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ECONOMIC CRIME AND BUSINESS CYCLES IN TAIWAN

YA-HWEI YANG

DISCUSSION PAPER SERIES No.9501
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Economic Crime and Business Cycles in Taiwan

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Abstract

This paper analyzes economic crimes both theoretically and empirically. Theoretically, an individual utility function is adopted in the beginning. The variables of real police expenditures and economic environment, such as the business cycle are considered. The directions of influence of these variables on economic crime are dependent upon the risk attitudes of potential criminals. Empirically, time series data are adopted from 1966 to 1989 and average economic crime per capita is taken as a dependent variable. The conclusions are as follows: the unemployment rate has a significantly positive effect (a higher unemployment rate results in a higher crime rate), the business cycle has a significantly negative effect (a rising business cycle results in a lower crime rate), police expenditures have an insignificantly negative effect; and real income per capita has an insignificantly positive effect. In general, potential criminals have the tendency of risk-neutrality or risk-preference.

I. Introduction

Crime is almost impossible to eradicate in the course of a country's economic development, no matter how hard the government tries to stamp out criminal behavior. The reasons for crime, especially economic crime, deserve analysis from an economic viewpoint. The subject of crime economics began with Becker (1968) and Ehrlich (1973), who initially proposed this field of study. They have been followed by many scholars who have conducted both theoretical and empirical studies. General crime and some specific crimes are examined in this literature. However, studies about economic crime from an economic viewpoint are seldom seen.

Recently, the problem of crime has become more serious in Taiwan. Although the economy has grown, the more complicated society has made crime problems even tougher. Economic factors greatly influence economic crime because when the economic environment changes as business cycles appear, the expected profits of potential criminals are affected. This paper takes into consideration economic factors, especially the business cycle, in determining factors involved in economic crime.

This paper considers crime influencing factors (such as the economic environment and police expenditure), including the business cycle factor, to examine economic crimes. In addition, this paper investigates the question of whether criminals are risk-preferential or risk-averse. The framework of this paper is as follows: Section I is the introduction, followed by Section II, a literature survey. Section III presents the theoretical modeling of the problem. While Section IV conducts an empirical study of it. Finally; Section V is the discussion of results and the conclusion.

II. Literature Review

The study of crime from an economic stance started with Becker (1968) and Ehrlich (1973). Since these two initial works, some scholars have conducted theoretical and empirical studies on general crime, but specific studies focusing on economic crime have not been conducted often.

Criminals can be classified into two types. One is the rational criminal who has measured the benefits and costs, and made detailed plans beforehand, such as those who commit economic crimes. The other kind is the spontaneous irrational criminal who does not think of the result of the crime at the time he commits it, such as someone who commits murder due to an emotional argument. This paper concentrates on economic crime analysis.

Factors influencing crime in general include expenditure on police, perpetrator's income and employment status, the general business cycle, and the perpetrator's risk attitude. These factors affect economic crimes also.

This section reviews the related literature in sequence.

1. Expenditure on police facilities

Becker (1968) proposed that crimes have benefits and costs from the stance of the whole society. The criminals obtain benefits, and the victims have loss costs. The difference between benefits and costs is net social loss. In order to decrease social loss, it is necessary to expand public police expenditure and private protection costs. At the equilibrium of marginal benefit and marginal cost, a social equilibrium crime level is reached.

Burnell (1988) extended Becker's model to include an environmental variable and the effects of community police. Community police forces influence neighboring communities' crime rates as well as their own because when a police force in one community grows, crimes tend to shift from the community with the larger police forces to communities with smaller police forces.

2. Income

As an economy becomes more advanced and the quality of life increases, most people can earn an acceptable monetary income engaged in normal legal activities. This can help lower the tendency to crime. However, a general rise in monetary income does not always definitely imply an increase in the quality of life. As an economy becomes more advanced, lifestyles become more complicated and psychological pressure can increase. Some persons might then attempt to commit crimes in order to change their lifestyle. This stimulates an increased tendency toward crime. In other words, the influence of increases in income on crime has both positive and negative effects.

Yang (1986) concluded that the influence of per capita income on the crime rate is uncertain. Extending the models of Becker (1968) and Ehrlich (1973), Good & Pirog-Good (1986) considered three activities : employment, crime, and others, as individual activity choices. Past articles have considered only employment and crime. They find that people of different races face different legal job opportunities. If more high income jobs were available to minorities, the crime rate, especially among black youth, would decrease. Non-minorities usually have more legal job opportunities, and therefore sometimes use legal activities as a cover for illegal activities. Hashimoto (1987) did an empirical study and found that the existence of a minimum wage leads to an increased crime rate for teenagers (age 15-19), but has no influence on young adults (age 20-24).

3. Unemployment

Income factors are strongly related to unemployment. Fleisher (1963) conducted an empirical study and found that unemployment has a positive influence on youth crime. Good and Pirog-Good (1986) believe that among minorities unemployment is one of the important factors in criminal behavior. Apparently minorities choose between employment and crime as sources of income. On the other hand, employment status does not significantly influence the criminal tendencies of non-minorities.

4. Business cycle

Good & Pirog-Good (1986) believe that recession causes employment opportunities to decrease and thus, crime incentives to increase.

