“Natural disasters, information/communication technologies, foreign direct investment and economic growth in developed countries”

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Natural disasters, information/communication technologies, foreign direct investment and economic growth in developed countries

Abstract

This paper investigates the causal relationship between natural disasters (DMS), information and communication technologies (ICT), foreign direct investment (FDI) and economic growth (GDP per capita) for 10 developed countries over the period 1990 to 2016. Panel DOLS and FMOLS results show that there is a positive relationship running from ICT to natural disasters and to foreign direct investment. In addition, ICT have a positive effect on GDP per capita. VECM Granger causality analysis results reveal a unidirectional causality in the short and long term from ICT to natural disaster and to FDI at the 5% and 10% levels. Therefore, one may note that there is a unidirectional relationship running from natural disaster to GDP and a bidirectional relationship between FDI and GDP.

Keywords: natural disasters, information/communication technologies, economic growth, panel data analysis.
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Introduction

Natural disasters are gaining ground in terms of frequency, duration and disastrous consequences. They affect more than 300 million people each year worldwide and are considered as complex threats involving several factors simultaneously (Rim et al., 2012), hold back the development of countries and increase poverty.

During the last decade, the risks and costs of natural and man-made disasters have significantly increased. For example, in 2010, a 7.3 magnitude earthquake on the Richter scale devastated Haiti, killing more than 222 000 people and leaving 300 000 injured, 1.2 million homeless in Port-au-Prince and more than 2 million displaced, especially in rural areas (United Nations Report, 2010).

In 2004, the most violent earthquake in the world after Chile in 1960 caused devastating tidal waves in part of the Indian Ocean, killed or disappeared more than 280 000 people (Red Cross Report 2010). In fact, from 2002 to 2011, there were 4 130 natural hazard disasters in the world, resulting in at least $ 1 195 billion in economic losses (UNISDR, 2015). Losses from natural disasters were estimated at $ 150 billion in 2010 (Becklumb, 2010).

In view of all this, governments around the world, civil society actors, scientists, development and humanitarian aid organizations, local communities that are most affected, etc., should take the consequences of disasters seriously and invest in developing disaster prevention and resilience capacities.

In addition, the world will be forced to accept the need for a coordinated and collaborative use of new communication technologies in the disaster management. The use of information and communication technologies (ICTs) is helping to strengthen disaster resilience through good climate science and information sharing. When an earthquake occurs, for example, a coordinated ICT system can monitor developments, send emergency messages and assist affected populations.

This paper examines the relationships between Information Communication Technology, natural disasters, Foreign Direct Investment and GDP per capita for 10 developed countries over the period 1990 to 2016. Panel DOLS and FMOLS and Granger causality-VECM approach are used to investigate the short- and long-run relationship between variables and to reveal the direction of causality among them.

The paper is organized as follows. Section 1 presents an overview of literature, section 2 presents the data and the methodology, the empirical results are in Section 3 and the last section presents a summary of the results and draws conclusions.

1. Literature review

Skidmore and Toya (2002) revealed a positive correlation between natural disasters,human capital investment and factors of production. In addition, the occurrence of natural disasters encourages the adoption of new technologies and consequently leads to an increase in the factors

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of production in the long term. Cuaresma et al. (2008) and Hallegatte and Dumas (2009) showed that natural disasters do not affect long-term economic growth. The empirical results of Cavallo and Noy (2010) and Sawada et al. (2011) indicated that there is a negative relationship from natural disasters to economic growth. Cuñado and Ferreira (2014) used panel vector autoregression models, and showed that flood shocks have a positive impact on per capita GDP growth. In another study, Anuchitworawong and Thampanishvong (2015) investigated the effect of natural disaster on FDI. They found that an increase in severity of natural disaster leads to a decrease of FDI flows into Thailand. Benali et al. (2016, 2017) showed that there is a unidirectional relationship from natural disasters to budget deficit. Benali and Saidi (2017) have tested the relationship between natural disaster, economic growth, physical capital, labor and electricity for 41 countries. They showed that for African countries, natural disaster has a negative effect on all variables, for American countries, disaster measures have a negative and significant effect on economic growth and consumption electricity, and for European countries, there is a unidirectional relationship from the disaster measures to labor and from the disaster measures to electricity consumption. In reality, few studies have examined the role of ICT in the production of a common history of risk. In this regard, Shklovski et al. (2008) showed the importance of using ICT to solving the problems of catastrophic events. Samarajiva and Waidyanatha (2009) indicated that using mobile application helps Asian government overcome difficulties caused by natural disasters. According to John et al. (2015), ICTs are instrumental in the recovery after the earthquake in Japon. Their use increases the level of social capital and civic participation. Toya and Skidmore (2015) examined the relationship between ICT and disaster fatalities. By using a panel data model over the 1980-2013 period, they showed that ICTs help to minimize the number of fatalities following disaster events.

