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# FLOOD DISASTER AND GDP GROWTH IN MALAYSIA

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## ABSTRACT

This paper seeks to examine the impact of flood disaster on GDP growth in Malaysia for the period of 1960 to 2013 by applying the Autoregressive Distributed Lag (ARDL) bounds testing approach to cointegration and the error correction model (ECM) for short run relationship. ADF, PP and KPSS unit root test examines the stationarity of the series. The results show that the series are cointegrated. The findings suggest that all four flood variables significantly affecting GDP growth in both long run and short run. The results of the study have important implications for the GDP growth in both long run and short run. First, the government should have a proper flood mitigation plan so as to avoid the negative impact of flood on GDP growth in the long run. Second, prepare sufficient stockpiles of basic necessities in a safe place to avoid shortages and temporary setback in the short run.

***Keywords:*** *Flood Disaster, GDP Growth*

## 1. Introduction

Natural disasters are common cause of economic shocks such as tsunamis, earthquakes, volcanic eruptions, floods, hurricanes and droughts. Natural disasters only affect a limited part of the whole economy due to a localized events. According to the study of Horwich (2000), economic losses in the capital stock are generally related with natural disasters. However, the impact of natural disasters may be enlarged if the gross domestic product (GDP) is taken as the measurement of an economic output due to recovery process. The definition of disaster according to the National Security Council Malaysia is *"an incident that occurs unexpectedly, complex in nature, resulting in the loss of lives and damage to properties and the environment as well as interfering in the daily activities of the local community"*.

The economic impact and the consequences of natural disasters are more on developing countries. For instance, nine different hurricanes has been hit in Dominica since 1984. Approximately USD400 million losses caused by the Hurricane Georges in 1998 which is estimated over 140 percent of the country's GDP. Furthermore, in a study from Horwich (2000) stated that the impact on macroeconomic with regard to economic output are often large caused by the extreme events. The number in the occurrences of natural disasters have been increasingly for the last three and a half decades. For instance, out of a total number of 6436 natural disasters, approximately 77% have taken place in the developing countries between year 1970 and 2012. Furthermore, the reoccurrences of disasters which concentrated in a certain geographic areas are affecting the countries with great severity.

Furthermore, according to the Center for Research on the Epidemiology of Disasters (CRED), most usual natural disaster such as floods occurring are accounted for almost 40% of all the occurrences of natural hazards between the year 1985 and 2009. Therefore, it is relevant to analyze the potential impact of flood on economic performance. In another study by Brakenridge (2011) stated that over the last 25 years, floods are becoming bigger and more frequent. Similarly, in a study by Nel & Righarts (2008) reported that climate change forecasted by the Intergovernmental Panel on Climate Change (IPCC) lead to a change in the timing of extreme weather, intensity, frequency, duration and climate events. Thus, this situation resulted in climate events and extreme weather such as heat waves, floods and droughts.

In a study by Noorazuan (2006) stated that the most significant natural hazard in Malaysia is flood. Flood disaster is measured in terms of frequency of flood, flood duration, social economic damage, area extent and population affected. Malaysia has experienced many cases of major floods since 1960s. According to the Emergency Database, flood that hit Kuala Lumpur and many other states in January 1971 had resulted in the death of 61 persons and a loss of more than USD 37 million. In fact, due to abnormal heavy rainfall events had caused massive floods which occurred in Johor in year 2006-2007. The estimated total cost of these flood disasters is nearly USD1 billion. This event can be considered as the most costly flood events in Malaysian history.

Several socio economic studies on flood have been conducted in Malaysia. Among others are Mohd Safie *et al.*, (2006), Amir Hussin and Austin Okezie (2012), and Atikah Shafie (2009). However, their studies focused more on natural hazards management. Moreover, to the best of our knowledge, there is limited study has attempted to examine the effect of flood disasters on GDP growth in the case of Malaysia. The main aim of this study is to fill the research gap in the case of Malaysia. The dataset for flood variables such as size of affected area, duration of flood, frequency of flood and total damage cost are used in this paper allows further examination of which flood variables gives most effect on GDP growth in the case of sectors.

The rest of the paper is organized as follows: Section 2 reviews the literature on the impacts of natural disasters on economic growth. Section 3 explained the method used to achieve the aim of the paper. Section 4 analyzed and discuss the results of the analysis. Section 5 concludes the paper.

## 2. Literature Review

The purpose of this section is to review the existing literature on the impacts of natural disasters on economic growth. These are studies that have been done previously to analyze the effect of natural disasters on economic growth (among others are Benson and Clay, 1998, 2000, 2001; Raddatz, 2007; Noy and Vu, 2010; Noy and Nualsri, 2007).

