Competition to commit crime: An economic experiment on illegal logging using behavioral game theory

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ABSTRACT

This study constructs an economic experiment using behavioral game theory to figure out policies that discourage illegal logging in Thailand. A player is assigned to be either a police or an outlaw in the game. The game randomly matches two players in different roles. The lawbreaker can offer a bribe to police under uncertainties whether the police may refuse it or reject the offer because of too small amount of the bribe. Even when bribery is accepted, it is still uncertain for an lawbreaker that he may be arrested afterwards. The study compares the decisions to give bribe and commit illegal logging in two scenarios. First, it compares the results between two regimes of incentives for police; high punishment with low reward versus low punishment with high reward. Second, it compares the decisions of an lawbreaker when he is independent to other lawbreakers and when he faces competitions among lawbreakers. Findings show that most of lawbreakers offer bribes to police. Lawbreakers under a competitive situation offer higher amount of bribe. Police tends to accept briberies and let the outlaws commit the logging. However, illegal logging is relatively discouraged when police is attracted by high arresting reward rather than suppressed by strong punishment for not arresting the lawbreakers. The study concludes that despite illegal logging is naturally attractive for lawbreakers especially in the competitive situation it can be discouraged by applying the incentive of high arresting reward to police.

Keywords: Illegal logging, bribery, reward and punishment, behavioral game theory, experimental economics

JEL Classification: C91, C71, C54

1. Rationale

Illegal logging has become more severe which cannot be solved permanently even though there is a strict control law. This problem is caused by internal corruption in organizations. Therefore, it is not difficult for lawbreakers to have a cooperation with officials through bribery negotiation process which widely happens in almost every field in Thailand. Such process is regarded as a failure of non-transparent and dishonest administration which leads to some effects in the society.

The problem on illegal logging through the bribery process is a main reason of rapid forest decline. The lawbreakers take an advantage from this unlawful procedure for their convenient illegal logging without any impediment from concerning officials or organizations. It is difficult to untangle the problem constantly due to the conspiracy of internal officers. Thus, simulation scenarios are necessary for an analysis of resolutions towards the illegal logging stemmed from human's decisional behavior regarding to economic theories, especially specific issues related to the study while other factors are unchanged.

Game theory is applied as a tool for the analysis of decisional behavior or strategies associated with conditions and rules used to control the relationship between the game players. Simple mathematical model is taken to investigate complicated social involvement. The theory explains potentials and risks coming along with the decisional behavior. In economic aspect, it is very helpful to examine the economic decision making behavior because the game theory helps better understand the results which may happen in the real world to vastly solve social situations.

An economic experiment on illegal logging using behavioral game theory under the game theory's concept is the simulation scenarios based on experimental economics which focus on the analysis and comparison of the decisional behavior of 48 respondents (24 pairs). These samples' characters include both lawbreakers and officials (policemen) under the simulation scenarios of the illegal logging through the bribery process. Moreover, another issue in the game is analyzed and compared by the author which is the samples' decisional behavior under the condition of deforestation control policies and changing environment to apply the result to solve the problem and achieve defined goal.

2. Objectives of the study

1) To analyze and compare the decisional behavior of the samples under different policies consisting of reward and penalty if the officials responsible for the illegal logging ignore their duties

2) To analyze and compare the decisional behavior of the samples under the situation with and without the competition of bribery process between the lawbreakers

3) To explore factors affecting the lawbreakers' decision making behavior in the illegal logging

3. Conceptual framework

Game theory is a concept used to study the decisional behavior and the rationality of 2 persons or more in the same situation. The result of each situation depends on each respondent's decision making to response to such situation. Consequently, in each decision making, one has to consider several elements in the situation and possibility of others' selection which may cause an effect.

Regarding to Samuel Bowles's literature (2003), he notes that human's decisional behavior is investigated under the ultimatum game and the game theory to test hypothesis of the rationality of decision making. He indicates that the decisional behavior relies on institutional rules or simulation game which can determine the behavior and value of the game players. Additional, when certain rules are adjusted, the game players' behavior, the result or the balance of game will be changed too. This kind of situation does not hinge on any rules or conditions because one expects that the result of his or her decisional behavior will give the most advantage but the least disadvantage. Therefore, study proposes an economic experiment on illegal logging using behavioral game theory under the ultimatum game and the same conceptual framework.

4. An economic experiment on illegal logging using behavioral game theory

Details of the experiment on illegal logging are described as follows:

4.1 Players: Lawbreakers and officials (policemen)

4.2 Strategies: Alternatives to decision making of both lawbreakers and officials (policemen)

1st *decision making*

    Lawbreakers : offer the officials the bribes or do not offer the officials the bribes

2nd *decision making*

    Officials (Policemen) : The officials take the bribe or do not take the bribe.