5. Risk attitude of individual potential criminals

Ehrlich (1973) analyzed criminal behavior by maximization of the utility function, considering the differing returns of legal and illegal activities, and considering also time constraints. This model was then used to analyze the deterrence effects of arrest probability and penalty level. The comparative static result is as follows: (1) If an individual is seeking to avert risk to himself, an increase of legal earnings will make illegal activities decrease, and an increase of rewards from illegal activities makes illegal activities increase. (2) The relative effects of penalty and arrest possibility is dependent upon the risk attitude of criminals. Penalty has stronger effect for those who are risk-preferential. Arrest probability has a stronger effect for risk-averters.

Block and his co-authors do not agree with the viewpoint of Ehrlich. Block and Heineke (1975) criticize Ehrlich's assumption that time allocation and wealth allocation are mutually dependent. Block and

Heineke think that time allocation must influence the wealth and substitution effects, which make the net effect uncertain. Block and Lind (1975a) prove that the monetary value of prisoners is not the same as that of general people. Block and Lind (1975b) believe that increasing the probability of arrest does not guarantee a strong deterrence effect, even for risk-preferential individuals.

The crime-related literature as summarized briefly above uses different theoretical models and emphasizes different issues. Seldom have papers dealt with either economic crime specifically,or the business cycle as a variable. The purpose of this paper is to analyze economic criminal behavior, considering the following five factors: expenditure on police facilities, the general business cycle, and the income level, employment status, and risk attitude of potential criminals.

III. Theoretical Analysis

The theoretical model developed in this section includes consideration of the business cycle and other related variables in the analysis of economic crimes.

The utility level of a representative individual is influenced by wealth and other social factors. The more wealth one has, the higher is one's utility level. The utility function can be represented as

$$U_i = U_i\,(W_i\,,\,H\,) \tag{1}$$

$$\partial U_i \,/\, \partial W_i > 0 \quad .$$

In this equation, W_i and U_i mean the wealth and utility of the i-th individual. H represents other social and psychological factors.

Wealth is related to income. The wealth function is:

$$W_i = f\,(\,Y\,) \tag{2}$$

$$\partial W_i / \partial Y > 0 \quad .$$

Y represents per capita income. The higher one's income is, the more wealth one has. Combining (1) and (2), we get:

$$U_i^* = U_i^* (Y, H) \tag{3}$$

$$\partial U_i^* / \partial Y > 0 \quad .$$

The above equations deal with the i-th individual who does not commit a crime. Those who commit crimes also have utility functions. Illegal activities contain the risk to the individual of being arrested. Suppose a criminal will be arrested under situation "*a*," and not be arrested under situation "*b*," with probabilities of π_a and π_b, respectively. Then,

$$\pi_{ai} + \pi_{bi} = 1, \quad i = 1, 2, \ldots, p \tag{4}$$

where p is the total population. The probability of arrest will increase as police facilities increase. Let A then be expenditure on police facilities. The arrest probability function is as follows:

$$\pi_{bi} = \pi_{bi} (A) \tag{5}$$

$$\partial \pi_{bi} / \partial A > 0 \quad .$$

When an individual commits a crime, he has an expected return of C.

If captured, he will obtain a penalty of D. Therefore, the utility function of the criminal is as follows:

$$V_i = \pi_{ai} U_{ai} (W_i + C, H) + \pi_{bi} U_{bi} (W_i - D, H) \tag{6}$$

where C represents expected return, including monetary income and nonmonetary income. A criminal has a stronger incentive to become involved in illegal activities during a recession because recessions result in inadequate working capital and a higher default risk for businesses. If one can survive by illegal activities, he can avoid losses on both the monetary side and the reputation side. This can be considered the benefit to the criminal.

The penalty level, *D*, has a relationship with two factors. One factor is the loss of others (the victims) due to the crime. The greater the victim's loss, the greater the penalty. The other factor is the job opportunity of the criminal. Once one is imprisoned, he is deprived of his job opportunity and he cannot earn an income, which is part of the penalty. If the criminal was unemployed originally, being arrested does not mean any opportunity cost for him. Therefore, the penalty function is represented as:

$$D = D(C, Z) \tag{7}$$

$$\partial D / \partial C >= 0, \quad \partial D / \partial Z < 0 \ .$$

Where *C* represents the expected return of criminal activities, and *Z* represents unemployment rate.

C, the expected return, is influenced by the business cycle. When the economy prospers, market profitability opportunities increase. With easier access to financial resources, businesses feel comfortable using legal activities to settle credit or bankruptcy problems. Production and consumption problems can be solved without taking criminal risks. On the contrary, in periods of recession and fewer market profitability opportunities, an individual finds it more difficult to finance production and consumption activities. If risk of default is involved, in order to resolve the emergency, he might pursue illegal activities to gain a significant return. In other words, committing crimes has a higher return in a recession. Therefore, the expected return of crime is a function of the business cycle with a negative relationship:

$$C = C(S) \tag{8}$$

$$\partial C / \partial S < 0 \ .$$

S in this equation represents the business cycle.[1] A higher S represents a better economic situation.

