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An Economic Analysis of the Law on the Level of Significance of Criminal Penalties and Arrest Probability for the Degree of Property Crimes

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Abstract

Crime is a persistent social phenomenon arising from the committing of criminal offenses against the law of the state. Criminals' incentives or motivations for criminal acts are affected by many factors such as the severity of penalties, the chances of getting arrested, level of education, gender, socio-cultural factors, and so on. This research focuses on the correlation between the severity of criminal penalties and the probability of arrest and the seriousness of crime using concepts and processes of economic law. This includes mathematical modeling as well as testing the statistical significance of the models. The results show that it is the severity of legal penalty that reduces property offenses. A person's behavior changes when they feel they may face a high magnitude of criminal penalty. In other words, in judging whether to perform a criminal act towards property, criminals do not consider the probability of arrest but look at the criminal penalty. The Thai legislature will be able to take this conclusion into consideration in order to modify or create appropriate legal measures in the future. One of the most suitable policies is increasing the size of legal penalties in the Thai criminal code. When people perceive severe punishments, they will commit fewer crimes. Increasing the size of legal penalties can be achieved in a number of ways, including increasing the size of fines and requiring longer prison sentences.

Keywords: criminology, criminal penalty, criminal gravity, economic law
JEL Classification: K11, K14

1.Introduction

According to Section 59 of the Criminal Code of the Kingdom of Thailand (Krisdika, 2020), a person is criminally liable only if they have intentionally committed or omitted any act as provided by law, where the law clearly states that it is an offense, even if perpetrated under negligence. An intentional act refers to an action of the performer leading to results or the ability to foresee the act's consequences after it has been done, while an act of negligence refers to an act performed without care or taking precautions but insufficient according to the nature and circumstances of the ordinary person. In the

Thai Code of Law, there are various sections, such as offenses against officials, offenses against the position of government, offenses relating to public peace, offenses relating to life and the body, and offenses relating to property, etc. (Nil, 2019). In the legislation processes, each section of the Thai Penalty Code clearly states the element of an offense describing what factors must exist in order for a person to be regarded guilty of an offense. The Criminal Code also clearly states the severity of punishment criminal offenders are subjected to. The criminal penalties enforced in Thailand include fines, imprisonment, forfeiture, execution, etc. The seriousness of punishment depends on the history of criminal offenses – including the potential reduction of criminal penalties – whereby prosecutors, as well as judges, work together in a systematic manner to make criminal judgment of offenders.

According to statistics from the Royal Thai Police, collected from January 1, 2019 to December 31, 2019, it was found that 51,564 victims of criminal cases related to property were reported to the police (National Statistical Office, 2021) – the highest number of offenses by type in the Thai criminal system. It can be assumed that property offenses constitute the majority of offenses in Thailand. Motivation for property crime and how it relates to the number of legal cases is therefore topical and revealing. Literature review shows that motives for criminal acts consist of several incentives, all of which influence individuals to make criminal decisions (Kizilgol, 2017). Factors influencing a person to break criminal law include the seriousness of the penalties, gender, education level, as well as the probability of arrest (Gordon, 1998; Kruttschnitt, 2013). A person was found to have a lower probability of committing a crime if the offense were to lead to a high chance of being arrested by the police. Gender also plays a large and influential role in driving a person to criminal activity, both physiologically and psychologically (Hjalmarsson, 2012). In accordance with other researchers, it was found that education level was significantly related to the degree or number of criminal offenses committed. In this study, *the significance of the seriousness of criminal penalties, M*, and *the probability of arrest, P*, were considered to be factors affecting criminal offenses related to property. Although a person may be driven or motivated to commit a criminal offense due to a combination of factors, this research focuses on the seriousness of penalties and the probability of arrest

as the primary variables because these variables are seen as more tangible and concrete than others, thereby rendering them easily studied through quantitative methodology, for example in economic models, as well as being able to subject them to statistical processes, etc.

