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# The Impact of Information and Communication Technology Development on Regional Economic Growth

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***Abstract***—The study aims to investigate the relationship between information and communication technology development and the economic region. The method used in this study is the panel regression model. The data source was obtained from Statistics Indonesia (BPS), namely the index of information and communication technology development as a proxy for the development of information and communication technology and regional gross domestic product based on current per capita prices as a proxy for regional economies. There is also a method used in this research is panel regression. The results of this study conclude that modeling the relationship between information and communication technology development and the regional economy is a fixed-effect model. Based on the model, information can be obtained that the development of information and communication technology has a positive and significant effect on the regional economy. Therefore, the right policies and programs are needed to improve the development of technology and information, especially the improvement and equitable distribution of infrastructure.

***Keywords***— Digital, Economy, Information technology, Panel regression

## I. INTRODUCTION

Digitization refers to the digitalization in term of business process which is not manually run but done in a standardized, systemized, computerized, and online. So that digitization can perform activities of operating a business as efficiently. Digitalization is the spirit of the digital economy. The digital economy is the state of the socio-political and system of economy which has the characteristics of a space intelligence, includes information, a variety of access instruments, capacity, and booking information [3]. According to Tapscott [3], the internet and the World Wide Web rise to a form of economic new based on the network intelligence of humans (networking of human intelligence). It implies in the era of the digital economy, information-shaped digital.
The digital economy relies on the technology of information and communication including the internet. Indonesia has a region of islands with a barrier sea that separates, in the economics of digital difficulty geography not become barriers that mean, so that aspect of the development of technologies of information and communication is crucial in encouraging the growth of the economy around the corners of the groundwater in Indonesia. According to Reference [2], digitization and the internet contribute positively to economic growth. According to the author, digitization depends on technology information and communication, where the perpetrators attempt to use it as business e-commerce. Because e-commerce is part of the economy, when e-commerce has progressed, the economy has also increased. Hence, the writer investigates whether the development of technologies of information and communication affect the regional economy positively and significantly. The author uses an index of development of technology information and communication as a proxy of development of technology of information and communication, and domestic gross regional product (GDRP) based on prices prevailing per capita as a proxy of the economy of the region. The method used in this research is panel regression, which can provide more information than time-series and cross-section regression.

Therefore, this study aims to investigate the relationship between information and communication technology development and the regional economy using a panel regression model. This paper consists of five parts, Part 1. The introduction contains a summary of the background of the research; Part 2. Related Work, contains a summary of several studies, Part 3. The method contains a summary of the data sources and methods used; Part 4. The result and Discussion contains a description of the estimation results, and Part V. The Conclusion and Recommendation contains conclusions on the discussion and recommendation.

## II. RELATED WORK

Reference [4] researched the effect of using information and communication technology infrastructure on economic growth in EU countries for the 2000–2017 period using panel data estimation. The results found a positive and highly significant impact of information and communication technology infrastructure on GDP per

 

capita. Besides, Other macroeconomic factors like the unemployment rate, inflation, government expenditures, the degree of trade openness, and foreign direct investment would significantly affect GDP per capita at the EU level.
On the other hand, reference [5] tested whether higher IT adoption in developing countries results in higher total factor productivity (TFP) growth using panel data regression for the 2002-2006 period. From empirical estimation, the research found that IT adoption and higher educational attainment are the most affecting significant factors of TFP growth in developing countries.

In the reference [6], this study explored the role of technological development on economic growth. Technology development helps enterprises and individuals in reducing costs and enhanced productivity gains. The use of new technologies enhanced the international competitiveness of individual countries. Besides, it enhanced the quality of scientific research.

Reference [7] researched the effect of the human development index (HDI), the open unemployment rate, economic growth, and regional GRDP per capita on poverty levels in Sumatera Island. This study used a dynamic panel approach. The results found that the HDI and economic growth had a negative effect on poverty levels.

## III. METHODOLOGY

**Data Source**
The data used in this study is index construction technology of information and communication as a response variable and the source from the Statistics Indonesia-BPS. In the meantime, the predictor variable is the growth of gross regional domestic product (GRDP) per capita at the current price as a proxy economy of regional. The data period used is 2015 - 2017 with the coverage of 34 provinces in Indonesia.