Incorporating (2), (5), (7) and (8) into (6), the expected utility function of crime is :

$$V_i^* = V_i^*(A, Y, Z, S, H) \tag{9}$$

The partial differential of V_i^* is as follows:

$$\partial V^*/\partial A<0, \quad \partial V_i^*/\partial Z>0, \quad \partial V_i^*/\partial S<0, \quad \partial V_i^*/\partial Y>0 \ .$$

Now, V^* and U^* are compared. If U^* is larger than V^*, that is, if the utility of legal activity is higher than that of illegal activity, a rational individual would not choose criminal behavior. On the contrary, if U^* is smaller than V^*, the individual would prefer criminal activity. It is assumed that an individual would not choose criminal behavior when U^* is equal to V^*. Let X_i represent the status of the choice of individual i:

$$X_i = 0 \quad if \ U_i^* \geqq V_i^*$$

$$X_i = 1 \quad if \ U_i^* < V_i^* \ . \tag{10}$$

The total criminal population is P_0:

$$P_0 = \sum_{i=1}^{m} X_i \ . \tag{11}$$

The crime rate is the ratio of the criminal population over total population:

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[1] Some people might think that a rising business cycle and high business returns present attractive crime incentives. However, the empirical results of this paper reveal their negative relationship. If we consider the coefficient of the relationship between the volume of economic crimes and the business cycle, the value is -0.40071 with a t-value of -2.04, which is significantly negative. Therefore, our results do not support this concept of a positive relationship.

$$E = P_0 / p \quad . \tag{12}$$

Where p stands for total population.

Assuming each case involves one perpetrator,[2] we can obtain a crime rate:

$E =$ crime cases / total population

Once this theoretical framework is established, the comparative static can be derived. This paper is concerned with variables for police facilities (A), income (Y), unemployment (Z), and business cycle (S). A change in any of these variables will influence the relative levels of U^* and V^*. If the increasing degree of U^* is larger than that of V^*, criminal tendency decreases. Given an original crime with the value of X_i as 1, lowering the criminal tendency results in the value of X_i as 1 or 0. Given an individual who commits no crime, lowering the criminal tendency results in the value of X_i being 0, as before. Therefore, when U^* increases more than V^*, the total criminal population should decrease or remain the same. That is:

$$if\ \Delta U_i^* > \Delta V_i^*,\quad then\ \Delta E \leqq 0 \quad .$$

By the same reasoning, we get:

$$if\ \Delta U_i^* < \Delta V_i^*,\quad then\ \Delta E \geqq 0$$

and

The comparative static procedure is used to analyze the influence of

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2 Although we do not have data on the population of economic crimes, the above hypothesis can be supported by looking at the relationship between cases of total criminals (CC) and population of total criminals (LL) by the following regression :

LL = a + b*CC

LL = -5648.116 + 0.991 CC adjusted $R^2 = 0.973$.

(1895.566) (0.034)

The numbers in parenthesis are standard deviations. Let us test the null hypothesis :

$H_0 : b = 1$

$H_1 : b \neq 1$.

The t-value for b is derived as

$$\frac{0.991-1}{0.034} = -0.265 \ .$$

Therefore, H_0 cannot be rejected.

$$if\ \Delta U_i^* = \Delta V_i^*,\quad then \Delta\ E = 0\ . \tag{13}$$

variables *A*, *Y*, *Z*,and *S* on crime rate, *E*. A summary of the comparative static results is shown in Table 1. The comparative static procedures are shown in Appendix 1.

In summary, the following functions are derived (the symbol on top of each variable represents its direction of influence):

Under an assumption of risk neutrality,

$$E = f\ (\overset{-}{A},\ \overset{0}{Y},\ \overset{+}{Z},\ \overset{?}{\overset{0}{S}}\ )\ . \tag{14}$$

Under an assumption of risk aversion,

$$E = f\ (\overset{-}{A},\ \overset{?}{Y},\ \overset{+}{Z},\ \overset{?}{\overset{+}{S}}\ )\ . \tag{15}$$

Under an assumption of risk preference,

$$E = f\ (\overset{-}{A},\ \overset{?}{Y},\ \overset{+}{Z},\ \overset{?}{\overset{-}{S}}\ )\ . \tag{16}$$

The influence of *S*, the business cycle, is uncertain in general. Assuming $\pi_{ai}=\pi_{bi}$ and $\partial D/\partial C=1$, the influence of *S* turns out to be determinative. The above condition makes the expected return of either crime or no crime similar. Therefore, the expected utility level of the choice between ‘‘crime’’ and ‘‘no crime’’ is dependent completely upon risk attitude of the potential perpetrator.

Table 1 Comparative Static of Crime Rate

	A police protection	Y income	Z employment status	S business cycle	
Risk Neutrality	-	0	+	?	0
Risk Aversion	-	?	+	?	+
Risk Preference	-	?	+	?	-
Conditions	none	none	none	none	$\pi_{ai}=\pi_{bi}$ $\partial D/\partial C=1$