A numerous case studies on the impact of natural disasters in Vietnam, the Philippines, Fiji and Domonica are investigated by Benson and Clay (1998, 2000, 2001). The time frame of the studies focused mostly on the short term which is the period up to one year after a disaster. The authors found that agriculture sector was being hit most and the impacts on the economy is significantly negative.

More current literature show different results and typically employs the econometric techniques. For instance, Raddatz (2007) using a Panel-Vector Autoregression framework on a sample of 40 low income countries to estimates the effect of external shocks on short run output in developing countries between 1965 and 1997. The author further investigates the contribution of external shocks of natural disasters on the output changes. The result indicates that natural disasters have an adverse short run impact on the output trend.

Moreover, in a study by Noy and Vu (2010) employ the Blundell-Bond General Method of Moments approach to estimate the short run impact of natural disasters on the macroeconomy from 1995 to 2006 in Vietnam. The authors concluded that, disasters result in lower output growth. Furthermore, the disasters that destroyed capital and property appeared to boost the economy in the short run.

Other than that, Noy and Nualsri (2007) using panel data between year 1975 and 1990 to examine the effect of natural disaster on economic growth. The study covers 98 developed and developing countries. The authors found that a negative shocks to the stock of physical capital do not have statistically long run effect of natural disaster on economic growth while a negative shock to the stock of human capital resulted in a decreased growth rate.

Several conclusions can be derived from the discussed literatures. First, empirical literature on the effect of natural hazards on economic growth have mixed results. Some study report positive impacts while others report the negative. Second, the concurrent increases in price and lowered economic growth experienced by the economy resulted in negative and positive effects of natural disasters. Third, there is limited studies analyzing the effect of flood on GDP growth in Malaysia. In the case of Malaysia, the results may be different from the discussed literatures due to different economic development and structures. Since the main focus of the paper is to analyze the effect of flood on GDP growth, we include flood variables as one of the independent variable.

## 3. Research Methodology

Prior to testing for cointegration relationship, unit root tests were conducted to check the stationarity as well as the order of the series variables used by using the Augmented Dickey-Fuller (Dickey and Fuller, 1979), Phillips-Perron (1988) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. This study then employs the Autoregressive Distributed Lag (ARDL) bounds testing approach for cointegration by Pesaran, Shin and Smith (2001) to check for the long-run movement of the variables as well as to consider the robustness of the results. The ARDL bound test (Pesaran, Shin and Smith, 2001) is being employed for cointegration analysis since it can be applied irrespective of whether the regressors are purely I(0), purely I (1), or mutually cointegrated. Moreover, it is unnecessary that the order of integration of the underlying regressors be determined prior to test the existent of a level relationship between two variables (Pesaran *et al.*, 2001).

Moreover, the bounds testing procedure (Pesaran *et al.,* 2001) employed in this study is robust for small sample study (Pattichis, 1999; Mah, 2000; and Tang and Nair, 2002). Furthermore, the bound testing approach is possible even when the explanatory variables are endogenous (Alam and Quazi, 2003). To test whether this is indeed appropriate in the current application, the entire variables are change to be dependent variable to compute the F-statistic for the respective joint significance in the ARDL models. Under the conventionally used level of significance such as 5% and 1%, if the F-statistic exceeds upper critical bound, then the null hypothesis of no cointegrating relation can be rejected. If the test statistic (F-statistic) falls below the lower critical bound, we cannot reject the null of non cointegration. Finally, if the F-statistic falls between the bounds, the test is inconclusive (Pesaran *et al.,* 2001).When the results of F-statistics in the first step support the evidence of the existence of cointegration between variables, the second step of ARDL approach is to estimate for long run coefficient. In this study, the model for cointegration equation for GDP growth is shown in Equation (1).

$$Y_t = \alpha_{10,0} + \sum_{i=1}^{p} a_{11,i} SIZE_{t-i} + \sum_{i=1}^{p} a_{12,i} DUR_{t-i} + \sum_{i=1}^{p} a_{13,i} DAM_{t-i} + \sum_{i=1}^{p} a_{14,i} FREQ_{t-i} + \sum_{i=1}^{p} a_{15,i} G_{K_{t-i}} + \sum_{i=1}^{p} a_{16,i} IGDP_{t-i} + \sum_{i=1}^{p} a_{17,i} G_{L_{t-i}} + \sum_{i=1}^{p} a_{18,i} HUMAN_{t-i} + \sum_{i=1}^{p} a_{19,i} INF_{t-i} + \varepsilon_t \quad (1)$$

where, $Y_t$ is GDP growth at time *t*. The flood variables are represents by $SIZE_{t-i}$ is size of area affected, $DUR_{t-i}$ is duration of flood, $DAM_{t-i}$ is total damaged cost and $FREQ_{t-i}$ is frequency of flood. The control variables include, $G_{K_{t-i}}$ represents capital growth, $IGDP_{t-i}$ represents initial GDP per capital, $G_{L_{t-i}}$ represents labor growth, $HUMAN_{t-i}$ represents human capital and $INF_{t-I}$ represents inflation rate. The study identify the long run relationship between GDP growth and flood variables.