Scholars have already laid out some basic principles of economic model analysis, for example (Pokpong, 2016) who described the relationship between criminological variables that led criminals to commit offenses under the principles of economic analysis. In the book *Advanced Criminal Law,* it is stated that *the crime cost of a criminal, C ,* is a mathematical function depending on *the seriousness of the criminal penalties, M ,* and *the probability of arrest, P* . On the one hand, if the seriousness of the criminal penalties is large, criminals are less likely to commit a crime, while on the other, if the legal penalties are less severe, criminals are more likely to commit a crime. The severity of punishment can be varied, for example, fines, imprisonment or execution. Execution is certainly the worst criminal punishment, while fines are the lightest. Potential criminals compare the benefits they might receive from the crime with the costs (punishment) of the crime. If the potential criminal judges the cost of committing the crime higher than the expected benefit, they will choose to restrain the wrongdoing. If the potential criminal sees that they could gain more than the cost they pay, they are likely to commit crimes (Cooter, 2016).

This research studies the level of statistical significance of criminological variables. It discusses how the severity of criminal punishment and the probability of arrest affect the dependent variable of the extent to which property crime is likely to be committed. Criminal offenses related to property include burglary, seizure robbery, robbery, extortion misappropriation, spoilage and fraud, etc. (Yoksiw, 2019). These property offenses are integrated into an economic law model to describe the relationships between the factors that drive criminals to criminal acts. The severity of penalties and the probability of arrest are the two main factors that were chosen to form the economic law model because they are concrete and can be clearly verified by mathematical processes.

This research provides a preliminary hypothesis that the two variables, M and P, conform to the economic equation (Gujarati, 2009). In this research, an economic model was constructed using multiple linear regression analysis which analyzes and predicts how

the two variables are related under the economic model (Kongsak, 2008). A mathematical model explaining the correlation between the severity of criminal penalties, M, and the probability of arrest, P, is constructed, related them to the number of property crimes committed, Q. In addition, the model mathematically simulates how criminals assess the cost and benefit of potential property crime. After constructing an economic model, the hypothesis was also examined to reveal how significant the results of the simulated mathematical model were. This testing process relied on real data from the National Statistical Office of Thailand on criminal cases in relation to property.

The data were analyzed using an appropriate statistical process and compared with the model to determine the significance of the data generated by the model. By using a traceability method, substituting numerical values into the model to calculate the quantity of committing property crimes, C, it was possible to compare how closely the model conformed with real values. Initially, the researchers speculated that the magnitude of legal penalties and the probability of arrest would be significantly correlated with criminality when the level of statistical significance was set at 0.05. There are many utilities of the research to the criminal justice system. If the severity of penalties and the probability of arrest are statistically related to the amount of criminal activity involving property, the state can design or plan more effective policies to control property crime by adjusting the magnitude of criminal penalties to be more appropriate. In the same way, legal procedures can be established to optimize the probability value of criminal arrest to maintain social peace and order.

2. Method

The research process is divided into two major parts: the first is concerned with the economic modeling process, while the second part measures the level of statistical significance of data generated by the model. For a hypothesis to simulate economic equations, this research assumes that the crime cost of a criminal, C, and the quantity of committing property crimes, Q, are mathematical functions dependent on the seriousness of the criminal penalties, M, and the probability of arrest, P, at 0.05 level of statistical significance. The crime cost of a criminal, C, can be established from a mathematical

relationship between the seriousness of the criminal penalties, M, and the probability of arrest, P. M and P values are assumed to have a linear relationship with C, which can then be written as a mathematical equation according to the assumed conditions as follows:

$$C = MP \tag{1}$$

The quantity of committed property crimes, Q, is assumed to be a mathematical relationship with both M and P, which can be written as a non-linear equation, where M is exponented by a while P is exponented by b. The coefficient of the model was set by A. A, a, and b are then defined as constants in the simulated equation which can be shown as follows:

$$Q = AM^{a}P^{b} \tag{2}$$

Next, the variables Q, M, C, P, as well as the coefficients A, a and b, are modeled as an economic model. The economic model is written as a mathematical equation showing the relationship between the above variables. The goal of economic modeling is to find out how the variables C and Q are mathematically related to the variables M and P. An important preliminary hypothesis is that the variables C and Q are modeled under the condition that a criminal acts at the lowest criminality cost. To create a mathematical equation to describe the behavior of variables, C and Q are analyzed using Lagrangean analysis. Lagrangean analysis is applied in the modeling process to keep the model under optimized conditions (Thanyarat, 2015). Given l as a Lagragean multiplier, the Lagrangean function can be expressed as follows:

$$z = MP + l\left(Q - AM^{a}P^{b}\right) \tag{3}$$

By taking the first order of partial differentiation of the Lagrangean function with respect to M, P and l respectively:

$$\frac{\partial Z}{\partial M} = 0 = P - al\ AP^{b}M^{a-1} \tag{4}$$

$$\frac{\partial Z}{\partial P} = 0 = M - b\lambda\ AM^{a}P^{b-1} \tag{5}$$

$$\frac{\partial Z}{\partial \lambda} = 0 = Q - AM^{a}P^{b} \tag{6}$$

In reference to (4), P can be numerated as follows:

$$P = a\lambda\ AP^{b}M^{a-1}$$

Or

$$\lambda_{P} = \frac{PM}{aAP^{b}M^{a}} \tag{7}$$

In reference to (5), M can be numerated as follows:

$$M = b\lambda\ AM^{a}P^{b-1} \tag{8}$$

Or

$$\lambda_{M} = \frac{PM}{bAP^{b}M^{a}}. \tag{9}$$

(10)

Where $\lambda_{M} = \lambda_{P} = \lambda$

According to equation (6), Q can be rearranged as follows:

$$Q = AM^{a}P^{b} \tag{11}$$

From equation (1) to (10), Q and C can be expressed as follows:

$$Q = AM^{a}\left[a\lambda\ AP^{b}M^{a-1}\right]^{b} \tag{12}$$

$$Q = AM^{a}\left[a(\frac{PM}{aAP^{b}M^{a}})AP^{b}M^{a-1}\right]^{b} = AM^{a}P^{b} \tag{13}$$

Substitution of (10) in (8) gives the result as follows:

$$M = (b\,(\frac{PM}{aP^{b}M^{a}})\,AP^{b-1})^{\frac{1}{1-a}} = (\frac{bM}{aM^{a}})^{\frac{1}{1-a}} \quad (14)$$

Or $$b = a\,e^{1-a} \quad (15)$$

Equation (15) can be demonstrated by Figure. 1 as follows:

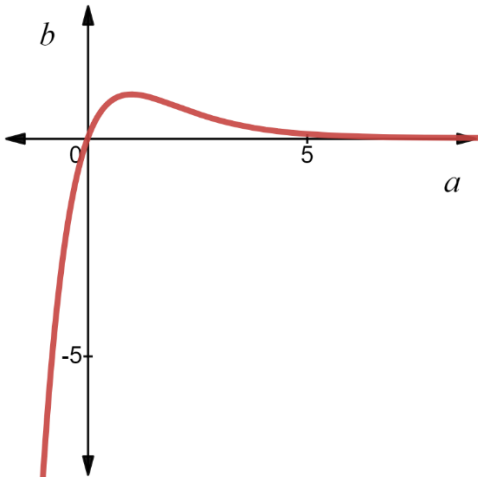

Figure 1: Relationship between coefficient a and b represented in exponential form

According to Figure 1, the relationship between coefficient a and b is represented in exponential form. If the coefficients a and b were based on equation (15), the coefficient a and b should be both positive and negative according to the graph in Figure. 1. Under the cost minimization condition, a must be equal b according to equation (7), (8), and (10). So, a and b must equal 1.

Substitution of (15) in (13) gives the result as follows:

$$Q = AM^{a}P^{a[e^{1-a}]} = AMP\ ;\ A<0 \quad (16)$$

and $$C = M[a\,AP^{b}M^{a-1}] \quad (17)$$

So $$C_{min} = M[a(\frac{PM}{aAP^{b}M^{a}})AP^{b}M^{a-1}] = MP \quad (18)$$

From the analysis above, it can be concluded that criminals will commit crimes of Q at the minimum cost of crime of C, where criminals compare the economic cost on the basis of how to perform the given crimes under the lowest cost to achieve the highest utility. This can be explained by the principles of economic laws. To reconsider equations (4) and (5), each side of the equations can be resolved to find the values of M and P as follows:

$$P = al\ AP^{b}M^{a-1} \tag{19}$$

$$M = bl\ AM^{a}P^{b-1} \tag{20}$$

By applying the first order of partial differentiation of the function P respect to M.

$$\frac{\partial P}{\partial M} = \left(\frac{\left(al\ {}_{P} AM^{a-1} \right)^{\frac{1}{1-b}}}{1-b} \right) \left(al\ {}_{P} AM^{a-2} \left(a-1 \right) \right) \tag{21}$$

