DIGITAL CRIME: TRACKING SUB-INDICATOR AND DETERMINANTS

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Abstract This research focuses on three things, namely the digital world, crime, and the relationship of crime to the digital world. The measurement of the relationship of crime to the digital world consists of two steps of testing. First, examining the power of crime indicators with the digital world constructed on 16 correlations to find the most robust sub-indicators. Second, testing the most robust sub-indicators with determinants of control variables. The control variable determinants used in this study are economic group variables (GDP per capita and GINI ratio), geography (total natural resources rents), social (secondary enrollment), and politics (human freedom index). This research uses Fixed Effect (FE) and Random Effect (RE) models based on panel data with Ordinary Least Square (OLS) method with 138 observations in the world in 2012-2016. The results obtained include: the crime sub-indicator that is the homicide variable, and the digital world sub-indicator namely individual using internet, secure internet servers, and information technology export are most robust and consistence of the homicide variable. Furthermore, the determinant of control variables, namely GDP per capita, has a significant negative effect and the GINI ratio has a significant positive effect to homicide, gross secondary enrollment has no significant effect to homicide, the human freedom index has a significant negative relationship to homicide, and the total resources rents variable has a significantly positive effect to the homicide.

Keyword: criminality, digital, determinants

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Introduction

Changes in the digital world are growing rapidly and reaching to all corners of the world, so that the digital world is monitoring people's industrial activities. Changes in the digital world have an impact in two directions, namely positive and negative impacts. One of the positive impacts is increasing internet penetration and the number of adoption of digital technology. Digital technology provides a large capacity and freedom for individuals to innovate (Khan, 2016). By innovating, individuals will create something or renew the function of the use of products or resources that have been there before, thus improving the quality of life of the community. The development of this innovation is a form of individual space freedom through changes in individual Behaviour that has a positive impact on people's lives.

But the freedom of individual space also has a negative impact. Freedom of individual space that is not monitored will have an impact on individual Behaviour that deviates and leads to criminal activity. Criminal acts can be viewed from various aspects, namely economic aspects (Donohue and Levitt, 2001; Oliver, 2002; Jonathan et al. 2012; Karnadi, 2015; Ros, 2016; Dutta and Husain, 2009, and Cheong and Wu, 2013), social aspects (RÍos, 2016), and political aspects (Jonathan et al., 2012; Karnadi, 2015). According to Baryamureeba and Tushabe (2004), crime in the digital world is defined as a virtual environment created by software and hardware that is characterized by evidence of crime and incidents. Criminal acts also occur in the form of cyberbullying, homicide, theft, terrorism, sexual harassment, smuggling, and so forth.

Previous research generally did not detect the relationship of crime with the complex digital world. Some previous researchers only measured the dimension of crime with economic, geographic, social, and political control variables without the interrelated dimensions of the digital world. Block and Heineke (2001) discussed the dimensions of crime with variables of violence, property crime, and homicide; Oliver (2002) used a crime index variable. Jonathan et al. (2012) discussed the dimensions of the relationship of crime to the digital world using mobile variables, violence, robbery, and attack; and Karnadi (2015) used crime index, conflict, and internet users, with determinants of control variables.

Previous research measured the relationship of crime and combine it with a digital world that is constructed with varying dimensions. These varied dimensions lead to an increasingly complex relationship between crime and the digital world. The complexity of the relationship indicates that the relationship of crime and the digital world is not as simple as previous research, so this complexity of the relationship is the basis of this. This research wants to discuss three things, namely the digital world, crime, and the relationship of crime to the digital world and this is constructed by 16 correlations between crime indicators and digital world indicators. Testing the correlation between these indicators will show the result of the digital world sub-indicators that most influence to the crime sub-indicator, so all the sub-indicators of the two indicators will produce the most significant factorial. This significant factorial will be estimated by determinant control variables consisting of economic, geographic, social, and political variables.

This research uses panel data analysis in accordance to the previous research, namely Block and Heineke (2001); Karnadi (2015); RÍos (2016); Dutta and Husain (2009); and Cheong and Wu (2013). The time period of this research data is 2012-2016 using the Ordinary Least Square (OLS) method. The data used were sourced from Knoema, The Global Economy, and the World Bank World Development Indicator (WDI) and CATO Institute.

