

The Role of Institutions and Governance on Digitalisation: Evidence from ASEAN Economies

Ruhaini Muda^{1*}, Anetta Čaplánová² and Azlina Hanif³

¹*Faculty of Business and Management, Universiti Teknologi MARA, Selangor, Malaysia*

²*Department of Economics, University of Economics in Bratislava, Bratislava, Slovakia*

³*Arshad Ayub Graduate Business School, Universiti Teknologi MARA, Selangor, Malaysia*

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ABSTRACT

This study investigates how institutions and governance influence digitalisation and how economic growth moderates these effects. Despite the substantial benefits of digitalisation, less developed economies are still lagging behind in terms of maturity. This study employs panel data analysis, using data from eight ASEAN countries from 2000 to 2023. The study employs Feasible Generalized Least Squares (FGLS) for short-run analysis and Fully Modified Ordinary Least Squares (FMOLS) for long-run effects. The results reveal that strong institutions are crucial in ensuring policy stability and effective regulation for driving digitalisation. Economic growth, when interacting with institutions and governance, further enhances these positive impacts. However, ASEAN governance has an adverse influence on digitalisation, and prolonged economic growth may lead to diminishing effects in digital adoption if institutions fail to progress accordingly. The findings highlight the importance of transparent regulatory frameworks, regional standards, and capacity-building initiatives to enhance an integrated and resilient digital ecosystem across ASEAN economies. This study provides empirical evidence on how institutions and governance affect digitalisation in ASEAN economies while incorporating the moderating role of economic growth in both short-run and long-run dynamics.

1. INTRODUCTION

Digitalisation is characterised as a comprehensive process that includes not only the use of digital tools but also the regulatory and institutional frameworks that enable and support digital infrastructure and services. While prior studies have extensively examined the impact of digitalisation globally, significant gaps remain

^{1*}Corresponding author. *E-mail address:* ruhaini@uitm.edu.my

in understanding its drivers within the Association of Southeast Asian Nations (ASEAN) economies. One major gap lies in addressing ASEAN's uniqueness, particularly its varying institutional capacities and inconsistencies in digital policies. Studies focusing on governance and institutions rarely explore their combined effects on digital transformation in a region characterised by diverse socio-economic conditions. Furthermore, the feedback mechanisms of how economic growth strengthens or hinders digitalisation are underexplored in ASEAN countries. Another significant area is the region's disparities in digital maturity. Nations like Singapore and Malaysia lead in digital adoption, whereas Cambodia and Laos lagged significantly due to limited resources and infrastructure.

This study addresses these gaps by investigating how governance and institutions interact with economic growth to influence digitalisation and provide a comprehensive understanding specific to ASEAN, which represents one of the most dynamic and rapidly expanding economic regions globally. It represents 3.7% of the global gross domestic product (GDP) and 8.6% of the world's population (Asian Development Bank, 2024). This study emphasises the importance of adaptive governance and institutional frameworks specified to ASEAN's unique challenges, and thus, it offers insights for stakeholders as well as policymakers.

The quality of regulatory frameworks and the effectiveness of implementation enforcement have a significant influence on digital transformation (Paul et al., 2024). In countries with efficient regulatory systems, clear guidelines and consistent enforcement foster innovation and provide businesses with the confidence to invest in digital initiatives. Golubtsov et al. (2025) provide empirical evidence on how digital technologies, including artificial intelligence (AI), enhance supply chain efficiency within the businesses. However, in ASEAN countries where regulatory bodies may be less consistent or lack authority, businesses often face bureaucratic obstacles or uncertainty, slowing the adoption of digital technologies.

The advantages of digitalisation are often shaped by the quality of institutions as well as by contextual factors such as income levels, infrastructure disparities, workforce skills, and geographical locations (Mia, Hossain & Sangwan, 2024). Access to digital resources tends to be concentrated among more affluent and empowered segments of society. Although digitalisation offers substantial economic and social benefits, less developed economies continue to lag behind their more developed economies in terms of digital readiness and technology adoption (Xu, Zhong, & Li, 2022). Nonetheless, digitalisation remains a transformative force in shaping both economic and societal progress in developing countries.