2. Data description and methodology

2.1. Data description. Data on GDP per capita (GDP) (constant 2005 US$), foreign direct investment and information and communication technology (ICT) include mobile cellular subscriptions and internet users downloaded from the World Bank Data. Data on natural disasters are obtained from the EM-DAT. The specific countries selected for the study are Australia, Canada, France, Germany, Italy, Japan, Spain, Suisse, the United Kingdom, and the United States over the period 1990 to 2016.

The measurement of natural disasters is based on three factors: the number of people killed, the number of people affected and the amount of economic damage. According to Noy (2009), the measurement of natural disaster (DM) is calculated as follows:

$$(1)\ \text{Total population affected} = \left[\sum_{j=1}^{N}\left(\frac{\text{total population affected}_{ijt}}{\text{total population}_{i,t}}\right)\right], \qquad (1)$$

$$(2)\ \text{Total population killed} = \left[\sum_{j=1}^{N}\left(\frac{\text{total people killed}_{ijt}}{\text{total population}_{i,t}}\right)\right], \qquad (2)$$

$$(3)\ \text{Economic damage} = \left[\sum_{j=1}^{N}\left(\frac{\text{damage}_{ijt}}{\text{total GDP}_{i,t}}\right)\right], \qquad (3)$$

where *i* denotes the country, *j* represents the natural disaster (drought, floods, earthquake and storms) and t = 1, ..., N indicates the year. The disaster measures (DMS) are calculated as follows:

$$\text{DMS} = \text{DM}\,\frac{(12\ -\ \text{month})}{12}$$

Table 1. Descriptive analysis

Designations	DMS	FDI	GDP	INT	MOB
Mean	9.296636	24.33731	28.59990	5.817559	4.619739
Median	0.000000	24.41079	28.44392	6.170566	4.658163
Maximum	287.0400	26.95012	30.45760	7.615198	5.115002
Minimum	0.000000	17.36548	27.55213	0.959658	3.255843
Std. Dev.	30.57922	1.289830	0.745525	1.482024	0.290700
Skewness	6.410964	-1.446996	1.127144	-1.291834	-1.089863
Kurtosis	52.80463	9.066193	3.531894	4.460448	5.920181
Jarque-Bera	15428.60	263.5143	31.29424	51.01441	77.45886

2.2. Methodology of the study. In this section, the necessary tests are presented. First, the heterogeneous unit root test, the cointegration for the panel data, the panel DOLS and FMOLS estimates and then the Granger causality test are exlained.

2.2.1. Panel unit root tests. In order to apply the panel cointegration test as time series, the stationarity test must be used.

To consider the panel unit root, one can apply the following autoregressive model:

$$Y_{it} = \rho_{1i} Y_{it-1} + \delta_i X_{it} + \varepsilon_{it}\,, \tag{1}$$

where i 1, 2, ..., N is the series for country, t 1, 2, ..., T indicates the time, X exposes the exogenous variables, p indicates the autoregressive coefficient, and ε_i is the error term. If $|p_i| = 1$, Y_i has the unit root. Levin, Lin, and Chu (LLC) (2002) adopted the assumption of a homogeneous coefficient for all panels. However, Im, Pesaran and Shin (IPS)'s (2003) tests, Fisher-ADF and Fisher-PP tests were conducted by the assumption of a heterogeneous coefficient (Costantini & Martini, 2010).

The IPS test takes the following form:

$$\Delta \mathrm{y}_{\mathrm{it}} = \alpha_{\mathrm{i}} + \beta_{\mathrm{i}} \mathrm{y}_{\mathrm{it}-1} + \sum_{\mathrm{j}=1}^{p_i} \rho_{\mathrm{ij}}\, \Delta \mathrm{y}_{\mathrm{it}-1} + \varepsilon_{\mathrm{it}}\,, \tag{2}$$

where Δ is the first-difference operator, p_i is the ag order in the ADF regression.