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Theoretical Approach

Empirically, crime indicators as the dependent variable has varying sub-indicators, because crime can be measured based on crime index (Karnadi, 2015; Oliver, 2002; Cheong and Wu, 2013), violence, property crime, and homicide (Donohue and Levitt , 2001; Jonathan et al. 2012; RÍos, 2016), robberies, attacks (Jonathan et al. 2012), criminal organizations (RÍos, 2016), and Penal Code (Dutta and Husain, 2009).

Oliver (2002) measured crime rates using variables of the age group <25 years. The results showed that the age variable <25 years had a significant effect on the crime variable. This means that criminal acts are also committed by perpetrators of productive age. Furthermore, the police variable is negatively related significantly to the crime variable. This means that a large number of police officers will increase oversight in preventing deviant Behaviour in an area. This form of supervision will reduce the potential for criminal acts committed by perpetrators of productive age. Furthermore, other variables such as unemployment do not significantly affect crime.

Karnadi (2015) measured the relationship between the digital world and crime using one dimension of crime, that is crime index. In his research, he said that internet censorship can reduce crime rates through the detection of accessible network sites. In addition, the educational variable supports this research, namely the higher level of individual education can anticipate changes in individual Behaviour to participate in criminal acts.

Jonathan et al. (2012) refers to Becker's model (Becker, 1968) discusses the impact of cell phone use on crime. This research builds a crime index as a dependent variable consisting of violence, robbery, attack, and property crime. The results show that increasing the use of mobile phones will reduce crime. According to him, mobile phones with technological features will make it easier for individuals to contact the police by sending coordinate points so that detection of criminal acts is more efficient.

Method

Measurement of Indicators of Crime and the Digital World

The measurement is constructed by 16 correlations between crime indicators with the digital world based on *Spearman Rank Correlation.* The regression model is shown in the following equation:

$$= + . + \quad (1)$$

is the dependent variable used in this research. z states an indicator of crime *z* which consists of the number of homicide per 100,000 population , the number of theft per 100,000 population , the number of prisoners per 100,000 population , and the number of assault cases per 100,000 population , in *i* country in *t* year. This measurement is stated by is an independent variable stating the digital world indicator *m* consisting of the number of internet users per 100,000 population , internet bandwidth , the amount of secure internet servers per 1,000,000 population , and the percentage of total information

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technology exports, in *i* country in *t* year. I examine the power of each crime sub-indicator with the digital world to produce and choose the most significant factorial at a certain level, at least 1% or 5% at significant level overall.

Measurement of Sub-indicators with the Determinants of Control Variable

This measurement of the two sub-indicators of crime and the digital world is carried out to see the strength of robustness if it is influenced by the determinant of the control variable. The measurement regression model is shown in the following equation:

$$= + \beta_1 + . + \quad (2)$$

is the determinant of control variable *n*, namely economic, geographic, social, and political, which consists of GDP per capita , GINI index , total natural resources , gross school enrollment , and human freedom index , in *i* country in *t* year. Testing of both sub-indicators and determinants of control variables uses the Fixed Effect (FE) and Random Effect (RE) models based on panel data with the Ordinary Least Square (OLS) method of the Hausman test.

Result and Discussion

Correlation Analysis of Individual Crime Indicators and the Digital World

In the crime sub-indicator, which is the homicide variable, the results show that the overall sub-indicator of the digital world is negatively correlated to the homicide variable with a probability value of 1%. Through advances in technological development, users will more quickly receive access to information that is distributed virtually, making it easier to detect early to prevent any threat of crime against users - including fraud-motivated information, hacking sites by hackers - leading to threats of homicide. The results of the overall correlation see the criteria in Table 1:

Table 1. Individual Correlation of Crime Sub-indicators and Digital World
Spearman Rank Correlation (2012-2016)