IV. Empirical Study

An empirical study is conducted using equations (14), (15) and (16). The difference between optimal level of crime and equilibrium levels of crime must be dealt with. According to the partial adjustment model, the optimal crime rate, E^*, and the actual crime rate, E, can be represented by the following equation:

$$(E_t - E_{t-1}) = \alpha (E_t^* - E_{t-1})$$

where α is a parameter. Extending this further, we get:

$$E_t = \alpha E_t^* + (1-\alpha) E_{t-1}$$

$$= \alpha \cdot f (A_t , Y_t , Z_t , S_t) + (1-\alpha) E_{t-1} .$$

Therefore, the empirical model of economic crime is the following:[3]

$$E_t = f (A_t , Y_t , Z_t , S_t , E_{t-1}) \quad (17)$$

Where

E: Economic crime rate (the ratio of economic crime cases over the total population and multiplied by 10^6)
A: Real police expenditures
Y: Real income per capita
Z: Unemployment rate
S: Business cycle (prosperous, $S_i = 1$; recession, $S_i = 0$)

According to the statistics report provided by the police in Taiwan, economic crimes include tax avoidance, illegal processing and sale of meat, smuggling, illegally sale of gasoline, illegal use of patents, illegal registration of businesses, violation of food management regulations, production and sale of privately-made wine and tobacco, and financial (forgery, underground financial companies, illegal transaction of money, intentional bankruptcy), and agricultural (cutting of forests, overuse of forestry land) crimes. There are many different kinds of economic crimes

[3] It would seem at first glance that unemployment *Z*, business cycle *S*, and income *Y* might have a significant relationship. Actually, in characterizing the business cycle, unemployment rate is not considered an influencing factor. Their correlation of coefficients are insignificant, as shown in the table below. The values in parentheses are the t-values.

	Z	*S*	*Y*
Z	1.000		
S	0.021 (0.098)	1.000	
Y	0.064 (0.301)	-0.232 (-0.120)	1.000

and their classification has been adjusted several times.[4]

The factors which influence economic crimes include:

1. Police facilities

Effective use of police facilities can raise the probability of arrest and help attack the crime incentive. On the other hand, insufficient police facilities leave criminals at large and the crime environment intensifies.

2. Income

As a nation's economy becomes more advanced, per capita income may influence the nation's crime rate. First, increasing income causes expected wealth to increase. People do not have to commit crimes if they are satisfied with their current income level. However, when income increases to some degree and external diseconomies appear, i.e., when improvement in material life does not translate into improvement of quality of life, then the economic crime rate during economic development might have a different result.[5]

3. Unemployment rate

Employment status influences an individual's expected income. The higher the unemployment rate is, the higher is the probability of an individual being fired, and the lower is expected income. Therefore, high unemployment means the opportunity cost of being arrested is lower. This is an incentive crime.

4. Business cycle

As the economy prospers, business profits are higher, earning opportunities

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[4] Because the classification method has changed so much over the years, this study considers only the totals of economic crimes.

[5] Unequal income distribution results in jealousy. This might increase the incentive to crime. However, income distribution in Taiwan is relatively equal, compared to other countries. Complete time series of the income distribution coefficient is not available. This paper projects interpolate projected values from published Gini coefficient data to do the empirical study and obtains an insignificant result.

are greater, and social life satisfaction and job optimism are high. In such an environment, legal working activities can fully satisfy an individual's life demands without his taking illegal risks. As a result, a rising business cycle means a lower crime rate. For a risk-preferential individual, the expected return on illegal activities during a rising business cycle cannot match the expected return of illegal activities during a falling business cycle. Therefore, the crime incentive for such an individual decreases in the rising period. The conclusion reverses for a risk averter.

5. Previous crime rate

The crime rate in previous periods can be used to estimate the current crime rate. Empirically, a previously explained variable is usually considered one of the explanatory variables in successive models. There are several reasons for this. One reason is that the partial adjustment model explains the lag adjustment phenomenon of market equilibrium to the optimal point. The second reason is due to the habitual behavior of criminals. Even if the criminal is not a repeat offender, his behavior can have a demonstration effect on other potential criminals. The third reason is that other, noneconomic, factors significantly influence the crime rate, in addition to economic factors. These noneconomic factors are absorbed by the previous crime rate factor.

The observations used are from 1966 to 1989. Data sources are presented in Appendix 2. The ordinary least squares (OLS) method is used for regression analysis. The results are as follows:

By OLS:

$$
\begin{aligned}
E_t = \underset{(0.586)}{247.97} - \underset{(-0.148)}{0.001A_t} - \underset{(-0.119)}{0.0013Y_t} + \underset{(1.437)}{176.85Z_t} - \underset{(-1.364)}{142.67S_t} \\
+ \underset{(5.028)^{**}}{0.698E_{t-1}} \qquad \textbf{(18-1)}
\end{aligned}
$$

$\bar{R}^2=0.7713 \quad F^{**}=15.839 \quad Durbin\text{-}h^{*}=-2.12$

*: significant at 10% level
**: significant at 5% level

The degree of fitness of this equation passes the 5% significance level test. Due to the existence of the lag variable, the autocorrelation test should be executed by the Durbin-h value.[6] Durbin-h = -2.12, which is not significantly different from 0 at the 5% significance level, but is significantly different from 0 at the 10% significance level. Whether this equation needs further adjustment is dependent upon the significant level of error.