Null hypotheses and alternatives can be written as follows:

$$\mathrm{H}_0 \colon \beta_{\ i} = 0, \forall i$$

$$\mathrm{H}_1 = \begin{cases} \beta_{\mathrm{i}} = 0 < 1\, pour\ certai\ i's \\ \beta_{\mathrm{i}} < 0\ \exists i \end{cases}$$

2.2.2. Panel cointegration test. In general, cointegration tests are performed on time series. However, Pedroni (1999) and Kao (1999) have proposed cointegration tests that apply to longitudinal data. The use of cointegration techniques in panel data makes it possible to test the presence of long-term relationships between integrated variables. The test developed by Pedroni (1999) is part of the tests based on the residue. He considers the following regression model:

$$\mathrm{GDP_{it}} = \alpha_{\mathrm{i}} + \beta_{1\mathrm{i}} \mathrm{DMS}_{\mathrm{it}} + \beta_{2\mathrm{i}} \mathrm{FDI}_{\mathrm{it}} + \beta_{3\mathrm{i}} \mathrm{MOB}_{\mathrm{it}} + \beta_{4\mathrm{i}} \mathrm{INT}_{\mathrm{it}} + \varepsilon_{\mathrm{it}} \tag{3}$$

t = 1, ..., T et i = 1, ..., N,

Where t denotes the time and i is the number of individuals, $\beta_{1i}, \beta_{2i}, \beta_{3i}, \beta_{4i}$, and α_i are parameters to estimate.

To better take into account the degree of heterogeneity of the panel, Pedroni (1997, 1999) suggests seven tests: four are based on the intra-individual dimension and three on the interindividual dimension.

$$\hat{\varepsilon}_{it} = \rho_{1i} \varepsilon_{it-1} + u_{it}$$

The differentiation between intra- and inter-individual dimensions is made at the level of alternative hypothesis formulation. Tests are based on the intra-individual dimension formulating alternative hypothesis $H_1 : p_i = p < 1$. In the inter-individual dimension, alternative hypothesis is spelled $H_1 : p_i < 1$.

$$\rho_i = \rho < 1 \ \forall i\text{: within}$$

$$\rho_i < 1 \ \forall i\text{: between}$$

In contrast to Pedroni tests, Kao considers the special case, in which co-integration vectors are supposed to be homogeneous among individuals. In other words, these tests do not make it possible to consider heterogeneity under the alternative hypothesis and are otherwise valid only for a bi-varied system.

2.2.3. Panel DOLS and FMOLS estimates. Having proved that all variables are stationary in first differences and the long-term cointegration in the preceding steps exists, one can apply the estimation tests of these long-term panel relationships using the methods of FMOLS and DOLS estimators proposed by Pedroni (2001) and Mark and Sul (2002). The FMOLS and DOLS estimates generally give different results.

2.2.4. Panel causality tests. After establishing the existence of cointegration relationship, in order to study the long-term causal relationship between variables, one can use the Granger causality test (Granger, 1988). If the cointegration relationship is confirmed, Vector Error Correction (VECM) Granger causality test can be applied.

$$\begin{aligned}\Delta GDP_{it} = \beta_1 &+ \sum_{i=1}^{P} \beta_{1i}\, \Delta GDP_{it-k} + \sum_{i=1}^{P} \beta_{1i} \Delta DMS_{it-k} + \sum_{i=1}^{P} \beta_{1i} \Delta FDI_{it-k} \\ &+ \sum_{i=1}^{P} \beta_{1i} \Delta MOB_{it-k} + \sum_{i=1}^{P} \beta_{1i} INT_{it-k} + \delta_1 ECT_{it-1} + \varepsilon_{1it}\,,\end{aligned} \tag{4}$$

$$\begin{aligned}\Delta FDI_{it} = \beta_2 &+ \sum_{i=1}^{P} \beta_{2i}\, \Delta FDI_{it-k} + \sum_{i=1}^{P} \beta_{2i} \Delta DMS_{it-k} + \sum_{i=1}^{P} \beta_{3i} \Delta GDP_{it-k} \\ &+ \sum_{i=1}^{P} \beta_{4i} \Delta MOB_{it-k} + \sum_{i=1}^{P} \beta_{5i} INT_{it-k} + \delta_2 ECT_{it-1} + \varepsilon_{2it}\,,\end{aligned} \tag{5}$$

