Crimonometric Analysis: Testing the Deterrence Hypothesis in Sabah

Lau, Evan and Hamzah, Siti Nur Zahara

Universiti Malaysia Sarawak, Swinburne University of Technology, Sarawak Campus,

26 May 2012

Crimonometric Analysis: Testing the Deterrence Hypothesis in Sabah

Evan Lau[1] and Siti Nur Zahara Hamzah[2]

Abstract

This paper empirically estimates disaggregated crime categories for Sabah from 1968 to 2006. The criminometric analysis incorporated in a within sample analysis of cointegration and error correction framework and the beyond sample analysis using the decompositions of variance. Our findings suggest that any support for the deterrence hypothesis is sensitive to the inclusion of prison or courts related variables. In the long run we find that only robbery is exogenous in all crime model tested however, the beyond sample estimation proves that in longer time period of approximately 50 years the post-sample dynamic VDCs imply that a substantial portion of the variance of the forecast error of these crime are explained by their explanatory variables.

[1] Corresponding Author: Faculty of Economics and Business, Universiti Malaysia Sarawak. 94300 Kota Samarahan, Sarawak. Tel: +6082-584368, Fax: +6082-583999, E-mail: lphevan@feb.unimas.my or ygwiex@yahoo.com

[2] Swinburne University of Technology, Sarawak Campus, Jalan Simpang 3, 93350 Kuching, Sarawak. Tel: +6082-260870, Fax: +6082-260815, E-mail: shamzah@swinburne.edu.my

1. Introduction

Crime is a by-product of development (Meera, 1993) in which societies are becoming more materialistic and anomistic. *Anomie* can be referred to as "normless" state where individuals' goals are more important than the means adopted to attain them, and it is likely to be a feature of periods of rapid economic or social change. Barlow (1984) pointed out that under those conditions where anomie is prevalent; all types of crime may be expected to rise in the society including non-pecuniary crimes like rape and murder (Meera, 1990). Since growth and development are concerned with economists and policy makers, so do crime. Crime or the non-compliance attitude of individuals can be viewed as negative externality with destructive power.

Economics of crime emerged from the economics' basic problem of efficient utilization of scarce resources for maximum benefits towards individuals or societies. Crime on one strand can be viewed as the outcome of inefficient resource allocation of developing countries. It is inevitable that in the midst of development and globalization crime comes hand in hand with other socio-demographic problems. Table 1 shows Malaysia's HDI, GDP and crime rates from 1980 up to 2006. It is obvious that Human Development Index (HDI), Gross Domestic Product (GDP) and crime in Malaysia are increasing. HDI are an index measuring the development phase of a country. A general view from Table 1 will definitely support the hypothesis that crime are by- product of development.

Table 1: Malaysia's HDI, GDP and Crime trends 1980 - 2011

Year	HDI	GDP	Crime Rate
1980	0.559	54.29	70745
1985	0.600	78.89	89165
1990	0.631	119.08	68488
1995	0.674	225.83	81183
2000	0.705	356.40	167130
2005	0.738	522.45	157365

Sources: Human Development Report, 2011

Arguments prevail as of why economics of crime and critics towards rational choice theory adapted to crime and criminology in an economic perspective (for detailed explanations on criticism towards rational choice theory see, Ulen, 1999). It is important to note that, crime "contribute" to the economy from two strands. While crime activities robs part of a nation's income for its control is one strands, increasing loss of future economic production is another. Both a nation's income and the demolition of its future economic production are important measure for policy makers thus giving economists' concern over increasing crime rate in a country. In the case of Malaysia, crime staggered to the peak of the nation's policy agenda under the National Key Results Areas (NKRA) in 2010 and reducing crime was one of the important elements in providing better security for the people.

Malaysian Vision 2020 which aims to attain fully developed nation status by the year 2020 was carried out through encouraging economic growth, enhancing small and medium enterprise development, increasing public-private partnerships and attracting targeted high-quality foreign direct investment forget or neglected the social norms or values embedded in the lives of their people. Here is where anomie comes into picture portrayed by increasing crime rate over the years of economic progress in Malaysia with its highly capitalistic mission. Crime in Malaysia are increasing by leaps and bounds since the past 20 years (Hamzah and Lau, 2011) and evidence are everywhere in the

mass media, printed and electronic, alike. Meera (1993) while explaining Malaysian public expenditure on the criminal-justice system highlighted that, growth in crime rates would sooner or later become a threat to the society and feeling of insecurity may prevail and it may take a somewhat long time to become obvious or to be noticed. It is proven these days that across the nation, societies are crying for peace and security depositing the government into unrest and forcing them to increase police force, review its training programme and develop new security policies to increase safety measures in Malaysia. From an economics of crime's view it is not the best trained police force which will decrease crime rates in a highly capitalistic and materialistic society (Teh, 2008); it is the improvement in the imbalances of the economic system.

