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Research Paper

The Role of ICT and Human Capital Development in Pursuing a Demographic Dividend and Improving Economic Welfare in Indonesia

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Abstract

This article aims to provide evidence that Information and Communication Technology (ICT) and human development play an important role in pursuing a demographic dividend and accelerating economic welfare in Indonesia by exploiting provincial data from 2012 to 2017. The empirical evidence implemented in this research is Two-Stage Least Squares and dynamic system Generalized Method of Moments (GMM) techniques. The results show that a 1%-point rise in ICT development growth potentially leads to an approximately 0.24%-point increase in economic welfare growth, whereas an in life expectancy may decrease GDP per capita. The analysis also finds that a 1%-point increase in the ratio of the participation rate will promote a nearly 0.16%-point rise in per capita output. Meanwhile, a 1%-point increase in the share of the working-age population will generate roughly 0.19%-point rise in per capita income. A recent paper suggests that policymakers have to promote more supportive ICT and human development policies to pursue a demographic dividend since even though they have a positive impact on per capita income, the magnitude remains relatively low.

Keywords: ICT, Human Development, Demographic Dividend, Economic Welfare.

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1. Introduction

The present paper examines the critical role that Information and Communication Technology (ICT) and human development may have in pursuing a demographic dividend, which in turn accelerates the country's standard of living. The motivation of the article is to try to follow the analysis of Cruz and Ahmed (2018) whose analytical framework is based on the decomposition theory of Bloom & Canning (2005) and Bloom & Finlay (2008). In their work, Cruz and Ahmed (2018) underlined the potential endogeneity issues in the previous research. They, therefore, proposed the application of the system General Method of Moments (system-GMM) as an econometric tool to analyze the impact of demographic changes on the growth of Gross Domestic Product (GDP) per capita and poverty.

Their work is similar to the work presented in this article in the attempt to relate demographic changes to economic growth. However, the present analysis deviates from what Cruz and Ahmed (2018) have done in two aspects. While their work assumes that the growth of participation rate is constant, the present work sheds the assumption by trying to estimate the coefficient of that variable in the decomposition as well. Secondly, due to the scarcity of literature, this paper focuses on a single country analysis to obtain more comprehensive findings.

Other novelties that are different from previous papers (Baerlocher et al., 2019; Choudhry & Elhorst, 2010; Liu & Hu, 2013; Mason et al., 2016; Misra, 2017; Wongboonsin & Phiromswad, 2017) are the two main insights. Firstly, the paper addresses endogeneity problems with two simulations. Treating only one variable that suffers from endogeneity issues will be the first simulation and treating all variables as suspected endogenous is the other simulation. The first simulation treats ICT development as an endogenous one and determines human capital development indicators as instrumental variables for it. ICT development becomes one of the determinants of the output per worker variable decomposed by Bloom & Canning (2005). Meanwhile, the second simulation treats all regressors as predetermined variables or to be suspected endogenous by adopting a dynamic system-GMM technique. The estimation method allows the lagged dependent variable to be one of the regressors in addition to other independent variables.

Another new insight from this paper is the exploitation of the ICT Development Index (IDI). IDI is a more comprehensive measurement of ICT or technology development indicator that is less frequently used since it is relatively new. The ICT proxies broadly used in the previous research are mobile phone subscriptions, internet adoption and penetration, and fixed broadband subscriptions. Including an ICT development indicator in the analysis is extremely necessary as its role in improving output per worker is incredible. As found by R. Solow, technical progress contributed to more than 80% of the growth in output per worker hour in the USA during the 1909-1949 period (Dornbusch et al., 2011).

The research takes Indonesia as the sample. Indonesia is currently experiencing a demographic transition. The number of the working-age population in Indonesia has continued to increase significantly, whereas the dependency ratio has been gradually decreasing recently. Based on recent data, the dependency ratio of Indonesia has been below 50% since 2012, and the projection shows it will continue to decline until it reaches its lowest point in 2028-2031 (Kementerian PPN/Bappenas, 2014). This demographic change economically benefits the country since it creates many more opportunities, meaning that it becomes a demographic dividend. A research conducted by Bloom and Finlay (2008) claims that an increase in the working-age population contributed to around 40% of output growth in Indonesia from 1960 to 2005 (the Assistance Team for Fiscal Decentralization, the Ministry of Finance the Republic of Indonesia, 2011). Moreover, many East Asian countries such as China, Japan, and South Korea also enjoyed it during 1960-1990 (Bloom et al., 1999; Bloom & Finlay, 2008). They have succeeded in taking advantage of the demographic changes to become a demographic bonus so that it becomes their economic miracles.