Substitution of (7) in (21) gives the result as follows:

$$\frac{\partial P}{\partial M} = \left(\frac{\left(a\left(\frac{PM}{aAP^{b}M^{a}} \right) AM^{a-1} \right)^{\frac{1}{1-b}}}{1-b} \right) \left(a\left(\frac{PM}{aAP^{b}M^{a}} \right) AM^{a-2} \left(a-1 \right) \right) = -\frac{P^{2}}{M} \tag{22}$$

Consider $\frac{\partial C}{\partial M}$, $\frac{\partial C}{\partial M} = \frac{\partial (MP)}{\partial M} = P$ (23)

Considering the necessary condition; Bordered Hessian Determinant of the function of quantity of committed property crimes, Q;

$$\left|\bar{H}\right| = \begin{vmatrix} -\lambda Q_{MM} & -\lambda Q_{MP} & -\lambda Q_{Ml} & -Q_M \\ -\lambda Q_{PM} & -\lambda Q_{PP} & -\lambda Q_{Pl} & -Q_P \\ -\lambda Q_{lM} & -\lambda Q_{lP} & -\lambda Q_{ll} & -Q_l \\ -Q_M & -Q_P & -Q_\lambda & 0 \end{vmatrix} \quad (24)$$

$$\left|\bar{H}\right| = \begin{vmatrix} -\lambda \frac{\partial}{\partial M}\left(\frac{Q}{\partial M}\right) & -\lambda \frac{\partial}{\partial P}\left(\frac{Q}{\partial M}\right) & -\lambda \frac{\partial}{\partial l}\left(\frac{Q}{\partial M}\right) & -Q_M \\ -\lambda \frac{\partial}{\partial M}\left(\frac{Q}{\partial P}\right) & -\lambda \frac{\partial}{\partial P}\left(\frac{Q}{\partial P}\right) & -\lambda \frac{\partial}{\partial l}\left(\frac{Q}{\partial M}\right) & -Q_P \\ -\lambda \frac{\partial}{\partial M}\left(\frac{Q}{\partial l}\right) & -\lambda \frac{\partial}{\partial P}\left(\frac{Q}{\partial l}\right) & -\lambda \frac{\partial}{\partial l}\left(\frac{Q}{\partial l}\right) & -Q_l \\ -Q_M & -Q_P & -Q_l & 0 \end{vmatrix} \quad (25)$$

It is found that if the values of Bordered Hessian Determinants of $\left|\bar{H}_2\right|$, $\left|\bar{H}_3\right|$, and $\left|\bar{H}_4\right|$ are all less than zero, it can be interpreted that the equation $C = MP$ and $Q = AM^{a}P^{a[e^{1-a}]}$ concords with cost minimization conditions. Equation (22) shows lawyers that theoretically, increasing the magnitude of the legal penalties (M) by one unit, the probability of crime (P) is reduced in P^2 / M units and by calculating the derivative of the total cost of crime function according to equation (23), it is possible to interpret that if the criminal costs are increased by one unit, criminals will have higher crime costs P. The severity of legal sanctions imposed by the state should be enough to minimize the probability of crime under the rule of law and jurisprudence.

3. Results

Table 1: Number of offenders related to property in 2017 in the Kingdom of Thailand

Offense Type	Number of Offenders					
	Reported to Police (RP)	% RP	Arrested (AR)	% AR	Prosecuted (PS)	% PS
Gang-Robbery (GR)	143	25.22	113	19.93	311	54.85
Robbery (RB)	667	36.85	529	29.23	614	33.92
Snatching (S)	1,194	38.15	913	29.17	1,023	32.68
Theft (T)	29,355	40.46	18,627	25.67	24,572	33.87
Extortion (E)	165	36.83	101	22.54	182	40.63
Fraud (F)	9,362	47.81	4,385	22.39	5,835	29.80
Misappropriation (MA)	8,358	45.88	4,361	23.93	5,498	30.18
Mischief (MC)	3,414	37.95	2,582	28.70	3,000	33.35
Receiving Stolen Property (RSP)	1,152	32.49	1,013	28.57	1,381	38.95
Ransom (RS)	5	33.33	3	20.00	7	46.67
Total Offenses Related to Property (TT)	6,3387	41.36	38,800	25.32	51,059	33.32

Source: National Statistical Office (2021)

Table 1 shows the number of lawsuits based on property crime. The data in 2017 are chosen because it is the most up-to-date data collected by the National Statistical Office of Thailand. The consonant in each bracket is the abbreviation of the word before it. These abbreviations will continue to be used until the end of this paper. The table contains statistics on criminal cases involving property offenses from investigation by police to conviction of criminal offense. For example, it can be seen that during 2017, the number of people reported to the police for robbery was *667* , with only *614* leading to prosecution. Similarly, in criminal cases related to burglary, which was the highest recorded criminal case type in Thailand from the table, it is clear that *29,355* people were reported to the police, but only *24,572* were charged with this type of crime. From the table, it is clear that each type of criminal case has varying levels of probability of arrest. This reveals that

some cases are less likely to lead to arrest while some cases have a high chance of leading to arrest.