The existence of long-run relationship between GDP growth and flood variables were tested for mining sector. If cointegration has been detected between series suggesting a long-run relationship between the variables, there must be a short-run relationship between the variables. The third step of ARDL approach is to estimate for short run relationship. Error Correction Model (ECM) will be used to evaluate the short-run relationship between the cointegrated series. Relying on the presence of a cointegrating relationship, the Error Correction Model (ECM) can be written as in Equation (2),

$$Y_t = \alpha_{10,0} + \sum_{i=1}^{p} a_{11,i} SIZE_{t-i} + \sum_{i=1}^{p} a_{12,i} DUR_{t-i} + \sum_{i=1}^{p} a_{13,i} DAM_{t-i} + \sum_{i=1}^{p} a_{14,i} FREQ_{t-i} + \sum_{i=1}^{p} a_{15,i} G_{K_{t-i}} + \sum_{i=1}^{p} a_{16,i} IGDP_{t-i} + \sum_{i=1}^{p} a_{17,i} G_{L_{t-i}} + \sum_{i=1}^{p} a_{18,i} HUMAN_{t-i} + \sum_{i=1}^{p} a_{19,i} INF_{t-i} + \varphi ECM_{t-1} + \varepsilon_{1t} \quad (2)$$

where $\varphi ECM_{t-1}$ is the error correction term. All other variables are as before.

In the study, all variables have been transformed into natural log and the lag order is selected using the minimum values of AIC. Lag orders were selected using AIC because results are usually better and more consistent than utilizing other information criteria (Lutkepohl, 2006). The diagnostic test and stability test of long run and short run parameters is tested by using the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares (CUSUMsq) of recursive residuals.

## 4. Results And Discussion

Table 1 present the results of Augmented Dickey-Fuller (ADF) test, Phillips-Perron (PP) test and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test for all series in levels and first differences using annual data from 1960 until 2013. The results show that the null hypothesis of unit root at the 5% and 1% critical value for all series can be rejected except for Inflation, Human Capital and Initial GDP. Nevertheless, the null hypothesis is rejected at the 5% and 1% critical value for the series in the first difference. The results in Table 1 show that there is a mixture of I(0) and I(1) of underlying reggressors.

**Table 1** Unit root test

| Variables | ADF | | PP | | KPSS | |
|---|---|---|---|---|---|---|
| | Level | 1st diff. | Level | 1st diff. | Level | 1st diff. |
| Flood Size | -7.674832*** | -8.669051*** | -7.675324*** | -15.33453*** | 0.038896*** | 0.064076*** |
| Flood Damage | -7.520201*** | -11.25796*** | -7.327544*** | -12.05270*** | 0.114371 | 0.039842*** |
| Flood Duration | -8.156938*** | -7.194510*** | -8.164155*** | -13.56496*** | 0.061118*** | 0.094900*** |
| Flood Frequency | -6.923116*** | -8.255660*** | -6.878716*** | -9.063773*** | 0.110803 | 0.065409*** |
| Growth | -5.231273*** | -7.733156*** | -5.244262*** | -11.39345*** | 0.050103*** | 0.040873*** |
| Capital | -8.508230*** | -7.628008*** | -8.551741*** | -18.36174*** | 0.075251*** | 0.052448*** |
| Labor | -6.878435*** | -7.894636*** | -6.889434*** | -19.36771*** | 0.140754** | 0.046490*** |
| Inflation | -2.951708 | -5.917019*** | -2.653648 | -5.917019*** | 0.074957*** | 0.050550*** |
| Human Capital | -1.158239 | -5.760611*** | -1.175741 | -5.618707*** | 0.243375 | 0.074951*** |
| Initial GDP | -0.887505 | -7.480802*** | -0.887505 | -7.483244*** | 0.246296 | 0.042608*** |

SIC was used for ADF to select the lag length; the maximum number of lags was set to 10.Barlett-Kemel was used for PP and KPSS as the spectral estimation method.
***,** and * are statistically significant at 1, 5 and 10% respectively.