	Homicide(log)	*Theft rate(log)*	*Prison(log)*	*Assault rate(log)*
Individual using internet	-0.598***	0.678***	-0.134**	0.077
Internet bandwidth (log)	-0.405***	0.385***	0.021*	0.023
	Homicide(log)	*Theft rate(log)*	*Prison(log)*	*Assault rate(log)*
Secure internet servers(log)	-0.522***	0.503***	-0.080	-0.196**
Information technology export	-0.394***	0.232	-0.048	0.028

***,**,* 1%, 5%, 10% significant level
The numbers in the table use correlation

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Regression Analysis of Sub-indicators with the Determinants of Control Variable Group

This section explains the relationship between crime sub-indicators and the digital world with the determinant group of control variables. This research was divided into three groups, namely economic, social and geographic groups; economic, social and political; and social, political, and geographic. Based on the correlation testing in Table 1, this sub-chapter uses only the most robust and consistent crime sub-indicator, the homicide variable.

Thus I regress simultaneously the homicide variable with determinants control variable. The overall results of the economic, social, political and geographic group regression models are shown in Table 2. It shows that secure internet servers has a significant to the homicide variable in the whole regression model. Internet bandwidth variable has no significant on all models in each determinant group regression model. This means that crime that is shown as homicide is not influenced by the amount of user data connected to the internet network. Gross school enrollment also doesn't not have a significant effect on all determinant group regression models. This means that the level of education of an individual is only able to explain criminal acts as a whole in accordance with the research of Karnadi (2015) and Cheong and Wu (2013), but it is not significant enough if criminality is identified as homicide.

Furthermore, the overall determinant group regression model shows that only certain variables in the digital world sub-indicators are positively and significantly correlated with each other, namely internet user, secure internet servers, and information technology exports. This indicates that: the greater the number of internet users, the country will strive to improve secure internet servers to prevent user data hacking, and the greater the number of technology exports will increase the growth of technology adoption. The explanation believes that those variables are the most robust variable based on its level of significance, and which best explains the indicators of the digital world.

The group of geographical variables, namely total natural resources rents, has a significant positive effect to the homicide variable on the overall economic, social and geographic regression model. This explains that there is a tendency for exploitation of natural resources and wildlife, based on violations of norms and mechanisms, weak regulation of national and international security, and especially in developing countries (Steward et al., 2017).

The economic variable groups, namely the GINI index and GDP per capita, have a significant effect to the homicide variable on the overall determinant group. The results show that a country with a high level of GDP per capita and a more even distribution of income distribution will reduce the potential for homicide. This is consistent with the results of research conducted by Oliver (2002) and Dutta and Husain (2009). However, the total resources rents and GDP per capita variable does not significantly influence the homicide variable when combined with the human freedom index variable.

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Table 2. Regression Model of Crime Sub-indicators and Digital World with Determinants of Control Variable

	Determinants of Economic, Social and Geographic Groups					
Dependent Variable: *Homicide*(log)						
Intercept	-0.075 [0.24	-0.88 [0.238] **	-0,249 [0,252	0,745 [0,388]**	-0,088 [0,262]	0,745 [0,434] *
Individual using internet	-0.595 [0.139]***				-0,559 [0,181]**	-0,312 [0,223] *
Internet bandwidth(log)		-0.014 [0.013]			0,001 [0,013]	0,12 [0,015]
Secure internet servers(log)			-0,097 [0,031]**		-0,026 [0,038]*	-0,020 [0,043]
Information technology export				-0,701 [0,387]**		-0,793 [0,389]**

