Digitalization and Productivity in Asia and the Pacific

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Abstract

Digitalization creates fundamental economic structural change by improving labor productivity. In many advanced economies, the digital-led productivity has been declining owing to demographic changes, institutional and regulatory barriers. In addition, measurement problems have underestimated the productivity gains resulting from digitalisation. Unlike in most developing economies, digital inclusion has led to increased labor productivity in Asia and the Pacific region. Digitalisation influences labour productivity through various channels. The study found that the availability of digital tools including infrastructure availability is the main channel through which productivity has improved in Asia and the Pacific region. However, affordability, relevance and readiness need further improvements to harness the full benefits of digitalization.

Key words: Digital inclusion; Availability; Affordability; Relevance; Readiness

1. Introduction

Digitalization drives growth by stimulating productivity improvements (Brussevich, et al., 2018; Anghel, 2024). Digital technologies generate productivity gains by altering production processes, improving complementarity between labour and capital and increasing automation (Anghel, 2024). Digital revolution alters the labour markets and nature of work (Deschacht, 2021; Ivanov, Kuyumdzhiev, & Webster, 2020). As a result, labour demand, the occupational structure and the work task composition of occupations are changing. These occupational changes eventually influence the labour market outcomes: wages, inequality, job quality and unemployment.

Technological advances are a major source of productivity improvement. Despite the boom and optimism toward technology, growth has slowed down in the past couple of decades, especially in the post-pandemic period. This productivity puzzle could be due to lags and J-curve effects. Thus, technology-driven bigger boost to productivity is yet to come. However, it is uncertain whether this is the case for productivity slowdown in all countries?. Unlike the advanced economies, most developing countries are still at a very early stage or no evidence of substantial digital adoption. To produce broader economy-wide and sustained increase in digital-led productivity growth, learning cross-country differences is vital.

Productivity slowdown could be due to various reasons. When less productive firms remain in the market, it drags down productivity (Decker, Haltiwanger, Jarmin, & Miranda, 2017). Productivity decline in the manufacturing sector is primarily owing to either difficulties in natural resource extraction or the underutilization of technical capacity (Gu & Willox, 2018). Innovation is critical for productivity. Yet, in large firms, the productivity loss is mainly owing to lack of innovation (Tang & Wang, 2004). The advanced economies face productivity slow down as the technological advancements driven by digitalization was not impactful as in the early years of its adoption (Balsmeier & Woerter, 2019). It is also argued that it is not decline in productivity but rather returning to normalcy following an exponential growth (Fernald, 2015). The new digital economy is strictly depend on information communication technology (ICT) services and knowledge products (Van Ark, 2016). The expected productivity gains are therefore, possible only after a period of maturity of these technologies. Despite the claims on productivity slow down, digital technology has the potential to stimulate productivity improvements and long-term growth. The gains, however, not distributed in an equitable manner. This inequality can increase disparities in productivity at firm level, thus, can negatively impact on aggregate productivity growth.

Digital penetration into labour markets is enormous during the post-pandemic period. Digital adoption and its labour market impacts are however, vary significantly across countries. This is because, the application of new technologies depends on the investment in intangible assets like human capital, new processes and organisational structures (Brynjolfsson, Rock, & Syverson, 2019). Understanding of how digitalization affects productivity and what digital skills are more impactful in increasing productivity enhances prospects of economic growth.

There were three industrial revolutions. Steam power and mechanization, electricity and fossil fuel energy and adoption of information communication technology (ICT). The fourth revolution is acceleration of digitalization. Despite the technological advancements since the

early 2000s, recent decades show relatively poor growth in productivity in both advanced and emerging economies (Mollins & Taskin, 2023). Labour productivity is stagnated in developing countries compared to developed countries over the period 2017-2022 (Figure 1A in the Appendix). Unlike in developed countries, the association between digitalization and labour markets in developing countries is not well-understood. Hence, this study significantly contributes to the existing literature by answering the research question, 'what is the impact of digital inclusion on labour productivity and inequality in developing countries". Therefore, the study specifically focuses on pandemic-induced digitalization on labour productivity.

It has found that among all developing economies, pandemic-induced digitalization has significant positive impact on improving labor productivity only in Asia and the Pacific region. The magnitude of these impacts are however, quite smaller. The disaggregated analysis on digital inclusion index for Asia and the Pacific region shows that availability is satisfactory while the other three domains – affordability, relevance and readiness – need considerable improvements, if expecting to harness the full benefits of digitalization.

The remainder of the study is organised as follows. Section 2 presents methodology which includes the data and the empirical strategy. Section 3 contains the results and discussion. Finally, Section 4 presents concluding remarks.

2. Methodology

Pandemic induced digitalization has long lasting implications on productivity and labour markets (Jaumotte, Oikonomou, Pizzinelli, & Tavares, 2023). Higher digital adoption could improve productivity, yet, poor adoption breeds inequalities. There is a dearth of available empirical evidence on the impacts of pandemic induced digitalization on labour markets in developing economies. In a context where digital adoption rates are substantially lower in most developing economies, investigations on the belief that the digital economy would become the mainstay in the post-pandemic world is therefore, vital in creating inclusive labour markets.

2.1 Data

This study uses country-level annual data over the 2017-2022 period and comprises of 97 countries. This includes 25 developed economies and 72 developing economies in Africa (30), Asia and the Pacific (26) and Latin America and the Caribbean (16) regions. This study uses two main outcome variables, labour productivity and inequality. Labour productivity is measured as the output per hour worked and data obtained from the International Labour Organization (ILO, 2024). Inequality is given by the Gini coefficient and population under the poverty line and data extracted from the Economist Impact web platform (EI, 2024). Gini coefficient measures the inequality on a scale of 0 to 1, where higher values indicate higher inequality.

Assuming the recent pandemic as a key driver of labour productivity, this study uses the number of COVID-19 confirmed cases per million people as an explanatory variable. The data extracted from the 'Our World in Data' open web platform (OWID, 2024). This variable explains the risk of exposing to COVID-19. Digitalization is measured using the inclusive

internet index of the 'Economist Impact' web platform (EI, 2024). The overall index score is consisting of four domains: availability (quality and breadth of infrastructure and internet usage); affordability (access cost and market competition); relevance (Local and relevant content) and readiness (capacity to access including skills, culture, policy). Each main domain contains several sub-domains as indicated in Table 1A in the annex).

The study uses several other control variables. The stringency index of the Oxford Covid-19 government response tracker (OxCGRT, 2024). This variable explains the pandemic related policy measures implemented by various governments. The government investment, GDP per capita and regulatory quality published by the World Bank are the other variables used in the analysis (WDI, 2024; WGI, 2024). The government investment is measured as the gross fixed capital formation, a measure that has been significantly contracted during the pandemic. Then, GDP percapita indicates economic performance of a country. The regulatory quality index of the worldwide governance indicators shows the government policies toward private sector development.

2.2 Empirical Strategy

Digital adoption is depended on the availability, affordability, policy relevance and readiness of a particular country. Variations in digital adoption rates create differences in productivity and inequality across countries. To understand these heterogeneous impacts, this study investigates the association between pandemic induced digital inclusion on productivity and inequality. The estimation closely follows the cross-country event study design that focuses on impacts of digitalization on employment by Jahan & Zhou (2023).

This study uses the following baseline model:

$$Y_{it} = \beta_1 + \beta_2 lncovid_{it} + \beta_3 Digital_{it} + \beta_4 X'_{it} + \mu_i + \eta_t + \varepsilon_{it} \quad (1)$$

where the outcome variable, Y_{it}, is either labour productivity or inequality for country i at time t. The explanatory variables include $lncovid_{it}$, the natural logarithm of total covid-19 confirmed cases in 97 countries. $Digital_{it}$ is the inclusive internet index of country i at time t. The other control variables (X'_{it}) are the stringency index, government investment, GDP percapita and regulatory index. The regression (1) is likely to suffer from omitted variable and endogeneity bias. The change in labour productivity and inequality may not be necessarily due to digital skills but due to other factors, thus, a number of control variables are used in the estimation. μ_i and η_t are country and year fixed effects, respectively. Country fixed effects control for unobserved influences that vary across countries (geography, culture etc.) and time fixed effects control for evolving unobserved national attributes that affect the likelihood of labour productivity (government policy reforms etc.). ε_{it} is the error term. The estimation uses 1,000 bootstrap replications to address the issue of autocorrelation.

3. Results and Discussion

The objective is to evaluate the impact of digitalization on labour productivity by estimating the Equation (1) in Section 2.2. The estimation begins by considering the full sample of 92

countries and subsequently investigate the impacts across income, geographic region and employment sector.

Table 1: Summary Statistics

Variables	Obs.	Mean	Std. Dev.	Min	Max
Labour productivity (Output per hour worked) (GDP constant 2017 international $ at PPP)	600	26.885	23.751	1.320	141.640
COVID confirmed cases per million (ln)	300	9.766	2.271	-1.356	15.996
Digital inclusion	600	51.534	28.821	0	86.100
Stringency index	600	20.368	26.445	0	84.260
GDP per capita	600	15,855.020	19,635.160	433.838	97,316.880
Regulatory quality	600	0.104	0.955	-2.387	2.227
Investment	600	23.128	6.841	1.225	54.274

3.1 Impact of digital inclusion on labour productivity during pandemic

Table 2 presents the estimates of digital inclusion on labour productivity. Digital inclusion varies across countries. Declined productivity and increased inequality are quite common during crisis. As pandemic triggers lockdowns and workplace closures, there is a possibility that labour productivity and inequality to be negatively affected. However, higher digital inclusion might have altered these impacts in a favourable manner. In that scenario, improving digital adoption would help lessen the long-term negative impacts of the pandemic. Thus, it is hypothesised that the digital inclusion has a significant positive impact on labour productivity during pandemic.

Table 2: Estimates of digital inclusion on labour productivity

	All	Developed	Developing	Africa	Asia & Pacific	Latin America & Caribbean
	(1)	(2)	(3)	(4)	(5)	(6)
COVID	0.209***	0.054	0.202***	0.355	0.112	-0.196
	(0.055)	(0.554)	(0.050)	(0.237)	(0.094)	(0.560)
Digital inclusion	-0.031	-0.300	0.100	-0.009	0.545***	-0.096
	(0.043)	(0.185)	(0.086)	(0.036)	(0.140)	(0.140)
Covariates	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.999	0.999	0.998	0.998	0.999	0.997
Observations	291	75	216	90	87	48

Notes: Robust standard errors in parentheses are bootstrapped with 1,000 replications. ***, **, and * indicate statistical significance at 1%, 5% and 10% nominal level, respectively.

This table presents the estimation results of the change in labour productivity owing to COVID-19 confirmed cases and digital inclusion index during 2017-2022. The estimation

considered heterogeneous impacts based on income and geographic location. According to the estimates in Columns (1) and (3), COVID-19 has a small but positive impact on labour productivity in the full sample and in developing countries. On average 1% increase in the COVID-19 variable increased labour productivity by about 0.002 units for the entire sample and for developing countries. In contrast, the digital inclusion is having negative but insignificant impact on labour productivity across all sub-groups except the Asia and Pacific region. Accordingly, one-unit increase in the digital inclusion index increases labour productivity by 0.545 units for Asia and the Pacific region.

Table 3: Decomposed impacts of digital inclusion on labour productivity, by region

	Developing	**Africa**	**Asia & Pacific**	**Latin America & Caribbean**
	(1)	**(2)**	**(3)**	**(4)**
Availability	0.107	0.043	0.373*	-0.010
	(0.097)	(0.038)	(0.159)	(0.061)
Affordability	0.036	0.021	0.270	-0.365
	(0.042)	(0.028)	(0.141)	(0.175)
Relevance	0.016	-0.017	0.077	-0.010
	(0.033)	(0..017)	(0.049)	(0.047)
Readiness	0.006	-0.029	0.048	-0.005
	(0.022)	(0.020)	(0.048)	(0.056)
Covariates	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Observations	75	90	87	48

Notes: Robust standard errors in parentheses are bootstrapped with 1,000 replications. ***, **, and * indicate statistical significance at 1%, 5% and 10% nominal level, respectively.

The equation (1) was estimated replacing the digital inclusion index with the all four sub domains separately. Only the 'availability' domain has significant positive impact on labour productivity in the Asia and Pacific region. So that, one-unit increase in the availability (usage, quality, infrastructure and electricity) could increase labour productivity by 0.373 units. The estimates indicate that all developing countries need significant improvements in digital adoption. Comparatively, Africa and Latin America and Caribbean regions needs the most effort.

Knowing to what extent digitalisation leads to productivity gains ensures achieving economic growth and prosperity. Digitalization influences labour productivity through various channels. Investment in digital goods, digital intermediate inputs The availability domain which includes usage, quality, infrastructure and electricity is such Investment in digital goods

Efficiency gains of digital transformation declines over time. Further, techno-pessimists claimed that digital technologies are less efficient in triggering productivity gains compared to electrification.

In Table 4, the estimates show the impact of pandemic induced digital inclusion on employment in agriculture, industry and services sectors in developing economies. None of the estimates are significant. Agriculture sector is the least affected in terms of employment. And this is acceptable as it is the sector that uses digital adoption the minimum.

Table 4: Estimates of digital inclusion on employment, by sector

	Developing	Africa	Asia & Pacific	Latin America & Caribbean
	(1)	(2)	(3)	(4)
Agriculture	-0.088	-0.076	0.086	-0.328
	(0.069)	(0.077)	(0.133)	(0.294)
Industry	0.017	0.031	-0.055	0.055
	(0.025)	(0.032)	(0.108)	(0.127)
Services	0.071	0.045	-0.031	0.272
	(0.061)	(0.059)	(0.145)	(0.230)
Covariates	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Observations	216	90	87	48

Notes: Robust standard errors in parentheses are bootstrapped with 1,000 replications. ***, **, and * indicate statistical significance at 1%, 5% and 10% nominal level, respectively.

Table 5 shows that the impact of digital inclusion on inequality is insignificant, but it has been able to reduce inequality in all regions except Africa. The biggest impact is observed for Asia and the Pacific region. Thus, one-unit increase in the digital inclusion index could reduce inequality by 0.151 units.

Table 5: Estimates of digital inclusion on inequality

	All	Developed	Developing	Africa	Asia & Pacific	Latin America & Caribbean
	(1)	(2)	(3)	(4)	(5)	(6)
COVID	0.067	-0.053	0.071	0.413	0.080	-0.196
	(0.041)	(0.176)	(0.050)	(0.497)	(0.094)	(0.560)
Digital inclusion	-0.036	-0.048	-0.011	0.022	-0.151	-0.096
	(0.041)	(0.118)	(0.093)	(0.101)	(0.163)	(0.140)
Covariates	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.986	0.992	0.982	0.990	0.981	0.997
Observations	291	75	216	90	87	48

Notes: Robust standard errors in parentheses are bootstrapped with 1,000 replications. ***, **, and * indicate statistical significance at 1%, 5% and 10% nominal level, respectively.

4. Conclusion and Policy Implications

Digital inclusion ensures higher labour productivity and declined inequality. Digitalization encourages productivity gains that leads to long-term growth. Despite the world-wide productivity slow down during post-pandemic period, digital inclusion has significant positive impact on productivity in Asia and the Pacific region.

Digitalisation affects labour productivity developments in various ways. The analysis shows that availability of digital technologies is vital in productivity growth. This explains the usage, quality, infrastructure and electricity.

Productivity gains in developed countries tend to decline while most developing countries are yet to increase their adoption rates. Yet, during pandemic digitalization has improved in most developed and developing economies in Asia and the Pacific region.

Digitalisation drives structural growth and long-term economic growth through labour productivity enhancement. The level of digital adoption is heterogeneous across countries while advanced countries are ahead of developing economies. Investment in digital technologies is vital in improving labour productivity.

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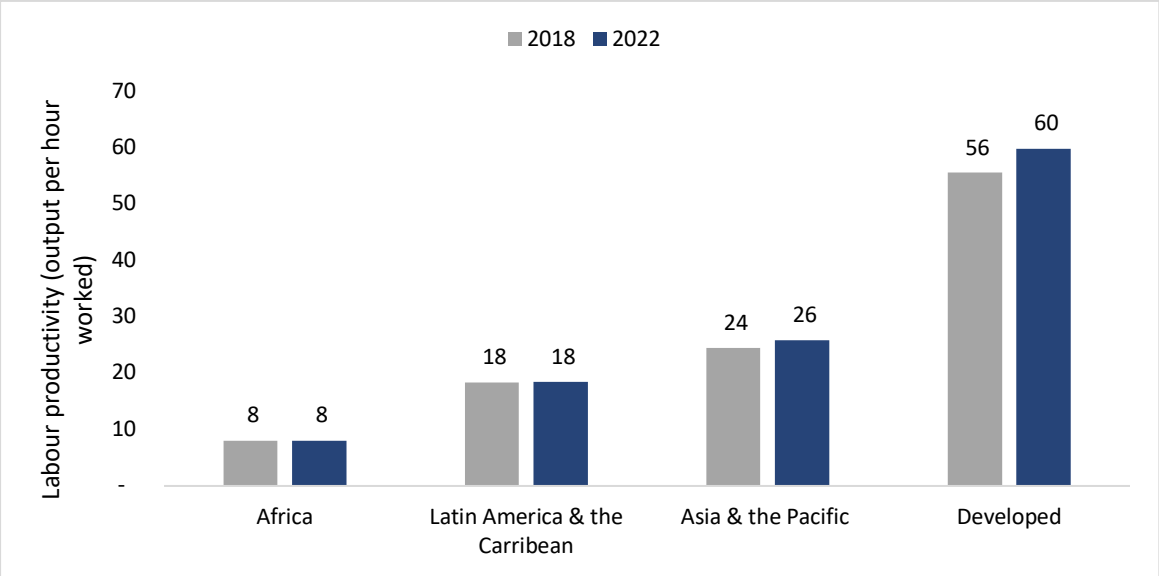
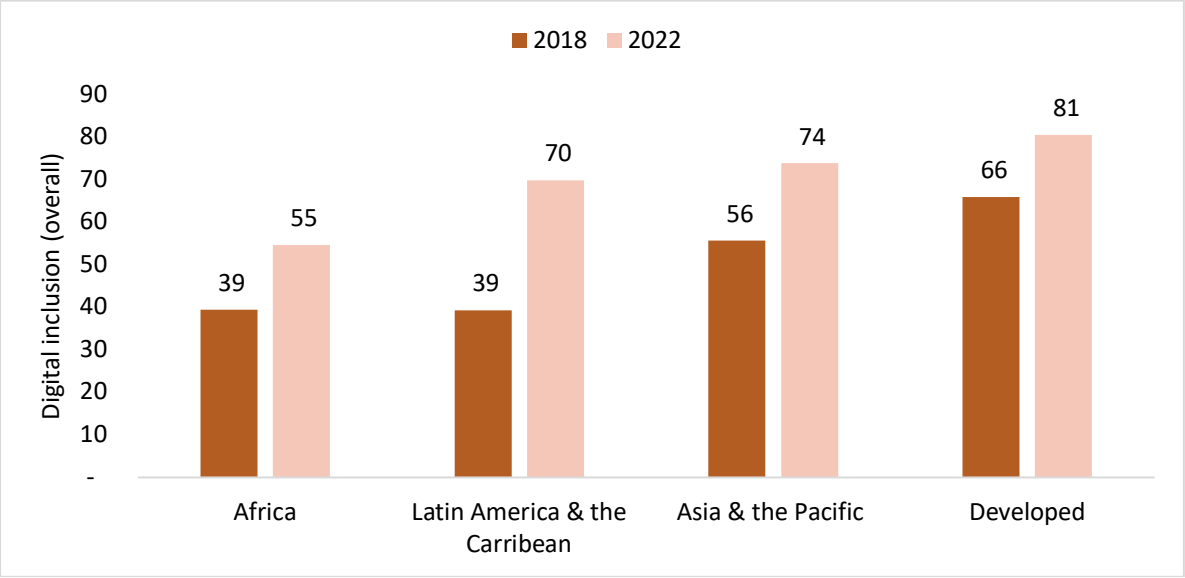
Appendix

Figure 1A: Labour Productivity



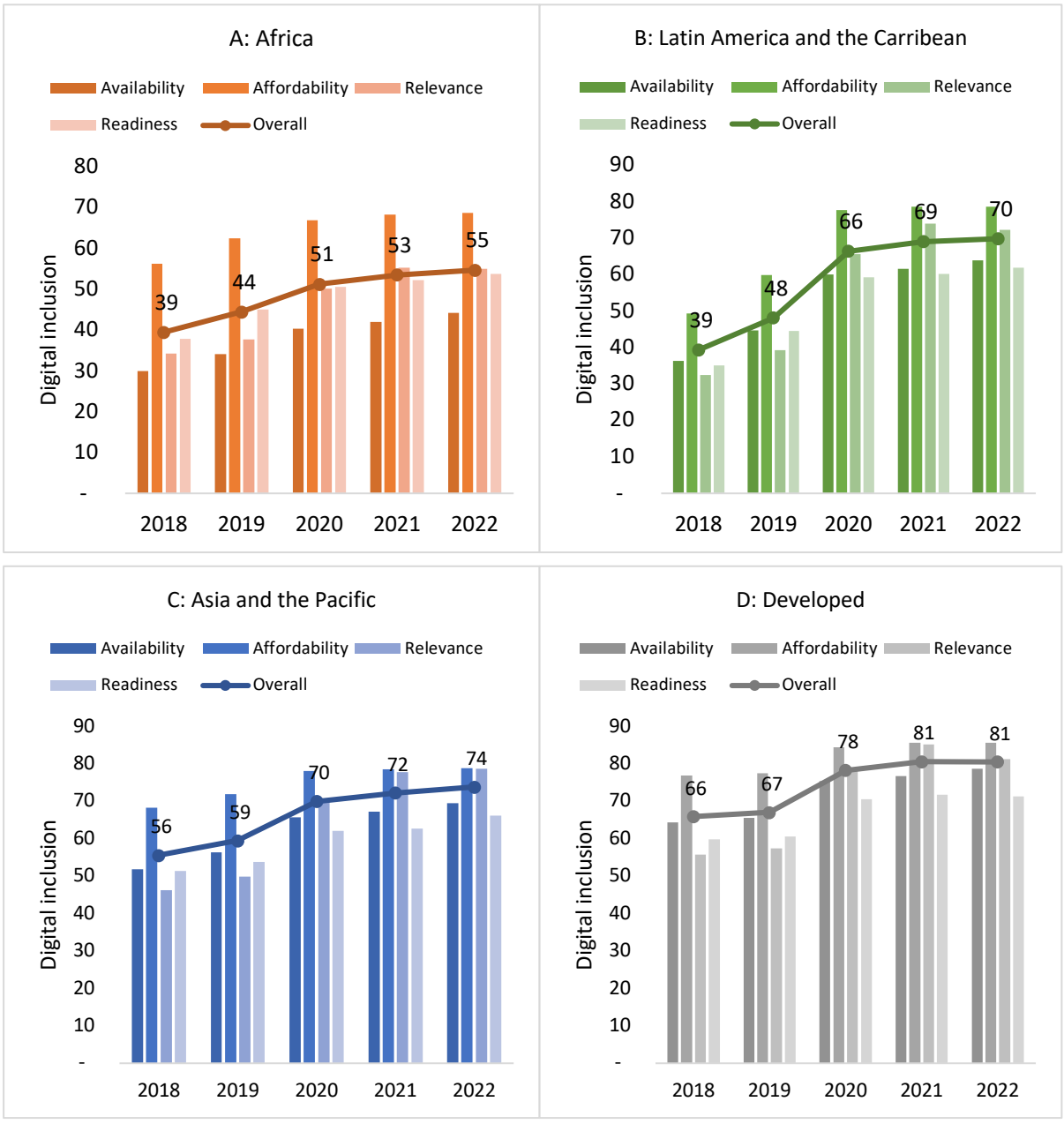
Notes: Labor productivity is measured as the output produced per hour worked, GDP constant 2017 international $1,000 at PPP
Source: ILOSTAT, International Labour Organisation 2024

Figure 2A: Digital Inclusion (Overall)



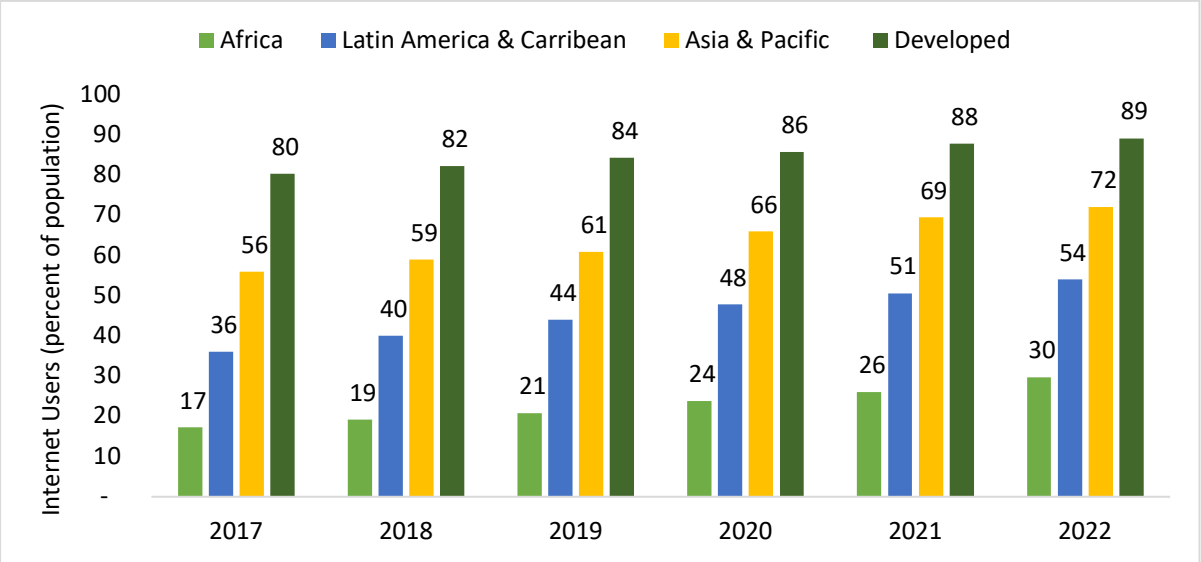
Source: Inclusive Internet Index 2024. Economist Impact.
https://impact.economist.com/projects/inclusive-internet-index/.

Figure 3A: Digital Inclusion – Sub Domains



Source: Inclusive Internet Index 2024. Economist Impact. https://impact.economist.com/projects/inclusive-internet-index/.

Figure 4A: Internet Users



Source: Inclusive Internet Index 2024. Economist Impact. https://impact.economist.com/projects/inclusive-internet-index/.

Table 1A: Inclusive Internet Index Domains

Availability (40%)	Affordability (30%)	Relevance (20%)	Readiness (10%)
Usage (25%)	Price (66.7%)	Local content (50%)	Literacy (33.3%)
Quality (25%)	Competitive environment (33.3%)	Relevant content (50%)	Trust and safety (33.3%)
Infrastructure (25%)			Policy (33.3%)
Electricity (25%)			

Source: Inclusive Internet Index 2024. Economist Impact. https://impact.economist.com/projects/inclusive-internet-index/.

Table 2A: Digitalization Country Classification

Developed Countries	Developing Countries		
	Africa	Asia and the Pacific	Latin America and the Caribbean
Australia	Algeria	Bahrain	Argentina
Austria	Angola	Bangladesh	Brazil
Belgium	Benin	Cambodia	Chile
Bulgaria	Botswana	China	Colombia
Canada	Burkina Faso	India	Cuba
Denmark	Cameroon	Indonesia	Dominican Republic
Estonia	Congo (DRC)	Iran	El Salvador
France	Côte d'Ivoire	Jordan	Guatemala
Germany	Egypt	Kuwait	Honduras
Greece	Ethiopia	Lebanon	Jamaica
Hungary	Gabon	Malaysia	Mexico
Ireland	Ghana	Mongolia	Panama
Italy	Kenya	Myanmar	Paraguay
Japan	Liberia	Oman	Peru
Lithuania	Madagascar	Pakistan	Trinidad & Tobago
Netherlands	Malawi	Philippines	Venezuela
New Zealand	Mali	Qatar	
Poland	Morocco	Saudi Arabia	
Portugal	Mozambique	Singapore	
Romania	Namibia	South Korea	
Spain	Nigeria	Sri Lanka	
Sweden	Rwanda	Taiwan	
Switzerland	Senegal	Thailand	
United Kingdom	South Africa	Turkey	
United States	Sudan	UAE	
	Tanzania	Vietnam	
	Tunisia		
	Uganda		
	Zambia		
	Zimbabwe		

Source: World Economic Situation Prospects (2024).