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Does Digital Readiness Affect Economic Growth?

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Abstract

This study aims to analyze the impact of digital readiness on economic growth and see the difference based on the level of state income using interaction dummy variables. Networked Readiness Index and its 16 individual indicators is used as a proxy for digital readiness. The research method used is panel data regression analysis covering 105 countries over a period of 4 years (2013-2016). Panel data regression analysis shows that public investment and labor force are significantly positive on economic growth, while inflation has a negative significant impact. Digital readiness is significantly positive on economic growth only in high-income countries but has a significant negative impact in middle and low-income countries. Indicators that have the greatest impact on economic growth are Government Procurement of Advanced Technology in high-income countries and Adult Literacy Rate in middle-income countries. Digital readiness cannot directly increase economic growth without adequate capital and labor factors. Governments of middle and low-income countries should focus more on ICT development, both through ICT infrastructure and the quality of human resources to take advantage of digital technology.

Keywords
digital readiness; economic growth; panel data

JEL Classification:
C33, O11, O33

I. Introduction

The use of digital technology worldwide is increasing, especially since the COVID-19 pandemic in early 2020. The enforcement of social distancing (policies lockdown), restrictions on various community activities in public places, and other measures in dealing with the COVID-19 pandemic have encouraged the community to increase the various uses of digital technology to meet their needs. This has resulted in increased demand for internet and cellular data services (WTO 2020). Network and spectrum capacity to accommodate the shift to online activities must be adapted immediately by operators and governments.

GlobalWebIndex's Coronavirus Multi-Market Study on the We Are Social (2020) website said that as of April 2020 there was a change in digital traffic during the COVID-19 pandemic. As many as 47% of the world's internet users do shopping online more during this pandemic, the biggest increase in online shopping for buying food needs is 33%. ContentSquare, still on the same site, also reported an increase in traffic in web thee-commerce supermarkets reaching 251%. Statista (2020) notes that in the UK, the number of daily active users (DAU) of the Zoom app peaked at over 770k in mid-May 2020 around

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the same time that the COVID-19 outbreak hit the UK. Still from the same source, the number of DAU for Microsoft Teams applications increased from 32 million users on March 12, 2019, to 75 million on April 30, 2020.

WTO (2020) also said the pandemic had highlighted the importance of the digital economy so that it became an urgent need to bridge the digital divide, both within and across the country. The pandemic has emphasized the question of the extent to which small producers, sellers, and consumers in developing countries, particularly in LDCs (Least Developed Countries), can take advantage of the opportunities that provide e-commerce. Many obstacles become more pronounced during the COVID-19 pandemic. These barriers include access to an internet connection, sufficient electricity supply, online payment mechanisms, etc. Some communities continue to have limited access to ICTs, either because they live in rural areas or because their incomes are low, or both. In some countries, prices can be very high for computers and telecommunications equipment, while in other countries the prices for these goods are relatively cheaper with higher per capita income levels.

The World Economic Forum (WEF) has issued a Global Information Technology Report (GITR) since 2001 intending to see a country's readiness to face digital developments. The GITR produces a Networked Readiness Index or it can also be called the Digital Readiness Index because it is the main tool in assessing a country's readiness to use and benefit from digital technology. The GITR discusses various indicators of a country's readiness to face digitalization. In the 2013-2016 GITR, there are 53 indicators. These individual indicators are aggregated to obtain a pillar score, which is then combined to obtain a subindex score and finally combined to produce a score Networked Readiness Index (WEF, 2016). Yugo et.al (upcoming) has reduced 53 individual NRI indicators to 16 individual indicators using the principal component analysis (PCA) method.

GITR 2016 also shows that differences in network readiness between countries are strongly influenced by differences in per capita income. The composition of the 10 countries with the best NRIs in 2016 did not change from 2015, all of which were high-income countries consisting of a mixture of high-income countries in Asia (Singapore and Japan) and European countries (Finland, Sweden, Norway, Netherlands, Switzerland, United Kingdom and Luxembourg) and United States.

Many studies have been conducted to examine the influence of digital technology (ICT) on economic growth in developed and developing countries. The difference in the influence of ICT on economic growth in developed and developing countries is shown in research conducted by the International Telecommunication Union (2018) which results first, fixed broadband and mobile broadband have had a significant impact on the world economy over the last seven years (2010-2017). However, the economic impact generated by the penetration of fixed broadband (through the effect of a return to scale) is higher in more developed countries than in less developed countries. On the other hand, the economic impact resulting from the penetration of mobile broadband is higher in less developed countries than in more developed countries. Yousefi (2011) also points out that ICTs play a major role in the growth of high- and middle-income countries, but fail to contribute to the growth of lower-middle-income countries.