Unfortunately, when demographic shifts take place, demographic gains do not automatically arise (Bloom et al., 2011). A country can seek a demographic dividend by promoting a set of supportive policies for example, improving human capital. To pursue that dividend, the government of Indonesia has taken steps focusing on human capital in the National Midterm Development Plan 2015-2019 (Kementerian PPN/Bappenas, 2014). Policymakers, then, continue to set policies in the Government Work Plan 2019

(RKP 2019) and the Technocratic Design of the National Midterm Development Plan 2020-2024 (Kementerian PPN/Bappenas, 2018, 2019). In the RKP 2019, policymakers emphasize heavily two policies, namely human resources and equality across regions (Kementerian PPN/Bappenas, 2018). Another effort to pursue a demographic dividend is enhancing ICT that is also one of the strategic policies in Indonesia (Kementerian PPN/Bappenas, 2014).

This paper aims at examining the role of ICT and human development in helping to pursue a demographic dividend and to improve welfare in Indonesia. By implementing a rigorous analysis, it may yield comprehensive findings, which provide excellent suggestions for future research and valuable recommendations for policymakers, particularly in developing countries which are encountering demographic changes.

The rest of the structure of this article is as follows: Section 2 explores the literature review from previous papers; Section 3 describes the data and methodology; Section 4 discusses the findings; Section 5 presents the conclusions and recommendations; and finally, Section 6 provides the limitations of the research.

2. Literature Review

There are a significant number of researchers that have examined the relationship between ICT development and economic growth, which in turn influences per capita output. For example, Vu (2013) conducted research in Singapore and found that there is a strong positive relationship between the intensity of ICT use and economic output and labor productivity growth. He also concluded that during 1990-2008, the ICT investment contributed around one percentage point to Singapore's GDP (Vu, 2013). Erumban and Das (2016) in India, and Hong (2017) and Hwang & Shin (2017) in Korea also stated that ICT investment has a strong relationship with economic growth. Moreover, Hariani RS (2017) found that the number of internet users has a positive and significant effect on economic growth in Indonesia. These results are also in line with those of multinational study cases such as the research conducted in Asian countries (Das et al., 2016), OIC countries (Aghaei & Rezagholizadeh, 2017), and BRICS economies (Latif et al., 2018).

There are also numerous studies on the relationship between human development and economic output when countries experience demographic change. Most of them conclude that human capital development plays a critical role in improving the countries' welfare. A study by Mason et al. (2016) exemplified those linkages. They claimed that changes in the age-structure of human capital investment over the demographic shifts have a crucial impact on the standard of living (Mason et al., 2016). Taking Brazil as a sample, Baerlocher et al. (2019) also found the same results. They argue that age-structure shifts will have a significant effect on growth rates after controlling human capital, especially the level of education (Baerlocher et al., 2019). That finding strengthens previous research conducted by Wongboonsin and Phiromswad (2017) who revealed that education is a channel through which an increase in the share of middle-aged workers has a positive impact on output growth in developed countries.

Several studies have also revealed how demographic shifts have an impact on per capita output. In 1999, Bloom and Channing examined the relationship between demographic change and output growth in Asia using data between 1965 and 1990. They found that despite the little significance of population growth, the age-structure changes have an incredible impact on growth rates. Additionally, the demographic shifts are a source of economic miracles in East Asian countries since they can be a catalyst for their economies (Bloom et al., 1999; Bloom & Finlay, 2008). Choudhry and Elhorst (2010) presented a similar perspective after examining the links between demographic transitions and economic growth by adopting a Solow-Swan Model from 70 countries over the period 1961-2003. Their main finding is that GDP per capita has a positive association with the working-age population and differences in total population growth (Choudhry & Elhorst, 2010). This finding resembles that of Cruz and Ahmed's (2018) study, that attempted to determine which demographic shifts could influence economic output. The study by Misra (2017) and Fang (2018) also yielded similar results as they scrutinized the links between demographic transition and economic outcomes. Finally, Liu and Hu (2013) concluded that the average annual GDP per capita growth rate of China rose by 1.19 and 0.73 percentage points during 1983-2008.

3. Methodology

3.1 Data

This research uses only secondary data collected from BPS-Statistics Indonesia. The structure of the data is a balanced panel consisting of 33 provinces from 2012 to 2017. The 34th province in Indonesia, North Kalimantan, is excluded from the analysis due to limited data availability as a new province in Indonesia.