3rd *decision making*

    Lawbreakers : The lawbreakers engage in the illegal logging or do not engage in the illegal logging.

4th *decision making*

    Officials (Policemen) : If the lawbreakers decide to make the illegal logging, the policemen will decide to do their duty to arrest the lawbreakers or ignore them following an agreement of cutting tree.

4.3 Payoffs: The result of the decision making will be presented as utility and reward of the lawbreakers and the officials (policemen)

4.4 Rules: The game players were divided into groups; the lawbreakers and the policemen. All of them must make their decision for 4 times (the lawbreakers made their decisions in the 1st and 3rd round while the policemen make their decisions in the 2nd and 4th round).

1) The lawbreakers started to play the game in the 1st round.

2) The lawbreakers had 2 choices for their decision making in the 1st round including offering the policemen the bribe or offering them nothing. In case of giving the bribe, a specific amount must be defined.

3) The policemen had 2 options in the 2nd decision making that they might accept the bribe from the lawbreakers or refuse the bribe from the lawbreakers.

4) The lawbreakers had 2 alternatives in the 3rd decision making that they might make the illegal logging or not make the illegal logging.

5) The policemen had 2 choices in the 4th decision making that, in case of the lawbreakers made the illegal deforestation, they would decide to do their duty to arrest the lawbreakers or ignore their duty regarding to the agreement of bribery.

In each decision making process of both parties of the game players, it led to the utility or satisfaction level from the decision making which was shown in an equation below.

Utility of lawbreakers = Value of trees – Value of bribe – Value of risk of being
                                       arrested

Remarks : If the lawbreakers were arrested, the value of risk of being arrested =
          2×(value of trees)

          If the lawbreakers were not arrested, the value of risk of being arrested = 0

Utility of policemen   =   Value of reward + Value of bribe – Value of fear due to
                               breaking a promise – Value of loss caused by government
                               punishment in case of refraining from doing their duty

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Remarks: Value of reward = % of value of trees

           Value of fear due to breaking a promise = 10×(value of reward)

Value of loss caused by government punishment :

In case of refraining from doing their duty $= \theta P$

In case of no arrest following the agreement of the bribery process $\mathbf{\theta} = 0$

4.5 Objective of the game: To receive maximized benefits for the highest satisfaction as much as possible.

4.6 Choice: Rational and careful decision making.

Regarding to the illegal logging game, the author was able to predict the decisional behavior of the sample by conducting a tool of economic statistics to analyze the data and the results collected from the experimental game.

5. Methods of data collection

In this research, a process of experimental economics was applied to the illegal logging game in July 2011 at Chiang Mai Laboratory of Experimental Economics.

The experiment of the illegal logging game aimed to inspect the decisional behavior in negotiating of 48 samples (24 pairs) under the simulation scenarios of the illegal logging through the bribery process selected from random sampling to diminish deviation in the experimental game. Then it was analyzed and compared under the following conditions.

1) The high reward policy under the condition without any bribery competition between the lawbreakers[1].

2) The high reward policy under the condition with the bribery competition between the lawbreakers[2].

3) The heavy punishment policy if the officials refrained from doing their duty under the condition without any bribery competition between the lawbreakers.

4) The heavy punishment policy if the officials refrained from doing their duty under the condition with the bribery competition between the lawbreakers.

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[1] There was one lawbreaker and one policeman for the bribery negotiation process.

[2] Each lawbreaker offered 12 policemen the bribe. The only one who offered the highest amount of bribe would continue the play in the next round.

The purpose of data collection was to gather the result of the samples' decisional behavior under each condition. Thus, each experiment was separately conducted whereas the samples must follow the same rules of the game.

The data assembled from the experimental game was quantitative data and it was analyzed by non-parametric statistical analysis to figure out the tendency of the samples' decisional behavior.

6. Methods of data analysis

Additional, Wilcoxon signed rank test was applied to analyze matched data while Wilcoxon-Mann-Whitney Test was used to analyze unmatched data and compare average. Besides, logit model for panel data was conducted for probability prediction of the illegal logging and the factors of illegal logging as shown in the following equation.

$$cut = f \text{ (bribe value, policy, accept bribe)}$$

Dependent variable:

cut is the decision of making the illegal logging

cut= 1, to decide to make the illegal logging

cut= 0, not to decide to make the illegal logging

Independent variable:

bribe value = value of bribe offered for the illegal logging

policy = a used policy:

policy = 1, High punishment and low reward

policy = 0, Low punishment and high reward

accept bribe = to take money or gift giving to alters the behavior:

accept bribe =1, to take money or gift giving to alters the behavior

accept bribe =0, to refuse money or gift giving to alters the behavior

7. Findings and discussions

The results of the illegal logging game were divided into 2 parts: non-parametric statistical analysis and econometrics analysis using logit model for panel data as follows.

