Determinants of digitalization: Evidence from Asia and the Pacific countries

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Abstract

Purpose – Digitalization is one of the major factors that fosters economic growth across the world. However, the level of digitalization varies significantly between developed and developing countries, with the latter often lagging behind. To bridge this gap, it is crucial to pinpoint the drivers of digitalization, specifically from the macroeconomic and country-level governance dimensions. Therefore, this study aims to investigate the determinants of digitalization, particularly for countries in Asia and the Pacific region.

Design/methodology/approach – Our study utilizes unbalanced panel data from 46 Asian and Pacific countries for the period of 2001–2021. Initially, we analyzed the data using conventional econometric methods, such as pooled ordinary least squares (POLS), random-effects model (REM) and fixed-effects model (FEM). Moreover, we employed endogeneity-corrected techniques and alternative proxies to enhance the robustness and reliability of our findings.

Findings – Our findings reveal that economic development progress, government expenditure relative to country size and political stability are key drivers of digitalization. In contrast, corruption at the country level emerges as a significant impediment. Notably, our results remain robust to endogeneity-corrected techniques and alternative proxies of digitalization. Overall, these insights can inform policymakers, helping them to

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understand the macroeconomic and governance factors shaping digitalization and guide their decision-making toward effective policy interventions.
Originality/value – This study's empirical findings add significant value to the existing literature by quantifying the impact of macroeconomic and governance factors on digitalization in selected countries. This offers valuable insights for policymakers, particularly in nations with lower levels of digitalization.
Keywords Digitalization, Determinants, Technology, Internet subscription, Fixed broadband subscription
Paper type Research paper

1. Introduction

The development of information and communication technology (ICT) during the past two decades has significantly changed how we live, interact and conduct business. The world is rapidly embracing technological innovation and digital transformation, often simply referred to as digitalization. In essence, digitalization entails "the use of digital technology, and probably digitized information, to create and harvest value in new ways (p. 56)" (Gobble, 2018). Within the economic sphere, digitalization manifests as the application of cutting-edge technologies to boost the effectiveness of social output (Pradhan, Arvin, Nair, Bennett, & Bahmani, 2019). Education, innovation and invention serve as the bedrock of this digital transformation (Johnson, 2019), enabling nations to modernize their economies and societies. Moreover, digitalization is often credited with facilitating economic growth due to its impact on knowledge exchange and dissemination (Myovella, Karacuka, & Haucap, 2021). However, a considerable gap often exists between the development of digital technology and its integration into markets. Beyond the economic impact, digitalization also shapes social transformation by influencing access to essential services and communication. Nevertheless, navigating the digital world necessitates not only access to infrastructure and technology but also the ability to adapt to its evolving landscape.

The benefits of digitalization can be significantly unevenly distributed, influenced by factors like income levels, skill sets, infrastructure disparities, geographical location and institutional quality (Chowdary, 2002). Accordingly, Chowdary (2002) noted that those with access to digital information often represent wealthier, empowered segments of the population. Similarly, despite the substantial benefits digitalization offers at individual, household and national levels, most Asian and Pacific countries lag behind their Western and European counterparts in terms of digitalization maturity (Xu, Zhong, & Li, 2022).

Underscoring the digital divide, the International Telecommunication Network (ITU) report [1] showed that 36% of the population in least developed countries (LDC) use the internet, compared to the global average of 66% in 2022. The report further highlighted affordability as a major barrier, with 43% of LDCs lacking access due to higher prices compared to developed countries. Pinpointing the exact factors behind the low level of digitalization in Asia and the Pacific is complex. However, a range of factors could be at play, including inadequate digital infrastructure, limited digital literacy and the ineffectiveness of existing digitalization efforts. Thus, analyzing these factors is crucial to understanding the specific challenges and opportunities for each country.

Despite a substantial number of studies investigating the effect of digitalization at the individual and societal level (Grybauskas, Stefanini, & Ghobakhloo, 2022), within firms (Jardak & Ben Hamad, 2022), and on a country-wide scale (Myovella, Karacuka, & Haucap, 2020; Zhang, Zhao, Wan, & Yao, 2021), there seems to be an inadequate number of studies focusing on the factors or determinants influencing a country's digitalization. Moreover, most of the existing studies are concentrated on African countries (Myovella *et al.*, 2021; van Deursen & Mossberger, 2018), with limited research available on countries in Asia and the Pacific region. According to the World Bank (2022), the game-changing potential of digitalization remains largely untapped in many developing countries, particularly in Asia and the Pacific. Promoting digitalization through macroeconomic and good governance practices can unlock significant economic opportunities for individuals. Conversely, failing to adapt to and utilize new technologies could leave individuals falling short in productivity, potentially hindering overall economic growth (Murthy & Nath, 2009).

Highlighting the poor digital adoption in Asia and the Pacific, a report from the Asian Development Bank stated that "the region's economies have the highest dispersion in terms of the adoption of digital technologies (p. 1)" (Saadi Sedik *et al.*, 2019). Figure 1 illustrates this, showing that while most countries in Asia and the Pacific region have an average penetration of 30%- 40%, a few outliers reach near 80%. Identifying the drivers behind this disparity is crucial, as the resulting empirical findings can guide policy recommendations for boosting digitalization, particularly in lagging countries.

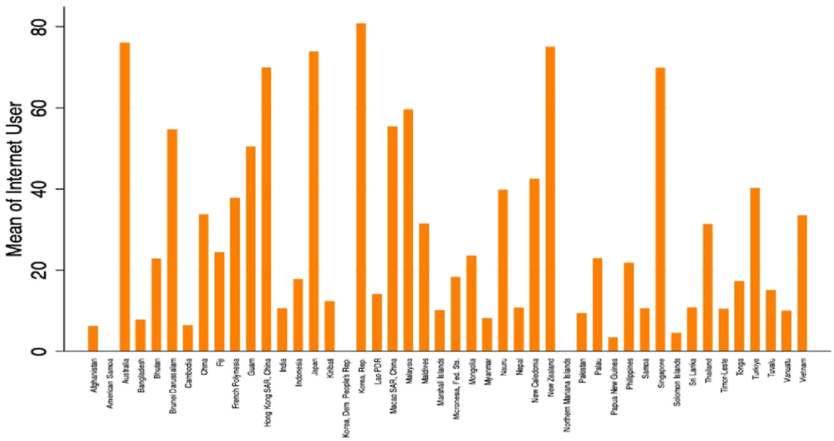
Furthermore, the Asia Pacific region holds global significance, as it is home to the world's two most populous nations, China and India, with a combined population of 4.3 billion (60% of the world total). As a contributor to 30% of the global gross domestic product (GDP) and housing several developing economies, the region's rapid growth, rising population and urbanization make it vital to global development. Therefore, motivated by the paucity of literature and the tremendous potential of digitalization, this study aims to identify macroeconomic and country-level governance factors driving digitalization within these Asia–Pacific countries.