The foundation of the analysis relies on the decomposition formulated by Bloom & Canning (2005) and Bloom & Finlay (2008). They attribute demographic change to economic welfare as follows;

$$\frac{Y}{N} = \frac{Y}{L}\frac{L}{WAP}\frac{WAP}{N} \quad (1)$$

In this equation, Y represents aggregate economic output; N indicates the total population of a country; L serves as the total number of labors; and WAP denotes the population of working-age 15-64 years. The left-hand side variables refer to per capita income since the formula divides the output by the total population. The analysis uses per capita income as a proxy for real Gross Domestic Product (GDP) per capita data published by BPS-Statistics Indonesia. To calculate real GDP per capita, each provincial real GDP (GRDP) must be divided by the number of residents in the middle of the year. This paper uses population data based on an official projection also measured by BPS-Statistics Indonesia.

In the meantime, the labor force and the working-age population depict the number of people aged 15-64 years in the societies who actively participate in economic activities and those who do not, respectively. That decomposition explains that GDP per capita ($\frac{Y}{N}$) equals productivity per labor growth ($\frac{Y}{L}$) times the participation rate ($\frac{L}{WAP}$) times the share of the working-age population ($\frac{WAP}{N}$).

Taking the natural logarithm on both sides of the equation (1), it yields:

$$\text{Log}\,\frac{Y}{N} = \text{Log}\,\frac{Y}{L} + \text{Log}\,\frac{L}{WAP} + \text{Log}\,\frac{WAP}{N} \quad (2)$$

Equation (2) above can be written as follows;

$$G_y = G_{opw} + G_{pr} + G_{swap} \quad (3)$$

Assuming that the growth in output per worker is a function of X variables, such that G_{opw} = a + bf(X), the final equation becomes:

$$G_y = a + bf(X) + G_{pr} + G_{swap} + \varepsilon \quad (4)$$

where ε is the error term.

The present analysis implements two indicators for measuring the growth of output per worker. Those indicators are ICT development and human development since it is undeniable that they significantly affect the output per worker growth. For example, a 2013 study conducted by Vu (2013) found that the intensity of ICT use has a strong positive relationship with economic growth and labor productivity growth at the sector level. As mentioned above, the use of the ICT Development Index (IDI) as a proxy of the ICT development indicator is less frequent in literature. This paper aims to fill that gap. The use of IDI may give new insights into literature since it is likely to produce more comprehensive results than those that only exploit individual ICT indicators such as mobile telephone subscriptions, internet subscriptions, or fixed broadband subscriptions.

The IDI comprises three sub-indices, namely ICT access, ICT use, and ICT skills. ICT access sub-index represents the readiness of infrastructure and access to ICT, while ICT use sub-index indicates the intensity level of the usage of ICT in societies. ICT skills sub-index describes the outcome of the efficient and effective use of ICT. BPS-Statistics Indonesia released several years of IDI data used in research whose calculations adopted the measurement of the International Telecommunication Union (ITU). However, for the purpose of completing the series of data, we also recalculated IDI data in the time series when the official agency did not release the data.

Another proxy used to explain the growth in output per worker is human development. Many economists believe that human capital development has a strong contribution to the growth of output per worker so that it leads to the production of much work on economic growth theories incorporating human capital as one of the determinants affecting countries' economic performance (Acemoglu, 2009). Scholars have also widely accepted the use of the Human Development Index (HDI) as a comprehensive measure of human capital development. Therefore, another X variable in this study is HDI. HDI consists of three dimensions, namely life expectancy representing the health level of a country, education dimension depicted by Mean Years of Schooling (MYS) and Expected Years of Schooling (EYS), and per capita consumption as an economic dimension.

A problem may arise when utilizing both IDI and HDI altogether because they both have education variables. For example, IDI has ICT skills, while HDI has MYS and EYS. Therefore, the article avoids employing education dimension twice so that the paper opts to use the overall IDI and only the health dimension of the HDI. Table 1 presents the definitions and summary of the data used in the analysis.

Table 1: Definition and summary of data used in the analysis

Variable	Definition	Measurement Unit	Mean	Std. Dev.	Min	Max
percapgdp	Real GDP per capita	Million Rupiahs	35.82	27.10	10.03	157.64
prate	Participation rate	Ratio	0.68	0.06	0.51	0.92
swap	Working-age population share	Ratio	0.66	0.03	0.53	0.72
idi	ICT Development Index	From 0 to 10	3.80	1.06	1.91	7.61
le	Life expectancy	%	69.09	2.64	63.04	74.74
eys	Expected years of schooling	Years	12.50	0.89	9.11	15.42

Source: Author's computation, 2020.