7.1 Non-parametric statistical analysis

Under the condition without bribery competition between the lawbreakers (a match of 1 lawbreaker and 1 policeman for the bribery negotiation), the different policies could change the samples' decision making as described below

- The percentage of the samples' bribery process seemed to be 100 percent increase when enforcing the high reward policy. Nevertheless, the percentage of high punishment policy when the officials refrained from doing their duty was at 66.67 percent only.

- The percentage of accepting the bribe of the samples seemed to be 25 percent increase whereas the percentage of heavy punishment policy when the officials refrained from doing their duty was at 8.33 percent only.

- The percentage of the samples' illegal logging seemed to be 41.67 percent increase when enforcing the high punishment policy when the officials refrained from doing their duty. On the contrary, the percentage of bribery acceptance was at 25 percent when using the high reward policy.

- The percentage of being arrested of the samples' illegal deforestation seemed to be 41.67 percent increase when applying the high punishment policy when the officials refrained from doing their duty. On the other hand, the percentage of bribery acceptance was at 25 percent when using the high reward policy.

Under the condition with bribery competition between the lawbreakers (each lawbreaker offered 12 policemen the bribery negotiation and the only one who proposed the highest amount of bribe would be considered in the next round), the different policies could alter the samples' decision making as follows.

- The percentage of the samples' bribery process was similar but the percentage of the bribery process was higher at 83.33 percent when using the high punishment policy if the officials refrained from doing their duty. However, the percentage of the bribery process was at 75 percent when applying the high reward policy.

- The percentage of the samples' bribery acceptance seemed to be 75 percent increase whereas the percentage of the bribery acceptance was at 41.67 percent when enforcing the high punishment policy if the officials refrained from doing their duty.

- The percentage of the samples' illegal logging was similar. Notwithstanding, the percentage of the illegal logging was higher at 91.67 percent when applying the high punishment policy if the officials refrained from doing their duty whereas the percentage of the bribery process was at 83.33 percent when using the high reward policy.

- The percentage of being arrested of the samples' illegal deforestation seemed to be 58.33 percent increase when enforcing the high punishment policy if the officials refrained from doing their duty meanwhile the percentage of being arrested of the samples' illegal logging was at 8.33 percent when applying the high reward policy.

TABLE 1. Percentage of the samples' decisional behavior between the high punishment policy and high reward policy if the officials refrained from doing their duty under the condition with bribery competition and without bribery competition

Decision	Obs.	Policy 1 (High punishment and low reward)			
		Amount of obs.		Percentage	
		Individual outlaw	Competition among outlaws	Individual outlaw	Competition among outlaws
Bribe	12	8	10	66.67	83.33
Accepting the bribe	12	1	5	8.33	41.67
Illegal logging	12	5	11	41.67	91.67
Arrested	12	5	7	41.67	58.33

Source: Calculated by author

TABLE 1. (continued)

Decision	Obs.	Policy 2 (High reward and low punishment)			
		Amount of obs.		Percentage	
		Individual outlaw	Competition among outlaws	Individual outlaw	Competition among outlaws
Bribe	12	7	9	58.33	75.00
Accepting the bribe	12	3	9	25.00	75.00
Illegal logging	12	3	10	25.00	83.33
Arrested	12	3	1	25.00	8.33

Source: Calculated by author

In table 2, regarding to the hypothesis test, it found that Asymp. Sig. < 0.01. Therefore, Ho was rejected at 99 percent level of significance. It also illustrated that, under the situation with the bribery competition, the enforcement of different policies affected the samples' changing decisional behavior in the bribery process. The average of the decision making in the bribery process, when using the high punishment policy if the officials refrained from doing their duty, was 10.17. However, the average of the decision making in the bribery process, when using the high reward policy, was 8.75. Thus, under the situation with the bribery competition between the lawbreakers, the high reward policy was more effective than the high punishment policy if the officials refrained from doing their duty.