**Panel Regression**
The panel regression model can be stated as follows [1]:

$$y_{it} = \boldsymbol{Z}_i'\boldsymbol{\alpha} + \boldsymbol{x}_{it}'\boldsymbol{\beta} + \varepsilon_{it} \quad (1)$$

where $\boldsymbol{y}_{it}$ is the vector of the response variable with dimension $KT \times 1$, $\boldsymbol{Z}_i'\boldsymbol{\alpha}$ is the effect of a specific individual, $\boldsymbol{\alpha}$ is vector constant, $\boldsymbol{\beta}$ is a coefficient vector (slope) dimension $p \times 1$, $\boldsymbol{x}_{it}$ is the observation matrix on the independent variable with dimension $KT \times p$, $\varepsilon_{it}$ it is the error vector with $KT \times 1$ dimension, $p$ is the number of independent variables, $K$ is the number of cross-section units, $T$ is the number of points in time, $i$ ($i$ = 1,…, K) is the cross-section index, and $t$ ($t$ = 1,…, T) is the time index.

The panel regression is divided into three model structures as an implication of the assumptions made on the intercept, slope, and error, namely: (1) common effect model, (2) fixed-effect model, and (3) random effect model.

*Common Effect Model (CEM)*

$$y_{it} = \alpha + \boldsymbol{x}_{it}'\boldsymbol{\beta} + \varepsilon_{it} \quad (2)$$

where $\boldsymbol{\alpha}$ is constant intercept, $\boldsymbol{Z}_i'\boldsymbol{\alpha}$ the equation (1) is assumed to be constant, $\boldsymbol{Z}_i'\boldsymbol{\alpha} = \alpha$. It means that there are no individual-specific effects.

*Fixed Effect Model (FEM)*

$$y_{it} = \boldsymbol{\alpha}_i + \boldsymbol{x}_{it}'\boldsymbol{\beta} + \varepsilon_{it} \quad (3)$$

where $\boldsymbol{\alpha}_i = \boldsymbol{Z}_i'\boldsymbol{\alpha}$ by accommodating the heterogeneity of the independent variables according to the individual.
*Random Effect Model (REM)*

$$y_{it} = \boldsymbol{\gamma}_i + \boldsymbol{x}_{it}'\boldsymbol{\beta} + u_{it} \quad (4)$$

where:

$$u_{it} = v_i + \varepsilon_{it}$$
$$\boldsymbol{\gamma}_i = E[\boldsymbol{Z}_i'\boldsymbol{\alpha}]$$
$$v_{it} = \boldsymbol{Z}_i'\boldsymbol{\alpha} - E[\boldsymbol{Z}_i'\boldsymbol{\alpha}]$$

In equation (4), $u_{it}$ is the combined error of $\boldsymbol{v}_i$ and $\varepsilon_{it}$. $\boldsymbol{v}_i$ is the specific error for the $i$-th observation but it persists over time.

**Selection Panel Regression Model**

*Chow Test*

Chow's test is used to find out whether the FEM model is more than CEM. The following test statistics are used:

Ho: The CEM model versus H1: The FEM model

$$F_{stat} = \frac{\left(RSS_{CEM} - RSS_{FEM}\right)/K - 1}{RSS_{FEM}/(KT - K - P)} \sim F_{(alpha,(K-1),(KT-K-P))}$$

$P$ is the number of parameters in FEM, $RSS_{CEM}$ is the residual sum of squares of CEM, $RSS_{FEM}$ is the residual sum of squares of FEM. If $F_{stat} > F_{(alpha,(K-1),(KT-K-P))}$ at the specified $alpha$ level, then Ho is rejected, so it can be concluded that the panel regression model chosen is FEM. This is comparable to if the probability value of $F_{stat}$ is less than the specified $alpha$ level, then Ho is rejected, so it can be concluded that the FEM regression model is a better model than the CEM model.