Most of the existing studies use cellular telephones, fixed line telephones, internet users, ICT investment, ICT imports, ICT exports, as proxies for digital technology. This study uses Networked Readiness Index (NRI) 2013 – 2016 and its 16 individual indicators as a proxy variable of digital readiness, including some of the indicators mentioned above. In addition, this study compares the differences in their impact across three groups of country income (high, middle, and low-income countries) using an interaction dummy variable. Based on the above background, the objectives of this study are to analyze the effect of digital readiness on economic growth and to see the differences in their effects in high, middle, and low-income countries.

II. Research Methods

2.1 Types and Sources of Data

Data used in this study are secondary data obtained from world data sources such as the World Bank and data from the World Economic Forum (WEF) in the Global Information Technology Report 2013 – 2016. The data that will be used for this research can be seen in Table 1.

Table 1. Variables in Research

No.	Variable	Type	Unit	Period	Source
1.	GDP	Dependent	million USD	2013 – 2016	World Bank
2.	Public Investment	Independent	million USD	2013 – 2016	World Bank
3.	Labor Force Population	Independent	person	2013 – 2016	World Bank
4.	Inflation	Independent	% annual	2013 – 2016	World Bank
5.	Networked Readiness Index (NRI)	Independent	Index 1-7	2013 – 2016	GITR 2013 - 2016
6.	16 NRI Indicators*)	Independent	Index 1-7	2013 – 2016	GITR 2013 - 2016

**) The number of indicators that will be used as independent variables in the model is following the results of the Principal Component Analysis (Yugo et.al, upcoming).*

Before further analysis needs to be done, the data cleansing aims to get rid of duplicate data, check for inconsistent data, and eliminate incomplete data (missing value). Missing value in this research dataset is done by removing records that have no value. From the dataset used in this study, initially, there were 139 countries and after cleaning the data, 105 countries were obtained, of which 34 countries had incomplete data (missing). As for the period (time series) used 4 years (2013-2016). Thus in the end this study uses panel data with data of cross-section 105 countries consisting of 45 high-income countries, 52 middle-income countries, and 8 low-income countries, with a period of 4 years (2013 – 2016) and 16 NRI indicators. The total observation is 420. Details of 16 indicators that use in this study can be seen in Table 2.

Table 2. 16 Networked Readiness Index (NRI) Individual Indicators

Principal Component	Code	Variable Name	Loadingfactor Score	Cummulative Percentage Variance
PC 1 (Capability dan Affordability)	B7	Tertiary education enrollment rate	0.3024	51.58%
	E3	Secondary education enrollment rate	0.2518	
	E4	Adult literacy rate	0.2574	
	F2	Individuals using internet	0.2420	
	F3	Households with personal computer	0.2499	
	F4	Households with internet access	0.2425	
	F5	Fixed broadband internet subscriptions	0.2369	
PC 2 (Law, Regulation dan Government)	A1	Effectiveness of law-making bodies	0.2527	8.60%
	A4	Efficiency of legal framework in settling disputes	0.2801	
	A5	Efficiency of legal framework in challenging regulations	0.2747	
	B2	Venture capital availability	0.2267	
	B9	Government procurement of advanced technology products	0.2829	
	G6	Extent of staff training	0.2109	
	H1	Importance of ICTs to government vision of the future	0.2653	
	H3	Government success in ICT promotion	0.2678	
	J3	ICT use and government efficiency	0.2095	

Source: Yugo et.al (*upcoming*).

2.2 Analysis and Data Processing

a. Panel Data Regression Analysis

Types of data in econometrics consist of cross-section data, time-series data, and panel data (pooled data). Data cross-section consists of one or several variables observed from sample units at one point in time. Data time-series consists of one or several variables that are observed over a certain period. Panel data is a combination of cross-section and time-series data. In other words, panel data includes one or more variables observed from the same sample units over a certain period.