This paper tries to adjust the residual autocorrelation. When residuals show autocorrelation, the iterative Cochrane-Orcutt procedure is adopted to estimate coefficients. This method might be inconsistent when explanatory variables include a lag explained variable; that is, the sum of squared errors might be a local minimization instead of a global minimization, so that the maximum likelihood estimation is adopted. The maximum likelihood estimation attempts a grid search between -1 and +1, and its sum of squared errors is expected to be a global minimization. This paper uses the iterative Cochrane-Orcutt procedure and maximization likelihood estimation to get the following results:

By the iterative Cochrane-Orcutt procedure:

$$\underset{}{E_t} = \underset{(-0.251)}{-68.805} \; \underset{(-1.016)}{-\,0.005A_t} \; \underset{(0.708)}{+\,0.005Y_t} \; \underset{(2.640)^{**}}{+\,219.80Z_t} \; \underset{(-3.126)^{**}}{-\,263.10S_t} \; \underset{(9.410)^{**}}{+\,0.831E_{t-1}} \qquad \textbf{(18-2)}$$

$$\overline{R}^2 = 0.8255 \qquad F^{**} = 21.81$$

By ML with Grid Search:

[6] Please refer to Pindyck and Rubinfeld (1991).

$$E_t = -\ 63.744 - 0.005A_t + 0.005Y_t + 219.13Z_t - 260.55S_t + 0.829E_{t-1} \quad (18\text{-}3)$$
$$\quad (-0.267) \quad (-1.151) \quad (0.795) \quad (3.030)^{**} \quad (-3.573)^{**} \quad (10.793)^{**}$$

According to these empirical results, the following conclusions are derived:[7]

[7] This paper tried different empirical methods such as the following:

By OLS:

$$E_t = 979.12 - 0.002A_t - 0.005Y_t + 356.31Z_t = 45.698S_t \quad (20\text{-}1)$$
$$(1.608) \quad (-0.190) \quad (-0.304) \quad (1.974)^{*} \quad (0.305)$$

$$\bar{R}^2 = 0.4629 \quad F^{**} = 5.740$$

$$D.W. = 0.7424(\rho > 0)$$

By ML with Grid Search:

$$E_t = 1620.2 + 0.002A_t - 0.012Y_t + 113.02Z_t + 3.975S_t \quad (20\text{-}2)$$
$$(3.144)^{**} \quad (0.357) \quad (-1.050) \quad (0.864) \quad (0.049)$$

$$\bar{R}^2 = 0.7813 \quad F^{**} = 19.20$$

By OLS:

$$E_t = 686.88 - 0.010A_{t-1} + 0.006Y_{t-1} + 473.87Z_{t-1} - 162.87S_{t-1} \quad (21\text{-}1)$$
$$(1.198) \quad (-1.018) \quad (2.962)^{**} \quad (2.962)^{**} \quad (-1.208)$$

$$\bar{R}^2 = 0.5324 \quad F^{**} = 6.977$$

$$D.W. = 0.8742(\rho > 0)$$

By ML with Grid Search:

$$E_t = 1173.1 - 0.009A_{t-1} + 0.006Y_{t-1} + 204.82Z_{t-1} - 181.96S_{t-1} \quad (21\text{-}2)$$
$$(2.408)^{*} \quad (-1.280) \quad (0.559) \quad (107.3) \quad (-2.340)^{*}$$

$$\bar{R}^2 = 0.7439 \quad F^{**} = 21.03$$

The fit of these equations is not better than (18-1), (18-2) and (18-3), and obtain similar results.

(1) The three equations above have acceptable fit and similar conclusions.

(2) The coefficient of the term for unemployment, Z, is significantly positive. An increase in the unemployment rate causes the economic crime rate to rise. A decrease in the unemployment rate causes the economic crime rate to fall.

(3) The coefficient of the term for the business cycle, S, is significantly negative. A rising business cycle helps to decrease the economic crime rate. A falling business cycle causes the economic crime rate to rise.

(4) The coefficient of the term for police expenditures is insignificantly negative. An increase in police expenditures has little deterrent effect on economic crimes.

(5) The coefficient of the term for income per capita is insignificantly positive. Rising incomes seem to stimulate economic crime at an insignificant level.

(6) The empirical study fits the models of (14) and (16) rather than (15). It is shown that potential criminals are possibly risk-neutral or risk preferring, with a low probability of being risk-averters.

If we use ''real police expenditure per capita'', or AP, to replace ''real police expenditure'' in the empirical regressions, the resulting regressions are:

By OLS:

$$\underset{}{E_t} = \underset{(0.826)}{237.95} - \underset{(-0.444)}{0.565AP_t} + \underset{(0.122)}{0.001Y_t} + \underset{(1.655)}{194.93Z_t} - \underset{(-1.365)}{140.30S_t} + \underset{(4.913)^{**}}{0.688E_{t-1}} \qquad \textbf{(19-1)}$$

$\overline{R}^2=0.7736 \quad F^{**}=16.038 \quad Durbin\text{-}h^{*}=-2.23$

By the iterative Cochrane-Orcutt procedure:

$$E_t = \underset{(0.350)}{61.214} - \underset{(-1.178)}{0.100AP_t} + \underset{(0.797)}{0.005Y_t} + \underset{(2.793)^{**}}{220.90Z_t} - \underset{(-3.052)^{**}}{249.06S_t}$$
$$+ \underset{(9.102)^{**}}{0.812E_{t-1}} \quad \textbf{(19-2)}$$

$$\overline{R}^2=0.8289 \qquad F^{**}=22.31$$

By ML with Grid Search:

$$E_t = \underset{(0.416)}{63.258} - \underset{(-1.346)}{0.099AP_t} + \underset{(0.906)}{0.005Y_t} + \underset{(3.214)^{**}}{220.62Z_t} - \underset{(-3.497)^{**}}{247.04s_t}$$
$$+ \underset{(10.457)^{**}}{0.810E_{t-1}} \quad \textbf{(19-3)}$$

$$\overline{R}^2=0.8287 \qquad F^{**}=30.16$$

The conclusions are similar to those in (18-1), (18-2) and (18-3).[8]

