Pertanika J. Soc. Sci. & Hum. 30 (3): 1165 - 1181 (2022)

SOCIAL SCIENCES & HUMANITIES

Journal homepage: http://www.pertanika.upm.edu.my/

Factors Affecting Crime Rate in Malaysia Using Autoregressive Distributed Lag Modeling Approach

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ABSTRACT

An increase in the crime rate may jeopardize a country's development and economic growth. Thus, understanding the relationship between crime and a few determinants is crucial in sustaining the economic growth in Malaysia. The four determinants used in this research are economic growth, population, education level, and inflation rate. The data covers the period from 1984 to 2019, and Autoregressive Distributed Lag (ARDL) modeling approaches were used in this research. The findings showed that only the population has a significant positive impact on crime rates for long-term and short-term relationships. Meanwhile, economic growth and education level have a significant long-term positive effect on the crime rate. On the other hand, the inflation rate did not significantly impact the crime rate in long-term and short-term relationships. Interestingly, it was found in the findings that the crime rate and population showed a bidirectional causal relationship indicating that the past population values are useful for a better prediction of the current crime rate and vice versa. Thus, the Malaysian government should encourage people to cooperate with the enforcement authorities to deter crime for future environmental safety effectively.

Keywords: ARDL modeling approach, cointegration, crime rate, Granger causality

ARTICLE INFO

Article history:
Received: 29 October 2021
Accepted:13 April 2022
Published: 6 July 2022

DOI: https://doi.org/10.47836/pjssh.30.3.13

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ISSN: 0128-7702
e-ISSN: 2231-8534

INTRODUCTION

An unlawful act that harms other people, societies, or countries is described as a crime, which the authorities or governments can punish. However, since each country has its own set of rules, the definition of crime varies from one region to another. According to the Department of Statistics Malaysia

(DOSM) data, the total number of crime cases reported in 2017, 2018, and 2019 was 99168, 88662, and 83475 incidents, respectively, as shown in Figure 1. However, the total number of crimes decreased from 2010 to 2019. It may have occurred due to the government's introduction to the Crime Reduction Initiatives under the Government Transformation Program (GTP) a few years ago. According to Deputy Prime Minister Datuk Seri Dr. Ahmad Zahid Hamidi in 2016, the crime index had dropped by almost 50% since implementing the government's initiatives. However, he admitted that, even though the crime index in Malaysia has decreased by half, the public is still aware of the situation. Hence, the government will continually update its statistics and initiative programs for better caution.

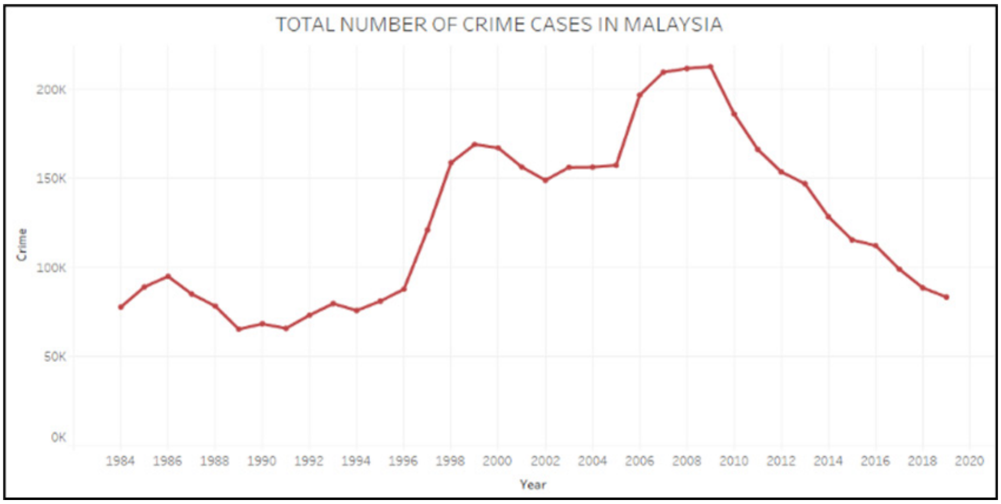

Figure 1. The total number of crime cases in Malaysia from 1984 to 2019

It can be seen in Table 1 that statistics from the Numbeo database revealed that the crime index in Malaysia for mid-year 2021 is 57.29, while the safety index is 42.71. The finding indicates that Malaysia has the highest crime index rating in Southeast Asia, followed by Cambodia, Myanmar, and Vietnam. However, although it has the highest crime index rating, crime levels between 40 and 60 are considered moderate. Meanwhile, the safety index of Malaysia is considered moderately safe. According to Kathena and Sheefeni (2017), most developing countries with higher crime rates could be due to economic growth, and the crime index in these countries is strongly associated.