Gujarati (2006) states that there are three types of estimation models used in panel data regression analysis, namely pooled regression models, fixed-effects models, and models random effects. In research using panel data, there are three ways to test the suitability of the model to determine the panel data regression model to be used, namely; 1. The F statistic test or Chow test is carried out to determine whether the pooled regression (PLS) model fixed effects (FEM)is more appropriate to use in the study, 2. The Hausman test is carried out to determine whether the model fixed effect (FEM) or the model random effect (REM) is more appropriate to be used in the study, and 3. Lagrange Multiplier Test (LM Test) was conducted to determine which model is more appropriate between PLS and REM.

However, in this study, it was determined at the outset that the method used was Generalized Least Square (GLS) with Random Effects. The Model is Random Effect directly selected without going through the selection of the best model. According to Nachrowi (2006), the selection of the Fixed Effect method or the method Random Effect can be done by considering the purpose of the analysis. It is said that if the panel data owned has a greater amount of time (t) than the number of individuals (i), it is recommended to use the method Fixed Effect. Meanwhile, if the panel data owned has a smaller amount of time (t) than the number of individuals (i), it is recommended to use the method Random Effect. This study uses individual data from 105 countries with a period of 4 years (2013 – 2016). Then the method of Random Effect is more appropriate. In addition, according to Widarjono (2009), the model is Random Effect used to overcome the weaknesses of the model Fixed Effect which uses dummy variables. The Panel data analysis method Random Effect must also meet the requirement that the number of individuals must be greater than the number of research variables. Thus, from all the requirements above, this research is most appropriate to use the model Random Effect (REM). The method used in this research is Generalized Least Square (GLS) with Random Effect Model (REM). Panel data regression analysis was performed using Stata 64 software.

The classical assumption test is a series of tests consisting of autocorrelation, heteroscedasticity, multicollinearity, and normality tests used in linear regression with the approach Ordinary Least Square (OLS). In many cases, the classical assumptions cannot be fulfilled completely, as a result, the OLS estimator is still unbiased or consistent but the uniform matrix is different from the one derived. The problem of classical assumptions can be overcome by using the method, Generalized Least Square (GLS), namely by lowering alternative estimators that are unbiased, linear, and best. According to Gujarati and Porter (2009), the random effect panel model estimation method (Random Effect) uses the method Generalized Least Square (GLS), while the combined effect panel model (Common Effect/ PLS) and the panel model fixed Effect Uses the Ordinary Least Square (OLS). One of the advantages of the GLS method is that it does not need to meet classical assumptions. So, if the regression model uses the Random Effect, there is no need to test the classical assumptions. On the other hand, if the regression model is used, common effect (PLS) or fixed effect it is necessary to test the classical assumption. Classical assumption test is not needed in panel data analysis because panel data can minimize bias that is likely to appear in the analysis results, provide more information, variation, and degree of freedom (Gujarati, 2006) With the advantages of panel data regression, the implication is that there is no need to test classical assumptions in the panel data model (Verbeek, 2000; Gujarati, 2006; Wibisono, 2005; Aulia, 2004 in Ajija et al, 2011).

Based on Juanda (2009), the description of the decrease in this alternative estimate is an unbiased, linear estimator, best following the Gauss-Markov assumption, what needs to be done is to transform the model in such a way that it meets the Gauss-Markov assumption, namely obtaining homogeneous residual components and does not show autocorrelation.

Several statistical tests must be considered, including the coefficient of determination (R2), the F-statistics Test, and the t-Statistical Test.

1. Coefficient of Determination (R2/R-squared)

   The coefficient of determination is used to see the extent to which the variability can be explained by the independent variable on the dependent variable. This value indicates how close the estimated regression line is to the actual data. The value of R2 or R2 corrected ranges from 0 to 1, the closer the better one.

2. F-Statistic

   The F-Stat test was used to test the coefficient (slope overall regression) hypothesis. The first step to perform the F-Stat test is to write the test hypothesis, as follows:

   H0 : $\beta 1 = \beta 2 = ... = \beta k = 0$
   H1 : there is at least one $\beta i \neq 0$; $(i = 1,2,...,k)$

   If the F-statistic is greater than Fα, (k – 1, NT – N – K) or the probability of the F-statistic is less than then there is sufficient evidence to reject H0. This means that with a confidence level of 1-α, it can be concluded that the independent variables used in the model together can explain the dependent variable.

3. t-Statistic

   Test The t-Stat test was used to determine how much influence each independent variable (Xi) had on the dependent variable (Yi). The first step to perform a t-test is to write a test hypothesis.