V. Conclusion

This paper analyzes the problem of economic crime through theoretical and empirical studies. An individual's utility function is used to develop a theoretical model which includes some other variables such as business cycle, police facilities, income, and unemployment. The direction of influence is dependent upon the risk attitude of criminals. The observations which comprise the data of the empirical study are from 1966 to 1989.

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[8] If the credit variable is considered and the growth rate of M_2 is taken as an explaining variable, the main results are not changed. Please refer to Appendix 3.

This paper can be summarized and compared to previous literatures as follows:

(1) Police facilities expenditures have an insignificantly negative influence on economic crimes. This conclusion is generally similar to findings as reported in previous literature.

(2) Per capita income has an insignificantly positive or negative influence on economic crimes. The degree to which measures of economic development can be used to explain crime rates is limited. However, Western research on the topic usually classifies people according to race and age, the effects of which are not considered in this paper. In fact, race discrimination is not seen in Taiwan.

(3) The unemployment rate has a significantly positive influence on economic crimes. This result corresponds to those of most of the previous literature.

(4) The business cycle has a significant negative influence on economic crimes. This issue has seldom been studied in past literature.

(5) Most economic criminals are risk-preferential or risk-neutral. Although some literature discusses risk attitude, there are few studies which test the criminal risk preference attitude.

Further studies could be extended in several directions:
(a) other types of crimes;
(b) causality of criminal behavior and criminal background;
(c) analysis of different kinds of economic crimes;
(d) consideration of social and psychological factors; and
(e) extension of the theoretical model to be more generalized or dynamic.

All of these studies need accurate statistical data. An improvement of census methods is needed to provide higher quality data.

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Appendix 1 Comparative Static

1. Change of A

$$\frac{\Delta U_i^*}{\Delta A} = 0$$

$$\frac{\Delta V_i^*}{\Delta A} = (U_{bi} - U_{ai}) \overset{(+)}{\frac{\partial \pi_{bi}}{\partial A}} < 0$$

due to $\partial\pi_{bi}/\partial A > 0$, and $U_{bi} < U_{ai}$

$$\frac{\Delta U^*}{\Delta A} > \frac{\Delta V_i^*}{\Delta A}$$

$$\therefore \frac{\Delta E}{\Delta A} \leq 0$$

2. Change of Y

$$\frac{\Delta U_i^*}{\Delta Y} = \frac{\partial U_i}{\partial W_i^e} \frac{\partial W_i^e}{\partial Y} > 0$$

$$\frac{\Delta V_i^*}{\Delta Y} = \pi_{ai}\frac{\partial U_{ai}}{\partial(W_i^e+c)}\frac{\partial W_i^e}{\partial Y} + \pi_{bi}\frac{\partial U_{bi}}{\partial(W_i^e-D)}\frac{\partial W_i^e}{\partial Y} > 0$$

$$\frac{\Delta V_i^*}{\Delta Y}-\frac{\Delta U_i^*}{\Delta Y} = \pi_{ai}\left[\frac{\partial U_{ai}}{\partial(W_i^e+C)} - \frac{\partial U_i}{\partial W_i^e}\right]\frac{\partial W_i^e}{\partial Y} + \pi_{bi}\left[\frac{\partial U_{bi}}{\partial(W_i^e-D)} - \frac{\partial U_i}{\partial W_i^e}\right]\frac{\partial W_i^e}{\partial Y}$$

Under Risk-neutrality

$$\frac{\partial U_{ai}}{\partial(W_i^e+C)} = \frac{\partial U_i}{\partial W_i^e} = \frac{\partial U_{bi}}{\partial(W_i^e-D)}$$

then we get $\Delta V_i^*/\Delta Y - \Delta U_i^*/\Delta Y = 0$

$$\therefore \frac{\Delta E}{\Delta Y} = 0$$

Under Risk-preference

$$\frac{\partial U_{ai}}{\partial(W_i^e+C)} > \frac{\partial U_i}{\partial W_i^e} > \frac{\partial U_{bi}}{\partial(W_i^e-D)}$$

$$\frac{\Delta V_i^*}{\Delta Y} - \frac{\Delta U_i^*}{\Delta Y} = \pi_{ai}\left[\frac{\partial U_{ai}}{\partial(W_i^e+C)} - \frac{\partial U_i}{\partial W_i^e}\right]\frac{\partial W_i^e}{\partial Y} + \pi_{bi}\left[\frac{\partial U_{bi}}{\partial(W_i^e-D)} - \frac{\partial U_{ai}}{\partial W_i^e}\right]\frac{\partial W_i^e}{\partial Y} \begin{matrix}<\\=0\\>\end{matrix}$$