TABLE 2. Average bribe value between the high punishment policy and the high reward policy if the officials refrained from doing their duty under the condition with the bribery competition

Method: Wilcoxon-Mann-Whitney Test			
Session	Obs.	Rank-sum	Expected
High punishment	12	199.5	150
High reward	12	100.5	150
Combined	24	300	300
z	2.955	Prob > |z|	0.0031
session	Ratio of bribery	Ratio of non-bribery	Total
High punishment	84.72%	15.28%	100.00%
High reward	72.92%	27.08%	100.00%

Source: Caculation using Stata 10

In table 3, regarding to the hypothesis test, it found that Asymp. Sig. < 0.01. Therefore, Ho was rejected at 99 percent level of significance. This demonstrated that, under the condition without competition of the bribe giving between lawbreakers, the use of high reward and the high punishment policy if the officials refrained from doing their duty had an effect on different values of the bribe. The value of the bribe under the use of high reward policy (5.16 million baht) was lower than the value of bribe under the use of heavy punishment if the officials refrained from doing their duty (9.63 million baht). Therefore, under the condition without competition of the bribe giving between lawbreakers, the use of high reward could motivate the increasing value of the bribe.

In table 4, regarding to the hypothesis test, it found that Asymp. Sig. > 0.01. Therefore, Ho was accepted at 99 percent level of significance. This indicated that, under the condition with competition of the bribe giving between lawbreakers, the use of high

reward and the high punishment policy if the officials refrained from doing their duty had no effect on different values of the bribe.

TABLE 3. Value of bribe between the use of high punishment policy and the high reward policy if the officials refrained from doing their duty under the condition without competition of the bribe giving between lawbreakers.

Method: Wilcoxon-Mann-Whitney Test			
Session	Obs.	Rank-sum	Expected
High punishment	12	118	150
High reward	12	182	150
Combined	24	300	300
z	-1.863	Prob > |z|	0.0625
Session	Mean	Std. Err.	[99% conf. Interval]
High punishment	5.17 million baht	2.06 million baht	9.07-9.47 mill.baht
High reward	9.62 million baht	2.40 million baht	4.65-14.60 mill.baht

Source: Caculation using Stata 10

TABLE 4. Value of bribe between the use of high punishment policy and the high reward policy if the officials refrained from doing their duty under the condition with competition of the bribe giving between lawbreakers.

Method: Wilcoxon-Mann-Whitney Test			
Session	Obs.	Rank-sum	Expected
High punishment	12	148	150
High reward	12	152	150
Combined	24	300	300
z	-0.118	Prob > |z|	0.9058
Session	Mean	Std. Err.	[99% conf. Interval]
High punishment	40.40 million baht	1.56 million baht	37.20-43.70 mill. baht
High reward	41.00 million baht	1.66 million baht	37.60-44.40 mill.baht

Source: Caculation using Stata 10

TABLE 5. Comparison of value of bribe with and without competition among
lawbreakers under the policy of high punishment and low reward

Method: Wilcoxon-Mann-Whitney Test			
Session	Obs.	Rank-sum	Expected
without competition	12	78	150
competition	12	222	150
Combined	24	300	300
z	-4.191	Prob > |z|	0.0000
Session	Mean	Std. Err	[99% conf. Interval]
without competition	5.17 million baht	2.06 million baht	0.91-9.43 mill. Baht
competition	40.40 million baht	1.56 million baht	37.20-43.70 mill. Baht

Source: Caculation using Stata 10

In table 5, regarding to the hypothesis test, it found that Asymp. Sig. < 0.01. Therefore, Ho was rejected at 99 percent level of significance. This demonstrated that, when using the high punishment policy if the officials refrained from doing their duty, the values of bribe under the conditions with and without competition of the bribe giving between lawbreakers were different. The value of bribe under the condition with competition of the bribe giving between lawbreakers (40.42 million baht) was higher than the value of bribe under the condition without competition of the bribe giving between lawbreakers (5.17 million baht). Thus, the use of high punishment if the officials refrained from doing their duty policy under the condition with competition of the bribe giving between lawbreakers could activate the rising value of bribe.

In table 6, regarding to the hypothesis test, it found that Asymp. Sig. < 0.01. Therefore, Ho was rejected at 99 percent level of significance. This illustrated that, when using the high reward policy,the values of bribe under the condition with and without competition of the bribe giving between lawbreakers were different. The value of bribe under the condition with competition of the bribe giving between lawbreakers (41 million baht) was higher than the value of bribe under the condition without competition of the bribe giving between lawbreakers (9.63 million baht). Consequently, the use of high reward policy if under the condition with competition of the bribe giving between lawbreakers could lead to the increasing value of bribe.

It can be concluded from table 5 and 6 that the condition with competition of the bribe giving between lawbreakers could motivate the outlaws to offer higher value of bribe which did not depend on any policies.