Considering the scope of the study, we pose the following research questions:

RQ1. What are the impacts of macroeconomic factors such as GDP growth, Foreign Direct Investment (FDI) and financial sector development on the digitalization of Asia and the Pacific countries?

RQ2. How do country-level governance factors, as measured by Worldwide Governance Indicators (WGI), affect digitalization in the same region?

The contribution of this research lies in two key dimensions. First, we explore the link between macroeconomic and country-level governance factors and the digitalization drive in Asia and the Pacific, an area with relatively scarce existing literature. While studies on African countries are prevalent (Myovella *et al.*, 2021; van Deursen & Mossberger, 2018), this region has received less attention. Second, by quantifying the impacts of macroeconomic and governance factors on digitalization, our findings can empower policymakers in Asia and the Pacific to draft targeted policies that leverage digitalization for economic growth and individual prosperity. Digitalization can create economic opportunities when propelled by



Note(s): We have calculated the mean for each country by considering the internet users data between the period of 2001-2021. The countries are chosen based on the availability of the data from Asia and the Pacific region
Source(s): Authors

Figure 1. Trend of individual internet users as a percentage of population for Asia and the Pacific Region (selected countries)

macroeconomic and governance factors. Failure to embrace evolving technology may result in decreased productivity and hindered economic growth for individuals (Murthy & Nath, 2009).

The rest of the paper is organized as follows. Section 2 describes the overview of digitalization and relevant literature, section 3 provides the methodology of the study, section 4 presents the empirical analysis and section 5 closes the study with the conclusion, policy implications and future research directions.

2. Literature review

2.1 Brief overview of digitalization

The past three decades have witnessed a digital revolution, transforming economies worldwide. The term "digitalization" itself is multifaceted. At its core, it refers to the integration of digital tools, systems and technologies into various facets of society, business and daily life (Legner *et al.*, 2017). This entails converting analog information and processes into digital formats, enabling efficient data storage, manipulation, analysis and communication (Brennen & Kreiss, 2016). Beyond these technical aspects, Kane, Palmer, Phillips, Kiron and Buckley (2015) define digitalization as the transformative process of adopting diverse digital technologies to reshape business models, strategies and procedures. Ultimately, the driving force behind the digitalization process is the pursuit of economic growth and prosperity. In essence, it signifies the organization of numerous interactions around digital media and communication infrastructure. The discussion surrounding digitalization's complexities and, more importantly, its economic potential, has been extensive (Hanrahan, 2021). While prior research has extensively explored ICTs and the Internet's reach, the current focus is on digitalization's role in accelerating human progress (Lee, Hong, & Hwang, 2017) and powering the digital economy (Sharma, Fantin, Prabhu, Guan, & Dattakumar, 2016).

Measuring digitalization is inherently complex, with no single metric capturing its scope. Thus, researchers have employed various methods to assess a country's digitalization level. The most popular measures rely on internet access or usage by the population, recognizing the internet as a critical backbone of digitalization. DiMaggio, Hargittai, Neuman and Robinson (2001) highlight the potential of internet access disparity to restrict opportunities in education, government information access, political participation and social networks, favoring its use as a digitalization measure. However, internet access can be measured in several ways, including individual internet usage (Maji & Laha, 2022; Myovella *et al.*, 2021), fixed broadband subscriptions (Maji & Laha, 2022; Myovella *et al.*, 2021), digital economy and society indices (Boikova, Zeverte-Rivza, Rivza, & Rivza, 2021) and network readiness indices (Tudose, Georgescu, & Avasilcăi, 2023). While acknowledging the limitations of accessing the latter two indices, this study primarily uses the percentage of internet users as a main dependent variable for digitalization. Moreover, fixed broadband subscriptions will be employed as a secondary indicator, in line with past studies.

2.2 Brief overview of factors affecting digitalization

Since its 1990s breakthrough, internet usage has surged, though unevenly, creating a digital divide. In many Western nations, widespread access has shifted focus beyond mere connectivity to reaping the full benefits of the internet. With the broad adoption of broadband and digital gadgets, the binary notion of "internet access" as the sole measure of digitalization has been challenged (Scheerder, van Deursen, & van Dijk, 2017). This concern over expanding ICT and its resultant social inequalities has become a prominent global policy issue. Several studies have investigated the potential merits and demerits of implementing digitalization initiatives (van Deursen & Mossberger, 2018; Vicente & López, 2011). However, most researchers agree to some extent that in this globalization era, digitalization is essential for every economy (Parviainen, Tihinen, Kääriäinen, & Teppola, 2017; Rosin, Proksch, Stubner, & Pinkwart, 2020). While the drivers of digitalization remain debated, it is clear that diverse factors influence a country's level of digitalization.

The previous literature revealed two main approaches to identifying factors influencing digitalization: micro level and macro level. At the micro level, prominent drivers include demographic characteristics, firm decision-making capacity, knowledge sharing, professional business strategy, access to finance, R&D investment and information technology (IT) infrastructure (Aghion, Howitt, Howitt, Brant-Collett, & García-Peñalosa, 1998; Scheerder *et al.*, 2017). Macro-level studies, on the other hand, have focused on national income, foreign trade, human resources, public debt, financial sector development, government R&D investment, political stability and corruption (Berg, Wustmans, & Bröring, 2019; Myovella *et al.*, 2021; Xin, Sun, Zhang, & Liu, 2019). However, this study will exclusively focus on macro-level drivers potentially affecting digitalization in Asian and Pacific countries.