From Table 1, it is clear that each crime has a different number of convictions. This research hypothesized that the chances of being arrested were significantly related to the number of convictions. In the process of testing the hypothesis, it is necessary to calculate some of the necessary statistics first which will be explained in detail in the next paragraph.

The statistical significance of the economic model was the tested. This included testing the significance level of variables in the model. It was necessary to use linear multiple regression, but since the economic model was written in the form of a non-linear equation, not a linear multiple regression. To test the significance level of the generated model, then, the simulated equation had to be changed to linear multiple regression before statistical hypothesis testing. In this case, a natural logarithm process was selected to replace the established equation to linear multiple regression transition as illustrated below.

According to the initial criminological model assumed, $Q = AM^{a}P^{b}$, a natural logarithm was applied to both sides of the equation as follows:

$$lnQ = ln\left[AM^{a}P^{b} \right] \tag{26}$$

Or

$$lnQ = lnA + alnM + b\,lnP \tag{27}$$

According to equation (27), the dependent variable, lnQ was written as a linear multiple regression in terms of independent lnM and lnP by applying the ordinary least squares method, OLS, where variable M denotes the expected seriousness of a criminal penalty which is numerated by interpretation of legal penalty by exact quantity. This is in reference to the Thai criminal code (TCC) of section *334*, which states *"whoever, dishonestly taking away the thing of another person or in which the other person is co-owner is said to have committed theft, and shall be imprisoned for not more than three years and fined not more than sixty thousand baht"*. From the mentioned legal penalty,

the independent variable M was numerated by selecting the maximum penalty for calculation. The research assumed that one day's imprisonment is equivalent to a fine of *200* Thai baht, (THB). If there were conjunctions such as "or", this study relied on the fine penalty because choosing to be fined instead of imprisonment is considered a more lenient punishment. Moreover, life imprisonment means 30 years imprisonment and one-year equals 365 days. For example, from section *334* of the Thai Criminal Code, it is calculated from the prisoner being sentenced to three years; confinement, which is *219,000* baht, plus a fine of *60,000* baht, totaling *279,000* baht, see table 2 below.

Table 2: Thai penal penalties, M, calculated from the Thai Criminal Code, and arrest probability with their natural logarithmic values

Offense Types	Section in TCC	Q (Person)	RP (Person)	AR (Person)	P	M (kTHB)	lnQ	lnP	lnM
GR	340	311	143	113	0.790	1,368	5.740	-0.235	14.129
RB	339	614	667	529	0.793	930	6.420	-0.232	13.743
S	366	1023	1,194	913	0.765	465	6.930	-0.268	13.050
T	334	24,572	29,355	18,627	0.635	279	10.109	-0.455	12.539
E	337	182	165	101	0.612	465	5.204	-0.491	13.050
F	341	5,835	9,362	4,385	0.468	60	8.671	-0.758	11.002
MA	352	5,498	8,358	4,361	0.522	60	8.612	-0.651	11.002
MC	358	3,000	3,414	2,582	0.756	60	8.006	-0.279	11.002
RSP	357	1,381	1,152	1,013	0.879	100	7.231	-0.129	11.513
RS	313	7	5	3	0.600	1,860	1.946	-0.511	14.436

Source: Nil (2019)