$$\begin{aligned}\Delta MOB_{it} = \beta_3 &+ \sum_{i=1}^{P} \beta_{3i}\, \Delta MOB_{it-k} + \sum_{i=1}^{P} \beta_{3i} \Delta DMS_{it-k} + \sum_{i=1}^{P} \beta_{3i} \Delta GDP_{it-k} \\ &+ \sum_{i=1}^{P} \beta_{3i} \Delta FDI_{it-k} + \sum_{i=1}^{P} \beta_{3i} INT_{it-k} + \delta_3 ECT_{it-1} + \varepsilon_{3it}\,,\end{aligned} \tag{6}$$

$$\begin{aligned}\Delta INT_{it} = \beta_4 &+ \sum_{i=1}^{P} \beta_{4i}\, \Delta INT_{it-k} + \sum_{i=1}^{P} \beta_{4i} \Delta DMS_{it-k} + \sum_{i=1}^{P} \beta_{4i} \Delta GDP_{it-k} \\ &+ \sum_{i=1}^{P} \beta_{4i} \Delta FDI_{it-k} + \sum_{i=1}^{P} \beta_{4i} MOB_{it-k} + \delta_4 ECT_{it-1} + \varepsilon_{4it}\,,\end{aligned} \tag{7}$$

where Δ is the first difference operator, ECT presents the error correction term.

3. Empirical results

3.1. Panel unit root results. The results of the unit root tests from Table 2 show that the GDP, DMS, FDI, MOB and INT are not stationary in level, but stationary in first difference (Table 3). Given that all variables are integrated for order 1 I (1), the long-term relationship between these variables is possible

Table 2. Panel unit root tests results: series in level

	GDP		DMS		FDI		MOB		INT	
	Intercept	Trend	Intercept	Trend	Intercept	Trend	Intercept	Trend	Intercept	Trend
LLC	-1.42516 (0.0771)	-2.84495 (0.0022)**	-2.34097 (0.2196)	-1.32403 (0.0927)***	-2.74388 (0.2530)	-4.16033 (0.9827)	-3.05953 (1.0000)	-5.20898 (0.1249)	-7.31763 (0.0000)*	-5.50126 (0.0000)*
IPS	0.80224 (0.7888)	-0.88262 (0.1887)	-2.48549 (0.3465)	-0.37843 (0.3526)	-0.47633 (0.3169)	0.88915 (0.8130)	-3.51597 (0.1651)	-1.62189 (0.2135)	3.54364 (0.8742)	-1.44455 (1.0000)
ADF	13.8441 (0.8383)	23.3895 (0.2701)	35.2602 (0.0088)*	5.3934 (0.1868)	24.0917 (0.2384)	3.5978 (0.8503)	4.9427 (0.9992)	31.4102 (0.6502)	47.7904 (0.9628)	30.1729 (0.8671)
PP	37.8855 (0.0091)*	31.4779 (0.0492)*	93.2405 (0.3012)	11.296 (0.0000)*	6.0298 (0.0000)*	5.3163 (0.3680)	3.924 (0.9999)	59.0282 (0.9992)	65.9529 (0.3112)	56.2540 (0.1000)

Note: *, **, and *** represent significance at the 1%, 5%, and 10% levels, respectively.

Table 3. Panel unit root tests results: series in first difference

	D(GDP)		D(DMS)		D(FDI)		D(MOB)		D(INT)	
	Intercept	Trend	Intercept	Trend	Intercept	Trend	Intercept	Trend	Intercept	Trend
LLC	5.48235 (0.0000)*	-5.33025 (0.0000)*	-2.45232 (0.0071)*	0.03410 (0.5136)	-5.15333 (0.0000)*	-7.48349 (0.0000)*	-4.83356 (0.0000)*	-2.18391 (0.0145)**	-2.91279 (0.0018)*	-2.21300 (0.0134)**
IPS	-3.05673 (0.0011)	-0.91920 (0.0790)	-4.44500 (0.0000)*	-2.76438 (0.0029)*	-2.18159 (0.0146)**	-2.23646 (0.0127)**	-1.94114 (0.0261)**	0.73352 (0.0684)	-4.59415 (0.0000)*	-2.44480 (0.0072)*
ADF	41.3836 (0.0033)	24.4258 (0.0243)	61.3996 (0.0000)*	42.6016 (0.0023)*	34.5075 (0.0229)**	42.2772 (0.0025)*	31.4052 (0.0501)**	13.4601 (0.08568)	57.2473 (0.0000)*	37.4337 (0.0104)*
PP	66.4015 (0.0000)	44.9316 (0.0011)*	208.792 (0.0000)*	169.566 (0.0000)*	47.2523 (0.0005)*	57.9463 (0.0000)*	60.4827 (0.0000)*	26.3875 (0.01534)	161.133 (0.0000)*	126.909 (0.0000)*