Table 1
Crime index and safety index in Southeast Asia in 2021 mid-year

Rank	Country	Crime index	Safety index
1	Malaysia	57.29	42.71
2	Cambodia	51.13	48.87
3	Myanmar	46.51	53.49
4	Vietnam	46.19	53.81
5	Indonesia	45.93	54.07
6	Philippines	42.46	57.54
7	Thailand	39.35	60.65
8	Brunei	29.00	71.00
9	Singapore	27.96	72.04

Source: Numbeo (2021)

Despite this, many people worldwide are still concerned about the rise in criminal activity, which is a serious problem that needs to be immediately addressed since it affects a wide range of people. Criminal victims may experience financial and property losses and mental health problems such as stress, paranoia, anger, depression, and anxiety. Based on Federal Government Expenditure (2021) on the development expenditure, the economic sector remains the largest share of development expenditure at 57.1%; however, the social and security sectors take about 37.2%, divided into 26.1%, and 11.1%, respectively. Since the rise in crime rate may jeopardize the country's development and economic growth, thus the government expenditure on security services needs to be increased. A higher crime rate will portray Malaysia as insecure regarding economic and social activities and future investment.

Various econometric techniques have been used in investigating the relationship between crimes and other economic and non-economic factors, including Arif et al. (2017), Rahman and Prasetyo (2018), Hamid and Bitran (2021), Anser et al. (2020), Schargrodsky and Freira (2021), Rosenfeld et al. (2019), Eva (2021), and Peng et al. (2021), among others. According to Hassan et al. (2016), inflation is one of the determinants of crime and occurs when price levels increase continuously. However, inflation did not have an impact on crime rates. The findings revealed that an increase in poverty, economic growth, and urbanization would increase the crime rate in the long and short run. The result also found a two-way direction between urbanization and crime rate, as well as urbanization and economic growth.

Khan et al. (2015) have investigated the relationship between the crime rate in Pakistan and the unemployment rate, poverty rate, GDP, and enrolment rate. The data covers the period from 1972 to 2011. The findings showed that all variables except enrolment rate positively affect the crime rate in the long run. Therefore, good economic growth and higher revenue would raise the chances of crime such as theft due to the enormous volume of stolen goods and less time at home. Besides, in poverty and higher unemployment, mental illness and high level of stress arise, thus, motivating people to become criminals.

On the other hand, education showed an insignificant negative impact on crime in both long-term and short-term relationships. This finding implied that higher-educated people are more realistic, averse to risk, and have excellent job opportunities in the legal sector. Additionally, the researchers mentioned that criminal offenders are typically from low income and educational backgrounds, implying that criminal activities can be reduced in rural and urban regions by encouraging education and expanding work opportunities.

Based on the theory on crime by Gary Becker, an increase in income inequality has a robust effect of increasing the crime rates. Similar studies by Chintrakarn and Herzer (2012) have stated that theoretically**,** the sign of the effect of income inequality on crime is ambiguous. However, the author suggested that income inequality may positively be associated with the level of protection from crime. This finding was similar to a study by Arif et al. (2017), whereby the income inequality and crime rate of Asian countries showed a significant and positive relationship. On the other hand, Rahman and Prasetyo (2018) have found that income inequality has a negative and significant effect on the crime rates in Indonesia.

Rahman and Prasetyo (2018) have investigated the effects of unemployment, education, wages, and case completion rates on the crime rate in Indonesia. The panel data covers the period between 2012 and 2016. The findings indicated that the unemployment, education, and case completion rates insignificantly affect the crime rate in Indonesia. As expected, the wages have a negative and significant effect on the crime rate in Indonesia. Another study conducted by Anser et al. (2020) has examined the effect of poverty, income inequality, and social expenditure on the crime rate using a panel data approach. The panel data consists of 16 countries between 1990 and 2014. The findings showed that while income inequality and the unemployment rate contribute to a rise in crime, trade openness contributes to a fall in the crime rate. Social expenditures did not affect the crime rate indirectly. For example, increasing health and education expenses will increase the income rate. An increase in per capita income will lower the poverty rate and lower the crime rate. The result showed that the crime rate declined from 2010 to 2014 as health and education expenses improved.