Under Risk-aversion

$$\frac{\partial U_{ai}}{\partial (W_i^e + C)} < \frac{\partial U_i}{\partial W_i^e} < \frac{\partial U_{bi}}{\partial (W_i^e - D)}$$

$$\frac{\Delta V_i^*}{\Delta Y} - \frac{\Delta U_i^*}{\Delta Y} = \pi_{ai}\left[\frac{\partial U_{ai}}{\partial (W_i^e + C)} - \frac{\partial U_i}{\partial W_i^e}\right]\frac{\partial W_i^e}{\partial Y} + \pi_{bi}\left[\frac{\partial U_{bi}}{\partial (W_i^e - D)} - \frac{\partial U_{ai}}{\partial W_i^e}\right]\frac{\partial W_i^e}{\partial Y} \begin{matrix} < \\ =0 \\ > \end{matrix}$$

3. Change of Z

$$\frac{\Delta U_i^*}{\Delta Z} = 0$$

$$\frac{\Delta V_i^*}{\Delta Z} = -\pi_{bi} \overset{(+)}{\frac{\partial U_{bi}}{\partial (W_i^e - D)}} \cdot \overset{(-)}{\frac{\partial D}{\partial Z}} > 0$$

$$\frac{\Delta V_i^*}{\Delta Z} - \frac{\partial U_i}{\partial Z} > 0 \quad .$$

4. Change of S

$$\frac{\Delta U^*}{\Delta S} = 0$$

$$\frac{\Delta V_i^*}{\Delta S} = \pi_{ai}\overset{(+)}{\frac{\partial U_{ai}}{\partial(W_i^e+c)}}\overset{(-)}{\frac{\partial C}{\partial S}} - \pi_{bi}\overset{(+)}{\frac{\partial U_{bi}}{\partial(W_i^e-D)}}\overset{(+)}{\frac{\partial D}{\partial C}}\overset{(-)}{\frac{\partial C}{\partial S}} \gtreqless 0$$

$$\frac{\Delta V_i^*}{\Delta S} - \frac{\Delta U_i^*}{\Delta S} = \pi_{ai}\frac{\partial U_{ai}}{\partial(W_i^e+C)}\frac{\partial C}{\partial S} - \pi_{bi}\frac{\partial U_{bi}}{\partial(W_i^e-D)}\frac{\partial D}{\partial C}\frac{\partial C}{\partial S} \gtreqless 0$$

$$\therefore \frac{\Delta E}{\Delta S} \gtreqless 0 \quad ,$$

if $\pi_{ai} = \pi_{bi}$, and $\partial D/\partial C = 1$.

Under Risk-neutrality

$$\frac{\partial U_{ai}}{\partial(W_i^e+C)} = \frac{\partial U_{bi}}{\partial(W_i^e-D)} \quad ,$$

so we get

$$\frac{\Delta V_i^*}{\Delta S} - \frac{\Delta U_i^*}{\Delta S} = 0$$

$$\therefore \frac{\Delta E}{\Delta S} = 0 \quad .$$

Under Risk-preference

$$\frac{\partial U_{ai}}{\partial (W_i^e + C)} > \frac{\partial U_{bi}}{\partial (W_i^e - D)} \quad ,$$

so we get

$$\frac{\Delta V_i^*}{\Delta S} - \frac{\Delta U_i^*}{\Delta S} < 0$$

$$\therefore \frac{\Delta E}{\Delta S} < 0 \quad .$$

Under Risk-aversion

$$\frac{\partial U_{ai}}{\partial (W_i^e + C)} < \frac{\partial U_{bi}}{\partial (W_i^e - D)} \quad ,$$

so we get

$$\frac{\Delta V_i^*}{\Delta S} - \frac{\Delta U_i^*}{\Delta S} > 0$$

$$\therefore \frac{\Delta E}{\Delta S} > 0 \quad .$$

Appendix 2 Data Sources

Data Sources:

E: Number of Cases of Economic Crimes
From *Police Statistical Analysis in Taiwan*, National Police Administration and Department of Police of Taiwan Provincial Government.

P: Population
The same source as E.

Y: Per Capita Real GNP
From *Taiwan Statistical Data Book*, CEPD.

Z: Unemployment Rate
From *Annual Report of Economic Statistics*, Department of Statistics, The Ministry of Economic Affairs.

S: Business Cycle Index
From *Business Cycle Index in Taiwan*, CEPD.
S=1 from trough to peak
S=0 from peak to trough

M2: Growth Rate of Money Supply (Broad Definition)
From *Taiwan Statistical Data Book*, CEPD.

A1: Police Expenditures of Taiwan Provincial Government
From *Statistical Annual Report of Taiwan Province*, DGBAS.

A2: Police Expenditures of Each County in Taiwan
From *Statistical Annual Report of Taiwan Province*, DGBAS.

A3: Police Expenditures of Taipei City
From *Statistical Overview of Taipei*, DGBAS of Taipei.

A4: Police Expenditures of Kaohsiung City
From *Statistical Overview of Kaohsiung*, DGBAS of Kaohsiung.

CPI: (1986=100) Consumer Price Index
From *Taiwan Statistical Data Book*, CEPD.