This study intend to make a humble attempt in finding relationship between crime and economic determinants while at the same time proving the effectiveness of existing law and enforcement strategy in Sabah. Sabah's fluid cultural, social and economic boundaries with both Indonesia and the Philippines renders the role of national identities, citizenship and formal economic networks less important than the informal transnational networks that facilitates the flow of commodities and humans across boundaries, often undetected by the Malaysian/Sabahan state apparatus. These undetected activities are said to be root cause for increasing Sabah's crime rates in recent years which event called for a Memorandum of Understanding (MoU) to be signed between the Sabah National Unity and Integration Department (NUID) and districts' police in order to reduce crime rates in the district level. The rest of the papers is constructed as follows with section 2 provides the discussion on the literature review, section 3 illustrates the methodology used for the analysis, section 4 present the results and section 5 conclude the overall findings.

2. Literature Review

Meera (1990; 1993) in his study highlighted that increasingly larger amount of resources per head are being spent from public resources to control crime in Malaysia. However, the share of public expenditure on economic costs for crime control had been constant and does not burden the nation for the period studied. The effect of crime activities are extensive and far reaching to beyond the injury and loss suffered by victims during the crime (Keng, 2006). The costs incurred by victims as results of victimization, government allocation for efficient law enforcement and individual or organizations precautionary movements are all the sum of costs from criminal activities. Government plays an important role in implementing efficient law enforcement for a nation because crime is a costly social phenomenon that can leads to paralyzed economy, political turbulences and social morality problems.

Elsewhere in the literature, Malaysia became important country for analysis of crime in criminology (Moss, 1997), blue water crime (Kuperan and Sutinen, 1998), policing (Sidhu, 2005; Sidhu, 2006; Teh, 2008) and economics (Meera and Jayakumar, 1995; Habibullah and Baharom, 2009; Baharom and Habibullah, 2009; Tang, 2009; Tang 2011 and Hamzah and Lau, 2011). All studies, at best, provide mixture finding for crime in Malaysia. Meera and Jayakumar (1995) found that crimes in Malaysia are generally motivated by economic factors. All crime categories are also found to exhibit long-run relationship with economic conditions (Habibullah and Baharom, 2009) however fails to portray cointegration with income inequality (Baharom and Habibullah, 2009). When testing for crime, inflation and unemployment, Tang (2009) concluded that there are positive relationship between unemployment and inflation with crime in the long-run.

The finding holds even when tourists' arrivals are incorporated in the crime model (Tang, 2011). Employing a panel analysis of 14 states in Malaysia, Hamzah and Lau (2011) identified that all crime categories are negatively related to unemployment. However, no studies - as far as the authors are aware of - that analyse deterrence hypothesis in Malaysia.

Studies on economics of crime are wide-ranging differentiated by types of data used, methodological choices and geographical situation of the case studied. However, consensus on the support for economics of crime theory had never been achieved. Ehrlich (1977) contends that the possibility of bias due to omitted variable bias never can be denied however, it is impossible to capture all variables that are said to be the influence in increasing crime rates (see Masih and Masih, 1996 and Kelaher and Sarafidis, 2011 for examples). Omitted variable bias are also been accused as the reasons for conflicting results obtained in the literature of economics of crime. According to Mustard (2003), conviction rate and time served are theoretically important but often neglected in economics of crime analysis. This can generates omitted variable bias if in reality those neglected variables are indeed correlated with arrest rate. This study will analyse crime in econometric model of supply and deterrence to overcome existing shortage of deterrence analysis tested in Malaysia.

3. Econometric Methodology

Theoretical Framework

Becker (1968) starts the supply of offences model with economists' usual analysis of choice and assumes that a person commits an offence if the utility he could get by using his time and other resources at other activities. Dumped by theories of determinants of crime from various field of studies, Becker (1968) pointed out that, "*Practically, all the diverse theories agree, however, that when other variables are held constant, an increase in a person's probability of conviction or punishment if convicted will generally decrease, perhaps substantially, perhaps negligibly, the number of offenses he commits.*" to support the model of economics of crime.

According to Becker (1968), assume an availability of more legal jobs in the market, increase in population knowledge will decrease the incentive to enter illegal market thus reducing number of offences. Same goes to changes in punishment meted out by the government or policy changes related to punishment, for example, imposing more severe punishment for particular offence would tend to reduce the number of offenses, according to Becker at least temporarily since they cannot be committed while going under punishment. Thus, the individual's expected utility, $E[U]$ from committing an offence would be:

$$E[U_j] = p_j U_j(Y_j - f_j) + (1 - p_j) U_j(Y_j)$$

where U_j is the individual's von Neumann-Morgenstern utility function, p_j is the subjective probability of being caught and convicted, Y_j is the monetary plus psychic income or monetary equivalent from an offence and f_j the monetary equivalent of the punishment.

Improvements made in Ehrlich (1973) from Becker's economics model of crime are numerous which later became among the most influential papers in economics of crime literature. First, it assumes that criminals now have the choice between costs and gains from legitimate and illegitimate industries and support the new model with existing empirical evidence. Secondly, the models relates the theory of participation in illegitimate activities with the general theory of occupational choices hence it can helps economists predict both the direction and relative magnitude of the response of specific offenders to changes in various observable opportunities. The model also allows differentiation between the deterrent and preventive effects of punishment by imprisonment and permits the empirical investigation to gauge the deterrent effects alone. Lastly, Ehrlich (1973) analyzes the interaction between offense and defence using simultaneous-equation model to test the model empirically. The supply of offences equation by Ehrlich (1973) after the modification of separating quantifiable and non-quantifiable behavioural function can be written as follows:

$$\left(\frac{Q}{N}\right)_i = P_i^{b_{1i}} F_i^{b_{2i}} Y_i^{c_{1i}} Y_l^{c_{2i}} U_l^{d_i} V^{c_i} \mathrm{Z_i}$$

where $\left(\frac{Q}{N}\right)_i$ represent the crime rates for a given category, *i*; F_i, Y_i and Y_l are the arithmetic means of the monetary components of costs of punishment, income from illegitimate activities and income from legitimate activities; *V* is a vector of environmental variables and *Z* summarizes the effect of psychic and other non-quantifiable variables on the crime rate.