Note: *, **, and *** represent significance at the 1%, 5%, and 10% levels, respectively.

3.2. Panel cointegration test results. Table 4 reports the results of Pedroni co-integration test statistics. The majority of those tests indicate the existence of a cointegration relationship. In addition, Kao test result (Table 5) shows that there is a strong evidence of long-run cointegration relationship between variables.

Table 4. Pedroni cointegration test

Method	Within dimension (panel statistics)			Between dimensions (individuals statistics)		
	Test	Statistics	Prob	Test	Statistics	Prob
Pedroni (1999)	Panel v-Statistic	-2.811313	0.9975	Group rho-Statistic	1.895160	0.9710
	Panel rho-Statistic	0.900793	0.8162	Group PP-Statistic	-16.96227	0.0000*
	Panel PP-Statistic	-14.27152	0.0000*	Group ADF-Statistic	-9.022776	0.0000*
	Panel ADF-Statistic	-8.838662	0.0000*			
Pedroni (2004)	(Weighted statistic)					
	Panel v-Statistic	-2.284997	0.9888			
	Panel rho-Statistic	0.977786	0.8359			
	Panel PP-Statistic	-11.68505	0.0000*			
	PanelADF-Statistic	-7.154127	0.0000*			

Note: The null hypothesis is that the variables are not cointegrated. * indicates the rejection of the null hypothesis at 5%.

Table 5. Kao residual cointegration test result

Model specification: No deterministic trend	t-Statistic	Prob.
ADF t-statistics	-8.814367	0.0000*

3.3. DOLS and FMOLS results. This sub-section presents the estimation of the long-term impact of all explanatory variables on the GDP per capita in 10 countries. The results of the panel FMOLS estimator are not similar to the DOLS estimators in all cases; all results are presented in Table 6.

Table 6. FMOLS and DOLS

		Panel group			
		FMOLS		DOLS	
Dependent variables	Independent variables	Coefficient	Prob	Coefficient	Prob
DGDP	DDMS	-4.08120	0.0378*	-2.00498	0.0000*
	DFDI	10.43789	0.0292*	0.032201	0.0207*
	DMOB	9.64637	0.0003*	-0.307186	0.1880
	DINT	12.02363	0.0288*	0.096969	0.0295
DFDI	DDMS	0.000766	0.6606	-0.043789	0.2576
	DGDP	12.53303	0.0004*	-6.127486	0.3401
	DMOB	0.502733	0.0076*	2.609391	0.0365*
	DINT	0.242251	0.0103*	0.044097	0.0556*
DMOB	DGDP	35.54141	0.3861	1.234080	0.0154*
	DDMS	0.000198	0.2194	0.003379	0.2956
	DFDI	-0.001513	0.8066	-0.005989	0.8289
	DINT	0.022178	0.6970	0.122110	0.0057*
DINT	DGDP	0.752953	0.2776	3.144133	0.0370*
	DDMS	0.000511	0.1329	-0.013181	0.2927
	DFDI	-0.012724	0.3275	-0.105731	0.4904
	DMOB	-0.015980	0.9501	2.551554	0.0042*
DDMS	DGDP	-167.0814	0.1399	-806.1912	0.0000*
	DFDI	1.168724	0.5814	3.462353	0.5448
	DMOB	-1.478470	0.0000*	254.2503	0.0000*
	DINT	-36.85091	0.0569*	-6.371243	0.8005

Note: * indicates statistical significance at the 5% level.