3.2 Econometric Model

Empirical evidence is used in this research to scrutinize the relationships between demographic change variables, ICT and human development variables, and economic welfare formulated in the equation (4) above. The analysis implements two econometric strategies, namely Two-stage Least Squares (2SLS) and the dynamic system Generalized Method of Moments (GMM) developed by Arellano-Bond (1991), Arellano-Bover (1995), and Blundell-Bover (1998).

In the 2SLS specification, the analysis attempts to estimate equation (4) by implementing instrumental variables. In this case, the suspected endogenous variable is the IDI, meaning that the IDI is correlated with past or contemporaneous disturbances. Meanwhile, the instrumental variables are human development dimensions such as life expectancy and the EYS since the only variable that intersects with IDI is MYS. The specification based on 2SLS is as follows:

$$lpercapGDP_{i,t} = \alpha + \beta_1 lprate_{i,t} + \beta_2 lswap_{i,t} + \beta_3 lidi_{i,t} + \beta_4 lle_{i,t} + \eta_i + \varepsilon_{i,t} \quad (5)$$

In this equation, *lpercapGDP* is the natural logarithm value of per capita income of province *i* at period *t*; α is a constant term; $lprate_{i,t}$ depicts the participation rate; $lswap_{i,t}$ is working-age population share; $lidi_{i,t}$ represents the overall IDI value; and $lle_{i,t}$ indicates the life expectancy of province *i* at period *t*. Finally, η_i and $\varepsilon_{i,t}$ serve as province-specific effects and disturbances.

As in the Ordinary Least Squares (OLS), the 2SLS technique also has diagnostic tests, namely endogeneity test and over-identification restriction test (OIR test). Since the 2SLS estimator can have an extremely high standard error compared to the OLS estimator, it is crucial to test whether the use of the technique is necessary (Wooldridge, 2013). The test, then, principally compares the estimators produced from those techniques. The basic principle of the endogeneity test lies in the significance of the difference between the estimators from 2SLS and OLS. Wooldridge (2013) stated that if the difference is statistically insignificant, the OLS is the best estimation and vice versa.

Another diagnostic test is the OIR test. As external instrumental variables are available and they outnumber the endogenous variable and satisfy the minimum rank condition, it is possible to test whether or not some of them are uncorrelated with the structural error. Since the analysis uses two external instrumental variables (LE and EYS) while only having one endogenous variable (the IDI), it is possible to do the OIR test and come to a conclusion whether instrumental variables proposed in the specification are valid. The OIR test used in the paper is the Hansen test or J-statistics test.

In the meantime, the purpose of using the dynamic system GMM is to provide another insight into the analysis. As claimed by Roodman (2009), the motivation for using the dynamic system GMM is for the following situations: the data has a few periods and a large number of individuals; there is a linear functional relationship; there is a lagged dependent variable as regressors; the regressors are not strictly exogenous; there are fixed effects; there are heteroskedasticity and autocorrelation within individuals.

In the dynamic system GMM, the analysis introduces a lagged dependent variable as also one of the regressors on the right-hand-side variables. Therefore, there will be a one-period lagged per capita income variable in the independent variable lists. The paper only includes one-period lag of GDP per capita since it follows the work of Asongu and Odhiambo (2019).

The model specifications both in level (equation 1) and first-difference (equation 2) are as follows:

$$lpercapGDP_{i,t} = \alpha + \beta_1 lpercapGDP_{i,t-1} + \beta_2 lprate_{i,t} + \beta_3 lswap_{i,t} + \beta_4 lidi_{i,t} + \beta_5 lle_{i,t} + \eta_i + \mu_t + \varepsilon_{i,t} \quad (6)$$

$$lpercapGDP_{i,t} - lpercapGDP_{i,t-1} = \alpha + \beta_1(lpercapGDP_{i,t-1} - lpercapGDP_{i,t-2}) + \beta_2(lprate_{i,t} - lprate_{i,t-1}) + \beta_3(lswap_{i,t} - lswap_{i,t-1}) + \beta_4(lidi_{i,t} - lidi_{i,t-1}) + \beta_5(lle_{i,t} - lle_{i,t-1}) + (\mu_t - \mu_{t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \quad (7)$$

i = 1, 2, … 33; and t = 2, 3, … T.

The variables are mostly the same as those in equation (5) above. The difference is only in the existence of μ_t that represents a time-specific constant to cover the time variation. The use of the time dummies is for making the assumption more likely to hold (Roodman, 2009). The analysis applies orthogonal deviations to maximize the sample size, rather than the difference transformation.

The research considers that all the regressors are predetermined, whereas, for time-invariant variables, the analysis treats them as strictly exogenous variables. It follows what Asongu and Odhiambo (2019) did when examining the relationship between ICT and income inequality in 48 African countries between 2004 and 2014. Roodman (2009) argued that time-invariant is unlikely to be endogenous after a first-difference transformation.

As in OLS and 2SLS, there are also specification tests for testing whether the specification is correct. In GMM estimation, there are two specification tests, namely the Sargan/Hansen test for examining the validity of instrumental variables used in the model, and serially uncorrelated error test exploiting AR(1) and AR(2) . Following Cameron and Trivedi (2009), the serially uncorrelated test has to reject the null hypothesis at order one and accept the null hypothesis at order two and higher.

Another specification test is the Sargan/Hansen test. This test functions to examine the over-identification restrictions (OIR), determining whether or not the population moment conditions are appropriate. The Sargan/Hansen test must not reject the null hypothesis stating that over-identifying restrictions are valid.

4. Results and Discussions

Equation (4) describes the relationship between GDP per capita growth equal to the sum of the growth of output per worker (ICT and human development), the growth in participation rate, and the growth in the share of the working-age population. On the other hand, there are also two X variables reflecting the growth of productivity per labor ($\frac{Y}{L}$), which are the ICT Development Index (IDI) and the health dimension of the Human Development Index (HDI), namely Life Expectancy (LE). As explained, the analysis began by examining equation (4) by applying Two-stage Least Squares (2SLS) and then continued with the implementation of the dynamic system GMM developed by Arellano-Bond (1991), Arellano-Bover (1995), and Blundell-Bover (1998). Table 2 provides the results of the 2SLS strategy, while table 3 illustrates the output of the dynamic system-GMM technique.

4.1 ICT, Human Development, and Economic Development

The role of ICT development in significantly improving welfare is undeniable. Table 2 depicts the results of adopting the 2SLS strategy with AR(1) error for dealing with no serial correlation assumption (Wooldridge, 2013, p. 540). According to the estimation, ICT development strongly affects economic prosperity as measured by GDP per capita. The effect is positively significant, implying the crucial role of ICT in generating the country's income. In other words, every 1%-point increase in ICT development growth can possibly lead to an approximately 0.24%-point increase in economic welfare growth. The finding is in line, both in sign and in magnitude, with the results of a research conducted by Vu (2013) in Singapore during 1990-2008. However, this analysis estimates in different accounting, whereas Vu (2013) analyzed the linkage in level accounting.

In the 2SLS estimation strategy, Life Expectancy (LE) and Expected Years of Schooling (EYS) are external instrumental variables for ICT Development Index (IDI) in addition to participation rate (PR) and working-age population share, which serve as internal instrument variables for themselves. In the specification, therefore, the IDI is endogenous, while PR and SWAP are exogenous. It may be well-accepted that the development of ICT depends on the human development of the country. There are a significant number of human development indicators, but this paper utilizes the health dimension and one of the education dimensions, namely LE and EYS, with the reasons explained in the previous section.

Table 2. Estimation of the GDP per capita growth by applying 2SLS strategy

No	Variables	Coefficient	t-Statistic	p-value
1	C	3.2296	0.1729	0.0000
2	LOG(PRATE)	0.0756	0.0541	0.1647
3	LOG(SWAP)	0.0716	0.0683	0.2961
4	LOG(IDI)	0.2372	0.0902	0.0096
5	AR(1)	0.7825	0.1271	0.0000
Adj R-squared		0.9987	Instrument rank	41
Durbin-Watson stat		2.2653	F-statistic	4999.6
Prob(J-statistic)		0.1474	Prob(F-statistic)	0.0000

Source: Author's computation, 2020.

The difference is indeed significant compared to the IDI estimate in table 3 since they are different in the transformation processes. The 2SLS technique uses AR(1) coefficient estimated in table 2 for its transformation, while the system GMM uses AR(1) which equals one in its transformation process. Nonetheless, IDI variables are positively significant both in table 2 and in table 3 (Model 2 and Model 3), meaning that the effect is robust in both specifications.

Table 3. The effect of ICT and human development on economic welfare by adopting the dynamic system-GMM technique
Dependent Variable – lpercapgdp

	(1) M1	(2) M2	(3) M3
L.lpercapgdp	**0.9821***	**0.9691***	**0.9749***
	(0.000)	(0.000)	(0.000)
lprate	**0.1552***	**0.1593***	**0.1333***
	(0.000)	(0.000)	(0.000)
lswap	**0.1810***	**0.1909***	**0.1642***
	(0.000)	(0.000)	(0.000)
lidi		**0.0207***	**0.0706***
		(0.063)	(0.000)
lle			**-0.5300***
			(0.000)
constant	0.0000	0.2480***	0.0000
	(.)	(0.000)	(.)
Time-specific effect	Yes	Yes	Yes
N	165	165	165
j	23	29	35
ar1p	0.0879	0.0807	0.0876
ar2p	0.2566	0.2516	0.1931
sarganp	0.0000	0.0000	0.0000
hansenp	0.1720	0.4213	0.6048
F_p	0.0000	0.0000	0.0000

p-values in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Source: Author's computation, 2020.

Based on table 3, one of the human development dimensions, namely life expectancy, negatively influences per capita output. Its significance is remarkably high at 1% significance level, meaning that an increase in life expectancy may decline GDP per capita. The reason may be because productivity will plunge as the people or the population grow old. It also implies that younger people tend to be more productive since they may contribute more to economic activities. Since the overall IDI includes the educational level of societies, which is in the ICT skills sub-index, and the estimate is also positively significant, in line with that, the development of humans will also become positive and significant. These findings are in line with the analysis of Cruz & Ahmed (2018) who concluded that improving human development such as increasing school attainment ratio and reducing teenage pregnancies has a critical role in fostering per capita income since it can reduce the fertility rate.

The analysis recommends policymakers to take steps while Indonesia is encountering a demographic change. For example, the government can prioritize enhancing the level of ICT development, creating much more employment to absorb the productive age population, and providing great support for everyone, especially women, who wish to participate in economic activities.

4.2 Pursuing a Demographic Dividend

Demographic dividend is a condition when the number of the working-age population rises, leading to a plunge in dependency ratio. When an abundant working-age population contributes more to economic output and welfare, this shift refers to the terms demographic dividend and demographic disaster the other way around. Therefore, it is necessary to examine whether the booming working-age population happening in Indonesia is a demographic dividend or not.

The effect of demographic change as represented by the rate of participation and the share of working-age population on a country's welfare is positive and significant. It implies that the country's labor market can absorb the abundant working-age population and give opportunities to participate in the development. This will potentially lead to higher prosperity, meaning that the country is pursuing a demographic dividend. Even though the estimation of both the 2SLS and the dynamic system-GMM techniques is quite complicated in its interpretation due to the transformation processes, both the sign and magnitude are in line with previous research. For example, Cruz & Ahmed (2018) find that a 1%-point increase in the share of the working-age population induces a 1.6%-point increase in per capita output growth.

The growth of participation rate significantly contributes to the growth of per capita output. A 1%-point increase in the ratio of the participation rate will promote a nearly 0.16%-point rise in GDP per capita. Meanwhile, a 1%-point increase in the share of the working-age population will generate roughly 0.19%-point increase in per capita income. Both analyses in the 2SLS and the dynamic system-GMM produce relatively the same estimates either in the sign or the magnitude so that they indicate that those estimations are robust.

Even though the SWAP variable has a positive effect on per capita income, the impact remains relatively low. It implicitly shows that the abundant working-age population has not yet been maximized by the country. Previous studies have concluded that the magnitude is around 1.4-2% point (Bloom & Canning, 2005; Bloom & Finlay, 2008). Thereby, policymakers can regulate more supportive policies to make the working-age population participate more actively in the labor market. The policies should encourage more people to participate in economic activities such as inviting women to be involved in the economy. The government must ensure that they can provide much more employment to absorb the abundant working-age population and assure the stability of the labor market.

4.3 Robustness Checks

In the 2SLS technique, this paper implements the 2SLS with AR(1) error strategy to cope with the potential of no serial correlation assumption issues. Wooldridge (2013, p. 539) states that as in the OLS case, it is challenging to satisfy no serial correlation assumption. Using AR(1) is an alternative to address the autocorrelation assumption violation. There is also EYS, in addition to LE and other exogenous regressors, in the instrumental variables with the hope of holding an Overidentifying Restrictions (OIR) test. As explained, the 2SLS can only test the OIR as it has enough rank conditions.

The probability of J-statistics is 0.1474 that outnumbers the significance level of 5%. We then fail to reject the null hypothesis stating that a set of instrumental variables (41 instruments rank) that the analysis proposes is valid. The model is in accordance with the adjusted R-squared of 99.87%, meaning that the variance of the independent variables explains the 99.87% variation in per capita income.

In the meantime, specification tests of a dynamic system-GMM estimation method consist of serially uncorrelated error assumption and OIR test. Table 3 has shown a result of AR(1) and AR(2) probabilities; for example, in Model 3, the p-values of AR(1) and AR(2) equal 0.0876 and 0.1931 respectively, which means that the serially uncorrelated error assumption spplird. Finally, in contrast to the Sargan test that rejects the hypothesis stating that the instrumental variables are correct, the Hansen test accepts null-hypothesis and concludes that the instrumental variables used in the analysis are appropriate.

5. Conclusions

Rapid demographic transitions can be beneficial to Indonesia due to the abundance of working-age societies. The productive working-age population can lower the level of dependency ratio, leading to demographic dividends. This does not occur automatically, but it needs a set of strategic policies that take this phenomenon into considerations. Some of those policies are improvement in human capital and enhancement of ICT development.

The article is to provide a shred of evidence to prove the crucial role of ICT and human development on societies' welfare. The paper follows the work of Cruz and Ahmed (2018) whose analysis adopts the decomposition theory of Bloom & Canning (2005) and Bloom & Finlay (2008). That final decomposition depicts that per capita output growth comprises the growth of participation rates, the share of working-age population growth, and productivity per labor growth, which are represented by ICT and human development.

To deal with endogeneity issues, we have implemented two techniques, namely 2SLS and dynamic system-GMM. In the 2SLS method, we have allowed ICT indicators to be endogenous, and allowed life expectancy and expected years of schooling to be instrumental variables for IDI. In the meantime, we treat all regressors as predetermined variables in the system-GMM estimation.

The analysis finds that a 1%-point increase in ICT development growth can potentially lead to about 0.24%-point rise in per capita income. On the other hand, a rise in life expectancy can decrease the growth rate of GDP per capita as productivity is likely to decline when people grow old. Another dimension of human development is education, which includes IDI, which is the ICT skills sub-index. We, therefore, imply that the estimation is also positively significant due to the positive effect that ICT has on economic welfare.

The demographic change in Indonesia possibly leads to a demographic dividend. The results show that for every 1%-point increase in the ration of the participation rate, the economic welfare will rise by 0.16% point. Meanwhile, a 1%-point increase in the share of the working-age population will generate a roughly 0.19%-point increase in per capita income. These findings are robust since they satisfy the specification tests such as the serially uncorrelated error assumption test and the OIR test.

For policy implications, policymakers should set more policies supporting the working-age population in the labor market. Even though the SWAP variable has a positive impact on GDP per capita, the magnitude remains relatively low. The findings recommend policymakers to first prioritize enhancing the level of ICT development. Second, the government need to assure that the economy creates much more employment to absorb the abundant working-age population to ensure the stability of the labor market. Finally, policies must encourage more people to participate in economic activities such as persuading women to be involved in the economy.

6. Limitations

Future studies should improve the analysis by dividing the ICT Development Index (IDI) into its sub-indices, namely ICT access, ICT usage, and ICT skills. It is recommended that this distribution of ICT be carried out to enrich the analysis of the links between ICT and human development and economic welfare.

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References

Acemoglu, D. (2009). Introduction to modern economic growth. In *Princeton University Press Published*. Princeton University Press.

Aghaei, M., & Rezagholizadeh, M. (2017). The Impact of Information and Communication Technology (ICT) on Economic Growth in the OIC Countries. *Economic and Environmental Studies*, *17*(2), 255–276. https://doi.org/10.25167/ees.2017.42.7 1.

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies*, *58*(2), 277.

Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, *68*(1), 29–51.

Asongu, S. A., & Odhiambo, N. M. (2019). How enhancing information and communication technology has affected inequality in Africa for sustainable development: An empirical investigation. *Sustainable Development*, *27*(4), 647–656.

Baerlocher, D., Parente, S. L., & Rios-Neto, E. (2019). Economic effects of demographic dividend in Brazilian regions. *Journal of the Economics of Ageing*, *14*(April), 100198. https://doi.org/10.1016/j.jeoa.2019.100198

Bloom, D. E., & Canning, D. (2005). *Global Demographic Change: Dimensions and Economic Significance* (Issue 1).

Bloom, D. E., Canning, D., & Malaney, P. N. (1999). Demographic Change and Economic Growth in Asia. In *East Asia* (Issue 15).

Bloom, D. E., Canning, D., & Rosenberg, L. (2011). *Demographic Change and Economic Growth in South Asia* (Issue 67).

Bloom, D. E., & Finlay, J. E. (2008). *Demographic Change and Economic Growth in Asia* (Issue 41).

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, *87*(1), 115–143.

Cameron, A. C., & Trivedi, P. K. (2009). Microeconometrics Using Stata. In *A Stata Press Publication*. Stata Press.

Choudhry, M. T., & Elhorst, J. P. (2010). Demographic transition and economic growth in China, India and Pakistan. *Economic Systems*, *34*(3), 218–236. https://doi.org/10.1016/j.ecosys.2010.02.001

Cruz, M., & Ahmed, S. A. (2018). On the impact of demographic change on economic growth and poverty. *World Development*, *105*, 95–106. https://doi.org/10.1016/j.worlddev.2017.12.018

Das, A., Khan, S., & Chowdhury, M. (2016). Effects of ICT Development on Economic Growth in Emerging Asian Countries. In B. Dey, K. Sorour, & R. Filieri (Eds.), *ICTs in Developing Countries: Research, Practices and Policy Implications*. Palgrave Macmillan. https://doi.org/10.1057/9781137469502

Dornbusch, R., Fischer, S., & Startz, R. (2011). Macroeconomics. In *The McGraw-Hill Companies, Inc.* (Eleventh). McGraw-Hill.

Erumban, A. A., & Das, D. K. (2016). Information and communication technology and economic growth in India. *Telecommunications Policy*, *40*, 412–431. https://doi.org/10.1016/j.telpol.2015.08.006

Fang, C. (2018). Population dividend and economic growth in China, 1978–2018. *China Economic Journal*, *11*(3), 243–258. https://doi.org/10.1080/17538963.2018.1509529

Hong, J. Pyo. (2017). Causal relationship between ICT R&D investment and economic growth in Korea. *Technological Forecasting and Social Change*, *116*, 70–75. https://doi.org/10.1016/j.techfore.2016.11.005

Hwang, W. S., & Shin, J. (2017). ICT-specific technological change and economic growth in Korea. *Telecommunications Policy*, *41*(4), 282–294. https://doi.org/10.1016/j.telpol.2016.12.006

Kementerian PPN/Bappenas. (2014). Rencana Pembangunan Jangka Menengah Nasional 2015-2019: Buku I Agenda Pembangunan Nasional. In *Kementerian PPN/Bappenas*. Kementerian Perencanaan Pembangunan Nasional/Badan Perencanaan Pembangunan Nasional.

Kementerian PPN/Bappenas. (2018). Rencana Kerja Pemerintah Tahun 2019. In *Kementerian PPN/Bappenas*. Kementerian PPN/Bappenas.

Kementerian PPN/Bappenas. (2019). Rancangan Teknokratik Rencana Pembangunan Jangka Menengah Nasional 2019-2024. In *Kementerian PPN/Bappenas*. Kementerian PPN/Bappenas. https://www.bappenas.go.id/id/data-dan...dan.../rpjmn-2015-2019/

Latif, Z., Mengke, Y., Danish, Latif, S., Ximei, L., Pathan, Z. H., Salam, S., & Jianqiu, Z. (2018). The dynamics of ICT, foreign direct investment, globalization and economic growth: Panel estimation robust to heterogeneity and cross-sectional dependence. *Telematics and Informatics*, *35*(2), 318–328. https://doi.org/10.1016/j.tele.2017.12.006

Liu, S., & Hu, A. (2013). Demographic change and economic growth: Theory and evidence from China. *Economic Modelling*, *35*, 71–77. https://doi.org/10.1016/j.econmod.2013.06.041

Mason, A., Lee, R., & Jiang, J. X. (2016). Demographic dividends, human capital, and saving. *Journal of the Economics of Ageing*, *7*, 106–122. https://doi.org/10.1016/j.jeoa.2016.02.004

Misra, R. (2017). Impact of Demographic Dividend on Economic Growth: A Study of BRICS and the EU. *International Studies*, *52*(1–4), 99–117. https://doi.org/10.1177/0020881717714685

Roodman, D. (2009). How to do xtabond2: An introduction to difference and system GMM in Stata. *The Stata Journal*, *9*(1), 86–136.

RS, P. H. (2017). Impact of Icts Development on economic growth in Indonesia. *IOSR Journal of Economics* *and Finance (IOSR-JEF)*, *8*(5), 49–56. https://doi.org/10.9790/5933-0805034956

the Assistance Team on Fiscal Decentralization for the Minister of Finance Republic of Indonesia. (2011). Indonesia's Intergovernmental Transfer: Response on Future Demographics and Urbanization Shifts. In *the Assistance Team on Fiscal Decentralization for the Minister of Finance Republic of Indonesia* (Issue November).

Vu, K. (2013). Information and communication technology (ICT) and Singapore's economic growth. *Information Economics and Policy*, *25*(4), 284–300.

Wongboonsin, K., & Phiromswad, P. (2017). Searching for empirical linkages between demographic structure and economic growth. *Economic Modelling*, *60* (February 2016), 364–379. https://doi.org/10.1016/j.econmod.2016.09.023

Wooldridge, J. M. (2013). Introductory Econometrics, A Modern Approach, Fifth Edition. In *Cengage Learning*. Cengage Learning.