Assuming that individual's taste for crime was either proportional to some of the quantifiable variables affecting crime, or uncorrelated in the natural logarithms with all the

explanatory variable, Ehrlich (1973) specify a stochastic function of the supply of offences function as follows;

$$\left(\frac{Q}{N}\right)_i = AP_i^{b_{1i}} F_i^{b_{2i}} Y_i^{c_{1i}} Y_l^{c_{2i}} U_l^{d_i} V^{e_i} \exp(\mu)$$

where, A is a constant and μ stands for random errors of measurement and other stochastic effects and is assumed to have a normal distribution. The study of Ehrlich (1973) goes on until Ehrlich (1996) where he explained the basic misconception on the positive and negative incentives faced by potential criminals in their decision making process. It is believed that deterrence hypothesis only applied to negative incentives while positive incentives are useful in determining crime level and reducing it where possible. These understanding of positive and negative incentives are wrong since Ehrlich (1996) spelled out that, "*The deterrence hypothesis and its logical extension - the market model - rely on the marginal efficacy of both positive and negative incentives and on the interaction between market demand and supply forces, to explain the observed variability in the frequency of offenses across space and time*".

Following Becker (1968) and its extension in Ehrlich (1973), this paper estimates following models of economics of crime for deterrence and determinants analysis in Sabah

$$C_r = \alpha + \beta_1 Y_r + \beta_2 U_r + \beta_3 CD_r + \beta IMP_r + \beta REC_r + \mu$$

where C_r refers to the crime rate; Y_r is the GDP that represents the legitimate income level; U_r is the unemployment rate which is the proxy for gains from illegitimate activities and time to allocate into illegitimate activities; CD_r is the number of cases disposed by high court,

IMP_r is the imprisonment rate and REC_r are the recidivism rate as proxy to estimates the efficiency of law enforcement strategies. The number of cases disposed by high court, imprisonment and recidivism are also deterrence variables which will explain the deterrence role played by Sabah's law enforcement strategies.

Estimation Procedures

1. ***Cointegration Analysis***

   Cointegration technique explains the long-run relationship between two or more variables. Two or more variables are said to be cointegrated when they share a common trends and this imply that variables in the system exhibit a long-run relationships among them. However, cointegration only indicates the presence or absence of causal relationship among variables in a system and the results does not indicate any direction of causality between variables. This study employs cointegration analysis developed by Johansen and Juselius (1988, 1990) to determine the long-run relationship properties of the crime model.

2. ***Vector Error Correction Modelling (VECM) & Causality Test***

   Engle and Granger (1987) illutrated that once a number of variables (say, x and y) are found to be cointegrated, there always exists a corresponding error correction representation which suggests that changes in the dependent variable are a function of the level of disequilibrium in the cointegrating relationship (captured by the error correction term) as well as changes in other explanatory variables. Masih and Masih (1996) elaborated that the error correction approach are incorporated of both short- and long-run components. It could be seen as capturing the short-run dynamics of the system, whilst incorporating the long-run equilibrium suggested by theory (Dolado et

al., 1990). A consequence of ECM is that either Δx_t or Δy_t or both must be caused by ε_{t-1} which is itself a function of x_{t-1}, y_{t-1}. Intuitively, if y_t and x_t have a common trend, then the current change in x_t is partly the result of x_t moving into alignment with the trend value of its independent variables (y_t). Through the error correction term, the ECM opens up an additional channel for Granger causality (ignored by the standard Granger, 1969 and Sims, 1972 tests) to emerge. VECM model allows Granger causality to be analysed through the error correction terms which were neglected in standard Granger (1969) and Sims (1972) tests. The Granger causality or endogeneity properties of the dependent variables are evidenced through the statistical significance of the t-test of the lagged error correction term and/or the F-test applied to the joint significance of the sum of the lags of each explanatory variable. The non-significance of these tests in opposite indicates the econometric exogeneity of the variables estimated.

3. Variance Decompositions (VDCs)

All the estimation procedures explained earlier can be inferred as within-sample estimations which only carter for the variables relationship within the sample period analysed. This weakness can be fixed using variance decompositions (VDCs) analysis which may be termed as out-of-sample causality tests. VDCs partitioned the variance of the forecast error of certain variables (crime categories for this study) into proportions attributable to shocks in each variable in the system including its own, provides an indication of these relatives. According to Sims (1982), variables that are optimally forecast from its own lagged values will have all its forecast error variance accounted for by its own disturbances.