   H0 : $\beta i = 0$
   H1 : $\beta i \neq 0$

   If the absolute value of t-statistic is greater than tα/2, (NT – K – 1) or the probability of t is less than, then there is sufficient evidence to reject H0. This means that with a confidence level of 1-α it can be concluded that the k-th independent variable partially affects the dependent variable significantly. In addition, hypothesis testing can also directly look at the significance value (p). When the significance value is less than 0.05 ($p < 0.05$), the null hypothesis (H0) is rejected and the alternative hypothesis is accepted (H1).

b. Model Specification

Panel data regression model is used to analyze the relationship between economic growth and unemployment with digital readiness. The variables that represent digital readiness are the Networked Readiness Index (NRI) itself and the 16 individual indicator variables. The variables in the equation model are based on several macroeconomic conceptual theories and empirical theories from several previous studies (Ramadhan et.al 2019) with some modifications to the results of the literature study. In this study, panel data regression analysis was carried out on the economic growth equation with a total of 34 models with the following details :

1. One model looks at the effect of the NRI composite index on GDP :

$$lnGDP_{it} = \alpha_{0i} + \alpha_1 lnGCF_{it} + \alpha_2 lnLF_{it} + \alpha_3 Infi_{it} + \alpha_4 NRI_{it} + \alpha_5 DhNRI_{it} + \alpha_6 DmNRI_{it} + u_{1it} \quad (1)$$

2. Sixteen models (one model with one NRI individual indicator) and see their effect on GDP:

$$lnGDP_{it} = \alpha_{7i} + \alpha_8 lnGCF_{it} + \alpha_9 lnLF_{it} + \alpha_{10} Inf_{it} + \alpha_{11} B7_{it} + \alpha_{12} DhB7_{it} + \alpha_{13} DmB7_{it} + u_{2it} \quad (2)$$

$$lnGDP_{it} = \alpha_{14i} + \alpha_{15} lnGCF_{it} + \alpha_{16} lnLF_{it} + \alpha_{17} Inf_{it} + \alpha_{18} E3_{it} + \alpha_{19} DhE3_{it} + \alpha_{20} DmE3_{it} + u_{3it} \quad (3)$$

$$lnGDP_{it} = \alpha_{21i} + \alpha_{22} lnGCF_{it} + \alpha_{23} lnLF_{it} + \alpha_{24} Inf_{it} + \alpha_{25} E4_{it} + \alpha_{26} DhE4_{it} + \alpha_{27} DmE4_{it} + u_{4it} \quad (4)$$

$$lnGDP_{it} = \alpha_{28i} + \alpha_{29} lnGCF_{it} + \alpha_{30} lnLF_{it} + \alpha_{31} Inf_{it} + \alpha_{32} F2_{it} + \alpha_{33} DhF2_{it} + \alpha_{34} DmF2_{it} + u_{5it} \quad (5)$$

$$lnGDP_{it} = \alpha_{35i} + \alpha_{36} lnGCF_{it} + \alpha_{37} lnLF_{it} + \alpha_{38} Inf_{it} + \alpha_{39} F3_{it} + \alpha_{40} DhF3_{it} + \alpha_{41} DmF3_{it} + u_{6it} \quad (6)$$

$$lnGDP_{it} = \alpha_{42} i + \alpha_{43} lnGCF_{it} + \alpha_{44} lnLF_{it} + \alpha_{45} Inf_{it} + \alpha_{46} F4_{it} + \alpha_{47} DhF4_{it} + \alpha_{48} DmF4_{it} + u_{7it} \quad (7)$$

$$lnGDP_{it} = \alpha_{49i} + \alpha_{50} lnGCF_{it} + \alpha_{51} lnLF_{it} + \alpha_{52} Inf_{it} + \alpha_{53} F5_{it} + \alpha_{54} DhF5_{it} + \alpha_{55} DmF5_{it} + u_{8it} \quad (8)$$

$$lnGDP_{it} = \alpha_{56i} + \alpha_{57} lnGCF_{it} + \alpha_{58} lnLF_{it} + \alpha_{59} Inf_{it} + \alpha_{60} A1_{it} + \alpha_{61} DhA1_{it} + \alpha_{62} DmA1_{it} + u_{9it} \quad (9)$$