The lag length selection test for economic growth is displayed in Table 2. The lag length usually selected using the minimum values of AIC. In this study, the minimum value for AIC is chosen. The maximum order of lag in the ARDL is 2. The next step is to estimate Equation (1) to examine the long run relationship among the variables for economic growth.

**Table 2** Lag Length Selection

| | GDP Growth | | | |
|---|---|---|---|---|
| Order of lags | 1 | 2 | 3 | F-statistics |
| AIC | -66.2432 | -69.0223 | -68.2458 | 4.9085*** |

Critical value bounds of the F statistic with $k$ = 10 with constant: ($k$ = 11 is not available) : (2.54, 3.86), (2.06, 3.24) and (1.83, 2.94) at the 1, 5 and 10% level of significance respectively.
***,** and * are statistically significant at 1, 5 and 10% respectively.

The calculated F-statistics for the cointegration test is displayed in Table 2. From the result, it is clear that there is a long run relationship amongst the variables since the calculated F-statistics are above the upper bound critical values at the 1, 5 and 10% level of Pesaran (2001). For example, in this study, the calculated F-statistics is 4.9085. The value is above the 1% upper bound critical value of 3.86. This implies that the null hypothesis of no long run cointegration among the variables can be rejected. Therefore, from the F-statistics results, we can conclude that there exist a long run cointegration relationship between GDP growth and the corresponding exogenous variables.

Table 3 reports the main empirical findings of the estimated long run coefficients for GDP growth equation. The significant variables which appear to affect GDP growth in the long run are Capital, Labor, Flood Size, Flood Duration, Flood Frequency and Flood Damage from flood variables. Flood Size, Flood Damage and Labor are significant at 5%. Other than that, Capital, Flood Duration and Flood Frequency are significant at 10%. The results of diagnostic test reported in the lower segment of Table 3 indicates no serial correlation. The residual term is normally distributed and there is absence of white heteroscedasticity for GDP growth equation. Moreover, the model have passed the Ramsey Test which indicates that functional form of model is well developed.

**Table 3** Long Run Results

| Dependent Variables: | Economic Growth | |
|---|---|---|
| Regressors | Coefficient | *t*-Statistics |
| Constant | -0.2431 | -0.31233 |
| Flood Size | 0.57934 | 2.4967** |
| Flood Damage | 0.19816 | 1.2170** |
| Flood Duration | 0.24983 | 1.6537* |
| Flood Frequency | -0.26910 | -2.0290* |
| Capital | 0.14890 | 1.7918* |
| Labor | 0.31980 | 2.1378** |
| IRGDP | 0.068968 | 0.035688 |
| Human Capital | -0.14840 | -0.20949 |
| Inflation | -0.10536 | -0.21993 |
| *Sensitivity Analysis* | | |
| Serial Correlation LM | 0.17307 | 0.677 |
| Functional Form | 1.2610 | 0.210 |
| Normality | 2.5660 | 0.277 |
| Heteroscedasticity | 0.55428 | 0.457 |

***,** and * are statistically significant at 1, 5 and 10% respectively.

The results show a positive relationship between size of affected area and economic growth in Malaysia. The result indicates that a 1% increase in the size of affected area, will increase the economic growth by 0.57%. This situation could be due to the size of destruction during flood disaster. In general, the bigger the size of affected area, the higher economic growth. This could be due to the destruction area that needs to be recovered. Recovery process may generate growth in the long run. This is consistent with the general findings from Noorazuan (2006) that found area extent is one of the most significant flood variables in Malaysia. The results is also similar with the study of Skidmore and Toya (2002) and Raddatz (2009) that investigate the impact of natural disasters on economic growth in the long run. The results of the study show that there is a significantly positive effect on GDP growth rates due to climatic disasters. The authors concluded that growth rates may be affected positively as newer and more productive technologies restore outdated ones in the long run. Nonetheless, the authors also concluded that disasters have possibilities in generating a chance to reconstruct better economies.

However, the long run results show a negative relationship between frequency of flood and economic growth. The result indicates that a 1% increase in frequency of flood, will decrease the economic growth by 0.27%. This situation could be due to the frequent disruption in production. The more frequent flood disaster strikes, the higher decrease in economic growth. The results is consistent with the study of Cuaresma *et al*., (2008), found that in developing countries, disaster frequency is associated with less knowledge in the disasters prevention and thus, decrease the economic growth due to recovery and reconstruction in the long run. In the case of Malaysia, floods are an annual occurrence which varies in terms of severity, place and time of occurrences. Recently, flood occurrences seem to be more frequent especially in some cities like Kuala Lumpur and Penang where rapid urbanization is taking place.