4. Results & Discussion

The model estimated for this study consists of six variables: different types of crime rates (*CR*)[3], GDP, unemployment (*UE*), number of cases disposed by high court (*CD*), imprisonment rates (*IMP*) and recidivism rates (*REC*). It is important to note that the level of crime in any society are determined by many differing and interrelated influences which is impossible to be incorporated in a single quantitative model in this study. Thus, the incorporation of the variables for this study is chosen partly due to the availability of the data for the region studied and partly based on the theories discussed in previous section.

A wide range of unit root tests was applied preceding the Johansen and Jesulius's (1990) multivariate cointegration tests to test the number of times a variable is differenced in order to turn it to stationarity[4]. Tests indicated that all variables were non-stationary at the `level' form but stationary after `first differencing'. It can be concluded that all the variables in the system estimated were *I*(1). This is a pre-requisite for econometric analysis before the test of cointegration of the variables.

The results based on Johansen's (1988) and Johansen and Jesulius's (1990) multivariate cointegration tests (Table 1) tend to suggest that these six variables are cointegrated or said to have common trends. In other words, all these six variables are bound together by long-run equilibrium relationships as indicated by the test of null or alternative hypotheses through the maximum eigenvalue and trace statistics. Interesting result was found in total crime model where only trace tests of the Johansen and Juselius

[3] Crime rates are divided into few categories namely, Robbery, Housebreaking, Theft and Total Crime.
[4] Results for unit root tests are not provided due to space and available upon request.

cointegeration test shows the existence of single contegrating vectors whilst maximum eigenvalue favour no long run relationship hypothesis. Conflicting results may occur in cointegration analysis and in this study we conclude that trace test are in favour and summarize that one cointegrating vector exists in the crime against property and total crime model. The conclusion was based on few studies that prefer trace tests as advantageous over maximum eigenvalue tests. Lütkepohl et. al. (2001) compared the properties of a range of maximum eigenvalue and trace tests for cointegrating rank of a vector autoregressive process. In a small sample size comparison, they conclude that trace tests are more robust than the maximum eigenvalue tests.

This evidence of cointegration is a departure from related literature for Malaysian case (Moss, 1997; Kuperan and Sutinen, 1998; Sidhu, 2005; Sidhu, 2006; Teh, 2008; Meera and Jayakumar, 1995; Habibullah and Baharom, 2009; Baharom and Habibullah, 2009; Tang, 2009; Tang 2011 and Hamzah and Lau, 2011) which neglected the incorporation of deterrence variables in their economics of crime model. The application of the multivariate testing procedure (Johansen, 1988 and Johansen and Juselius, 1990), which is an improvement on the Engle-Granger procedure, by incorporating some other theoretically backed deterrence variables, demonstrates that all these six variables are tied together by long-run equilibrium relationship(s) in the case of Sabah. The number of cointegrating relationships found in (Table 1) will result in a corresponding number of residual series, and hence error correction term (ECTs), to be analysed in the following error correction model (VECM).

Table 1: Johansen & Juselius's Test for Multiple Cointegrating Vectors

Vector Including:	Hypotheses		Test Statistics	
		***k*=1, *r*=1**		
	H_0	H_A	λmax	Trace
Robbery	$r = 0$	$r = 1$	57.04*	114.40*
	$r \leq 1$	$r = 2$	26.43	57.35
	$r \leq 2$	$r = 3$	18.02	30.92
	$r \leq 3$	$r = 4$	8.05	12.90
	$r \leq 4$	$r = 5$	4.61	4.84
	$r \leq 5$	$r = 6$	0.23	0.23
		***k*=1, *r*=1**		
	H_0	H_A	λmax	Trace
Housebreaking	$r = 0$	$r = 1$	81.19*	168.18*
	$r \leq 1$	$r = 2$	30.02	86.99
	$r \leq 2$	$r = 3$	32.12	56.97
	$r \leq 3$	$r = 4$	25.82	37.11
	$r \leq 4$	$r = 5$	19.3	20.56
	$r \leq 5$	$r = 6$	12.52	8.07
		***k*=3, *r*=1**		
	H_0	H_A	λmax	Trace
Theft	$r = 0$	$r = 1$	38.91*	84.77*
	$r \leq 1$	$r = 2$	30.44	45.85
	$r \leq 2$	$r = 3$	13.55	27.18
	$r \leq 3$	$r = 4$	8.31	13.64
	$r \leq 4$	$r = 5$	4.63	5.33
	$r \leq 5$	$r = 6$	0.69	0.69
		***k*=2, *r*=1**		
	H_0	H_A	λmax	Trace
Total	$r = 0$	$r = 1$	33.02	92.80*
	$r \leq 1$	$r = 2$	24.93	59.77
	$r \leq 2$	$r = 3$	21.31	34.84
	$r \leq 3$	$r = 4$	7.27	13.53
	$r \leq 4$	$r = 5$	4.79	6.26
	$r \leq 5$	$r = 6$	1.47	1.47

Notes: Asterisks (*) denote statistically significant at 5% level. *k* is the lag length and *r* is the number of cointegrating vectors(s). The test uses 95 critical values for all disaggregated crime group sourced from Johansen and Juselius (1990).

As stated earlier, cointegration cannot detect the direction of causality which in turn will be done by an analysis of results based on estimating ECTs in error correction model (Table 2). All robbery, housebreaking, theft and total crime model tend to prove the existence of cointegrating relationships in the system. Following tables in this section will illustrate the results for granger causality test in the first three columns and the last two column will summarize the error correction terms (ECTs) found from vector error correction model (VECM) utilized for models with long-run relationship found previously in Johansen's (1988) and Johansen and Juselius's (1990) multivariate cointegration tests.