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Gdp per capita(log)	-0.055 [0.034]	-0.092 [0.035]*	-0,069 [0,036]**	-0,379 [0,078]***	-0,051 [0,036]	-0,315 [0,105]**
Gini ratio	2.666 [0.432]***	3.430 [0.415]***	3,362 [0,417]***	3,251 [0,428]***	2,892 [0,454]***	3,149 [0,472]***
Gross secondary enrollment	0.095 [0.074]	0.020 [0.075]	0,056 [0,076]	0,065 [0,085]	0,087 [0,076]	0,076 [0,084]
Human freedom index						
Total natural resources rents	1.052 [0.438]*	1.463 [0.451]***	1,038 [0,468]**	1,607 [0,585]**	0,897 [0,479]*	1,361 [0,613]**
Obs	**215**	**211**	**209**	**169**	**205**	**162**
R2	**0.346**	**0.315**	**0,343**	**0,449**	**0,369**	**0,488**
F-statistik	**22.209**	**19.167**	**21,274**	**26,650**	**16,509**	**18,227**
Chi-sq Statistic	**25.171**	**27.456**	**25,926**	**4,210**	**26,604**	**12,867**
Fixed P	**0.0001**	**0.0000**	**0,0001**	**0,5195**	**0,0004**	**0,1165**
Chi-sq Prob.		**476,239 0,0000**		**496,781 0,0000**		

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Determinants of Economic, Social and Politic Groups

Variabel dependen: *Homicide*(log)

Intercept	0,770 [0,379]**	0,720 [0,388]*	0,776 [0,393]**	1,234 [0,451]***	0,771 [0,395]**	1,102 0,486]**
Individual using internet	-0,603 [0,149]***				-0,544 [0,199]**	-0,408 [0,233]*
Internet bandwidth (log)		-0,011 [0,014]			0,007 [0,014]	0,017 [0,016]
Secure internet			-0,102		-0,036	-0,040
servers(log)			[0,031]***		[0,040]	[0,044]
Information technology export				-0,816 [0,412]**		-0,912 [0,409]**
GDP per capita(log)	-0,031 [0,038]	-0,059 [0,039]	-0,041 [0,039]	-0,314 [0,106]	-0,031 [0,039]	-0,207 [0,132]
GINI ratio	2,533 [0,468]***	3,243 [0,446]***	3,179 [0,450]***	3,411 [0,457]***	2,678 [0,487]***	3,133 [0,502]***
Gross secondary enrollment	0,076 [0,080]	0,002 [0,081]	0,042 [0,082]	0,029 [0,090]	0,073 [0,081]	0,062 [0,088]
Human freedom index	-1,100 [0,421]***	-1,589 [0,412]***	-1,329 [0,415]**	-0,954 [0,566]*	-1,049 [0,427]*	-0,771 [0,562]
Total natural resources rents						
Obs	**221**	**220**	**215**	**172**	**214**	**168**
R 2	**0,323**	**0,300**	**0,327**	**0,430**	**0,340**	**0,462**

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F-statistik	**20,603**	**18,369**	**20,383**	**25,068**	**15,205**	**17,122**
Chi-sq Statistic	**20,751**	**18,012**	**21,101**	**3,438**	**21,923**	**11,430**
Fixed Effect Prob. Fixed Effect	**0,0009**	**0,0029**	**0,0008**	**0,6327**	**0,0026**	**0,1785**
Chi-sq Statistic				**484,380**		**531,221**
Random Effect Prob. Random Effect				**0,0000**		**0,0000**

Determinants of Social, Politic, and Geography Groups

Variabel dependen: *Homicide*(log)

Intercept	1,401 [0,258]***	1,227 [0,264]***	1,414 [0,267]***	1,170 [0,296]***	1,491 [0,265]***	1,576 [0,297]***
Individual using	-0,671				-0,548	-0,554

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	[0,101]***				[0,130]***	[0,138]***
Internet bandwidth (log)		-0,020 [0,010]**			-0,000 [0,010]	0,006 [0,011]
Secure internet servers(log)			-0,097 [0,018]***		-0,041 [0,022]*	-0,042 [0,024]*
Information technology export				-1,109 [0,314]***		-1,016 [0,303]***
GDP per capita(log)						
GINI ratio						
Gross secondary enrollment	0,055 [0,056]	-0,009 [0,056]	0,045 [0,056]	-0,038 [0,058]	0,065 [0,056]	0,037 [0,058]
Human freedom index	-0,886 [0,335]*	-1,115 [0,335]**	-0,977 [0,341]**	-0,960 [0,038]*	-0,923 [0,033]**	-0,918 [0,375]*
Total natural resources rents	-0,866 [0,331]	0,798 [0,335]	0,408 [0,376]	1,066 [0,419]	0,117 [0,388]	-0,100 [0,458]
Obs	**375**	**367**	**364**	**303**	**356**	**291**
R 2	**0,148**	**0,061**	**0,120**	**0,090**	**0,164**	**0,205**
F-statistik	**16,194**	**5,940**	**12,262**	**7,386**	**11,466**	**10,439**
Chi-sq Statistic Fixed Effect	**12,115**	**26,095**	**19,198**	**21,716**	**13,413**	**11,570**
Prob. Fixed Effect	**0,0165**	**0,0000**	**0,0005**	**0,0002**	**0,0369**	**0,1156**