This is consistent with the finding of Benson and Clay (1998), found the aggregate impacts of floods could be quite significant in terms of growth. Furthermore, major flood occurred in Kedah and Perlis in 2010 being among the worst flood ever experienced by the country. Besides, massive floods are not only affecting the usual east coast states such as Kelantan, Pahang and Terengganu, but have moved south towards Johor and north towards Kedah and Perlis[8]. In this case, the results show that the size of affected area gives more impact on economic growth since the variable is significant at 5% compared to frequency of flood which is significant at 10%. However, we expect both size of affected area and frequency of flood in several states such as Perlis, Kedah, Terengganu, Pahang, Kelantan and Johor affecting economic growth in Malaysia in the long run.

Furthermore, the results show a significantly positive relationship between total damage cost and economic growth in Malaysia. The result indicates that a 1% increase in total damage cost, will increase economic growth by 0.19%. The reason is probably due to recovery and reconstruction process. Higher damage cost means more needs to be recovered and the recovery process generate growth in the long run. Meanwhile, the long run results also show a significantly positive relationship between duration of flood and economic growth in Malaysia. The result indicates that a 1% increase in duration of flood, will increase GDP growth 0.25%. The reason is probably due to the longer duration of flood, the higher increase in GDP growth.

According to the data provided by Queensland Flood Report, there was a significant damage to infrastructure across Queensland. An estimated 18,000 residential and commercial properties were significantly affected in Brisbane and Ipswich due to flood in 2011 which costs USD10 billion reconstruction. Furthermore, in the study of Anderson (2002), found that the el Nino weather phenomenon in 1997 had caused massive destructions in many countries after setting off storms, fires, floods, frost and drought. It is estimated to have caused nearly USD32 billion in damage to property around the world. In the case of Malaysia, several major floods occurred in 1996 for example floods brought by Tropical Storm Greg in Sabah, caused more than USD97.8 million damage to infrastructure and property and destroyed thousands of houses. Furthermore, in 2000, floods caused by heavy rains in Kelantan and Terengganu caused USD0.35 million damage to properties. Moreover, the 2007 floods in Johor caused USD489 million damage to properties and infrastructures. In this case, the results show that the total damage cost gives more impact on economic growth since the variable is significant at 5% compared to duration of flood which is significant at 10%. However, we expect both total damage cost and duration of flood in several states such as Perlis, Kedah, Terengganu, Pahang, Kelantan, Johor and Sabah affecting economic growth in Malaysia in the long run. In the case of Malaysia, all four flood variables which is the size of affected area, duration of flood, frequency of flood and total damage cost affecting economic growth in the long run.

[8]The EM-DAT database (http://www.emdat.be/database), an emergency events database collected by the Centre for Research on the Epidemiology of Disasters (CRED), defines the total number of people affected by a natural disaster as the sum of those people injured, homeless, or needing immediate assistance following a disaster.

Other than that, the results also show a positive relationship between growth of labor and GDP growth in Malaysia. The result indicates that a 1% increase in labor growth, will increase GDP growth by 0.32%. This is probably due to an increasingly number of labor employed which increased the capacity of production and thus, leads to positive economic growth in the long run. This is also probably due to the increasing number of professional and skilled labor which bring improvement in the usage of technologies and thus, able to generate economic growth in the long run. Based on the data provided by Department of Statistics Malaysia, the number of labor employed are totaled 4.03 million in 1990, which increased to approximately 4.37 million in year 2000. Furthermore, the number of labor employed increase to approximately 5 million in year 2005. The number of employment is keep increasing as it has been striving to reduce the unemployment rate. In this case, labor growth is positively significant with the GDP growth in the long run.

Furthermore, capital growth also have significantly positive relationship with GDP growth in Malaysia. The result indicates that a 1% increase in capital, will increase GDP growth by 0.15%. This is most probably because of the adoption of more technologically advanced which will increase the productivity and thus, increase the possibility of future economic development of a country. Moreover, the long run growth rates could increase the investment capital through the acceptance of newer and more productive technologies. However, the results of the study is in contrast from Potiowsky and Qayum (1992) found that there is no any great effects of domestic capital formation on economic growth in the long run. This is probably due to the growth has more causal effect on capital formation rather than capital formation on growth. In the case of Malaysia, capital growth is positively significant with the GDP growth in the long run.

The results of the Error Correction Model obtained for GDP growth is presented in Table 4. The significant variables which appear to affect GDP growth in the short run are Capital, Labor, Initial GDP, Flood Size, Flood Duration, Flood Frequency and Flood Damage. Both Flood Duration and Flood Frequency are significant at 5% while Flood Size and Flood Damage are significant at 1% and 10% respectively. Meanwhile, Initial GDP, Labor and Capital are significant at 1%, 5% and 10% respectively.