Relative contributions of the explanatory variables in explaining any shocks in the dependent variable (each category of crime) for the time period afar from the sample period studied will be conducted using decompositions of variance presented in Table 3. Granger causality relationships are illustrated in Figure 1 for clear view of causal relationship exists among the variables studied in each crime model. The focal aim of this study is the temporal dynamic effects of deterrence and economic factors on various types of crime. Thus, results are restricted in explaining that aspects only in particular although many other interesting insights could be gained from it.

Robbery Panel 1 of Table 2 shows results for robbery crime model. Results derived from the VECM indicate that robbery remains econometrically exogenous or unexplained by the explanatory variables incorporated. This is proven by the non-significance of both the F-test and t-test of the analysis. GDP are the endogenous variables in the system which will bear the burden of short-run adjustment (to long term trend) in order to bring the system back to long-term equilibrium. It will take approximately 2.94 years for the system to revert to the equilibrium through GDP. However, the post- sample dynamic VDCs in Table 3 imply that a substantial portion of the variance of the forecast error of robbery (say, at 50-year horizons) is explained by GDP (34.15%), unemployment (6.65%), number of cases disposed (13.91%), imprisonment (6.73%) and recidivism (32%).

Table 2: Temporal Causality Results Based on VECM

Dependent Variable	Δcrime	Δgdp	Δue	Δcdis	Δimp	Δrec	ECT_1
	χ^2- statistics (p-value)						coefficient
Robbery							
Δcrime	-	2.36 (.12)	0.77 (.38)	0.01 (.93)	0.74 (.39)	1.01 (.31)	-.23 [-1.09]
Δgdp	5.60 (.02)*	-	0.09 (.76)	1.39 (.24)	0.01 (.94)	7.17 (.01)*	-.34* [-3.57]
Δue	0.37 (.54)	0.98 (.32)	-	1.73 (.19)	2.31 (.13)	0.10 (.75)	-.41 [-045]
Δcdis	0.20 (.65)	1.44 (.23)	10.2 (.00)*	-	0.09 (.76)	0.00 (.95)	.72 [1.88]
Δimp	0.73 (.39)	2.84 (.09)**	0.78 (.38)	2.35 (.13)	-	0.51 (.47)	-.51 [-1.92]
Δrec	3.11 (.08)**	4.34 (.04)*	0.39 (.53)	0.00 (.97)	0.52 (.47)	-	.21 [0.54]
Housebreaking							
Δcrime	-	3.30 (.07)**	0.08 (.78)	0.00 (.99)	0.39 (.53)	0.77 (.38)	-.06 [-.38]
Δgdp	0.13 (.73)	-	0.16 (.69)	0.04 (.84)	0.00 (.95)	0.01 (.93)	.07 [1.27]
Δue	2.42 (.12)	0.42 (.52)	-	0.76 (.38)	1.25 (.26)	1.03 (.31)	.88 [1.79]
Δcdis	0.05 (.82)	0.43 (.51)	9.23 (.00)*	-	1.46 (.23)	0.41 (.52)	.26 [1.15]
Δimp	3.80 (.05)**	1.60 (.21)	0.01 (.92)	0.07 (.79)	-	1.41 (.24)	-.51* [-4.36]
Δrec	2.89 (.09)**	1.96 (.16)	3.01 (.08)**	0.21 (.65)	0.90 (.34)	-	-.42 [-1.94]
Theft							
Δcrime	-	0.04 (.84)	2.32 (.13)	1.21 (.27)	5.92 (.02)*	0.11 (.75)	-.04 [-.65]
Δgdp	2.96 (.09)**	-	0.49 (.48)	0.18 (.68)	0.48 (.49)	1.33 (.16)	-.07 [-1.84]
Δue	0.28 (.60)	0.03 (.86)	-	2.59 (.11)	2.21 (.14)	0.27 (.61)	.24 [.66]
Δcdis	0.36 (.55)	0.00 (.98)	5.33 (.02)*	-	1.97 (.16)	0.08 (.78)	.32 [2.17]
Δimp	2.67 (.10)	6.14 (.01)*	3.30 (.07)**	2.57 (.11)	-	0.57 (.45)	-.27* [-2.90]
Δrec	3.00 (.08)**	0.09 (.76)	0.47 (.49)	0.31 (.58)	0.38 (.54)	-	-.23 [-1.53]
Total Crime							
Δcrime	-	0.23 (.63)	2.14 (.14)	1.28 (.26)	2.64 (.10)	1.98 (.16)	-.46* [-4.93]
Δgdp	0.65 (.42)	-	0.46 (.50)	0.12 (.73)	0.49 (.49)	0.68 (.41)	.08 [.96]
Δue	0.66 (.42)	0.27 (.60)	-	1.03 (.31)	0.61 (.43)	0.27 (.60)	-.92 [-1.27]
Δcdis	3.27 (.07)**	0.37 (.54)	9.78 (.00)*	-	0.55 (.46)	2.33 (.13)	.19 [.61]
Δimp	0.14 (.71)	2.43 (.12)	0.25 (.62)	1.03 (.31)	-	0.26 (.61)	-.05 [-.24]
Δrec	0.01 (.93)	1.16 (.28)	2.31 (.13)	0.13 (.72)	0.11 (.75)	-	-.32 [-.99]

The ECTs were derived by normalizing the one or more cointegrating vectors on respective crime variables resulting in *r* number of residuals. Asterisks * indicate significance at the 5% levels. Figures in parenthesis () are the probability of short-run adjustment and [] are the t-statistics of the corresponding error correction terms (ECTs).

