CHAT WINDOW

For each Round, you will have the opportunity to interact within your group before choosing your offer price. If you choose to communicate, a chat window will be available for 60 seconds. You may discuss your offer price but you are not allowed to reveal your identity, your location in the room, or any other personal information about yourself.

### YOUR SALES

After the chat window closes, you will select your offer price. After everyone has submitted their offer price, consumers will start buying trinkets starting from the lowest price until all the 120 lowest-priced trinkets are purchased.

If participants in your group have the same offer price, a proportional rule will be applied. For example, when one participant has sold all 50 trinkets and if the other 3 participants in the group have the same but higher offer price, they will each sell 23 trinkets.

At the end of each Round, the computer will display the details of your earnings and the earnings of the other participants in your group. Refer to the sample screen below.

You are playing Part 1. In practice Round 1

| | |
|---|---|
| Player 1 (you) would have earned PHP 500, | having sold 50 trinkets at an offer price of PHP 10. |
| Player 2 would have earned PHP 420, | having sold 35 trinkets at an offer price of PHP 12. |
| Player 3 would have earned PHP 420, | having sold 35 trinkets at an offer price of PHP 12. |
| Player 4 would have earned PHP 0, | having sold 0 trinkets at an offer price of PHP 15. |

At any time during the experiment, you will have access to a calculator displayed on your computer screen. An extra sheet of paper is also on your desk which you may use for note taking.

If you have a question, please raise your hand and one of the experimenters will come and answer it privately.

If you have no question, please click on the button labelled “Next” that appears on your screen. You will see a series of questions that you need to answer correctly. You may refer back to these instructions at any time during the experiment.

## Part 2 Instructions

In Part 2, you have the opportunity to earn an additional amount of money equal to the average of your earnings per Round. The actual number of Rounds will be randomly determined by the computer. This means that Part 2 may end at any time but will not last for more than 30 minutes.

### YOUR TASKS

Your tasks in Part 2 are similar to your tasks in Part 1. In every Round, you will have access to 50 trinkets. You will decide at what offer price, ranging from PHP1 to PHP15, you are willing to sell all your trinkets. In every Round, there are 200 trinkets that are available for sale. However, there are only 120 consumers who buy only 1 trinket each per Round at a maximum price of PHP12. This means that it is not possible for all 4 members of your group to sell all their trinkets.

The computer will again randomly group you with 3 other participants in this room or in the other room. It is possible that the participants you will encounter in Part 2 may be the same as or may be different from the participants you encountered in Part 1. However, they will be the same people you will encounter throughout Part 2.

### CHAT WINDOW

For each Round, you will have the opportunity to interact within your group before choosing your offer price. If you choose to communicate, a chat window will be available for 60 seconds. You may discuss your offer price but you are not allowed to reveal your identity, your location in the room, or any other personal information about yourself.

### YOUR GROSS EARNINGS

Towards the end of each Round, the computer will display the details of your earnings and the earnings of the other participants in your group. Refer to the sample screen below.

| You are playing Part 2. In Round 3 | |
|---|---|
| Player 1 (you) earned PHP 300, | having sold 30 trinkets at an offer price of PHP 10. |
| Player 2 earned PHP 300, | having sold 30 trinkets at an offer price of PHP 10. |
| Player 3 earned PHP 300, | having sold 30 trinkets at an offer price of PHP 10. |
| Player 4 earned PHP 300, | having sold 30 trinkets at an offer price of PHP 10. |

### PENALTY

In Part 2, the computer is programmed to partially detect your use of the chat window. At the end of every Round, there are 15 out of 100 chances (or 15 percent) that the computer will detect your use of the chat window. If the computer detects your use of the chat window, you will pay a penalty equal to 50 percent of your earnings in the current Round.

You will have the opportunity to avoid the possible penalty by reporting that your group used the chat window in the current Round. To report, click on the button labelled “Report” located on the upper-right-hand corner of the screen.

Refer to the sample screen below.

In every round, the first participant in your group who clicks on the button labelled "Report" shall not pay any penalty. The other users of the chat window will pay the full penalty.

Let us consider an example. Imagine that you are in Round 3. All participants in your group used the chat window and earned PHP 300 each. Below are two scenarios.

| Scenario | Penalty in Round 3 |
|---|---|
| (1) No one in your group clicked on the "Report" button in Round 3 | • If the computer detects (with 15% chance), all users of the chat window pay a penalty of PHP 150 (or 50% of PHP 300)<br>• If the computer does not detect, all participants pay zero penalty |
| (2) Someone in your group clicked on the "Report" button in Round 3 | • The first person who clicked on the "Report" button for sure pays zero penalty<br>• The other users of the chat window for sure pay the full penalty of PHP 150. |

YOUR NET EARNINGS

At the end of each Round, the computer will display your earnings and all penalties, if any. Refer to the sample screen below.

You are playing Part 2. You are in Round 3.