Meanwhile, Ahad (2016) has applied the ARDL modeling approach to examine the factors affecting the crime rate in

Pakistan. The cointegration test confirmed a long-run relationship between the crime rate and income inequality, poverty, and inflation. He found significant evidence that income inequality and poverty positively affect crime in the long and short run. However, inflation showed a significant positive impact on crime in the long run but positive insignificance in the short run. Increased income inequality and inflation rates will result in higher commodity prices, causing people to engage in criminal activity to meet their needs. Thus, the government is recommended to minimize income inequality by raising the minimum wage.

Habibullah et al. (2014) have examined the long-term association between the unemployment rate and three types of crime in Malaysia: violent crime, property crime, and total crime rates. Violent crimes are represented by murder, attempted murder, armed kidnapping, robbery, rape, and assault. At the same time, daylight burglary, night burglary, motorcycle theft, and any types of thefts are classified as property crimes. The result showed that the long-term association between unemployment and murder, robbery, assault, daylight burglary, night burglary, and theft of motorcycles does exist. The crime rate will decline when the unemployment rate decreases. However, this study explained that the unemployment rate negatively correlates with murder, robbery, assault, and motorcycle theft, typically during the recession. It could be due to a higher unemployment rate being influenced by a recession and unemployed people preferring to stay in their homes, thereby decreasing the chances of crime.

Regarding the negative impact on crime, it is crucial to lessen the crime rate by identifying the relationship between crime and various potential factors to maintain its long-term economic growth. Therefore, this research aims to investigate the long-term and short-term relationships between the crime rate in Malaysia with the selected socio-economic factors by using the autoregressive distributed lag (ARDL) model. Consequently, the government and related authorities can effectively use the research findings to formulate a new policy to prevent many criminal cases in Malaysia.

The remaining paper is organized as follows: a section for materials and methods which provides the data and methodology, another section for results and discussion summarizes the findings, and the last section is the conclusion.

MATERIALS AND METHODS

This research aims to conduct the ARDL modeling approach to investigate the impact of selected socio-economic factors on the crime rate in Malaysia. These variables are gross domestic product (GDP), population (POP), education (EDU), and inflation rate (INF). This research will perform logarithmic (log) transformation data throughout the analysis to produce more reliable and consistent results. Hassan et al. (2016) stated that the log transformation for all variables was performed to generate more effective and reliable estimated findings. Since time series data is usually non-linear, transforming the variable into the log is the most suitable. It can linearize the series before proceeding with the model estimation, and the results can be easily interpreted. In addition, it is simpler to deal with linear models as compared to non-linear models (Lazim, 2011). The summary of the data description and the data sources is presented in Table 2.

Table 2
Summary of data description

Variables	Description	Source
LCRM	Log of Total number of Crime Cases	Department of Statistics Malaysia
LGDP	Log of Gross Domestic Products (current US$)	The World Bank
LPOP	Log of Urban Population Growth (annual %)	The World Bank
LEDU	Log of Secondary School Enrollment (% gross)	The World Bank
LINF	Log of Inflation, consumer price (annual %)	The World Bank

Autoregressive Distributed Lag Modeling (ARDL)

Prior to estimating the ARDL modeling approach, it is necessary to test the stationarity of the data to avoid spurious effects (Guza et al., 2018) by conducting a unit root test. Even though the ARDL model does not require a unit root test, it cannot be implemented if all variables are integrated of order two, I(2); however, all variables are permitted to be integrated of order zero; I(0), order one; I(1), or a mixture of both orders. Therefore, an effective way of checking the accuracy of the conclusion is to compare the different findings from different tests, as mentioned by Nkoro and Uko (2016). Therefore, Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) test, and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) were used in this research.