Housebreaking The within-sample VECM results (Panel 2 of Table 2) shows that housebreaking Granger cause GDP in the short run thus proving the endogeneity of the dependent variable at least through the F-test applied to the joint significance of the lags of each explanatory variable. However, imprisonment are most endogenous since it can Granger cause housebreaking in the short-run and bear the burden of short-run adjustment of around 2 years to bring the system back into equilibrium states. The VDCs (Table 3) on the other hand shows that housebreaking are econometrically exogenous since even after 50 years horizon about 85% of the shocks in housebreaking are explained by its own shocks. Housebreaking, although is crime related to property, have violent forces in it in the sense that house owner or victim are brutalized in the event of housebreaking. It is expected that factors affecting crimes with violent forces will not have immediate impact but will accumulate over time. Results show that it takes longer period of time for the interaction of all the independent variables to manifest in the form of housebreaking or crime with violent forces.

Theft Results based on VECM for theft (Panel 3 of Table 2) crime model are similar to that of housebreaking. The estimate indicates that theft Granger-caused imprisonment in the short run as evidenced through the significance of the F-test for the theft-imprisonment rate. The burden of short-run adjustment falls to imprisonment rate and it will take around 3.70 years for the system to revert to its equilibrium level. The VDCs (Table 3) also shows that theft is explained by its own shocks (89.45%) even after the 50-years horizon beyond the sample period estimated.

Total Crime Results based on the VECM (Panel 8 of Table 2) indicates that in the short-run, although individually the explanatory variables did not significantly Granger-cause the homicide rate (as reflected in the non-significance of the F-tests of the lags of the explanatory

variables), the proportion by which the total crime rate adjusted endogeneously in the short-run to its long-term equilibrium relationship with other cointegrating variables is nevertheless significant. In other words, the short run disequilibrium in the long-run cointegrating relationship did Granger cause the total crime rate. Approximately, it will take 2.17 years for the system to revert back into the equilibrium states. For the post-sample estimation, in the long-run (say, 50-years horizon) shocks in other independent variables explain about 87.36% of the shocks in total crime rates in Sabah.

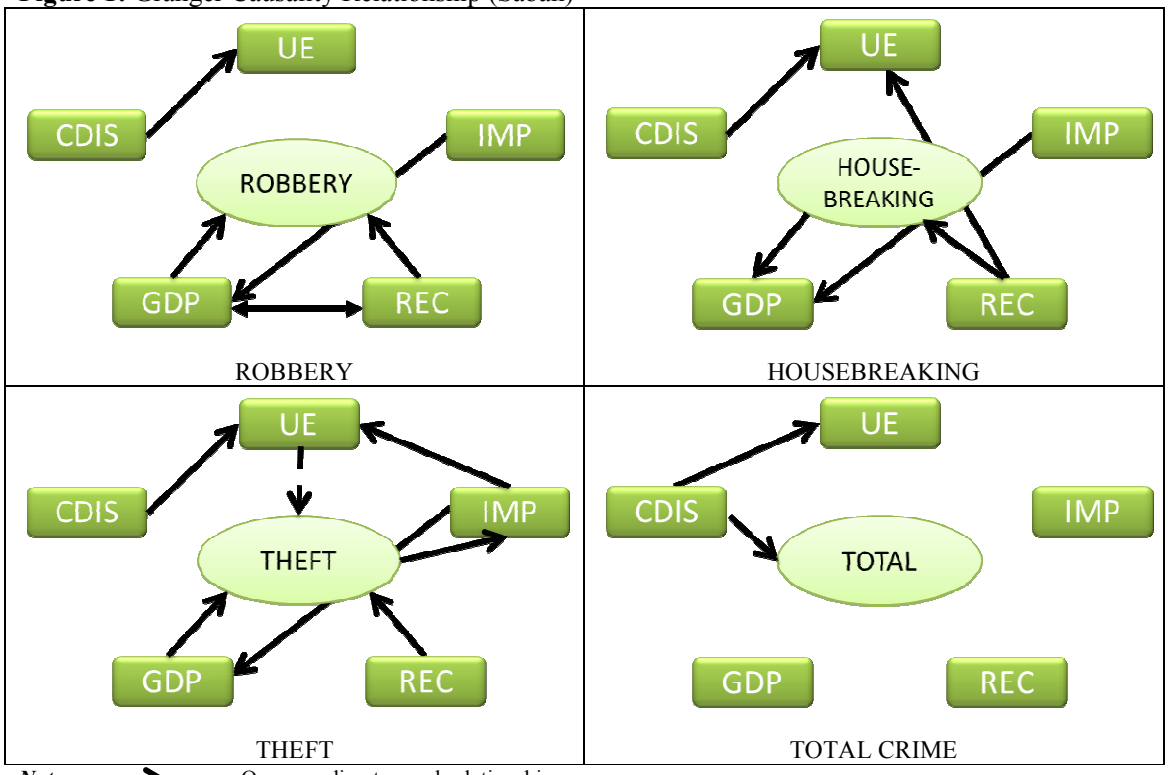
Table 3: Variance Decompositions (VDCs)