*Hausman Test*
The Hausman test is used to choose between the FEM and REM models. The Hausman test statistics are formulated as follows:

Ho: The REM model versus H1: The FEM model

$$W = \left(\boldsymbol{\beta}_{REM} - \boldsymbol{\beta}_{FEM}\right)' \boldsymbol{\Psi}^{-1} \left(\boldsymbol{\beta}_{REM} - \boldsymbol{\beta}_{FEM}\right) \sim \chi^2_{alpha,P}$$

where $\boldsymbol{\Psi} = V\left(\boldsymbol{\beta}_{REM}\right) - V\left(\boldsymbol{\beta}_{FEM}\right)$, $V\left(\boldsymbol{\beta}_{REM}\right)$ is the parameter covariance matrix (without intercept) of REM,

 

$V\left(\boldsymbol{\beta}_{FEM}\right)$ is the parameter covariance matrix (without intercept) of FEM, $P$ is the number of independent variables. If the value of $W > \chi^2_{alpha,P}$, then Ho is rejected, so it can be concluded that the selected model is FEM or equivalent to a *p-value* of $W$ less than a certain $alpha$ level, then Ho is rejected so it can be concluded that the chosen model is FEM.

## IV. RESULTS AND DISCUSSION

**Panel Regression Model Estimation**

**1. Common Effect Model**

Here are the results of the estimation of the Common Effect Model (CEM), as follows :

$$\hat{y}_{it} = -61448.52 + 26849.57x_{it} \quad (5)$$

t-stat (4.90) (9.31)
p-value [0.00] [0.00]
$R^2$-adj: 45.87%

Based on the estimation results for CEM, the development of information and communication technology has a positive (26849.57) and significant effect at the 5% alpha level on the regional economy of provinces in Indonesia. The common effect model can explain 45.87% variation of the economy regionally while remaining as much as 54.13% is explained by factors another outside of the model.

**2. Fixed Effect Model**

Here are the results of the estimation of the Common Effect Model (CEM), as follows :

$$\hat{y}_{it} = \hat{\alpha}_i + 6552.07x_{it} \quad (6)$$

t-stat (7.38)
p-value [0.00]
$R^2$-adj: 99.26%

In FEM, the value $\hat{\alpha}_i$ is different for each province, the value of $\hat{\alpha}_i$ by the province is presented in table 4.1.

Table 4.1 Estimation Results of the FEM equation for $\hat{\alpha}_i$

| PROVINCES | $\hat{\alpha}_i$ |
|---|---|
| ACEH | 3724.68 |
| SUMATERA UTARA | 19303.52 |
| SUMATERA BARAT | 9217.61 |
| RIAU | 75903.31 |
| JAMBI | 23335.93 |
| SUMATERA SELATAN | 18160.14 |
| BENGKULU | 2470.52 |
| LAMPUNG | 11638.71 |
| KEP. BANGKA BELITUNG | 19927.44 |
| KEP. RIAU | 69568.73 |
| DKI JAKARTA | 162706.6 |
| JAWA BARAT | 5024.12 |
| JAWA TENGAH | 4892.08 |
| DI YOGYAKARTA | -9322.78 |
| JAWA TIMUR | 19333.91 |
| BANTEN | 11279.67 |
| BALI | 10486.55 |
| NUSA TENGGARA BARAT | 1529.33 |
| NUSA TENGGARA TIMUR | -2937.21 |
| KALIMANTAN BARAT | 9764.57 |
| KALIMANTAN TENGAH | 16801.82 |
| KALIMANTAN SELATAN | 7486.65 |
| KALIMANTAN TIMUR | 115671.8 |
| KALIMANTAN UTARA | 69673.97 |
| SULAWESI UTARA | 10945.28 |
| SULAWESI TENGAH | 16903.21 |
| SULAWESI SELATAN | 15760.95 |
| SULAWESI TENGGARA | 12294.07 |
| GORONTALO | 2454.45 |
| SULAWESI BARAT | 7130.86 |
| MALUKU | -3682.97 |
| MALUKU UTARA | 3150.02 |
| PAPUA BARAT | 49657.52 |
| PAPUA | 36839.83 |

Source: author processing.

Based on the results of the estimation for FEM that the development of technology of information and communication gives effect positive (6552.07) and significant at the level of alpha 5% of the economy of regional provinces in Indonesia. Fixed effect model can explain 99.26% variation of the economy regionally while remaining as much as 0.74 % is explained by factors another outside of the model.

**3. Random Effect Model**

Here are the results of the estimation of the Common Effect Model (CEM), as follows:

$$\hat{y}_{it} = \hat{\gamma}_i + 7211.07x_{it} \quad (7)$$

t-stat (8.24)
p-value [0.00]
$R^2$-adj: 35.72%

Because of REM, the value $\hat{\gamma}_i$ is different for each province, here is a list $\hat{\gamma}_i$ by the province which is presented in table 4.2.