Focusing on the macro-level factors, higher gross domestic product growth (GDPGR) can potentially propel digitalization by enabling larger government investments in information technology infrastructure. This, in turn, could lead to better and more accessible internet for citizens (Czernich, Falck, Kretschmer, & Woessmann, 2011). Several studies support this link, suggesting GDP is a major driver of internet penetration and usage in economies (Nishijima, Ivanauskas, & Sarti, 2017; Vicente & López, 2011). Additionally, economically prosperous countries may find it easier to allocate resources towards widespread internet access (Czernich *et al.*, 2011).

Conversely, inflation can hinder overall economic growth and IT investment (Bagchi, 2005). This is because rising consumer spending during inflation leaves less room for investment in new initiatives. Moreover, Maji and Laha (2022) argue that increasing purchasing power can boost internet usage and overall digitalization. Thus, it is expected that inflation will affect the digitalization process negatively.

Financial sector development is an indicator of the overall progress of an economy (Ahmed & Ansari, 1998). The more financially developed a nation is, the better the availability of funds that can be channeled to support the ongoing expansion of digital infrastructure. In this study, we used domestic credit to the private sector (DCPS) as a proxy for financial sector development. In line with the previous study by Maji and Laha (2022), we hypothesize that DCPS will enhance digitalization.

Similarly, FDI is expected to influence digital transformation through its impact on economic development. Grazzi and Jung (2019) noted incoming FDI significantly drives the adoption of website services by organizations. Moreover, Pick, Nishida and Zhang (2013) established a positive link between FDI and internet use in China. FDI can boost the productivity and effectiveness of local companies through technology transfer (Liu, 2008), ultimately promoting digitalization.

In terms of gross capital formation (GCP), Bal, Dash and Subhasish (2016) found that it positively affects economic growth. Higher investments in infrastructure, production and government expenditure contribute to broader economic expansion, including technological advancements. Myovella *et al.* (2021) demonstrated that GCP increases the use of the internet in the sub-Saharan Africa region. Therefore, we expect increased government investment through GCP to promote digitalization in the Asia and Pacific region.

Government consumption spending (GCE) serves as an indicator of the government's commitment to promoting economic equality by providing essential services. This spending enables resource mobilization, which creates jobs and fosters economic growth (Irmen & Kuehnel, 2009). Consequently, higher GCE can translate to increased investment in information technology, boosting digitalization. Beyond infrastructure, governments also invest in digital literacy, targeting educational attainment and providing training for older individuals (Nishijima *et al.*, 2017). Some even offer free digital services to low-income populations, such as free public Wi-Fi in Brazilian cities (Nishijima *et al.*, 2017). These initiatives directly address the digital divide and promote wider participation in the digital economy.

The size of the nation in terms of population can also impact digital technology use (Quibria, Ahmed, Tschang, & Reyes-Macasaquit, 2003). A higher population growth rate (PGR) may be associated with increased digitalization, reflecting both a larger market for digital services and potential economies of scale for infrastructure development (Quibria *et al.*, 2003). Studies by Nipo and Bujang (2014) and Myovella *et al.* (2021) support this connection, finding positive correlations between PGR and ICT development, particularly in the context of internet use in sub-Saharan African countries (Myovella *et al.*, 2021).

Trade openness (TRADE), measured as the sum of exports and imports as a percentage of GDP, reflects a country's willingness to engage in international trade. This openness can boost productivity through technological transfer and access to larger markets for both inputs and outputs (Dowrick & Golley, 2004). Myovella *et al.* (2020) highlight how TRADE removes barriers to technology transfer across borders, while Murthy and Nath (2009) emphasize its positive correlation with access. Therefore, we can expect higher trade openness to positively impact digitalization. This relationship can be driven by enhanced economic growth fueled by technological advancements and increased exposure to global digital trends.

The relationship between employment and internet usage is positively affirmed (Crandall, Lehr, & Litan, 2007). Stojčić, Aralica, and Anić (2019) emphasize that the equitable development of access to technological infrastructure across regions plays a pivotal role in generating new industrial jobs. In the contemporary era, it is increasingly viable for unemployed individuals to frequently utilize the internet. This is substantiated by the crucial role the internet plays in the employment process, offering new avenues for job searches. Numerous online job boards provide platforms for companies to list opportunities, allowing individuals to submit their applications. Both parties can then navigate these forums using criteria that align with their needs. Job searching through the internet is deemed promising, effective and contemporary compared to traditional job search methods (Czernich, 2014). From this perspective, the unemployment rate (UNMR) emerges as a potentially significant determinant of digitalization.

Furthermore, urban areas typically boast superior infrastructure for digitalization, such as high-speed internet, mobile networks and data centers. This infrastructure advantage in urban areas (URBAN) facilitates easy connectivity to the digital world and the use of digital services. Liu and Xie (2013) emphasize the spillover effects of urbanization, indicating its significance as a conduit influencing the spread of internet-based technology. Thus, it is suspected that an increase in the percentage of the total population residing in urban areas corresponds to advancements in the country's digitalization.

Corruption stands out as a significant impediment to achieving economic growth (Everhart, Vazquez, & McNab, 2009; Perry, 2017). Therefore, fostering economic growth necessitates government intervention to regulate and control corruption within the country. Despite significant internet expansion since 1999, reaching even isolated regions of developing nations, governments focusing on governance indicators like control of corruption (COR) to achieve economic growth may steer towards internet technology, thereby facilitating digitalization.

Moreover, political stability (POL) is expected to enhance investment in digitalization (Heimeshoff, 2007). Generally, the quality of political institutions should foster the penetration of internet use among the population. Myovella *et al.* (2021) corroborate this trend in their study on the sub-Saharan Africa region, finding that political instability is associated with lower internet usage. The study emphasizes that countries in the African region facing political instability refrain from investing in the telecommunication sector due to delayed returns in such uncertain circumstances.