Dependent variables, which are described by lagged values themselves, are identified as “autoregressive” (AR), whereas successive lags of the independent variables are defined as “distributed lag” (DL) components. Abu (2017) eloquently stated that the ARDL model allows the variables to have various optimal lags, and implementation of the model is easier as it requires a single-equation setup. In addition, the ARDL method is more efficient and less sensitive to small sample sizes between 30 to 80 observations compared to other traditional cointegration tests. After determining the stationarity of the data, an ARDL bounds test was performed based on an unrestricted error correction model (UECM) to study the association between the crime rate and the four socio-economic variables. The UECM model is formulated as follows:

$$\Delta LCRM_t = c + \beta_1 LCRM_{t-i} + \beta_2 LGDP_{t-i} + \beta_3 LPOP_{t-i} + \beta_4 LEDU_{t-i} + \beta_5 LINF_{t-i} + \sum_{i=1}^{p} \alpha_{1i} \Delta LCRM_{t-i} + \sum_{i=1}^{q} \alpha_{2i} \Delta LGDP_{t-i} + \sum_{i=1}^{r} \alpha_{3i} \Delta LPOP_{t-i} + \sum_{i=1}^{s} \alpha_{4i} \Delta LEDU_{t-i} + \sum_{i=1}^{u} \alpha_{5i} \Delta INF_{t-i} + \varepsilon_t$$

Where Δ is the first-difference operator, c is the constant term, *p*, *q*, *r*, *s*, *u* is the optimal lagged value, α_1, α_2, α_3, α_4, α_5 are the short-run dynamics of the model, β_1, β_2, β_3, β_4, β_5 is the long-run coefficients, and ε_t is the error term. Therefore, it will produce an F-statistic value, compared with the Narayan (2005) critical value, and the hypothesis testing is stated as follows.

H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$ (There is no cointegration exists)

H_1: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$ (There is cointegration exists)

The obtained F-statistic value is less than the lower bound, implying no long relationship among the variables. Conversely, there is good reason to suggest long-term relationships among the variables if the obtained F-statistic value is greater than the critical upper bound. Next, as annual data series will be used in this analysis, the ARDL level relation model will be used to estimate long-run relationships with a maximum lag value of two. The recommended maximum lag length by Pesaran and Shin (1999) was two for annual data (Hamuda et al., 2013). Meanwhile, the optimal lag value is determined using information criteria, and the ARDL level model's general equation is constructed as follows:

$$LCRM_t = c + \sum_{i=1}^{p} \beta_1 LCRM_{t-i} + \sum_{i=1}^{q} \beta_2 LGDP_{t-i} + \sum_{i=1}^{r} \beta_3 LPOP_{t-i} + \sum_{i=1}^{s} \beta_4 LEDU_{t-i} + \sum_{i=1}^{u} \beta_5 LINF_{t-i} + \varepsilon_t$$

The final stage in the ARDL method is to estimate short-run dynamic equations by using the error correction model. The error correction term (ECT) should be between zero and one, representing the short-term speed of adjustment required to maintain the long-term stability. Zero ECT value implies no sense of a long-term relationship, while one ECT value implies that there is complete adjustment per time data unit. Moreover, if the ECT value is negative and significant, there is a stable long-term relationship. Finally, diagnostic checking such as tests of serially independent error and stability of model will be performed to meet the assumptions of the ARDL modeling approach. The serially independent error can be detected using the Breusch-Godfrey Lagrange Multiplier (LM) test. Meanwhile, the cumulative sum of residual tests (CUSUM) and cumulative sum of the recursive residual squares (CUSUMSQ) were performed to ensure the model's stability.

Next, after the relationship of the determinants has been modeled, the understanding of the causal effect between the determinants is of interest in this paper. Thus, the causal effect can be tested using the Granger causality test.

Granger Causality Test

The granger causality test was used to determine the causal relationship between variables and to discover whether forecasting is advantageous for one-time series (Kathena & Sheefeni, 2017). In other words, if there is evidence that X Granger causes Y, the prediction of the current value of Y is more accurate by using the past value of Y and X rather than the past value of Y itself. The formula for the pairwise Granger causality test is shown as follows:

$$Y(t) = \sum_{i=1}^{m} \alpha_i X_{t-i} + \sum_{j=1}^{n} \beta_j Y_{t-j} + \varepsilon_{1t} \quad (1)$$

$$X(t) = \sum_{i=1}^{m} \lambda_i X_{t-i} + \sum_{j=1}^{n} \delta_j Y_{t-j} + \varepsilon_{1t} \quad (2)$$

Where $Y(t)$ is Y at time t linked to the previous values of Y and X, $X(t)$ is X at time t that is linked to the previous values of X and Y, α_i and λ_i is the coefficient of X, δ_i and β_i is the coefficient of Y, and ε is the error term.

Once the methodology has been successfully employed, the data is analyzed using the ARDL modeling approach to determine the factors that affect the crime rate and the Granger causality test to determine the causality relationship between the determinants.