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Chi-sq Statistic		**1076,664**
Random Effect		
Prob. Random Effect		**0,000**

***, **, * 1%, 5%, 10% significant level
The numbers in the table use coefficient values and the values in parentheses [] are standard errors.

Based on the results of the regression above, a retest is done to obtain robust and consistent results. The results show that only the number of internet users and information technology exports has a significant negative and robust effect to the homicide variable. GINI index, has a significant positive effect on homicide. Human freedom index has a significant negative effect. Furthermore, natural resources rents, have a significant positive effect to the homicide variable. The probability value in this regression model is 0.2165 on the Fixed Effect, and 0.000 on the Random Effect. So that the best panel data regression using the Random Effect model. The results of the regression variables are shown in Table :

Table 3. Robustness Testing and Consistency Criminality Sub-indicator and the Digital World with Determinants of Economic, Social, Political and Geographic Groups

Variabel dependen: *Homicide*(log)	
Intercept	0,356 [0,385]
Individual using internet	-0,451 [0,136]***
Secure internet servers(log)	-0,932 [0,365]***
Information technology export	-0,864 [0,377]**
GINI ratio	2,983 [0,432]***
Human freedom index	-0,979 [0,427]**
Total natural resources rents	1,253 [0,544]**
Obs	181
R2	0,712
F-statistik	26,944

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Variabel dependen: *Homicide*(log)	
Prob F-statistik	0,000
Chi-sq Statistic Fixed Effect	7,055
Prob. Fixed Effect	0,2165
Chi-sq Statistic Random Effect	505,925
Prob. Random Effect	0,0000

***, **, * 1%, 5%, 10% significant level
The numbers in the table use coefficient values and the values in parentheses [] are standard errors.

Based on these regression in Table 2 and 3, the results show that the homicide variable correlates significantly to all sub-indicators of the digital world, so this variable is believed to form the sub-indicator of crime, while the variable number of internet users and information technology exports as forming the digital world sub-indicator based on the results of robustness and consistency testing. The sub-indicator of the digital world has a significant negative relationship to the variable of homicide, this explains that the progress of the development of the digital world will hinder the Behaviour of homicide. The greater the number of internet users, then the country will strive to increase internet network security to prevent user data hacking, and the greater the number of technology exports will increase the growth of technology adoption, but not in the whole category of crime.

Second, by adding control variables in the model that includes groups of economic variables, the results show a negative relationship to GDP per capita and positive to the GINI index. The variable gross secondary enrollment has no effect on homicide. Human freedom index variables are negatively related. Furthermore, the total resources rents variable is positively related to the homicide variable. The homicide event is not based on the level of education of the offender, but occurs because of the economic disparity. Countries with increasingly uneven levels of income distribution will increase the potential for acts of homicide, because there is a tendency to do all means such as seizing property and property, committing fraud, or justifying any means to keep their survival. Human freedom is based on the support of the order of life, such as creating peace, security, stability, and justice for human rights (Vásquez and Porčnik, 2015). The level of human freedom determines the formation of morals, so the better moral and human Behaviour, then humans will not behave criminally. In addition, efforts are needed to increase regulation of a country's total natural resources, especially in developing countries, to reduce the potential of resource exploitation and homicide that occur by unauthorized persons due to the lack of morality formed within them.

This research is far from perfect. The recommendation for future research is to extend the measurement time and to use both variable crime indicators and a more varied digital world.

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