A: Real Police Expenditure
A=(A1+A2+A3+A4)/CPI

E: Economic Crime Ratio
E=E1/P

Appendix 3 Empirical Study Considering the Credit Variable

By OLS:

$$E_t = \underset{(0.903)}{374.20} - \underset{(-0.669)}{0.0047A_t} + \underset{(0.352)}{0.0038Y_t} + \underset{(1.940)}{244.33Z_t} - \underset{(-0.998)}{103.35S_t}$$

$$- \underset{(-1.556)}{13.19M_t} + \underset{(5.007)^{**}}{0.673E_{t-1}} \qquad (18\text{-}1A)$$

$\bar{R}^2=0.7890 \quad F^{**}=14.707 \quad Durbin\text{-}h^{*}=-1.985$

By the iterative Cochrane-Orcutt procedure:

$$E_t = \underset{(0.151)}{42.837} - \underset{(-1.390)}{0.007A_t} + \underset{(1.046)}{0.008Y_t} + \underset{(2.959)^{**}}{262.87Z_t} - \underset{(-2.232)^{*}}{205.72S_t}$$

$$- \underset{(-1.347)}{8.923M_t} + \underset{(8.718)^{**}}{0.795E_{t-1}} \qquad (18\text{-}2A)$$

$\bar{R}^2=0.8331 \quad F^{**}=19.31$

By ML with Grid Search:

$$E_t = \underset{(0.194)}{46.096} - \underset{(-1.654)}{0.0068A_t} + \underset{(1.242)}{0.0079Y_t} + \underset{(3.530)^{**}}{262.80Z_t} - \underset{(-2.625)^{**}}{204.34S_t}$$

$$- \underset{(-1.621)}{8.987M_t} + \underset{(10.384)^{**}}{0.7935E_{t-1}} \qquad (18\text{-}3A)$$

$\overline{R}^2$=0.8331 F^{**}=27.74

By OLS:

$$E_t = 487.43 - 0.118AP_t + 0.005Y_t + 255.23Z_t - 91.085S_t$$
$$(1.553) \quad (-0.929) \quad (0.538) \quad (2.160)^{*} \quad (-0.889)$$

$$- 13.542M_t + 0.653E_{t-1} \qquad (19\text{-}1A)$$
$$(-1.642) \quad (4.828)^{**}$$

$\overline{R}^2$=0.7942 F^{**}=15.147 *Durbin-h**=−2.06

By the iterative Cochrane-Orcutt procedure:

$$Esubt = 240.15 - 0.136AP_t + 0.007Y_t + 260.50Z_t - 184.41S_t$$
$$(1.116) \quad (-1.538) \quad (1.108) \quad (3.113)^{**} \quad (-2.001)^{*}$$

$$- 9.006M_t + 0.768E_{t-1} \qquad (19\text{-}2A)$$
$$(-1.385) \quad (8.224)^{**}$$

$\overline{R}^2$=0.8372 F^{**}=19.86

By ML with Grid Search:

$$E_t = 243.31 - 0.136AP_t + 0.007Y_t + 260.61Z_t - 182.79S_t$$
$$(1.347) \quad (-1.830) \quad (1.316) \quad (3.712)^{**} \quad (-2.384)^{*}$$

$$- 9.091M_t + 0.766E_{t-1} \qquad (19\text{-}3A)$$
$$(-1.668) \quad (9.783)^{**}$$

$\overline{R}^2$=0.8371 F^{**}=28.53

By OLS:

$$E_t = \underset{(2.006)^*}{1148.9} - \underset{(-0.619)}{0.006A_t} + \underset{(0.078)}{0.0012Y_t} + \underset{(0.599)}{414.84S_t}$$

$$- \underset{(-1.438)}{17.179M_t} \qquad (20\text{-}1A)$$

$\overline{R}^2=0.5839$ $F^{**}=7.454$

$D.W.=0.8134$(*inconclusive*)

By ML with Grid Search:

$$E_t = \underset{(3.377)^{**}}{1624.9} - \underset{(-0.088)}{0.0006A_t} + \underset{(-0.698)}{0.0075Y_t} + \underset{(1.813)}{211.36Z_t} + \underset{(0.004)}{0.326S_t}$$

$$- \underset{(-1.448)}{10.292M_t} \qquad (20\text{-}2A)$$

$\overline{R}^2=0.7713$ $F^{**}=22.02$

By OLS:

$$E_t = \underset{(1.954)}{1015.1} - \underset{(-1.345)}{0.0123A_{t-1}} + \underset{(0.691)}{0.0098Y_{t-1}} + \underset{(3.381)^{**}}{460.85Z_{t-1}} - \underset{(-1.054)}{133.61S_{t-1}}$$

$$- \underset{(-1.662)}{17.427M_{t-1}} \qquad (21\text{-}1A)$$

$\overline{R}^2$=0.6344 F^{**}=8.635

$D.W.$=0.9981(*inconclusive*)

By ML with Grid Search:

$$E_t = \underset{(2.799)^{**}}{1246.6} - \underset{(-1.456)}{0.0096A_{t-1}} + \underset{(0.688)}{0.007Y_{t-1}} + \underset{(2.166)^{*}}{232.15Z_{t-1}} - \underset{(-2.455)^{*}}{184.13S_t}$$

$$- \underset{(-1.170)}{7.5031M_{t-1}} \qquad (21\text{-}2A)$$

$\overline{R}^2$=0.7794 F^{**}=22.39

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