RESULTS AND DISCUSSION

Table 3 displays the KPSS, ADF, and PP unit root tests. Based on the KPSS test, the LM statistic is lower than the critical values at the intercept for all variables except crime rate (LCRM) and inflation (LINF); hence the null hypothesis of stationary data cannot be rejected, suggesting that LCRM and LINF are stationary at 5% significance at level form. However, other variables such as gross domestic product (LGDP), population (LPOP), and education (LEDU) have no unit root after first differencing. Therefore, the ADF and PP tests result shows that the LINF is stationary. Additionally, the first difference showed that the null hypothesis of non-stationary data was rejected since the *t*-statistic for all variables is greater than its critical values at a 5% significance level. This result implies that all series have no unit root. To summarize, all series are integrated at the mixture of order one and zero, thus satisfying the assumption of the autoregressive distributed lag (ARDL) model.

Table 3
KPSS, ADF and PP unit root tests

Variables	KPSS Test		ADF Test		PP Test	
	Level	First difference	Level	First difference	Level	First difference
LCRM	0.3564 (0.4630)	0.3252 (0.4630)	-1.2088 (-2.9511)	-3.8228** (-2.9511)	-1.2711 (-2.9484)	-3.8228** (-2.9511)
LGDP	0.6920** (0.4630)	0.0792 (0.4630)	-0.5026 (-2.9484)	-5.1106** (-2.9511)	-0.5026 (-2.9484)	-5.1001** (-2.9511)
LPOP	0.6272** (0.4630)	0.3774 (0.4630)	1.0147 (-2.9484)	-4.2134** (-2.9511)	0.6804 (-2.9484)	-4.2134** (-2.9511)
LEDU	0.6276** (0.4630)	0.0861 (0.4630)	-1.2482 (-2.9484)	-5.7155** (-2.9511)	-1.2410 (-2.9484)	-5.7345** (-2.9511)
LINF	0.1089 (0.4630)	0.0786 (0.4630)	-4.1624** (-2.9484)	-9.9859** (-2.9511)	-4.2986** (-2.9484)	-10.773** (-2.9511)

Note. The asterisks ** denote the significance of the 5%

Pearson's correlation coefficient test was conducted to determine the association between the crime rate and the selected socio-economic variables in Malaysia. The multicollinearity problems among variables could also be observed by conducting the correlation analysis. The results tabulated in Table 4 show that pairwise correlation analysis for all variables is less than 0.9, suggesting there is no severe serious multicollinearity problem. However, the relationship between the crime rate in Malaysia and gross domestic product, population, and education does exist since it has a small *p*-value.

The correlation value of LPOP is -.3672, indicating a weak negative correlation with LCRM. Meanwhile, LGDP and LEDU also have a moderate positive association of .5595 and .6597 with LCRM. However, correlation analysis revealed that inflation has no relationship with the crime rate, gross domestic product, population, and education. Once the finding of the relationship exists among the determinants, the next step is to model the relationship using the ARDL modeling approach.

Table 4
Pearson's correlation coefficient

Variables	LCRM	LGDP	LPOP	LEDU	LINF
LCRM	1.0000				
LGDP	.5595**	1.0000			
LPOP	-.3672**	-.8846**	1.0000		
LEDU	.6597**	.8281**	-.8177**	1.0000	
LINF	.0568	.0673*	.1521	-.0834	1.0000

Note. The asterisks * and ** denote the significance at the 10% and 5%

Autoregressive Distributed Lag Modeling (ARDL)

Previously, the correlation analysis revealed that a relationship between inflation and the crime rate does not exist. However, a study by Hazra and Cui (2018) has confirmed the presence of a positive long-run relationship between inflation and crime rate, suggesting that an increase in the inflation rate will increase the crime rate. Therefore, this research includes the gross domestic product, population, education, and inflation in ARDL estimation to identify the effect of these factors on the crime rate in Malaysia, both in the long and short run. Before checking the presence of cointegration among variables, the result of the optimal ARDL bounds model and diagnostic tests can be seen in Table 5.