$$lnGDP_{it} = \alpha_{63i} + \alpha_{64} lnGCF_{it} + \alpha_{65} lnLF_{it} + \alpha_{66} Inf_{it} + \alpha_{67} A4_{it} + \alpha_{68} DhA4_{it} + \alpha_{69} DmA4_{it} + u_{10it} \quad (10)$$

$$lnGDP_{it} = \alpha_{70i} + \alpha_{71} lnGCF_{it} + \alpha_{72} lnLF_{it} + \alpha_{73} Inf_{it} + \alpha_{74} A5_{it} + \alpha_{75} DhA5_{it} + \alpha_{76} DmA5_{it} + u_{11it} \quad (11)$$

$$lnGDP_{it} = \alpha_{77i} + \alpha_{78} lnGCF_{it} + \alpha_{79} lnLF_{it} + \alpha_{80} Inf_{it} + \alpha_{81} B2_{it} + \alpha_{82} DhB2_{it} + \alpha_{83} DmB2_{it} + u_{12it} \quad (12)$$

$$lnGDP_{it} = \alpha_{84i} + \alpha_{85} lnGCF_{it} + \alpha_{86} lnLF_{it} + \alpha_{87} Inf_{it} + \alpha_{88} B9_{it} + \alpha_{89} DhB9_{it} + \alpha_{90} DmB9_{it} + u_{13it} \quad (13)$$

$$lnGDP_{it} = \alpha_{91i} + \alpha_{92} lnGCF_{it} + \alpha_{93} lnLF_{it} + \alpha_{94} Inf_{it} + \alpha_{95} G6_{it} + \alpha_{96} DhG6_{it} + \alpha_{97} DmG6_{it} + u_{14it} \quad (14)$$

$$lnGDP_{it} = \alpha_{98i} + \alpha_{99} lnGCF_{it} + \alpha_{100} lnLF_{it} + \alpha_{101} Inf_{it} + \alpha_{102} H1_{it} + \alpha_{103} DhH1_{it} + \alpha_{104} DmH1_{it} + u_{15it} \quad (15)$$

$$lnGDP_{it} = \alpha_{105i} + \alpha_{106} lnGCF_{it} + \alpha_{107} lnLF_{it} + \alpha_{108} Inf_{it} + \alpha_{109} H3_{it} + \alpha_{110} DhH3_{it} + \alpha_{111} DmH3_{it} + u_{16it} \quad (16)$$

$$lnGDP_{it} = \alpha_{112i} + \alpha_{113} lnGCF_{it} + \alpha_{114} lnLF_{it} + \alpha_{115} Inf_{it} + \alpha_{116} J3_{it} + \alpha_{117} DhJ3_{it} + \alpha_{118} DmJ3_{it} + u_{17it} \quad (17)$$

Note:

GDP = Economic Growth (million USD); GCF = Public Investment (million USD); LF = Labor Force Population (person); Inf = Inflation (annual percent); NRI = Digital Readiness Index (index 1-7); B7, E3, E4, F2, F3, F4, F5, A1, A4, A5, B2, B9, G6, H1, H3, J3 = NRI individual indicator variables (index 1-7), DhNRI = interaction dummy variable between NRI and countries high income (1 =country high income, 0 = other country), DmNRI = interaction dummy variable between NRI and country middle income (1 =country middle income, 0 = other country); u, v = error term; i = country; i = 1, 2, 3, …, 105; t = year; t = 1, 2, 3, 4.

A model that uses the individual indicators forming the NRI as the independent variable is made separately in sixteen models with one model and one individual indicator. This is because the correlation between the individual indicator variables that make up the NRI (especially those in one principal component group according to the results of the PCA) is very high so that the results are mostly insignificant.

III. Result and Discussion

3.1 Impact the Readiness Digital toward Economic Growth

Model 1 produces R2 (overall) is quite good at 0.9640, which means 96.40 percent of the diversity of endogenous variable of economic growth (GDP) can be explained by the variables in the model, while the rest only by 3.60 percent which is explained by other variables outside the model. The estimation results of the variables that are thought to affect economic growth show that all variables have a significant effect with a confidence level above 95%. The results of regression model 1 can be seen in Table 3.