Years	Percentage of forecast variance explained by innovations in:					
	Crime rate	**GDP**	**Unemployment**	**Number of cases disposed**	**Imprisonment**	**Recidivism**
			Robbery			
1	100	0.00	0.00	0.00	0.00	0.00
10	27.82	28.06	6.52	10.27	5.39	21.93
20	12.94	32.42	6.67	12.80	6.34	28.83
30	9.10	33.46	6.66	13.47	6.58	30.73
40	7.45	33.91	6.65	13.76	6.68	31.55
50	6.55	34.15	6.65	13.91	6.73	32.00
			Housebreaking			
1	100.00	0.00	0.00	0.00	0.00	0.00
10	86.15	12.10	0.09	0.00	0.04	1.61
20	85.36	12.88	0.09	0.00	0.02	1.65
30	85.09	13.13	0.10	0.00	0.01	1.66
40	84.96	13.26	0.10	0.00	0.01	1.67
50	84.89	13.34	0.10	0.00	0.01	1.67
			Theft			
1	100.00	0.00	0.00	0.00	0.00	0.00
10	90.35	0.98	0.96	4.07	1.58	2.05
20	89.81	0.55	0.51	5.36	1.30	2.47
30	89.61	0.40	0.35	5.82	1.20	2.62
40	89.51	0.32	0.26	6.05	1.15	2.70
50	89.45	0.28	0.22	6.19	1.12	2.74
			Total Crime			
1	100.00	0.00	0.00	0.00	0.00	0.00
10	17.69	2.51	56.60	2.64	20.39	0.18
20	14.35	2.35	59.71	2.79	20.64	0.15
30	13.38	2.31	60.62	2.83	20.72	0.15
40	12.91	2.28	61.06	2.85	20.75	0.14
50	12.64	2.27	61.31	2.86	20.77	0.14

Notes: Figures in the first column refer to horizons (i.e. number of years). All other figures are estimates rounded to two decimal places - rounding errors may prevent perfect percentage decomposition in some cases. Several alternative orderings of these variables were also tried with crime rates appearing after policy and economic variables. Such alterations, however, did not alter the results to any substantial degree. This is possibly due to the variance – covariance matrix of residuals being near diagonal, arrived at through Choleski decomposition in order to orthogonalize the innovations across equations.

Results from Granger-causality tests are presented in figure 1 for clearer view and ease of understanding. The short-run Granger causality analysis also provides some insights to related crime model analyzed in this study. It is significant that number of criminal case disposed for all the crime categories involved are the Granger cause of unemployment. This can be attributed to the efficiency of number of criminal cases disposed which in turn will increase or decrease the imprisonment rate will likely cause the unemployment rate to either increase or decrease due to the prejudice issues of employer.

Figure 1: Granger Causality Relationship (Sabah)



Notes: = One way direct causal relationship
= Indirect causal relationship
= Two way direct causal relationships

Imprisonment is also found to be Granger cause GDP for robbery, housebreaking and theft crime model. Labor force which is convicted and imprisoned will have negative effect in the GDP since the country lost the productive resources to the illegal industries. In housebreaking model, crime rates are the Granger cause for GDP while GDP Granger cause crime rates in robbery and theft model. This is best explained by the motivational effect of crime which is outlined in Becker (1968) for the case of robbery and theft in Sabah. On the other hand, housebreaking Granger cause GDP since most of the criminals will tend to engage in illegal industries while the country lost its productive resources in terms of labour force for the legal industries.

5. Conclusion

Unlike the existing recent work on economics of crime in Malaysia, which failed to incorporate any deterrence measure, this study is the first attempt at putting the analysis of six alternative types of crime in a temporal `causal' framework using Sabahan data by binding the relationship between each type of crime and its economics and deterrence variables in a multivariate cointegrated system. The presence of cointegration between these variables tends to suggest that these eonomic and deterrent variables, along with alternative types of crime, are bound together by common trends (i.e.: have a long-run relationship). In other words, it can be said that although these cointegrated variables will have short-run or temporal deviations from their long-run common trends, eventually forces will be set in motion which will bring all the variables into the equilibrium (cointegrated) states. This finding of a long-run temporal relationship between all these variables is very important for the policy designers. For more comprehensive analysis and thorough understanding of the economics of

crime in Sabah for policy makers, this study also indicates the direction of that causation between the variables through the analysis of VECM.

Results based on this recent methodology (cointegration, VECM and VDCs), generally shows that, although the relative importance of the determinants of crime varied by type of crime, of all the determinants it is GDP (a proxy for 'economies wealth'), number of cases disposed by high court, imprisonment and recidivism appears to impact more or less on all the categories of crime significantly. Unemployment has the least effect of all and interestingly, same evidenced for unemployment was found by Masih and Masih (1996) while investigating Australian data in similar cointegration framework. While Sabahan crime rates are increasing, it also proves that the law and enforcement strategies do not have significant contribution in deterring crime since they are cointegrated in the long-run.