3. Methodology

3.1 Data source and sample

We have explored various secondary data sources suitable for this study. Our initial database exploration revealed that data from around 46 Asian and Pacific countries between 2000 and 2021 met our analysis requirements. While we aimed to collect data for as many years and countries as possible, our sample size was limited by several factors. Notably, relevant data for our variables was only available up to 2021 at the time of research. Additionally, internet usage in many Asian countries only took off in the early 2000s, making pre-2000 data nearly non-existent for most. Therefore, our panel spans the period from 2000 to 2021. The complete list of countries included is presented in Appendix 1. However, due to missing data, the final sample size for model estimation was reduced to 29 countries. Data on digitalization (internet users as a percentage of population) and country-specific macroeconomic variables were collected from the World Bank's Development Indicators (WDI). Furthermore, we used another dataset on governance, sourced from the World Bank-hosted WGI developed by Kauffmann and Kraay (2023).

3.2 Research design

Considering the nature of the study and the availability of the data in a panel setting, we advance the following dynamic model.

$$DIGIT_{i,t} = \alpha_0 + \beta_i ME_{i,t} + \partial_i WGI_{i,t} + \gamma D_t + \varepsilon_{i,t} \quad (1)$$

where i represents an individual country from Asia and the Pacific; t, the time period (year); *DIGIT* is the main independent variable that captures the individual internet usage, in line with several past studies (Ha, Huong, & Thanh, 2022; Myovella *et al.*, 2020); ME_{it}, is the macroeconomic factors (e.g. GDPGR, INFR, DCPS, GCP, FDI, GCE, PGR, TRADE, UNMR, URBAN etc.); WGI_{it}, is the country-level governance indicators (e.g. COR & POL); $\mathrm{D_t}$ is the time dummy(t-1); and $\varepsilon_{i,t}$, a zero-mean error term. For a better model fitness, we used the natural logarithm of GCP, GCE and TRADE variables. Table 1 reported the definition of the variables used in this study, alongside their expected sign. Considering all these factors, the final model is given as follows:

$$\begin{aligned}\mathrm{DIGIT_{i,t}} = {} & \alpha_0 + \beta_1 \mathrm{GDPGR_{i,t}} + \beta_2 \mathrm{INFR_{i,t}} + \beta_3 \mathrm{DCPS_{i,t}} + \beta_4 \mathrm{LNGCP_{i,t}} + \beta_5 \mathrm{FDI_{i,t}} \\ & + \beta_6 \mathrm{LNGCE_{i,t}} + \beta_7 \mathrm{PGR_{i,t}} + \beta_8 \mathrm{LNTRADE_{i,t}} + \beta_9 \mathrm{UNMR_{i,t}} + \beta_{10} \mathrm{URBAN_{i,t}} \\ & + \partial_1 \mathrm{COR_{i,t}} + \partial_2 \mathrm{POL_{i,t}} + \gamma \mathrm{D_t} + \varepsilon_{\mathrm{i,t}} \end{aligned} \quad (2)$$

3.3 Estimation strategy

Given our panel data and static model setting, Eq (2) can be estimated through three primary methods: pooled ordinary least squares (POLS), random-effects model (REM) and fixed-effects model (FEM) (Torres-Reyna, 2007). Recognizing the distinct assumptions associated with each technique, we employed statistical analysis to ascertain the most appropriate models for our data. Specifically, we utilized the Breusch Pagan Lagrangian Multiplier (BPLM) test to choose between POLS and REM, followed by the Hausman test to differentiate between REM and FEM. Moreover, our sample includes countries of varying sizes and economic development levels, potentially introducing concerns about heteroscedasticity. Additionally, investigating macroeconomic variables raises the possibility of serial or autocorrelation. To address these issues, the final model incorporates country-level clustered standard errors (Torres-Reyna, 2007). Furthermore, consistent with past studies and the central limit theorem, we assume the error term is independent and normally distributed and

Variable	Definition	Type	Expected sign	Source
LNIU	Natural logarithm of individuals using the Internet [% of population]	Number		WDI
LNFBS	Natural Logarithm of fixed broadband subscriptions [per 100 people]	Number		WDI
LNTIU	Natural logarithm of total number of internet users in a country	Number		WDI
GDPGR	GDP growth [annual %]	Ratio	+	WDI
INFR	Inflation as measured by the consumer price index [annual %]	Ratio	–	WDI
DCPS	Domestic credit to private sector [% of GDP]	Ratio	+	WDI
GCP	Gross capital formation [formerly gross domestic investment] as % of GDP	Ratio	+	WDI
LNGCP	Natural logarithm of GCP	Ratio	+	WDI
FDI	Foreign direct investment, net inflows [% of GDP]	Ratio	–	WDI
GCE	Final government consumption expenditure [in million]	Number	+/−	WDI
LNGCE	Natural logarithm of GCE	Ratio	+/−	WDI
PGR	Annual population growth rate [annual %]	Ratio	+/−	WDI
TRADE	Trade is the sum of exports and imports of goods and services [% of GDP]	Ratio	+	WDI
LNTRADE	Natural logarithm of TRADE	Ratio	+	WDI
UNMR	Unemployment, total [% of total labor force]	Ratio	+/−	WDI
URBAN	Urban population [% of total population]	Ratio	+	WDI
COR	Control of corruption reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests	Ratio	+	WGI
POL	Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism	Ratio	+/−	WGI

Note(s): Definition of the variables compiled from different dataset including World Development Indicators (WDI) and Worldwide Governance Indicators (WGI) and both of the databases are hosted by the World Bank. Some of the variables were transformed to natural logarithm to have a better model fitness and minimize heteroscedastic issues
Source(s): Authors

Table 1.
Definition of the variables

has a zero mean, especially given our relatively large sample size (Bibi, Balli, Matthews, & Tripe, 2018). To assess the existence of a stable long-run relationship among variables, we conducted the Kao (1999) panel data cointegration test, with results detailed in Appendix 2. The findings reject the null hypothesis of no cointegration, strongly suggesting that all panels in the data are cointegrated and exhibit a long-run equilibrium relationship. Stata MP 17 version was used for all relevant regressions.

4. Results and discussion

The descriptive statistics of the sample data are provided in Table 2. The IU (individuals using internet services) figure shows that, on average, 30% of the Asian and Pacific region population uses internet facilities. The average fixed broadband subscription among the sample population is about seven percent. From this data, we can infer that internet access and usage through mobile phones and broadband are relatively lower in the Asia–Pacific countries. The lower cost and convenience of mobile internet compared to broadband services might be a plausible explanation for this trend (Loo & Ngan, 2012).