In Table 6, FMOLS test shows a positive relationship running from mobile cellular and internet users to GDP per capita, at 5% of significance. This means that, a 1% increase in mobile cellular and internet leads to increase in GDP per capita by 9.6% and 12%, respectively. The results are consistent with Stanley et al. (2015). Mobile cellular and internet users are further stimulate economic growth. This is due to the role of ICT in improving the functioning of markets, reducing transaction costs and increasing productivity through better management. Besides, 1% increase in disaster measure leads to a decrease in GDP by 4%. Natural disasters tend to cause a series of major economic upheavals. It reduces production and number of hours worked. Reconstruction efforts compensate part of these losses and, paradoxically, stimulating effect on economic growth. In addition, it is shown that there is a positive link between foreign direct investment and GDP per capita. This implies that foreign direct investment has an important part to play in the acceleration of economic growth in developed countries. Furthermore, the effects of Internet and mobile cellular on natural disaster event and foreign direct investment are positive and statistically significant at the 5% level. Using mobile cellular and Internet can help people in preventing and moderating the serious impact of disasters. In addition, ICT stimulates foreign investment; these results are similar to Fakher (2016). Panel DOLS results indicate that a 1% increase in DMS leads to a decrease in GDP per capita by 2%. In addition, an increase in ICT leads to an increase in FDI.

3.4. Panel causality tests results. Results are reported in Table 7. One can deduce the meaning of causal relationships that may appear between the variables at the critical level of 5%.

Table 7. The VECM Granger causality

Short run						Long run
	DMS	GDP	FDI	MOB	INT	ECM_{t-1}
DMS	-------------	27.89730 (0.0000)*	0.135797 (0.9344)	0.398904 (0.8192)	3.610625 (0.1644)	37.86786 (0.0000)*
GDP	4.899453 (0.1863)	-------------	0.658770 (0.0194)*	16.41732 (0.0003)*	9.689010 (0.0079)*	15.87895 (0.0441)*
FDI	0.207688 (0.9014)	5.152506 (0.0761)**	-------------	4.110949 (0.1280)	2.767809 (0.2506)	3.482585 (0.9005)
MOB	11.94869 (0.0025)*	3.945317 (0.1391)	1.135454 (0.0668)**	-------------	0.599846 (0.7409)	51.61618 (0.0000)*
INT	28.52297 (0.0000)*	2.834582 (0.2424)	1.588610 (0.0519)*	1.925118 (0.3819)	-------------	19.93186 (0.0106)*

Note: *, ** mean significance at the 5% and 10% levels, respectively.

The results show that there is a unidirectional causality in the short and long term from mobile cellular and internet users to natural disaster and to FDI. The conclusion that may be drawn from these results is that information and communication technologies can play a vital role in preservation of human life and reduction of recovery costs. Furthermore, result reveals that there is a unidirectional causality from natural disaster to GDP per capita. Capital assets and infrastructure, such as homes, schools, factories and equipment, roads, dams and bridges are destroyed following natural disasters. Human capital is reduced because of loss of life, loss of workers. Cyclical natural disasters can lead to a decrease in production, which leads to economic losses. Finally, there is a bidirectional causality relationship between FDI and GDP. This finding is consistent with Hansen and Rand (2006), Miankhel et al. (2009), Omri and Kahouli (2014), Majid Mahmoodia and Elahe Mahmoodib (2016). On the one hand, FDI can be considered as capital injections to revitalize the economy, on the other hand, economic growth is considered as a tool to stimulate foreign direct investment.

Conclusion

In this paper, the objective has been to use the Panel DOLS and FMOLS and Granger causality-VECM approach to characterize the relationship between natural disasters (DMS), information and communication technologies (ICT), foreign direct investment (FDI) and economic growth (GDP per capita). The study was carried out on a sample of 10 developed countries over the period 1990 to 2016. Results of FMOLS and DOLS showed that mobile cellular and internet users have a positive effect on GDP per capita and natural disaster event. In addition, natural disaster has a negative impact on GDP per capita. Results of VECM Granger causality test indicated that there is a unidirectional causality in the short and long term from ICT to natural disaster and to FDI at the 5% and 10% levels. Therefore, it was noted that there is a unidirectional causality from natural disaster to GDP and a bidirectional causality between FDI and GDP.

To avoid the consequences of disaster events, the ICT is an important learning phenomenon in the occurrence of disasters by reducing uncertainty of natural hazards. When they represent a simple information dissemination technology, digital tools are mainly used to configure alerts, establish diagnoses and record activity traces. Similarly, ICTs play a key role in accelerating the potential for economic growth, generating productivity gains of their own.

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