From model 1 it is known that the model equation becomes as follows:

$lnGDP_{it} = -\ 0.503_i + 0.539lnGCF_{it} + 0.432lnLF_{it} - 0.007Inf_{it} - 0.354NRI_{it} + 0.443DhNRI_{it} + 0.271DmNRI_{it}$

Dh = 1 and Dm = 0 → High-Income Countries

$lnGDP_{it} = -\ 0.503_i + 0.539lnGCF_{it} + 0.432lnLF_{it} - 0.007Inf_{it} + 0.088NRI_{it}$

Dh = 0 and Dm = 1 → High-Income Countries

$lnGDP_{it} = -\ 0.503_i + 0.539lnGCF_{it} + 0.432lnLF_{it} - 0.007Inf_{it} - 0.083NRI_{it}$

D1 = 0 and D2 = 0 → High-Income Countries

$lnGDP_{it} = -\ 0.503_i + 0.539lnGCF_{it} + 0.432lnLF_{it} - 0.007Inf_{it} - 0.354NRI_{it}$

Table 3. Regression Analysis Results on Model 1 (NRI on Economic Growth)

Dependent Variable (lnGDP)	Coefficient	z	p > |z|
lnGCF	0.5387996***	21.51	0.000
lnLF	0.4318088***	13.08	0.000
Inf	-0.0067397***	-4.23	0.000
NRI	-0.354181**	-5.44	0.000
DhNRI	0.4426586***	8.15	0.000
DmNRI	0.2712866**	5.50	0.000
Constanta	-0.5030573	-1.29	0.198
R-sq	0.9640		

Note:
****Significant at 1% significance level, **Significant at 5% significance level, *Significant at 10% significance level*

Variables GCF (public investment) and LF (labor) have a significant effect on increasing economic growth. On the other hand, the inflation rate variable (inflation) affects reducing economic growth. Digital readiness (NRI) has a significant effect on increasing economic growth only in high-income countries but has a significant effect on reducing economic growth in middle and low-income countries.

The public investment significantly increases economic growth according to the theory Y = C + I + E – M, where economic growth (Y) is influenced by the level of consumption (C), the amount of investment (I), and the net between exports (E) and imports (M). Following the positive sign, the amount of investment should increase economic growth. From the above equation, if public investment increases by 1%, economic growth will increase by 0.539%. Furthermore, Okun's Law assumes that the unemployment rate can serve as a variable substitute for the number of workers (LF) employed in the economy. According to Mankiw (2006), Okun's Law explains that the unemployment rate has a negative relationship with real GDP. Thus the number of workers (LF) means that it is positively related to real GDP. The regression results show that if the number of workers increases by 1%, then economic growth will increase by 0.432%.

Variable Inf (inflation) has a significant negative effect or reduces economic growth. Keynesian theory says that in the short term and increase in aggregate prices will increase output and increase economic growth, but in the long term a high inflation rate will cause people's purchasing power to decrease, aggregate consumption to decline, investment and government spending will also fall so that eventually it will decrease. reduce economic growth. The regression results show that every 1% inflation increases, economic growth will decrease 0.7%.

The influence of the NRI (digital readiness) variable on the three groups of state income is read together with the dummy variable. The effect of this digital readiness variable proved to be significantly different in high, middle, and low-income countries. In high-income countries, NRI significantly increases economic growth, every 1 point increase in the NRI index will increase economic growth by 8.8% (sum of elasticity of NRI coefficient + DhNRI coefficient). However, in middle-income and low-income countries, NRI has a significant negative effect or can reduce economic growth. Every 1 point increase in the NRI index will reduce economic growth by 8.3% (the sum of the elasticity of the NRI coefficient + the DmNRI coefficient) in middle-income countries and reduce economic growth by 35% (only the elasticity of the NRI coefficient because Dh and Dm are zero) in low-income countries. The neoclassical theory of economic growth by Solow says that economic growth (Y) is influenced by capital (K) and labor efficiency (AN) obtained from the entry of new technologies. Labor efficiency will result in increased productivity. Thus the inclusion of technology that will increase the productivity of workers only has a positive impact on economic growth when offset by a factor of capital (capital) are adequate labor factors(labor)that have the skills to operate the digital technology. In high-income countries, capital is abundantly available, the workforce is also most highly educated, so the entry of digital technology will undoubtedly increase economic growth. But in middle-income countries, especially low-income countries, the lack of capital factors and low skills labor will cause the entry of digital technology to not be matched by an increase in productivity, which in turn will reduce economic growth.