Variable	Obs	Mean	Std. dev.	Min	Max
IU	835	30.042	28.948	0.000	95.000
LNIU	818	2.594	1.742	−8.148	4.554
FBS	759	7.631	10.684	0.001	38.945
LNFBS	759	0.287	2.567	−6.619	3.662
GDPGR	948	3.744	5.206	−14.277	23.171
INF	796	4.435	4.699	−2.595	26.800
DCPS	651	65.001	50.984	1.361	267.934
LNDCPS	651	3.823	0.918	0.308	5.591
GCP	714	27.523	9.256	10.379	60.693
LNGCP	714	3.260	0.333	2.340	4.106
FDI	877	4.288	6.582	−4.031	36.175
GCE [Million US$]	629	285,000,000	940,000,000	235	5,760,000,000
LNGCE	629	28.007	4.450	19.273	36.289
PGR	1,012	1.075	1.138	−2.984	3.926
TRADE	833	102.451	73.362	24.390	402.223
LNTRADE	833	4.436	0.611	2.473	6.093
UNM	834	4.925	3.358	0.410	14.807
URBAN	1,012	53.628	27.740	13.091	100.000
COR	863	−0.023	0.970	−1.616	2.321
POL	862	0.127	1.064	−2.671	1.493

Source(s): Authors

Table 2.
Descriptive statistics

The average GDP growth rate among the sample countries was estimated to be between three and four percent, while the average inflation for the sample countries ranged from four to five percent. Financial sector development and foreign direct investment were, on average, 65% and four percent of their GDP, respectively. The average government consumption expenditure in the region was estimated to be 285,000 billion USD, with the minimum reaching as low as USD 0.235 billion. This indicates that our sample includes both larger and smaller economies. The PGR among the sample stood at one percent. The average trade value, measured in terms of import and export of goods and services, was estimated to be 102% of the GDP. The average unemployment rate among the sample countries ranges from four to five percent. Additionally, we observed that on average, 53% of the total population lived in urban areas. The different country governance indicators considered in the study are government corruption and political stability in the quality of public and civil services. The negative mean governance figures reflect a relatively higher level of corruption in the sampled countries. However, a positive mean value of political stability indicates that most of the selected countries have a better political standing.

Table 3 provides the correlation matrix for the selected independent variables (time dummies are intentionally excluded). The selected variables were found to be correlated to each other to varying degrees, barring a few exceptions. The variance inflation factor (VIF) value for the selected variables stood at 2.12 (Table 3). This reflects that the sample data do not suffer from severe multicollinearity problems since the pairwise correlation and VIF values were below than maximum threshold.

4.1 Baseline results

To analyze the various factors impacting the penetration of digitalization in the Asian and Pacific Region countries, we employed commonly used panel data techniques, as discussed above. The regression results are presented in Table 4. Overall, the models are fit, as the F/χ^2 was statistically significant at the 1% level. Moreover, the explanatory power of the models is also excellent, exceeding 80% for most of the estimated models. To determine which model is a better fit, we performed both the BPLM and Hausman tests. The findings revealed that

Table 3. Pairwise correlation and VIF

Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	VIF
[1] GDPGR	1												4.11
[2] INFR	0.172***	1											3.16
[3] LNDCPS	−0.186***	−0.371***	1										2.59
[4] LNGCP	0.224***	0.029	0.091***	1									2.52
[5] FDI	0.106***	−0.086***	0.270***	0.024	1								2.2
[6] LNGCE	0.173***	0.109***	0.251***	0.180***	0.003	1							2.05
[7] PGR	0.245***	0.096***	−0.339***	−0.107***	0.004	−0.142***	1						1.75
[8] LNTRADE	0.015	−0.169***	0.205***	−0.068*	0.598***	−0.327***	−0.073***	1					1.61
[9] UNMR	−0.149***	0.063*	0.031	0.184***	−0.086***	−0.069*	−0.036	−0.219***	1				1.41
[10] URBAN	−0.131***	−0.275***	0.627***	−0.089**	0.358***	0.017	−0.352***	0.312***	0.190***	1			1.39
[11] COR	−0.196***	−0.377***	0.635***	0.005	0.273***	−0.231***	−0.203***	0.271***	0.109***	0.588***	1		1.39
[12] POL	−0.218***	−0.405***	0.480***	0.042	0.260***	−0.468***	−0.286***	0.473***	−0.135***	0.443***	0.643***	1	1.24
Mean VIF													2.12

Note(s): $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$
Source(s): Authors' own computation

Table 4. Determinants of digitalization, POLS, REM and FEM

	Model-[1]	Model-[2]	Model-[3]
		DV = LNIU	
	POLS	REM	FEM
GDPGR	0.003 [0.010]	0.026** [0.012]	0.026** [0.010]
INF	−0.016 [0.013]	−0.011 [0.016]	−0.009 [0.016]
LNDCPS	0.618*** [0.068]	0.994*** [0.198]	0.882*** [0.175]
LNGCP	0.384*** [0.104]	0.316 [0.214]	0.365* [0.183]
FDI	−0.032*** [0.006]	−0.008 [0.012]	−0.004 [0.011]
LNGCE	−0.018 [0.013]	0.023 [0.039]	1.429*** [0.410]
PGR	0.043 [0.059]	0.022 [0.134]	−0.008 [0.160]
LNTRADE	0.207** [0.088]	0.132 [0.287]	0.484 [0.294]
UNM	−0.002 [0.014]	0.084** [0.040]	0.088* [0.044]
URBAN	0.026*** [0.002]	0.020*** [0.008]	0.036 [0.034]
POL	0.058 [0.056]	0.424*** [0.132]	0.565*** [0.144]
COR	−0.025 [0.078]	−0.167 [0.242]	−0.024 [0.272]
YD	yes	yes	yes
CONS	−4.348*** [0.735]	−6.488*** [2.165]	−48.376*** [11.667]
# of observations	445	445	445
F stat/χ^2	56.068	1624.850	59.840***
BPLM test		680.110***	
Hausman test			77.690***
R^2	0.841	0.802	0.828
# of countries		29	

Note(s): Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. BPLM: Breusch Pagan Lagrangian Multiplier Test. POLS: pooled ordinary least squares, REM: random effects model, FEM: fixed effects model and YD: year dummies

Equation: $LNIU_{i,t} = \alpha_0 + \beta_1 GDPGR_{i,t} + \beta_2 INFR_{i,t} + \beta_3 DCPS_{i,t} + \beta_4 LNGCP_{i,t} + \beta_5 FDI_{i,t} + \beta_6 LNGCE_{i,t} + \beta_7 PGR_{i,t} + \beta_8 LNTRADE_{i,t} + \beta_9 UNMR_{i,t} + \beta_{10} URBAN_{i,t} + \partial_1 COR_{i,t} + \partial_2 POL_{i,t} + \gamma D_t + \varepsilon_{i,t}$

Source(s): Authors

FEM is statistically preferred over other models. Moreover, FEM can account for the effect of time-invariant country-level variables on digitalization, enabling us to obtain reliable and consistent estimates.

The findings show that a country's economic condition had a positive and significant impact on the adoption of digitalization, corroborating the findings of Billon, Lera-Lopez, and Marco (2010). The GDPGR figures indicate that as a country's economy grows (measured by GDP), the adoption of internet services and fixed broadband subscriptions among the people increases. This can be attributed to the presence and development of more ICT infrastructure in these countries. Additionally, higher GDP growth reflects increased per capita income, making digital devices (laptops, smartphones) more affordable. Furthermore, Education attainment also plays a crucial role in internet utilization (Maji & Laha, 2022). Higher education levels often translate to higher digital literacy, leading to increased utilization of digital services. Economies with high GDP are likely to see more government or private investment in educational institutions, further promoting digital literacy.

Although not statistically significant, inflation exhibited a negative impact on the digitalization of the economy. The rationale behind this can be the decrease in purchasing power with rising inflation, making it difficult to afford technology-advanced devices like smartphones, laptops, or computers. The selected domestic credit to private sector factor showed an insignificant positive influence on the adoption of digitalization. However, credit disbursements can contribute to developing ICT infrastructure, as seen in India with Reliance Industries' investment in nationwide internet access.

Our finding further corroborates the previous study by Maji and Laha (2022), demonstrating a positive link between a well-developed sector and digitalization. Easy access to loans, savings accounts and other financial products can increase the affordability of internet equipment and services. A thriving financial industry also strengthens the nation's financial infrastructure encompassing elements like power grids, legal systems and telecommunications networks. These improvements may simplify the use of digital services for citizens. Furthermore, a strong banking system attracts technology investment, leading to the creation of new digital services and enhanced security for existing ones. Improved awareness of the benefits of digitalization, stemming from a robust financial sector, can encourage individuals to adopt digital services and increase internet usage. While we hypothesized a positive impact of FDI and trade openness on digitalization, our result showed a negligible and insignificant impact. This suggests that other factors may play a more significant role in driving digital adoption in the context of Asian and Pacific countries.

Our analysis revealed that government consumption expenditure (LNGCE) is a significant and positive factor impacting digitalization. This suggests that higher government spending leads to increased digital adoption in an economy. From a supply perspective, higher government spending can drive the development of digital infrastructure, lowering prices and making internet access more affordable (Pick *et al.*, 2013). In many countries, public expenditure expands ICT services to remote areas, ensuring "last-mile" connectivity. Additionally, governments often promote digitalization through subsidies and flat-fee subscription models (Billon *et al.*, 2010). Beyond infrastructure, government spending can mobilize human resources, create employment opportunities and raise incomes (Sharma, Kautish, & Kumar, 2018). The increased income and purchasing power ultimately lead to a wider diffusion and higher usage of internet services within the economy.

Our result also revealed that the PGR has a negative, albeit insignificant, impact on digitalization. This could be attributed to several factors. In many Asian countries, a large portion of the population resides in rural areas with limited access to developed ICT infrastructure. Additionally, rural areas often have lower literacy rates compared to urban areas (Zhao, Collier, & Deng, 2014), further hindering digital adoption.

Contrary to Schleife (2010) who suggested a negative impact of unemployment on ICT adoption, our study showed a positive and significant relationship between the unemployment rate and digitalization/internet usage. This could be due to unemployed individuals using the internet for job searching and training (Vicente & López, 2011), or for leisure activities. Consistent with Myovella *et al.* (2021), we found a positive association between urbanization (URBAN) and digitalization. This likely stems from better infrastructure access in urban areas, including electricity and high-speed internet, leading to a higher number of Internet users. Furthermore, urban dwellers are more exposed to digital culture through social media, online shopping and entertainment, which can raise awareness of the digital benefits and encourage its adoption.

Corroborating the findings of Heimeshoff (2007) and Myovella *et al.* (2021), our study revealed that political stability positively and significantly influences digitalization. A stable and progressive government is expected to prioritize investments in digital infrastructure and internet access. Furthermore, using time-period dummies, our study found a significant increase in internet penetration over the years. The positive and statistically significant coefficient values for most time dummies (except a few) indicate a continuous rise in digitalization across Asian and Pacific countries over the chosen time horizon [2].

4.2 Robustness/additional tests

To validate our findings, we conducted several robustness tests. First, we employed an alternative and more conventional proxy of digitalization: Fixed Broadband Subscriptions

(FBS) instead of individuals using internet services (IU). Then, we re-estimated the regression models using both REM and FEM techniques, with results presented in Table 5. The findings largely replicate the conclusions from the baseline regression in Table 4. Most variables previously found significant remain statistically significant, except for political stability which shows some variation between REM and FEM estimates. Interestingly, corruption emerges as a negative and significant factor influencing digitalization. This suggests that high-corruption environments demotivate both business investments in expanding digital infrastructure and individual adoption of broadband services due to cost inflation or mistrust.

To safeguard against potential endogeneity issues, we employed a random-effects generalized two-stage least squares (G2SLS) model, consistent with past studies (Becchetti & Adriani, 2005; Elmassah & Hassanein, 2022). This approach mitigates reverse causality biases that might arise due to the potential influence of certain macroeconomic variables on digitalization. In estimating the G2SLS model, we identified instrumental variables (IVs) likely to impact digitalization but not influenced by the fixed-year effect. Following previous studies, we used lagged values of the relevant macroeconomic variables as IVs. The results are reported in Table 6. Our G2SLS analysis reaffirms the significance of several factors identified in the baseline model (Table 4). When using "internet users" as the proxy for digitalization (Model 5), GDP growth, government consumption, urbanization, unemployment and political stability remain statistically significant. Furthermore, when replacing the proxy with "fixed broadband subscriptions" (FBS), GDP growth, financial sector development (e.g. DCPS), urbanization and political stability continue to demonstrate a

	Model-[2]	Model-[3] DV = LNFBS	Model-[4]
	POLS	REM	FEM
GDPGR	0.052*** [0.016]	0.058*** [0.015]	0.054*** [0.016]
INF	−0.011 [0.017]	−0.010 [0.022]	−0.003 [0.021]
LNDCPS	0.968*** [0.099]	0.859*** [0.267]	0.470* [0.264]
LNGCP	0.280 [0.197]	0.286 [0.411]	0.491 [0.351]
FDI	−0.025*** [0.009]	−0.014 [0.020]	−0.014 [0.021]
LNGCE	−0.023 [0.017]	−0.024 [0.056]	1.933** [0.709]
PGR	−0.217** [0.087]	−0.073 [0.176]	0.057 [0.291]
LNTRADE	0.057 [0.118]	−0.371 [0.359]	−0.323 [0.526]
UNM	0.038* [0.021]	0.134** [0.065]	0.198* [0.099]
URBAN	0.054*** [0.003]	0.064*** [0.009]	0.046 [0.055]
POL	0.119 [0.078]	0.483** [0.245]	0.527 [0.339]
COR	−0.288*** [0.090]	−0.762*** [0.249]	−0.913** [0.331]
YD	yes	yes	yes
CONS	−9.905*** [1.378]	−9.066*** [3.026]	−63.601*** [19.395]
# of observations	426	426	426
F stat/χ^2	61.182***	1146.10***	35.56***
BPLM test		177.920	
Hausman test			57.330***
R^2	0.840	0.731	0.751
# of countries		29	

Note(s): Robust standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1. BPLM: Breusch Pagan Lagrangian Multiplier Test. POLS: pooled ordinary least squares, REM: random-effects model, FEM: fixed-effects model and YD: year dummies

Equation: $LNFBS_{i,t} = \alpha_0 + \beta_1 GDPGR_{i,t} + \beta_2 INFR_{i,t} + \beta_3 DCPS_{i,t} + \beta_4 LNGCP_{i,t} + \beta_5 FDI_{i,t} + \beta_6 LNGCE_{i,t} + \beta_7 PGR_{i,t} + \beta_8 LNTRADE_{i,t} + \beta_9 UNMR_{i,}\ t + \beta_{10} URBAN_{i,t} + \partial_1 COR_{i,t} + \partial_2 POL_{i,t} + \gamma D_t + \varepsilon_{i,t}$

Source(s): Authors

Table 5. Robustness results [alternative proxy of digitalization-FBS]

	Model-[5] DV = LNIU	Model-[6] DV = LNFBS
GDPGR	0.028^{***} [0.010]	0.049^{***} [0.012]
INF	−0.017 [0.014]	−0.011 [0.020]
LNDCPS	0.917^{***} [0.205]	0.863^{***} [0.260]
LNGCP	0.233 [0.190]	0.200 [0.385]
FDI	−0.007 [0.014]	−0.010 [0.021]
LNGCE	0.033 [0.040]	−0.027 [0.057]
PGR	0.055 [0.128]	−0.086 [0.185]
LNTRADE	0.089 [0.295]	−0.496 [0.399]
UNM	0.082^{**} [0.039]	0.096 [0.062]
URBAN	0.017^{**} [0.007]	0.059^{***} [0.008]
POL	0.470^{***} [0.138]	0.443^{**} [0.220]
COR	−0.125 [0.250]	-0.663^{***} [0.216]
YD	yes	yes
CONS	-5.503^{**} [2.173]	-6.702^{**} [2.725]
# of observations	416	397
Wald χ^2	3504.89	2160.21
R^2	0.780	0.818
# of countries	29	29

Note(s): Robust standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1. G2SLS: Generalized two-stage least squares

Equations: $LNIU_{i,t} = \alpha_0 + \beta_1 GDPGR_{i,t} + \beta_2 INFR_{i,t} + \beta_3 DCPS_{i,t} + \beta_4 LNGCP_{i,t} + \beta_5 FDI_{i,t} + \beta_6 LNGCE_{i,t} + \beta_7 PGR_{i,t} + \beta_8 LNTRADE_{i,t} + \beta_9 UNMR_{i,t} + \beta_{10} URBAN_{i,t} + \partial_1 COR_{i,t} + \partial_2 POL_{i,t} + \gamma D_t + \varepsilon_{i,t}$

$LNFBS_{i,t} = \alpha_0 + \beta_1 GDPGR_{i,t} + \beta_2 INFR_{i,t} + \beta_3 DCPS_{i,t} + \beta_4 LNGCP_{i,t} + \beta_5 FDI_{i,t} + \beta_6 LNGCE_{i,t} + \beta_7 PGR_{i,t} + \beta_8 LNTRADE_{i,t} + \beta_9 UNMR_{i,t} + \beta_{10} URBAN_{i,t} + \partial_1 COR_{i,t} + \partial_2 POL_{i,t} + \gamma D_t + \varepsilon_{i,t}$

Source(s): Authors

Table 6. Robustness test [RE-G2SLS]

positive impact on digitalization. Notably, our study also reveals a statistically significant negative effect of country-level corruption on the digitalization drive across Asia and Pacific countries.

In our baseline model, we relied on the percentage of the population using the internet as the primary measure of digitalization. However, this metric can be misleading due to differences in population size. To address this, we tested whether the actual number of Internet users (TIU) provides a more consistent measure of digitalization. We estimated models 7, 8 and 9 using POLS, REM and FEM, respectively, with TIU as the dependent variable. The results are reported in Table 7. Our findings remain largely consistent with the baseline model when using TIU as the measure of digitalization. This suggests that the key factors influencing internet penetration are similar regardless of whether we consider the percentage or the absolute number of users.

5. Conclusions and policy implications

Considering the rapid technological advancements and the global spread of digitalization, this study empirically investigates the impact of different macroeconomic and governance factors on digitalization. We found that GDP growth rate, political stability, government expenditure, financial sector development, urbanization and GCP (to a lesser extent) are crucial drivers of digitalization. These findings offer valuable insights for policymakers, particularly in Asian and Pacific countries, on how managing macro-variables can facilitate the transformation towards a digital economy.

Our findings revealed that beyond macroeconomic factors, specific governance practices also significantly influence digitalization in Asia and the Pacific region. Specifically, political

Table 7.
Additional test [based on actual number of Internet users]

	Model-[7]	Model- [8] DV = LNTIU	Model- [9]
	POLS	REM	FEM
GDPGR	0.061*** [0.017]	0.030*** [0.011]	0.027*** [0.010]
INF	−0.067*** [0.017]	−0.014 [0.016]	−0.010 [0.016]
LNDCPS	1.752*** [0.101]	1.129*** [0.172]	0.890*** [0.173]
LNGCP	0.814*** [0.175]	0.399* [0.222]	0.403** [0.188]
FDI	−0.029*** [0.010]	−0.007 [0.011]	−0.005 [0.011]
LNGCE	0.315*** [0.019]	0.578*** [0.074]	1.551*** [0.420]
PGR	0.097 [0.080]	0.040 [0.141]	−0.028 [0.157]
LNTRADE	−0.622*** [0.118]	0.016 [0.328]	0.466 [0.291]
UNM	0.033 [0.026]	0.123*** [0.042]	0.093** [0.043]
URBAN	0.025*** [0.004]	0.020* [0.012]	0.027 [0.035]
POL	−1.333*** [0.085]	0.340** [0.135]	0.547*** [0.139]
COR	0.162 [0.115]	−0.034 [0.249]	−0.023 [0.266]
YD	−4.234*** [0.990]	−10.837*** [2.720]	−39.481*** [12.016]
# of observations	445	445	445
F stat/χ^2	149.555***	1909.32***	67.86***
BPLM test		1485.410***	
Hausman test			74.460***
R^2	0.878	0.6717	0.845
# of countries		29	29

Note(s): Robust standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1. BPLM: Breusch Pagan Lagrangian Multiplier Test. POLS: pooled ordinary least squares, REM: random-effects model, FEM: fixed-effects model and YD: year dummies

Equation: $LNTIU_{i,t} = \alpha_0 + \beta_1 GDPGR_{i,t} + \beta_2 INFR_{i,t} + \beta_3 DCPS_{i,t} + \beta_4 LNGCP_{i,t} + \beta_5 FDI_{i,t} + \beta_6 LNGCE_{i,t} + \beta_7 PGR_{i,t} + \beta_8 LNTRADE_{i,t} + \beta_9 UNMR_{i,t} + \beta_{10} URBAN_{i,t} + \partial_1 COR_{i,t} + \partial_2 POL_{i,t} + \gamma D_t + \varepsilon_{i,t}$

Source(s): Authors

stability is a critical driver, with stable and progressive governments likely to prioritize investment in digital infrastructure and internet access. Conversely, corruption acts as a major impediment, deterring investors from contributing to digital infrastructure development in highly corrupt countries. This underlines the importance of robust governance practices for policymakers aiming to accelerate digitalization in their countries.

Beyond its economic impact, digitalization serves as a powerful tool for achieving the United Nations Sustainable Development Goals (SDGs). Digital platforms like digital wallets, mobile banking, telemedicine and online tutorials can bridge the gap in access to quality education, financial services, healthcare and other resources for underserved populations, women, minorities and those in remote areas. This can ultimately reduce socioeconomic disparities and create a more inclusive, gender-neutral society. From an academic perspective, this study addresses a literature gap by identifying the key macroeconomic drivers of digitalization in the Asia and Pacific region.

This study is not without limitations. First, we relied on two primary indicators to capture the level of digitalization. While these offer valuable insights, other indices like the digital economy and society index as well as the network readiness index could provide a more comprehensive picture. Data access constraints prevented us from incorporating these. Second, our analysis uses a broad measure of government expenditure. A more refined measure, specifically focusing on government spending on digital infrastructure development, could provide clearer insights into the relationship between public investment and digitalization. Finally, a comparative study across different nations could provide deeper insights into the mechanism driving digitalization success and inform more effective national strategies.

Notes

1. https://www.itu.int/itu-d/reports/statistics/facts-figures-for-ldc/
2. The results are not presented to conserve space; however, it can be requested from the corresponding author.

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Appendix 1

List of countries included in the study

"Afghanistan" "American Samoa" "Australia" "Bangladesh" "Bhutan" "Brunei Darussalam" "Cambodia" "China" "Fiji" "French Polynesia" "Guam" "Hong Kong SAR, China" "India" "Indonesia" "Japan" "Kiribati" "Korea, Dem. People's Rep." "Korea, Rep." "Lao PDR" "Macao SAR, China" "Malaysia" "Maldives" "Marshall Islands" "Micronesia, Fed. Sits." "Mongolia" "Myanmar" "Nauru" "Nepal" "New Caledonia" "New Zealand" "Northern Mariana Islands" "Pakistan" "Palau" "Papua New Guinea" "Philippines" "Samoa" "Singapore" "Solomon Islands" "Sri Lanka" "Thailand" "Timor-Leste" "Tonga" "Turkiye" "Tuvalu" "Vanuatu" "Vietnam".

Source(s): Authors

Appendix 2

Table A1. Panel data cointegration test (Kao)

	t-statistics	*p*-value
Modified Dickey–Fuller	−8.3803	0.000
Dickey–Fuller	−5.2962	0.000
Augmented Dickey–Fuller	−5.7924	0.000
Unadjusted modified Dickey–Fuller	−10.2472	0.000
Unadjusted Dickey–Fuller	−5.8202	0.000
Number of panels	29	
Average number of periods	13.448	

Source(s): Authors

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