Table 4.2 Estimation Results of the REM equation $\hat{\gamma}_i$

| PROVINCES | $\hat{\gamma}_i$ |
|---|---|
| ACEH | 1489.68 |
| SUMATERA UTARA | 16796.13 |
| SUMATERA BARAT | 6459.72 |
| RIAU | 72773.49 |
| JAMBI | 20688.73 |
| SUMATERA SELATAN | 15627.7 |
| BENGKULU | -101.59 |
| LAMPUNG | 9441.8 |
| KEP. BANGKA BELITUNG | 17270.56 |
| KEP. RIAU | 65722.07 |
| DKI JAKARTA | 157170.4 |
| JAWA BARAT | 2111.72 |
| JAWA TENGAH | 2255.75 |

 

| PROVINCES | $\hat{\gamma}_i$ |
|---|---|
| DI YOGYAKARTA | -13068.3 |
| JAWA TIMUR | 16533.45 |
| BANTEN | 8194.8 |
| BALI | 6953.03 |
| NUSA TENGGARA BARAT | -576.96 |
| NUSA TENGGARA TIMUR | -4717.96 |
| KALIMANTAN BARAT | 7469.64 |
| KALIMANTAN TENGAH | 14092.36 |
| KALIMANTAN SELATAN | 4667.21 |
| KALIMANTAN TIMUR | 111498.5 |
| KALIMANTAN UTARA | 66185.29 |
| SULAWESI UTARA | 7962.59 |
| SULAWESI TENGAH | 14492.74 |
| SULAWESI SELATAN | 12975.65 |
| SULAWESI TENGGARA | 9752.95 |
| GORONTALO | 48.56 |
| SULAWESI BARAT | 5146.01 |
| MALUKU | -6091.84 |
| MALUKU UTARA | 1079.58 |
| PAPUA BARAT | 46978.68 |
| PAPUA | 35128.24 |

Source: author processing.

Based on the results of the estimation for REM that the development of technology of information and communication gives effect positive (7211.07) and significant at the level of alpha 5% of the economy of regional provinces in Indonesia. Fixed effect model can explain 35.72% variation of the economy regionally while remaining as much as 64.28% is explained by factors another outside of the model.

**Selection of Panel Regression Model**

In choosing the model regression panel of writers using the test Chow and Hausman, following the results of both tests are in Table 4.3:

Table 4.3 Estimation Results of Equation (10)

| Test | Test Statistics | Value | Prob. | Decision | Conclusion |
|---|---|---|---|---|---|
| Chow Test | $F_{stat}$ | **218.23** | **0.00** | **Ho was rejected** | **FEM** |
| Hausman Test | $W$ | **19.87** | **0.00** | **Ho was rejected** | **FEM** |

Source: author processing.

Based on the Chow test, we can conclude that FEM is better than CEM, while based on the Hausman test, FEM is better than REM. It captured phenomena that influence the development of technologies of information and communication in the regional economy by using panel data. The specification of the model regression panels is appropriate to describe the relationship is the fixed effect model. In FEM, it accommodates individual-specific effects (case for the province) so that the intercept is different for each cross-section unit, the slope remains the same between individuals.

Both CEM, FEM, and REM states that the development of technology of information and communication affect positively and significantly the economy of the region. Based on FEM, if there is an increase in the index of information and communication technology development by 1 point, then there will be an average increase in GDP per capita of Rp.6.56 million. It indicates that the development of technologies of information and communication improved and infrastructure distribution of information and communication in the entire country is balanced. In the end, this will boost the growth of unit business economics digital and improve the economy of the region. According to the authors, five things need to be the focus on in the development of technology information and communication, namely: (1) equalization and improvement of the quality of network communications, both spectrum and BTS tower, (2) speed and security in terms of access to the internet, (3 ) increase the ability of the source of the power of man, (4) the optimization of the process of business to take advantage of computerization in the activities of government and the business private, and (5) the creation of a climate of investment were friendly.

## V. CONCLUSION & RECOMMENDATION

Based on the previous discussion, it can conclude that the modeling of the relationship between information and communication technology development and the regional economy is a fixed-effect model. From the model, information obtained that the development of information and communication technology has a positive and significant effect on the regional economy. The recommendation is needed right policies and programs are appropriate to improve the development of technology and information, particularly for improvement and equalization of infrastructure.

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