Research conducted by Yousefi (2011) concluded that ICTs played a major role in the growth of the high- and upper-middle-income countries, but failed to contribute to the growth of lower-middle-income countries. Kimenyi and Moyo (2011) say that the lack of investment in technology in Africa leads to serious market and government failures, African governments should invest in improving the business climate and regulatory environment, should also invest in infrastructure to utilize and gain proper access to new technologies, and it is also very important to increase investment in research and extension services to improve access to information. Sulong and Albiman (2016) prove that by using nonlinear effect analysis, mass penetration of ICT proxies in Sub-Saharan Africa (SSA) countries slows economic growth. Threshold analysis shows that the penetration rate threshold of 4.5 percent for cellular phones and the internet, and 5 percent for fixed-line lines, can only trigger economic growth. Wamboye et.al (2015) show that fixed telephone and cellular technology have a positive and significant impact on labor productivity growth, but only after the penetration rate reaches a certain critical mass. Increasing access to fixed telephone and cellular communications technology by 10 percentage points will reduce annual productivity growth by between 3% and 4% over the next 3 years. However, doubling the access will increase the annual growth by 0.12% - 0.15% for fixed-line and 0.05% for cellular. The presence of this network effect also explains why internet usage, which is still relatively low in SSA, does not show a significant effect on growth.

Table 4. Summary of NRI Indicators Coefficients in Model 2-17 (NRI Indicators on Economic Growth)

16 NRI Indicator Variables	Coefficient of Regression Model 2 - 17		
	High Income	Middle Income	Low Income
B7 (Tertiary education enrollment rate)	0.0806179***	-0.034369***	-0.500781***
E3 (Secondary education enrollment rate)	0.0648616***	-0.0420387***	-0.224008***
E4 (Adult literacy rate)	0.125726***	0.0231509***	-0.0817422**
F2 (Individuals using internet)	0.0808448***	-0.0319981***	-0.388649***
F3 (Households with personal computer)	0.0577344***	-0.055298***	-0.5845997***
F4 (Households with internet access)	0.0345795***	-0.0433673***	-0.4461081***
F5 (Fixed broadband internet subscriptions)	0.0467666***	-0.0626707***	-0.9438834***
A1 (Effectiveness of law-making bodies)	0.0810537***	-0.0688108***	-0.2366109***
A4 (Efficiency of legal framework in settling disputes)	0.1146621***	-0.0525262***	-0.2247459***
A5 (Efficiency of legal framework in challenging regulations)	0.123789***	-0.029529***	-0.1772902***
B2 (Venture capital availability)	0.0854928***	-0.0808738***	-0.2985762***
B9 (Government procurement of advanced technology products)	0.1821313***	-0.0028264***	-0.1937342***
G6 (Extent of staff training)	0.1247824***	-0.0461651***	-0.2379326***
H1 (Importance of ICTs to government vision of the future)	0.1532625***	-0.0010343***	-0.2014155***
H3 (Government success in ICT promotion)	0.1767633***	0.0135949***	-0.1266594***
J3 (ICT use and government efficiency)	0.1765147***	0.0188124***	-0.16514***

Note:
****Significant at 1% significance level, **Significant at 5% significance level, *Significant at 10% significance level%.*

For the next 16 models (model 2 to model 17) is a model in which each model uses the independent variables GCF, LF, and Inf plus one NRI individual indicator variable and the interaction dummy variable from the NRI indicator variable used. The aim is to see the difference in the effect of each NRI indicator used in high, middle, and low-income countries on economic growth. Each indicator contributes to increasing digital readiness in a country, so every increase in the index of these indicators will increase the digital readiness of the country concerned. A summary of the NRI indicator coefficients in models 2–17 is in Table 4.

In high-income countries, all NRI indicator variables have a significant positive effect on economic growth. The three indicators that have the greatest influence relate to aspects of government support, namely B9 (Government procurement of advanced technology products), H3 (Government success in ICT promotion), and J3 (ICT use and government efficiency). Indicator B9 (Government procurement of advanced technology products) is an assessment based on a survey to assess the extent to which purchasing decisions are made by the government to procure technology products. The regression results show that if the B9 index increases by 1, which means the government increases its decision to procure high-technology products, then economic growth will also increase by 18.21%. The H3 indicator (Government success in ICT promotion) is an assessment based on a survey to assess how successful a country's government is in promoting the use of ICT. The regression results show that if the H3 index increases by 1, it means that the government is further promoting the use of ICT, then economic growth will also increase by 17.68%. Indicator J3 (ICT use and government efficiency) is an assessment based on a survey to assess the extent to which the use of ICT by the government can improve the quality of government services to its citizens. The regression results show that if the J3 index increases by 1 or it means that the quality of government services increases due to the use of ICT, then economic growth will also increase by 17.65%.