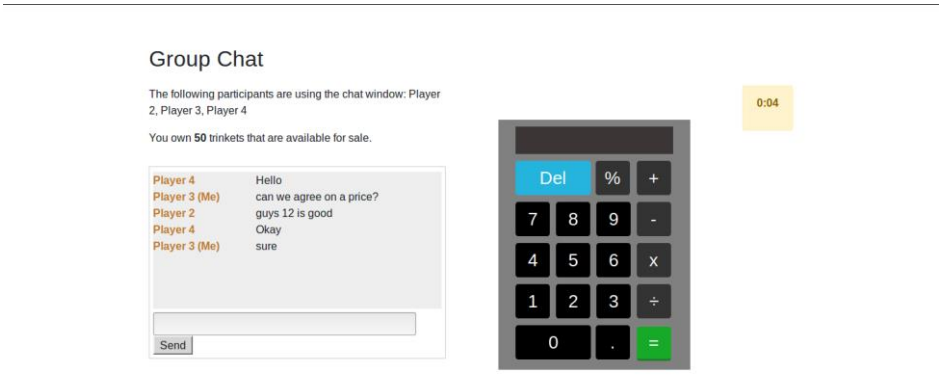
| | Gross earnings | Penalty | Net earnings |
|---|---|---|---|
| Player 1 (you) | _____ | _____ | _____ |
| Player 2 | _____ | _____ | _____ |
| Player 3 | _____ | _____ | _____ |
| Player 4 | _____ | _____ | _____ |

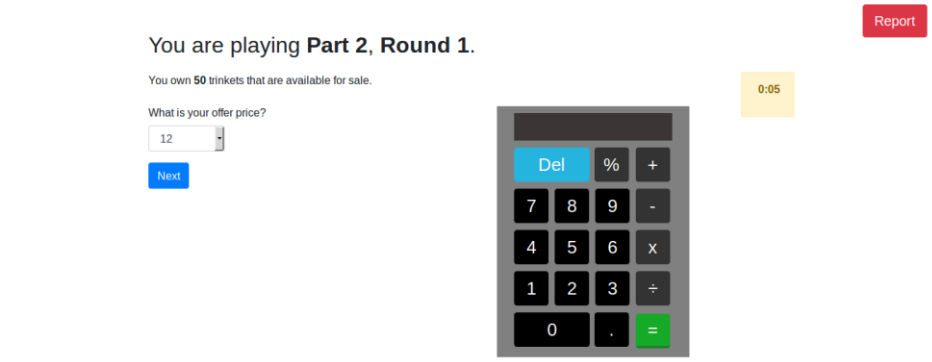
At any time during the experiment, you will have access to a calculator displayed on the computer screen. An extra sheet of paper is also on your desk which you may use for note taking.

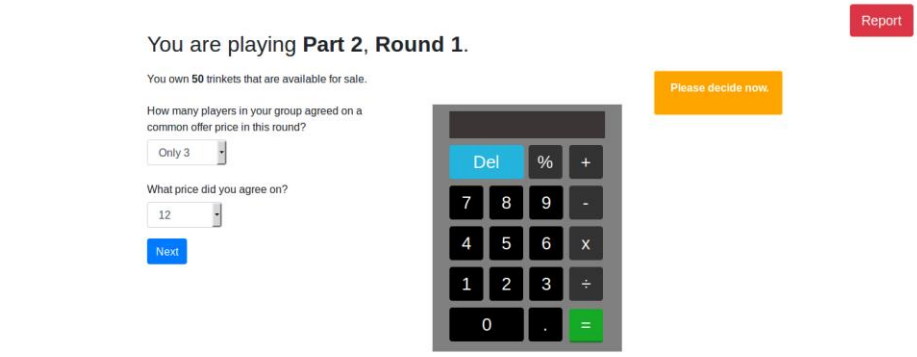
Remember that your actual earnings in this experiment will be your average earnings in Part 2 plus a show-up fee of PHP100.

If you have a question, please raise your hand and one of the facilitators will come and answer it privately. If you have no question, please click on the button labelled "Next".

APPENDIX B: SAMPLE SCREENS



APPENDIX C: PARAMETERS

In the experiment, the payoff from one-shot collusion ($\pi^C$) is 360, the payoff from not colluding ($\pi^N$) is 30, and the payoff from defecting is ($\pi^D$) is 580.

Table 1 below gives the values of the parameters used for each treatment. Across all treatments, the discount factor is 0.75, and the fine $F$ is obtained as a percentage of the collusive profit. We consider various levels of leniency discounts $\theta$, and probability of detection $\alpha$, and penalty $F$,

*Table 1. Values of parameters by treatment*

| | Baseline 1 | Baseline 2 | Leniency Treatments | | | | | |
|---|---|---|---|---|---|---|---|---|
| | No antitrust | No leniency | Leniency | Immunity | Reduced Discount | High detection | Higher detection | Full Penalty |
| Penalty, $F$ | NA | 50% | 50% | 50% | 50% | 50% | 50% | 100% |
| Leniency discount, $\theta$ | NA | NA | 80% | 100% | 50% | 50% | 50% | 100% |
| Prob. of detection, $\alpha$ | NA | 15% | 15% | 15% | 15% | 30% | 50% | 15% |

Using these parameters, we compute the applicable value functions for each treatment. Table 2 below provides a summary of the results.

*Table 2. Calculated values of different strategies by treatment*

| | Baseline 1 | Baseline 2 | Leniency Treatments | | | | | |
|---|---|---|---|---|---|---|---|---|
| | No antitrust | No leniency | Leniency | Immunity | Reduced discount | High detection | Higher detection | Full penalty |
| $V_{CR}$ | | | 414 | 450 | 360 | 360 | 360 | 450 |
| $V_{CNR}$ | | | 1332 | 1332 | 1332 | 1224 | 1080 | 1224 |
| $V_D$ | 670 | 643 | 643 | 643 | 643 | 616 | 580 | 616 |
| $V_C$ | 1440 | 1332 | | | | | | |
| $V_N$ | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |