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The impact of ICT on regional economic growth:
Empirical evidence from 34 provinces of Indonesia

By Yudi Adhi Purnama and Hitoshi Mitomo

ABSTRACT

Rapid ICT development in recent decades has attracted substantial consideration from academia. Moreover, many studies suggest the advancement of mobile technology has the substantial effect on development, especially in developing countries. Despite the massive adoption of mobile communication, there is a sparse study on emerging economy. Furthermore, Indonesia as a coastal nation has diverse social and geographical state, which affected the different impact of mobile adoption on the regional economy. In this study, we address the question on the mobile impact of the economy of 34 provinces in Indonesia by exploiting panel data for the 2009-2017 period with fixed effect model. Finding from our study present evidence the mobile adoption has positive relationships with economic growth especially in low-income per capita region. Moreover, we also found province with higher growth has benefited from more extended education level. Another interesting evidence suggests province with lower economic growth experienced higher income per capita. The government, business and society should consider the finding, especially on ICT development at the regional level.

Keyword: Regional Development, ICT, Mobile adoption, economic growth, fixed effect model, Klassen typology

1. Introduction

The purpose of this study is to explore the relationships between mobile telecommunication penetration and its impact on the economic growth in 34 provinces of Indonesia for the year 2009-2017. The importance of technology on economic growth already explored in the neo-classical economy school of taught by Robert Solow in 1956. Moreover, the globalisation as recent phenomena also supported by technology advancement, specifically information and communication technology (ICT). The recent industrial revolution called industry 4.0 placed ICT as the engine of development, making its role irreplaceable.

In Indonesia, the ICT has contributed average 3% to GDP with 10% average growth, surpassing national growth (BPS, 2016b, 2018c, 2018b), and established as meta-infrastructure to support country development (Coordinating Ministry For Economic Affairs, 2011). Viewing the importance of ICT to economic growth, the Government of Indonesia formulated national ICT policy called Indonesia Broadband Plan (IBP) as a blueprint of national ICT development (Bappenas, 2014). Moreover, the higher contribution of consumption sector on economy encouraging the government to issued e-commerce roadmap in 2017, expected to boost in value by 130 billion USD in 2020.

The ICT can take many forms such as a computer, telephone, internet, mobile phone as well as recent broadband and Internet of Things (IoT) development. This study will take mobile phone technology as a

form of ICT based on the consideration of its exponential use compare to another mean of telecommunication (see figure 1). Furthermore, we viewed mobile services as main telecommunication

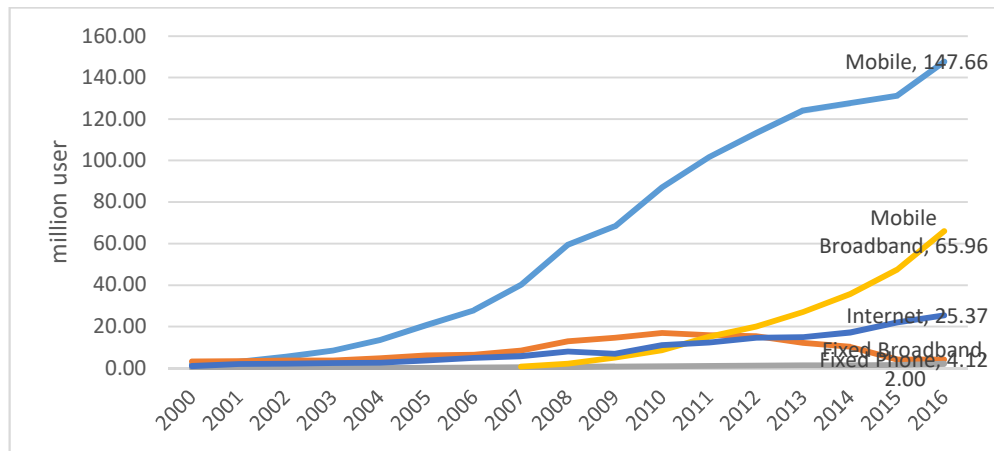


Figure 1. Indonesia Telecommunication User Statistics. From ITU ICT Statistics. Copyright (2018) International Telecommunication Union

backbone for Indonesia population due to national coverage, accessibility and affordability. Finally, challenging geographical condition and scattered population in Indonesia justified mobile services as primary communication tools.

Moreover, we conduct panel data analysis using fixed effect model for 34 provinces in period 2009-2017. The evaluation on the province as a unit of observation justified by imbalance development between regions, presented by the strong economy in Java Island (58.65% of national account) (BPS, 2016a) along with 70% population lived, despite the area only 6% of Indonesia (Kompas.com, 2018). Furthermore, the Klassen Typology implemented before econometric analysis, to measure economic growth pattern among province. Since the regions have different characteristic, the technology affects to economy expected different too.

This paper will be structured as follow; the prior study reviewed in chapter two while chapter three consist of methodology including data and model specification. The result and discussion presented in chapter four and conclusion in chapter five.

2. Related Study

Enormous study present evidence on the positive impact of ICT and economic growth (Gruber, Koutroumpis, Mayer, & Nocke, 2011; Lee, 2011; Lim & Chen, 2012; J. Prieger, 2012; Röller & Waverman, 2001; Vu, 2011; Ward & Zheng, 2016). Moreover, ICT shares a substantial part of national growth and boost productivity in a developed nation (The World Bank, 2013), placing ICT as critical infrastructure for today's economy.

Furthermore, the impact of mobile telecommunication as an ICT technology on economic growth has presented by many researchers. The study by Shiu & Lam (2008) found mobile telecommunication as one of the main supporters of global development in recent years. They also found latecomer (usually emerging economy) has significant advantages on ICT development, as lag experienced due to lack of financial and technological capability, but open the opportunity to implement the latest technology and has significantly benefited by leapfrogging.

According to Waverman et al. (2005), the mobile phone is the answer to lower teledensity in developing countries, while playing counterpart in the advanced one. They also claim mobile telephony has doubled its impact in developing nation, with 10% penetration increase will boost GDP by 0.59%. Moreover, the advanced services such as mobile broadband also have a more significant impact on emerging economy than advanced one (Thompson & Garbacz, 2011). An advanced mobile network such as 3G also claimed has increased GDP per capita by 0.15% for 10% penetration growth (Deloitte, 2012).

The study on APEC members country by Lim & Chen (2012) found telecommunication is substantial to growth as well as physical capital and human capital. Another research by Ghosh (2016) on Indian states from 2001-2012 found a significant impact of cellular to per capita growth. The study also shares the same view with Waverman et al. (2005) where fixed line acts complementary to mobile telephony, and increasing seamless communication capacity.

In contrast, the study by Albiman & Sulong (2017) in 27 sub-Saharan countries found mobile services tend to have an impact toward middle-income country alone, and non-substantial for lower-income countries, share the same view with Prieger (2013) where developing countries only experienced half growth from its OECD partner.

Furthermore, in Indonesian case, mobile penetration growth gap effected on substantial income per capita growth compare to Philippines peer (Waverman et al., 2005), while a study by Deloitte (2012) presented 1.5% growth for ten percentage mobile penetration. Telecommunication sector also attract \$17 billion FDI to Indonesia between 1999-2013 with value added was US\$28 billion in 2013, and forecasted to growth average 9% annually (Tabor & Yoon, 2015). Moreover, Indonesia ICT sector has contributed to 1.186 million jobs in 2016 (BPS, 2017).

The GDP impact from mobile telecommunication consists not only direct effect in telecommunication business in term of investment and employment but also spillover effect on society. For instance, mobile telephony can affect GDP by increasing productivity and efficiency, higher Human Development Index with better education facilitation as well as health and public services. Research by (Kumar, Stauermann, & Samitas (2016) shows mobile communication utilisation increased capital per worker and effected to Total Factor Production (TFP). Moreover, developing countries experienced increasing TFP by 4.2% for ten percentage mobile penetration growth (Deloitte, 2012). Despite productivity increase, the study by (Chew, Vigneswara Ilavarasan, & Levy (2012) found the lags for SMEs to utilise the mobile and increased productivity. They found business need averages two years to experience the significant benefit of mobile exploitation.

In addition to productivity, mobile telecommunication also holds a vital role in increasing efficiency, especially in lowering transaction cost. Research by Spence & Smith (2010) shows mobile technology has encouraged mobile banking development, text-based remittance and mobile ATM, delivering affordable banking services to the significant population. Further development of financial inclusion also helps the poor to access credit as well as saving their income. Furthermore, mobile adoption aid trading activity by lowering transaction and information cost, bypassing intermediaries and propose online marketplace.

The indirect effect of mobile telecommunication also preserves economic growth. The healthcare using ICT or e-health has improved health care (Walsham, 2010), enabling the worker and poor people access affordable services in shorter time, lowering the possibility of decreasing productivity caused by a health problem. Moreover, learning and expertise also helped by technology as education is a requirement to access high skilled and high paying job (Thompson & Garbacz, 2007), increasing employment rate and purchasing power, push demand and production aggregately. The ICT also support institutionalised democracy (Soper, Demirkan, Goul, & St. Louis, 2006) by offering better information access and increase

transparency as well as encouraging people participation, resulted in the stable political environment for growth.

3. Research Methodology

a. Sample and data collection

There are many studies on the relationship of ICT and economic development, from the fixed phone and PCs era to mobile communication, internet and broadband as well. As we concern of the mobile and adoption impact to the economy, this study will measure the relationship between mobile phone penetrations with economic growth for 34 provinces of Indonesia. Moreover, the different economic characteristic between regions will affect the technology utilisation as well as different economic impact.

We choose 2009 as the starting year due to data availability in provincial level. The data collected from Indonesia Telecommunication Statistic book, 2010-2016 edition and Statistic Indonesia Book 2017 edition published by BPS-Statistics Indonesia. The BPS held census on 300.000 households annually, surveying more than 1.2 million people on a different aspect of the economy including telecommunication.

Furthermore, the panel data structured by 34 observations throughout the eight year's period until 2017. The use of panel data will help us to control individual unobserved individual factor (Baltagi, 2013) of the province such as culture, main economic activity or local policies. Moreover, panel data can manage the dataset with different level of analysis such as mobile penetration in individual level while investment and employment at province level.

b. Model specification and variable measurements

We employ a simple macroeconomic production function on panel data proposed by (Thompson & Garbacz, 2011), who formulated aggregate economic growth as a function of investment, labour input, education. The steady state calculation is:

$$GRDPG_{it} = a_0 + a_1GRDPG_{i,t-1} + a_2\logGRDPC_{i,t-1} + a_3\logINV_{it} + a_4LBR_{it} + a_5EDU_{it} + a_6MobProv_{it} + Klassen + \varepsilon_{it} \quad (1)$$

where $GRDPG_{it}$ is the proxy for regional economic growth, as measured by the gross regional domestic product growth rate (in 2010 constant value) of provinces i at time t . $GRDPG_{i,t-1}$ is the lagged value of $GRDPG_{it}$ in 2010 constant value, $\logGRDPC_{i,t-1}$ is log form of lagged value of gross regional growth per capita in 2010 constant value. The lagged value of $GRDPG_{it}$ is beneficial for check the growth pattern constancy while GRDP per capita will demonstrated initial condition between regions. Moreover, \logINV_{it} is the natural logarithm of gross fixed capital formation in 2010 constant value while labour participation rate is proxies for LBR_{it} , and EDU_{it} is mean year of schooling. Finally $MobProv_{it}$ is mobile penetration rate at province i and year t and $Klassen$ is inter-region economy characteristic.

The Klassen typology examined the regional economic development structure and pattern (Aji, 2012; Mardiana, 2012; Mopanga, 2011; Munandar & Winarko, 2015). The typology grouped region by two indicators namely regional economic growth and income per capita. According to this classification,

the region classified in four group namely High growth and high income (HH), high growth but low income (HL), Low growth but high income (LH), and low growth and low income (LL). The matrix of typology presented below.

Table 1. The matrix of Klassen Typology

<i>GRDPCapita</i> (Y) <i>GRDPGrowth</i> (r)	($Y_i < Y$)	($Y_i > Y$)
($r_i > r$)	High growth but low income	High growth and high income
($r_i < r$)	Low growth and low income	Low growth but high income

Note: r is average national GDP growth, Y is average national GDP per capita, while r_i is average province economic growth and Y_i is average income per capita in province i .

Moreover, the equation one conducted with fixed effect model, to control the individual characters from each province. Fixed effect model will help to measure the net effect of the predictor to a dependent variable by removing time-invariant characteristic. We also view this time-invariant characteristic are specific for each province and should not influence another province characteristic.

4. Results and discussion

Our first analysis is classified province by Klassen typology. Table 2 provides empirical evidence of economic development disparity between provinces based on the Klassen typology.

Table 2. Matrix of Klassen Typology for 34 provinces of Indonesia

<p>High growth but low income (HL) Sumatera Utara, Sumatera Barat, Bengkulu, Lampung, Jawa Barat, Jawa Timur, Banten, Bali, Nusa Tenggara Barat, Kalimantan Tengah, Sulawesi Utara, Sulawesi Tengah, Sulawesi Selatan, Sulawesi Tenggara, Gorontalo, Sulawesi Barat, Maluku, Maluku Utara. (<i>eighteen provinces</i>)</p>	<p>High growth and high income (HH) Jambi, Kep. Riau, DKI Jakarta, Kalimantan Utara. (<i>four provinces</i>)</p>
<p>Low growth and low income (LL) Aceh, Sumatera Selatan, Kep. Bangka Belitung, Jawa Tengah, D.I. Yogyakarta, Nusa Tenggara Timur, Kalimantan Barat, Kalimantan Selatan. (<i>eight provinces</i>)</p>	<p>Low growth but high income (LH) Riau, Kalimantan Timur, Papua Barat, Papua. (<i>four provinces</i>)</p>

Source: Author analysis

Based on the national and provincial data from 2009-2017, we found the majority of province located in HL quadrant and LL quadrant, present evidence of imbalanced development between regions in Indonesia. Despite high economic growth in some province, most growth did not directly translate to individual welfare as described with majority members of quadrant HL. Moreover, we also found lower growth has resulted in lowering income per capita as presented in quadrant LL, in contrast to LH quadrant where four provinces experienced higher income despite their low growth rate. Finally, we found higher growth lead to higher income only in four provinces as presented in quadrant HH. Only one province in Java Island lives in this quadrant, raising concern on the high-income disparity in Java as the heart of the national economy.

All the result confirm the imbalance of economic development between the region and share the same view with BPS (2018a) on high-income disparity, presented by national Gini Ratio 0.391 in September 2017.

Moving from region classification, we summarised the variable before the econometric calculation. The result presented in table 3.

Table 3. Variables for data analysis

Variable	Observation	Mean	Std. Dev	Min	Max
$GRDPG_{it}$	304	5.832175	2.579567	-4.28	21.76
$GRDPG_{i,t-1}$	303	5.897057	2.688959	-4.28	21.76
$logGRDPC_{i,t-1}$	301	10.22871	.5796668	9.086437	11.91692
$logINV_{it}$	305	17.24823	1.237767	14.56746	20.31508
LBR_{it}	300	67.40415	3.954488	59.40698	80.99243
EDU_{it}	302	7.840384	.9910734	5.338198	11.02
$MobProv_{it}$	300	47.072	13.79702	13.35	76.99

Source: Author analysis

There is some variable have a different observation due to data availability. In the recent years, Government of Indonesia support the regional expansion in province, city and district level. From the period 2009-2017, the Kalimantan Utara province established in 2012, and the data for some variable will not be available before the province establishment year.

Table 4. Fixed effect model result

Variable	Fixed Effect Model				
	All Provinces	HH Quadrant	HL Quadrant	LH Quadrant	LL Quadrant
$CONS$	133.094***	120.3891*	185.9259***	221.1015	126.024***
$GRDPG_{i,t-1}$.0960992	.1418843	.0906198	.0624405	.3284817***
$logGRDPC_{i,t-1}$	-11.23688***	-14.10451***	-16.24605***	-10.45185	-11.16421*
$logINV_{it}$	-.2681758	.3026464	-.6094277	-.7601663	-.597759
LBR_{it}	-.0082411	-.0342221	.1265705	-.5101107	-.0492034
EDU_{it}	-1.857301	4.336502**	-3.473196**	-8.202937	-.3540015
$MobProv_{it}$.1441931***	-.0259543	.2553935***	.1785318	.1054176***
N	300	30	162	36	72

Note: *, ** and *** denote test statistical significance at the 10%, 5% and 1% level respectively.

Source: Author analysis

Next, we employ fixed effect model operation to identify the relationship between mobile penetration and economic growth. The result of data analysis divide between complete data set for all provinces as well as a segregated group according to Klassen Typology (table 4).

Based on all provinces model calculation, we estimated mobile penetration has positive relationships to economic growth with coefficient 0.1441931 and significant at the 0.01 level, suggesting that mobile adoption is beneficial for economic development. Moreover, the result also suggests lagged GDRP per capita present negative value, indicating the province with lower initial GDRP per capita will likely grow faster compared to their higher GDRP per capita peer. Finally, the rest of predictor show insignificant value in this study.

Furthermore, the calculation from high growth and high-income (HH) group show no substantial relationship between mobile adoption and economic growth. On the other hand, the education proved to have relationships to economic growth in this quadrant with coefficient 4.336502 at 0.05 significance. The result also shares the same view with all province calculation negative value of income per capita, suggest region with lower original income per capita will experience accelerated growth. Another variable found no substantial relationship with economic growth according to this model

Moreover, the HL quadrant shows mobile penetration has affected regional economic with 0.2553935 value at 99% significance. In addition to mobile, HL group also present evidence on GDRP per capita effect to province growth. In contrary, the education variable presents negative output to economic growth, pointed the region with lower mean years of schooling tend to have faster growth while the mature province has limited space for growth. The income per capita once again provide the negative result of economic growth, demonstrated higher growth would experience by province with lower start income per capita. Furthermore, another predictor shows no relationship to economic growth.

The fixed effect model on low growth high-income (LH) provinces did not find any significant relationship between predictor and regional growth. The Riau, Kalimantan Timur, Papua Barat and Papua demonstrated the evidence of high income not delivered from high growth. The nature of its economy depends on an export-oriented commodity such as palm oil and cacao with higher international prices, contributing to more significant value instead of its small population.

Apart from neither high growth nor high income, eight provinces in LL quadrant experienced the distressed condition. In contrary, the mobile penetration found to have a substantial impact on economic growth by providing coefficient 0.1054176 at 99% significance. Moreover, income per capita and lagged GRDP growth also affected growth by -11.16421 and 0.3284817 with 0.10 and 0.01 significance. Once more, the income per capita has negative value; imply the province with lower original GDRP expected to have faster growth.

In addition to all provinces result, the positive relationships of mobile penetration and economic growth illustrated by province with lower initial GRDP per capita, implying the importance of mobile communication to support regional growth in the disadvantaged community. Conversely, the province with higher start income per capita did not find any significant effect of mobile adoption to the economic growth, demonstrating the population has exploited and benefited to the optimum level. Comparing the result for two groups (HL and LL) which has a positive economic impact of mobile adoption, we found interesting evidence as HL quadrant present higher coefficient at 0.2553935 compare to 0.1054176 in LL quadrant. Between both lower income per capita region, the higher growth province likely to have more growth but not directly connected with increasing income per capita.

Moreover, education variable in high growth province has affected to economic growth. The high growth region can exploit human capital to an optimum level supported by its economic capacity, and benefited the economy. In contrary, the advantages of education will be limited to slow growth region due to limited economic expansion capacity as well as limited high skill employment opportunity and sparse job specialisation.

Furthermore, income per capita also presents positive relationships to economic growth in all provinces, HH, HL and LL Quadrant model. As Indonesia economy dominated by consumption sector (BPS, 2018c; Okezone.com, 2018), higher income per capita transmitted to economic growth by improving purchasing power as well as increased consumption, which leads to expanded production and more significant output.

In another hand, lagged GRDP value only significant in LL quadrant, provide evidence of stable growth in low growth provinces despite its small rate.

The overall result brings implication for the government, business and community. The government should maintain the effort to increase penetration rate viewing the high impact of mobile to the economy in low-income per capita region; higher penetration rate can aid by universal service obligation (USO) policy as well as ICT oriented policy from the local and regional government. Moreover, the government also required to elevating people capacity on mobile technology utilisation to reach optimum benefit. The higher expertise achieved by training or education, while retooling and financial aid can promote business transformation. Another way is by attaching ICT in the curriculum, expected to provide high skill job opportunity which leads to higher income.

In business side, the operator required to provide the population with accessible, available and affordable mobile services. The low growth and low-income province mostly located in the periphery, isolated and border area. The service accessibility and availability is low due to unfeasible market; the operator needs to address this problem by utilising USO fund as well as service consolidation between operators. Moreover, some operator implemented higher local tariff for the unfeasible area, raising affordability and equality issues. The operator can practice cross-subsidy between highly concentrated market and unfeasible area to reach fair end-user prices.

The people as the subject and object of the economy also required to support the mobile technology utilisation. Lower income per capita should not challenge the benefit of mobile utilisation. By cooperating with government and business, the community can learn to know how on exploiting mobile technology for their activity as well as increasing income per capita and regional support growth.

In summary, the mobile adoption is essential variable to promote economic growth in 34 provinces of Indonesia based on Fixed Effect Model. Similarly to the previous study, this research share same view on the positive relationships between mobile adoption and economic growth.

5. Conclusion

Our finding suggests that mobile technology can derive economic value in regional development. The coefficient value of mobile adoption to economy is 1.44% growth for every 10% penetration increase. Moreover, we found education only affect the province with high economic growth. Another evidence suggests the province with a lower initial per capita tend to have accelerated growth, while province with lower growth and lower income per capita proven have steady growth. It can be concluded that mobile phone penetration is beneficial for economic growth in 34 provinces in Indonesia, specifically in the region with lower income per capita.

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