**Table 4** Error Correction Model

| Dependent Variables: | Economic Growth | |
|---|---|---|
| Regressors | Coefficient | *t*-Statistics |
| Constant | -0.3173 | -0.26514 |
| Flood Size | 0.44600 | 2.7622*** |
| Flood Damage | 0.18667 | 1.05091* |
| Flood Duration | 0.19233 | 1.66015** |
| Flood Frequency | -0.14605 | -2.1940** |
| Capital | 0.11463 | 1.8716* |

Continued…

**Table 4** Error Correction Model continued…

| Dependent Variables: | Economic Growth | |
|---|---|---|
| Regressors | Coefficient | *t*-Statistics |
| Labor | 0.24620 | 2.0647** |
| IRGDP | 0.0886 | 3.0907*** |
| Human Capital | -0.11425 | -0.20630 |
| Inflation | -0.081107 | -0.21792 |
| $ECM_{t-1}$ | -0.06984 | -3.4089*** |

***,** and * are statistically significant at 1, 5 and 10% respectively.

The short run results for size of affected area show a positively significant relationship with GDP growth in Malaysia. The result indicates that a 1% increase in the size of affected area, will increase GDP growth by 0.45%. The size of affected area is significant at 1%. However, the short run results for frequency of flood show negatively significant relationship with GDP growth in Malaysia. The result indicates that a 1% increase in frequency of flood, will decrease GDP growth by 0.15%. This situation could be due to the frequent disruption in production. The more frequent flood disaster strikes, the higher decrease in economic growth due to frequent disruption in production. Recently, floods occurred in some cities like Kuala Lumpur and Penang where rapid urbanization is taking place and caused damaged to properties and infrastructures. In the short run, works and activities will be temporarily halted in much of the state as roads become impassable, a lot of equipment were damaged while thousands of houses and buildings are affected. During flood, work has stopped and temporary setback occurred in the area of flood.

According to the study from Otero and Marti (1995), found that the implication of the disaster impact depends on the size of the disasters, the size of the economy and the prevailing economic conditions. This is consistent to Ofori (2002), stated that Mozambique was affected by massive floods in 2000 and 2001. The floods swept away roads, bridges and buildings thus, creating a serious setback to the country. However, much of this will resume once the water has cleared. The demand for food, basic necessities and electrical machinery will increase in order to replace the outdated ones and thus, generates growth in the short run. In this case, the short run results show that the size of affected area gives more impact on economic growth since the variable is significant at 1% compared to the frequency of flood which is significant at 5%. However, we expect both size of affected area and frequency of flood in several states such as Perlis, Kedah, Terengganu, Pahang, Johor, Sabah, Kuala Lumpur and Penang affecting economic growth in Malaysia in the short run.

Furthermore, the results show a significantly positive relationship between total damage cost and economic growth in Malaysia. The result indicates that a 1% increase in the total damage cost, will increase economic growth by 0.19%. The reason is probably due to the increasing demand for food, basic necessities and electrical machinery which will generates growth in the short run. Meanwhile, the short run results also show a significantly positive relationship between duration of flood and economic growth in Malaysia. The result indicates that a 1% increase in the duration of flood, will increase GDP growth 0.19%. The reason is probably due to the longer duration of flood, the longer the temporary setback. However, once the flood has cleared and works are resume, the increasing in demand will cause higher increase in GDP growth in the short run. This is consistent with the finding of Benson and Clay (1998), found the aggregate impacts of floods could be quite significant in terms of growth. Furthermore, in the study of Noy (2009), concludes that countries with higher literacy rate, higher per capita income, better institutions and higher levels of government spending were able to survive the preliminary disaster shock and avoid more damages.

On the contrary, in the study of Hochrainer (2009), found that natural disasters, on average leads to a negative effect on GDP although the effects are significant only in the case of large shocks in the short run. However, in the case of Malaysia, flood disaster leads to a positive effect on economic growth in the short run. The result is supported based on the data provided by Department of Statistics and Ministry of Finance Malaysia, Malaysia's growth rose to 9.1%, 9.2%, 10%, 5.6%, 6.3%, 4.8% and 5.1% respectively in the following year after massive flood events in 1988, 1993, 1995, 2005, 2006, 2007 and 2010. In this case, the short run results show that the duration of flood gives more impact on economic growth since the variable is significant at 5% compared to total damage cost which is significant at 10%. However, similar to the earlier explanation, we expect both duration of flood and total damage cost in several states such as Perlis, Kedah, Terengganu, Pahang, Johor, Sabah, Kuala Lumpur and Penang affecting economic growth in Malaysia in the short run.