In middle-income countries it is slightly different from the results of the NRI composite index regression on economic growth which has a negative effect, it turns out that if the NRI index is dissected, 3 indicators have a significant positive effect or increase economic growth, namely the skill aspect E4 (Adult literacy rate), there are two aspects of government support, namely H3 (Government success in ICT promotion) and J3 (ICT use and government efficiency). Indicator E4 (Adult literacy rate) calculates the number of adults (population aged > 15 years) who can read and write by understanding short and simple statements about their daily lives. The regression results show that if the E4 index increases by 1 (or means that the percentage of adults who can read and write increases by 11.47%) then economic growth will increase by 2.31%. As in high-income countries, if the J3 index increases by 1 or means that the quality of government services increases due to the use of ICT, then economic growth in middle-income countries will increase by 1.88%. Meanwhile, if the H3 index increases by 1 or the government promote more ICT promotion, economic growth in middle-income countries will increase by 1.36%.

The opposite condition occurs in low-income countries, where the 16 indicator variables forming the NRI have a significant negative effect or will reduce economic growth. This is in line with model 1 where the NRI composite index also hurts economic growth in low-income countries. This means that every increase in the index of each of these NRI indicators will reduce economic growth.

IV. Conclusion

The results of the regression analysis to see the relationship between the digital readiness (NRI) and economic growth (GDP) show that the NRI has a significant effect on these macroeconomic variables. NRI has a significant positive effect on GDP in high-income countries, in the sense that it can increase the GDP of high-income countries. However, NRI has a significant negative effect or will reduce GDP in middle and low-income countries. The decline was greater in low-income countries than in middle-income countries. Readiness digital can not directly increase economic growth, as seen in middle-income countries and low, this is because economic growth is influenced by other very important factors, such as capital and skill (ability) of adequate human resources that are not owned by middle-income countries and low.

Regression analysis of 16 NRI indicators on three macroeconomic variables gives different results. In high-income countries, the NRI indicators that have the greatest influence on increasing GDP are B9 (Government procurement of advanced technology products), H3 (Government success in ICT promotion), and J3 (ICT use and government efficiency). In middle-income countries, although the NRI composite index reduces GDP, 3 NRI indicators have a significant effect on increasing GDP, namely E4 (Adult literacy rate), H3 (Government success in ICT promotion), and J3 (ICT use and government efficiency).

Suggestions

1. The digital readiness (NRI) has been proven to significantly increase economic growth in high-income countries while reducing economic growth in middle and low-income countries. To make better use of digital technology to increase economic growth, the governments of middle and low-income countries must strengthen capital and human resources (labor factors). Strengthening the capital factor by developing ICT infrastructure, facilitating access to investment, opening doors for foreign investors, increasing economic and technological cooperation between countries, especially with high-income countries. Improving the quality of human resources through the provision of various training, both hard skills and soft skills, training in operating computer hardware and software, increasing educational scholarships, improving the education system, and implementing equal distribution of education to villages.
2. Based on the analysis of NRI indicators that have the most influence on economic growth, the governments of each country should:
   - High-income countries

     Continue to increase aspects of government support, especially increasing the procurement of high technology (by increasing support for activities research and development that can lead to new technologies, increasing the allocation of funds/budgets for research and development, increasing cooperation in the procurement of high technology among developed countries (eg. OECD countries), increasing ICT development programs in government work programs, promoting ICT promotion in the country, continuing to monitor the use of ICT in the framework of the efficiency of government work programs.
   - Middle-income countries

     Improve aspects of government support as well, especially in terms of promoting the promotion of ICT in the country, monitoring the use of ICT in the framework of the efficiency of government work programs. In addition, it also improves the ability and skills of human resources by facilitating access to education from basic education (reading and writing) to higher education.

     The recording of digital transaction data (including e-commerce transactions) for each country needs to be done immediately. The completeness of this data will facilitate research on digitalization in each country to produce more government policies in each country applicable.

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