Suggestions are that policy makers should understand the contributions of each crime categories and their response in respect to any precautionary measurement taken in order to reduce crime activities in Sabah. Increasing the police force alone is not enough of strategies to curb crime rates, economic and social improvements are also important. At the same time, it is the increase in police efficiency and knowledge is also imperative. Overall, the results seem to be quite plausible and intuitive. However, future studies utilizing police enforcement efficiency and strength are highly suggested.

References

Baharom, A. H. and Habibullah, M. S. (2009), "Crime and income inequality: the case of Malaysia", *Journal of politics and law,* Vol. 2, pp. 55-70.

Barlow, H.D. (1984), *Introduction to Criminology,* Boston: Little, Brown and Company.

Becker, G. S. (1968), "Crime and punishment: an economic approach", *Journal of Political Economy,* Vol. 76, pp. 1169-1217.

Dolado, J., Jenkinson, T. and Sosvilla-Rivero, S. (1990), 'Cointegration and unit roots', *Journal of Economic Surveys*, 4, pp. 249-273.

Ehrlich, I. (1973), "Participation in illegitimate activities: a theoretical and empirical investigation", *Journal of Political Economy,* Vol. 38, pp. 521-565.

Ehrlich, I. (1977), 'The deterrent effect of capital punishment: Reply', *American Economic Association*, 67, pp. 452-458.

Granger, C. W. J. (1969), 'Investigating causal relations by econometric models and cross spectral methods', *Econometrica*, 37, pp. 424-438.

Habibullah, M. S. and Baharom, A. H. (2009), "Crime and economic conditions in Malaysia", *International Journal of Social Economics,* Vol. 36, pp. 1071-1081.

Hamzah, S.N.Z. and Lau, E. (2011), 'Is Peniaphobia an Incentive to Crime?', *Global Crime,* 24, pp. 312-326.

Johansen, S. (1988), "Statistical anlysis of cointegration vectors", *Journal of Economic Dynamics Control,* Vol. 12, pp. 231-254.

Johansen, S. and Juselius, K. (1990), Maximum likelihoos estimated and inference on cointegration with application to the demand for money, Oxford Bulletin of Economics and Statistics, 52, pp. 169-210.

Kelaher, R. and Sarafidis, V. (2011), 'Crime and Punishment Revisited', MRPA, Paper No.28213.

Kuperan, K., and Sutinen, J. G. (1998), 'Blue water crime: Legitimacy, Deterrence and compliance inFisheries', *Law and Society Review,* 32, pp. 309-338.

Masih, A.M.M. and Masih, R. (1996), 'Temporal causality and the dynamics of different categories of crime and their socioeconomic determinants: evidence from Australia', *Applied Economics,* 28, pp. 1093–104.

Meera, A.K. (1990), '*Crimes' Socio-Economic Aspects, A Case Study on Malaysia*,' Master's Thesis at the International Islamic University, Kuala Lumpur, Malaysia.

Meera, A.K. (1993), 'The Economic Implications of Crime: A Case Study on the Malaysian Public Expenditures on the Criminal-Justice System', *Journal of Islamic Economics,* 3, pp. 33-59.

Meera, A.K. and Jayakumar, M.D. (1995), 'Determinants of Crime in a Developing Country: A Regression Model', *Applied Economics,* 27, pp. 455-460.

Moss, G. (1997), 'Explaining the Absence of Violent Crime Among the Semai of Malaysia: Is Criminological Theory Up to the Task?', *Journal of Criminal Justice,* 25, pp. 177-194.

Mustard, D. B. (2003), 'Reexamining Criminal Behavior: The Importance of Omitted Variable Bias', *The Review of Economics and Statistics*, 85, pp. 205-211.

R. F. Engle and C. W. J. Granger, (1987), "Cointegration and error-correction: representation, estimation and testing", *Econometrica,* Vol. 55, pp. 251-276.

Sidhu, A (2005), 'The Rise of Crime in Malaysia: An Academic and Statistical Analysis', *Journal of the Kuala Lumpur Royal Malaysia Police College,* 4, pp. 1-28.

Sidhu, A (2006), 'Crime Levels and trends in the Next Decade', *Journal of the Kuala Lumpur Royal Malaysia Police College,* 5, pp. 1-13.

Sims, C. (1972), 'Money, income, and causality', *American Economic Review*, 62, 540-552.

Sims, C. (1982), 'Policy analysis with econometric models', *Brookings Papers on Economic Activity*, 1, pp.107-152.

Tang, C. F. (2009), 'The linkages among inflation, unemployment and crime rates in Malaysia', *International Journal of Economics and Management*, 3, pp. 50-61.

Tang, C. F. (2011), 'An exploration of dynamic relationship between tourist arrivals, inflation, unemployment and crime rates in Malaysia', *International Journal of Social Economics,* 38, pp. 50-69.

Withers, G. (1984), 'Crime, punishment and deterrence in Australia: an empirical investigation, *Economic Record*, 60, pp. 176–85.

Yik-Koon, Teh, (2008), 'The Best Police Force in the World Will Not Bring Down a High Crime Rate in a Materialistic Society', *International Journal of Police Science and Management,* 11, pp. 1-7.