Furthermore, capital growth has a significantly positive relationship with GDP growth in Malaysia. The result indicates that a 1% increase in the capital growth, will increase GDP growth by 0.12%. The result is in contrast with the finding from Blomstorm *et al.*, (1996), found a negative relationship between capital growth and economic growth in the short run. This is probably due to the effects that could be more or less permanent depending on the extent to which technological innovation is embodied in new capital. In the case of Malaysia, economic growth in Malaysia is positively significant with the GDP growth in the short run.

Meanwhile, the results show a positive relationship between growth of labor and GDP growth in Malaysia. The result indicates that a 1% increase in the labor growth, will increase GDP growth by 0.25%. This is probably due to the high degree of labor input with highly professional labor that able to adopt new mechanization, automation and other advanced methods. At the same time, both high degree of labor input and highly professional labor are more productive and thus, able to fully utilized new technologies and innovations which leads to a positive economic growth in the short run. The result is supported by the data provided from Department of Statistics Malaysia, labor growth in economic sector increased at the average of 2.38% from year 2000 until 2013. In this case, labor growth is positively affecting economic growth in the short run.

Moreover, the results between initial GDP and GDP growth in Malaysia also show a significantly positive relationship. The result indicates that a 1% increase in the initial GDP, will increase GDP growth by 0.09%. Furthermore, initial GDP is significant at 1%. This is probably due to the knowledge gap between actual and potential knowledge or capacity. The larger the knowledge gap, it is easier for a country to increase its productivity by imitating, adapting and learning technology from leading countries. Thus, increase economic growth in the short run. This is also consistent with the findings from Levine & Renelt (1992) that found positive relationship between initial GDP and economic growth. In this case, initial GDP positively affect economic growth in the short run.

In this case, the ECM causes the economic growth to converge to its long run equilibrium path in response to the changes in the exogenous variables. If the ECM is positive or less than -2, this will cause the economic growth to diverge. If the value is between -1 and -2, the ECM will reduce fluctuation in the growth around its equilibrium path. ECM is between 0 and -1 for economic growth in Table 4. This implies that the error correction process converges to the equilibrium path. In our case, the ECM term is significant at 1%. This confirms the existence of established cointegration. It also implies that a deviation from the equilibrium level of growth during the current year will be corrected by 0.07% in the next year.

The robustness of long run and short run results are investigated through stability tests. The stability tests have been conducted to examine the stability of long run and short parameters. In doing so, cumulative sum (CUSUM) and cumulative sum of squares (CUSUMsq) tests have been tested for economic growth model. Pesaran and Shin (1999) have suggested to check the stability of short run and long run estimates through CUSUM and CUSUMsq tests. The Figures 1 and 2 specify that plots for both CUSUM and CUSUMsq are between critical boundaries at 5% level of significance. This confirms the accuracy of long run and short run parameters which have impact on economic growth in the case of Malaysia. Furthermore, both tests also verify the stability of ARDL model for structural stability. This indicates that model is specified.