TABLE 6. Comparison of value of bribe with and without competition among lawbreakers under the policy of high reward and low punishment

Method: Wilcoxon-Mann-Whitney Test			
Session	Obs.	Rank-sum	Expected
without competition	12	78	150
competition	12	222	150
Combined	24	300	300
z	-4.175	Prob > |z|	0.0000
Session	Mean	Std. Err	[99% conf. Interval]
without competition	9.63 million baht	2.40 million baht	4.65-14.60 mill baht.
competition	41.00 million baht	1.67 million baht	37.60-44.40 mill. baht

Source: Caculation using Stata 10

7.2 Econometrics analysis using Logit model for panel data

The econometric result in table 7 (Random effect model) and table 8 (Fixed effect model) are the same. They can be described as below:

- Higher value of bribery induces higher probability of illegal logging significantly at 90% level of confidence (result from only random effect model).

- High punishment rather than high reward induces higher probability of illegal logging significantly at 90% level of confidence.

- Higher rate of acceptance of bribery induces significantly at 95% level of confidence.

The Hausman test points out that the random effect model is better than the fixed effect model because it cannot reject the null hypothesis. At the null hypothesis, the random effect model is efficient even though the fixed effect model is also consistent. However, the efficiency is more important than the consistency (Suriya, 2011). Therefore, when Hausman test cannot reject the null hypothesis, then the random effect model is superior than the fixed effect model and vice versa.

TABLE 7. Random effect model

Dependence variable: Logging					
variable	Coefficient	Std Err.	z	P > |z|	[95% conf. Interval]
Bribe value	4.00e-08	2.26e-08	1.77	0.077	-4.36e-09 8.44e-08
High punishment	1.649501	.8500809	1.94	0.052	-.0166273 3.315629
Accept bribe	3.273627	1.225807	2.67	0.008	.8710888 5.676164
_con	-2.084466	.8685656	-2.40	0.016	-3.786823 -.3821086
/lnsig2u	-17.07581	1117.403			-2207.146 2172.995
Sigma_u	.0001959	.1094495			
Rho	1.17e-08	.000013			
Number of observation					48
Wald chi2 (3)					11.43
Log likelihood					-21.24
Prob > chi2					0.0096
Likelihood-ratio test of rho=0: chibar2 (01)					0.0000
Prob > chibar2					.9999

Source: Calculation using Stata 10

TABLE 8: Fixed effect model

Dependence variable: Logging					
variable	Coefficient	Std Err.	z	P > |z|	[95% conf. Interval]
High punishment	1.791949	1.080197	1.66	0.097	-.3251974 3.909095
Accept bribe	21.17781	11457.01	0.00	0.999	-22434.15 22476.51
Number of observation					18
LR chi2 (3)					6.74
Log likelihood					2.87
Prob > chi2					0.0345

Source: Calculation using Stata 10

TABLE 9: Hausman Test

variable	Coefficient of fixed effect model (b)	Coefficient of random effect model (B)	Difference (b-B)	Standard error
High punishment	1.791949	1.649501	.1424482	.6664736
Accept bribe	21.17781	3.273627	17.90418	11457.01
Chi^2 (2) =	0.05	Prob.	0.9774	

Source: Calculation using Stata 10
Note: b = consistent under Ho and Ha; obtained from xtlogit
        B = inconsistent under Ha, efficient under Ho; obtained from xtlogit

8. Conclusion

This research investigated the decisional behavior through the illegal deforestation game by analyzing the 48 samples' rationality of negotiation under the scenarios of the illegal logging by offering the officials the bribe. The game theory was adapted as a tool in this study for behavioral analysis under given conditions and rules controlling the game players' relationship. The author emphasized and compared some issues in the game consisting of the samples' decisional behavior when applying different reward and punishment policy on officials under the condition with and without competition of the bribe giving between lawbreakers. The study also investigated factors influencing the decisional behaviors in the illegal logging.

The analysis of statistical data in Part 1 – Non-parametric statistical analysis was conducted by applying percentage and mean. It represented that the changing conditions in the game had the influences on the samples' decision making. On the contrary, the bribe value was analyzed by using Wilcoxon-Mann-Whitney Test which found that the bribe value decreased when enforcing the high reward policy to policemen.

The analysis of statistical data in Part 2 – Econometrics was conducted by applying Logit Model for Panel Data. It illustrated that the decision making in the illegal deforestation decreased significantly due to the refusal to bribe and the high reward policy.

Regarding to the above experiment, it could be summarized that the high reward policy was effective to help reducing the illegal logging problem. When using this policy, the samples' decision making in the illegal logging diminished. Moreover, when considering the decisional behavior under the condition with and without competition of the bribe giving between lawbreakers, it found that the without competition of the bribe giving led to the light value of bribe.

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