Table 5
Optimal ARDL bounds model and diagnostic test

Optimal Model	LM Test		Structural Stability Test	
	Lag 2	Lag 4	CUSUM	CUSUMQ
ARDL (1,0,0,0,2)	0.0877	0.0095**	Stable	Stable

Note. The asterisks ** denote the significance at 5%

Starting from a maximum lag of 2, by eliminating the highest insignificant variable at the higher lag one at a time until all coefficients are statistically significant, Hendry's general to specific method generated an optimal model of ARDL (1,0,0,0,2). Since the optimal model of ARDL (1,0,0,0,2) has no serial correlation and structural stability problem, the ARDL bounds cointegration test can be carried out. Table 6 provides the computed value of the F-statistic and two asymptotic Narayan

(2005) critical values. The result shows strong evidence that the crime rate has a long-term relationship with the gross domestic product, population, education, and inflation rate since the obtained F-statistic values are 6.329 and greater than the upper bound. Hence, it is appropriate to proceed with an estimated ARDL long-run relationship model.

Table 6

F-statistics long-run cointegration test

F-statistic	Significance level	Lower bound, I(0)	Upper bound, I(1)	Conclusion
6.3291	5%	3.615	4.913	Cointegration does exist

Table 7

Optimal ARDL level relation model and diagnostic test

Optimal Model	LM Test		Structural Stability Test	
	Lag 2	Lag 4	CUSUM	CUSUMQ
ARDL (1,1,0,0,2)	0.5646	0.3805	Stable	Stable

Table 7 shows that ARDL (1,1,0,0,2) is the optimal lag of the ARDL level relation model. The diagnostic checking of the LM test and structural stability test was performed to ensure the model is free from the serial correlation problem and dynamically stable. At lag 2, the null hypothesis failed to be rejected at the 5% significance level and proved that the model has no serial correlation. Meanwhile, the CUSUM and CUSUMQ plots stay between two critical values, indicating that the model is dynamically stable. Hence, the variables' long-run coefficients were estimated using the ARDL (1,1,0,0,2) model.

Table 8 depicts the result of the long-run coefficient of Malaysia's crime rate and proves that all variables, except the inflation rate, have a significant relationship with the crime rate at a 5% significance level. The result of the insignificant relationship between the inflation rate and the crime rate is supported by Kizilgol and Selim (2017). In the case of EU 28 and Turkey, they discovered that inflation is not affecting the crime rate. As predicted, the gross domestic product has a positive long-run relationship with the crime rates, suggesting that Malaysia's crime rate appears to increase by 2.08 percent when the gross domestic product increases by 1 percent. Mulok et al. (2016) also stated that more crimes would occur in good economic growth than in bad economic growth.

Higher revenues will raise the individual's accumulated wealth and boost economic growth, thereby generating opportunities for crime (Habibullah & Baharom, 2008).

Table 8

Estimated long-run coefficient results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGDP	2.0787	0.9333	2.2273	0.0352
LPOP	7.3338	3.0948	2.3697	0.0258
LEDU	5.5333	2.3918	2.3137	0.0292
LINF	-0.4578	0.3683	-1.2429	0.2254
C	-30.7789	15.0320	-2.0476	0.0512

Besides, the positive relationship between population growth and the crime rate is in line with Hussin et al. (2020). They found that rural and urban migration resulted in high population density, thus, increasing crime rates. According to Hussin et al. (2020), as the population increases, the urbanization process correlates with an increase in the cost of living. Therefore, to maintain their quality of living, individuals prefer to commit illegal activities. From the estimated long-run coefficient, it can be observed that education contributes to crime rates in Malaysia. According to Ishak and Bani (2017), by estimating the model with various types of crime, it is found that there is a significant positive relationship between education and type of crime such as burglary and larceny. It has been identified that criminal offenders misapply the skills, strengths, and abilities acquired through formal education.

There is a significant positive short-term association between crime and the population, as shown in Table 9, implying that a one percent increase in population will increase the crime rate by 1.15 percent in the short run. Surprisingly, inflation positively affects Malaysia's crime rate in the short run, suggesting that if inflation rates rise by 1%, crime rates will increase by 0.7 percent. Adekoya and Razak (2016) supported the finding of a short-run relationship between inflation and crime, arguing that inflation increases living costs and reduces purchasing power, thus inducing people to engage in criminal activity to sustain their living. However, other variables such as gross domestic product and education insignificantly affected the crime rate at a 5% significance level in the short run.