**Figure 1** Plot of Cumulative Sum of Recursive Residuals

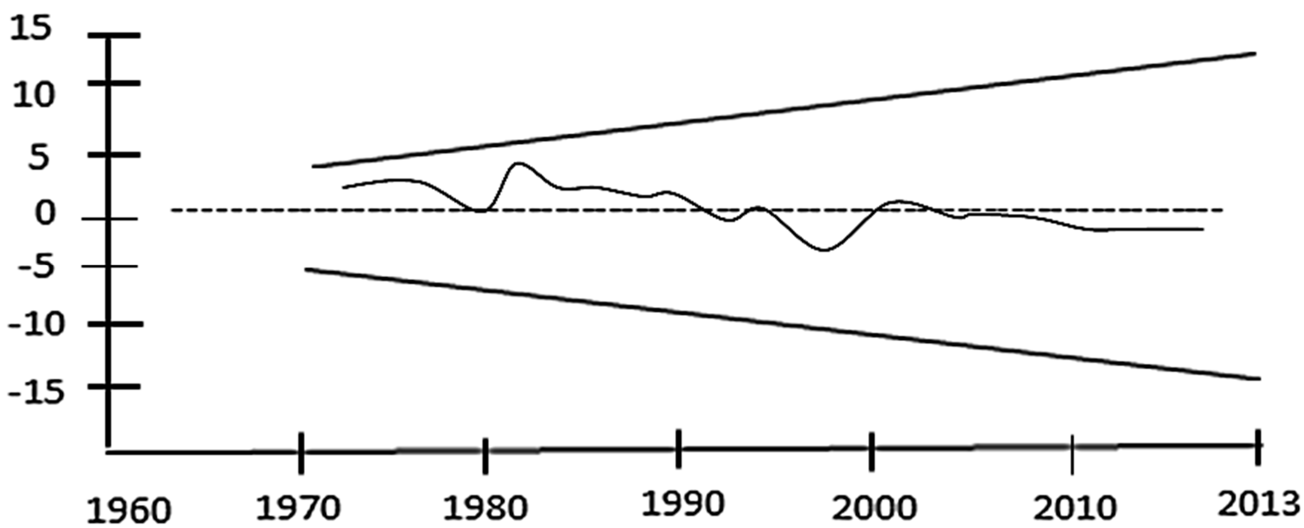
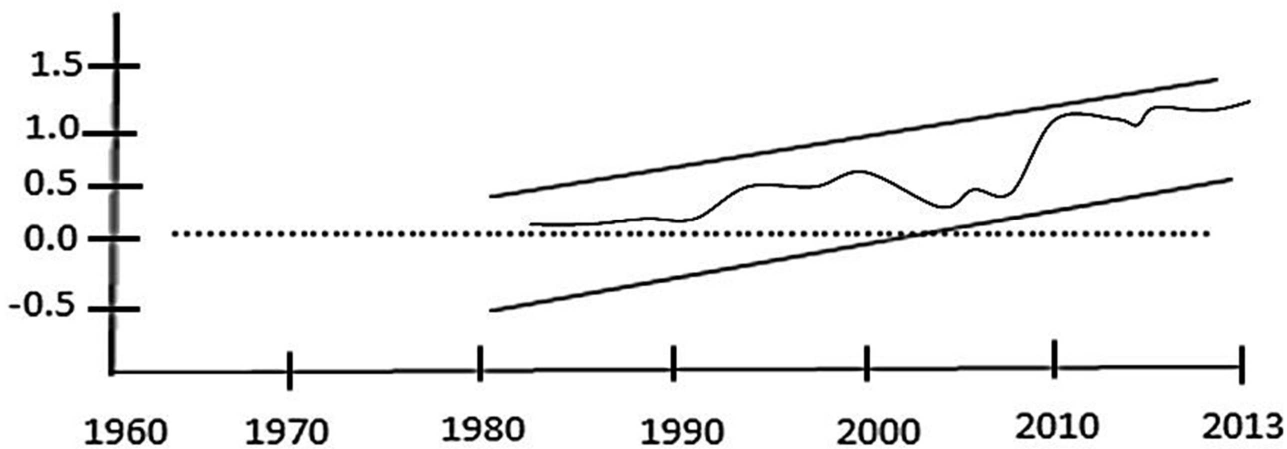



**Figure 2** Plot of Cumulative Sum of Squares of Recursive Residuals



**Conclusion**

This paper seeks to examine the impact of flood disaster on economic growth in Malaysia from year 1960 until 2013. The paper explores the existence of long run and short run relationship between economic growth and flood variables in the case of Malaysia. The paper used ARDL bounds testing approach to cointegration and the error correction model (ECM) for long run and short run relationship. ADF, PP and KPSS unit root test examines stationarity of the series. The results of the bound test show that the series are cointegrated.

In the case of Malaysia, flood disaster positively affecting economic growth in both short run and long run. The results show that there are long run and short run relationship between economic growth and flood variables. In the long run, all four flood variables appear significantly affecting economic growth. Similarly, all four flood variables appear significantly affecting economic growth in the short run. However, both the size of affected area and total damage cost gives high impact on economic growth in the long run. Meanwhile, the size of affected area gives most impact on economic growth in the short run. The result is supported by the study from Otero and Marti (1995), found that the implication of the disaster impact depends on the size of the disasters, the size of the economy and the prevailing economic conditions. The result is also supported based on the data provided by Department of Statistics and Ministry of Finance Malaysia, Malaysia’s growth increased by an average of 7.16% in the following year after massive flood events in 1988, 1993, 1995, 2005, 2006, 2007 and 2010.

The results of the study have several implications. First, the government should develop a proper flood mitigation plan so that when flood occur, there are possibility to deal with the excess water in a range of ways. A well plan water mitigation is able to avoid excess water from damaging houses, buildings and infrastructures and thus, could avoid massive damages. Second, identify vital records and create a backup for storage and sufficient stockpiles of basic necessities in a safe place to avoid shortages and temporary setback in the short run.

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