According to Table 2, Q denotes the quantity of committed property crimes in the unit of person; RP is the quantity of offenders reported to the police in the unit of person; AR is the number of arrested offenders; P refers to probability of arrest which can be estimated by AR divided by RP; M represents economic seriousness of the criminal penalties in Thai currency which can be estimated by summation of monetary loss in the unit of kiloTHB, and; lnX demonstrates natural logarithm of X. From table 2 and section *337* of the Criminal Code, *"Whoever, compels a person to give or to agree to give him or*

another person a benefit in the nature of being property by committing an act of violence or by a threat to commit violence against the life, body, liberty, reputation or property of the compelled person or a third person, so that the compelled person submits to the same is said to commit extortion, and shall be punished with imprisonment not exceeding five years and fined not exceeding ten thousand Baht". The criminal penalty is evaluated from the prisoner being sentenced to five years, which is equivalent to *365,000* baht, plus a fine of *10,000* baht, totaling *465,000* baht. Another example, according to the first part of section *340* of the Thai Criminal Code which states that *"Whoever with three persons upwards participates in committing robbery, such persons are said to commit gang-robbery, and shall be punished with imprisonment of ten to fifteen years and fined two hundred thousand to three hundred thousand baht"*. This is evaluated from the prisoner being sentenced to fifteen years, which is *1,068,000* baht, plus a fine of *300,000* baht, totaling *1,368,000* baht.

Table 3: Regression statistics

Regression Statistics	
Multiple R	0.734
R Square	0.538
Adjusted R Square	0.406
Standard Error	1.755
Observations	10

MS-EXCEL was applied to calculate some fundamental regression statistical values such as multiple R, R Square, adjusted R Square, standard error, and observations as presented in Table 3. From Table 3, it can be seen that the R square value is only 0.538, meaning that the independent variable in equation (2) is associated with only about *54%* of the Q dependent variable; however, R square alone cannot be used to conclude with certainty whether the independent and dependent variables are significantly related or not. It is therefore necessary to test the statistical hypothesis with ANOVA in order to summarize effectively.

Table 4: ANOVA results

ANOVA	df	SS	MS	F	Significance F
regression	2	25.136	12.568	4.080	0.067
residual	7	21.562	3.080		
total	9	46.699			

According to Table 4, the value of significance F is 0.067 which is less than 0.2, so for the established criminological model $Q = AM^{a}P^{b}$ there is at least one independent variable associated with the dependent variable, Q, with a significance level of 0.2 or at 80% confidence. Next, it is necessary to verify that of the coefficients a, b and A in the mentioned model, which coefficients are significant and can be used to explain this criminological phenomenon.

Table 5: Linear multiple regression testing results

Variables	Standard Error	t Stat	P-value
lnA	6.230	3.752	0.007
a	0.456	-2.805	0.026
b	3.000	0.333	0.749

According to table 5, the P-value of both coefficients lnA and a had a significance level of less than 0.2 but the P-value of b is greater than a significance level of 0.2. Both coefficient lnA and a were significant, but b was not. It can be concluded that the probability of arrest, P, is not associated with the number of accused in each criminal type, Q (Kanlaya, 2013).

4. Conclusion

The non-linear multiple regression model was used to predict and explain the behavior of criminals committing a criminal offense in relation to property. It was assumed that the seriousness of criminal penalty, M, and arrest probability, P, were both related to the number of property crimes committed, Q. Application of a statistical process to test

the hypothesis revealed that in fact, there is only one variable that can be used to describe Q, that is variable M. The statistical analysis results show that the severity of legal penalty reduces property offense. A person's behavior changes when they feel they have a high magnitude of penalty. In other words, in judging whether to perform a criminal act on property, criminals do not consider the probability of arrest but look at the criminal penalty. The research concluded that the likelihood of criminal penalty is associated with up to 80% of the amount of property-related crime.

5. Discussion

Although it is known that the degree of probability of a felon's arrest in a crime involving property is not correlated with the number of perpetrators, if future studies increase the amount of data, it is likely that the models will be more effective. This is because the model generated in this research was simulated from data collected over only one year. An analysis of just one year of data may not be good enough to conclude whether the hypothetical model works or not. Moreover, in future research, this kind of information on other criminal offenses should be analyzed as well because it may lead to different outcomes in comparison with property crime (Sangnuan, 2010). It may not be as good a representation of information as it should. In addition, the resulting model may utilize a model other than the given model, so that multiple models can be created and compared. Nevertheless, this initial study shows how criminal behavior changes when criminals feel that the criminal penalty changes. According to the conclusions obtained from the study, it is inferred that in the future if criminal law related to property will be reformed, legislators should take the conclusions of this research into consideration when drafting a new law. The size of legal penalties shall be increased to reduce the degree of property crime. This can be done in several ways, for example, increasing fines as well as serving longer prison sentences.

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