The error correction term (ECT) is important to act as a mechanism for stabilizing the disequilibrium in the short run to achieve long-run equilibrium. The coefficient of ECT has negative signs and is highly significant, indicating a stable long-term relationship. In contrast, the absolute coefficient value of the error correction term implies that 12 percent of disequilibrium

Table 9

Estimated short-run coefficient result

Variable	Coefficient	Std. error	t-Statistic	Prob.
C	-3.8529	0.5690	-6.7714	0.0000
ECT(-1)	-0.1257	0.0185	-6.8043	0.0000
D(LGDP)	-0.1365	0.1403	-0.9727	0.3393
D(LPOP)	1.1518	0.2801	4.1123	0.0003
D(LEDU)	0.1619	0.4260	0.3801	0.7068
D(LINF)	0.0193	0.0187	1.0280	0.3131
D(LINF(-1))	0.068486	0.0164	4.1776	0.0003

between crime rate and selected variables are adjusted within one year. Furthermore, it shows that the speed of adjustment in the short run to maintain long-term equilibrium is quite slow, and it takes approximately 8.33 years to achieve long-term stable equilibrium. Since the model relationship in the long term is stable, the causal effect between the variables can be tested, and the results are shown in the next section.

Granger Causality Test

A pairwise granger causality test was conducted, and the results were presented in Table 10. The results show that the null hypothesis of LPOP does not Granger Cause LCRM, and LCRM does not Granger Cause LPOP are rejected at a 5% significance level, concluding that there is bidirectional causality between crime and population. The finding indicates that the past value of the population is useful to give a better prediction of the current value crime rate and vice versa. These results are consistent with Hussin et al. (2020) as they found that the population contributes to total and property crimes.

Table 10

Pairwise Granger causality results

Null hypothesis	F-statistics	Prob.	Decision	Type of causality
LGDP does not Granger Cause LCRM	1.17047	0.2874	Accept H_0	Independence
LCRM does not Granger Cause LGDP	0.24271	0.6256	Accept H_0	Independence
LPOP does not Granger Cause LCRM	7.39174	0.0105	Reject H_0	Bidirectional causality

Table 10 *(Continue)*

Null hypothesis	F-statistics	Prob.	Decision	Type of causality
LCRM does not Granger Cause LPOP	13.5768	0.0008	Reject H_0	Bidirectional causality
LEDU does not Granger Cause LCRM	1.82179	0.1866	Accept H_0	Independence
LCRM does not Granger Cause LEDU	1.59288	0.2160	Accept H_0	Independence
LINF does not Granger Cause LCRM	5.43883	0.0261	Reject H_0	Unidirectional causality
LCRM does not Granger Cause LINF	0.00079	0.9778	Accept H_0	Unidirectional causality

The result also shows a unidirectional causality between inflation rate and crime rate running from inflation rate to crime rate, and these findings are in line with Rosenfeld et al. (2019). On the other hand, it can be observed that there is no causality effect between the crime rate with gross domestic product and education level. This finding is consistent with the results found in the short-term relationship.

CONCLUSION

This paper aims to analyze the socio-economic determinants of the crime rate in Malaysia by using the ARDL modeling approach. Based on the three different types of unit root tests, all series are found to be integrated of a mixture of an order of one and zero. The bounds test cointegration analysis suggests that the long-term relationship among variables exists. Gross domestic product, population, and education level have a long-term positive significant effect on Malaysia's crime rate. In contrast, the population and inflation rate will cause the crime rate in the short run. The research findings revealed that the population has a causal relationship with the crime rate. As a result, to minimize the number of crime cases, it is important to address the problems related to population growth as soon as possible.

Based on the research findings, there are a few recommendations for the government and authorities to strategize a crime prevention program to lower Malaysia's crime rate. First, as population growth has a causal relationship with the crime rate in Malaysia, the government should focus on improving the Malaysians' quality of life, such as salary increment, a safe working environment, increasing public safety, improving socio-culture, and providing better education, and others. A better and more viable quality of life will create a better living environment, and the improvement in quality of life must be in line with the social-economic development. The government also needs to implement comprehensive efforts such as omnipresence in crime-prone areas by increasing the number of CCTV, increasing the number of Royal Malaysian Police, and encouraging the community to cooperate with the enforcement authorities by joining the Rakan Cop or Community Policing program, or voluntarily participate in Rukun Tetangga (RT) for neighborhood surveillance activities.

Future research should consider different types of crime rather than focus on the overall crime cases and consider other factors such as the unemployment rate and other deterrent variables such as the number of police officers, number of divorcees, and number of prisoners.

ACKNOWLEDGEMENT

The authors want to thank the Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, for supporting the publication of this paper.

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