Furthermore, ASEAN countries differ widely in internet penetration rates, with nations like Singapore, Brunei, and Malaysia having high levels of connectivity and widespread internet access. In contrast, countries such as Laos, Myanmar, and Cambodia still face challenges in achieving robust digital infrastructure, leading to lower connectivity rates and slower digital progress. This disparity affects the ability of businesses, governments, and individuals to participate fully in the digital economy. The digital skills and literacy levels across ASEAN countries also vary significantly, which influences their capacity to adopt digital technologies (Martinus & Seth, 2023). For instance, countries like Singapore and Malaysia have relatively high digital literacy rates due to strong educational systems and digital training programmes. On the other hand, countries with lower digital literacy, such as Cambodia and Myanmar, struggle to equip their populations with the skills needed for a digital economy.

According to a report on digital integration in ASEAN by the Asia Competitiveness Institute (2023), ASEAN countries differ in their approaches to digital governance and policy. Singapore, for example, has comprehensive policies supporting digital innovation, data privacy, and cybersecurity, which drive its digital maturity. In contrast, countries with less developed regulatory frameworks may face barriers in areas like data protection, cybersecurity, and intellectual property, which hinder their ability to create a secure and enabling digital environment. This inconsistency in digital policy development across ASEAN impacts regional collaboration and integration. The level of investment in digital infrastructure and innovation also varies across ASEAN. Wealthier economies like Singapore and Malaysia invest heavily in digital transformation initiatives, smart cities, and tech ecosystems. Conversely, lower-income ASEAN nations lacked the resources to invest significantly in digital infrastructure, which affects their capacity to mature digitally. ASEAN's digital initiatives highlighted that there is difference in investment levels that contribute to the digital maturity gap, which in turn affects overall economic growth and digital resilience within the region (Isono & Priliadi, 2023). Addressing these disparities requires coordinated regional efforts, targeted investment, and policies that foster inclusive digital growth across all ASEAN countries.

Within the framework of digitalisation in ASEAN, various institutions play crucial roles in enabling, regulating, and promoting digital transformations. Digital transformation presents a considerable challenge to the ASEAN integration agenda, influencing both the internal dynamics of the bloc and its interaction with external partners. Due to the limited focus of existing literature on this intersection and the substantial transformative potential of digitalisation, this study seeks to investigate the extent to which institutions and governance influence digitalisation in ASEAN member states. In line with the objective of the study, the following research questions are proposed: (1) What is the impact of institutions and governance on digitalisation in ASEAN countries? and (2) How do country-level institutions and governance strengthen the growth effect of the economy on digitalisation in ASEAN countries?

This study contributes to the literature in two primary ways. First, it examines how institutions and governance influence digitalisation across ASEAN countries since this region has received relatively little attention. Second, this study looks at the evidence for how strengthening economies enhance the growth effects of digitalisation in developing economies. This study focuses on the characteristics of developing economies and their institutional and governance conditions, which play a crucial role in driving digitalisation. The study also draws on the policy implications of the need for regulatory reforms and capacity-building initiatives and assesses the short-term and long-term effects. This study covers two key aspects of digitalisation, namely, usage and access to digital technologies, highlighting the cause of the digital divide. Consequently, the ongoing process of digital expansion, particularly in terms of internet and mobile phone coverage, yields interesting findings for this study.

2. LITERATURE REVIEW

2.1 Theoretical Considerations

The Institutional Theory suggests that consistent and reliable regulatory frameworks incentivise businesses to invest in digital transformation. Strong institutions that provide clear regulations and enforceable policies help mitigate uncertainty for businesses and encourage them to invest in technology. Furthermore, the Theory also considers the social embeddedness of organisations, arguing that social

expectations and approval can shape the way organisations respond to technological progress (Bennich, 2024). In ASEAN, countries with more regulatory consistency attract greater digital investment than those with less predictable environments, as policy uncertainty may discourage potential investors from investing in long-term digital projects. In addition, the Theory suggests that social and normative pressures influence behaviour within organisations and societies. As a result, the Theory can offer important perspective on how these technologies gain legitimacy and how they are communicated within a country or nation (Hinings, Gegenhuber & Greenwood, 2018).

In the ASEAN context, governments that prioritise digital literacy through education policies and skill-building programmes establish a societal norm that values technological proficiency. This normative pressure encourages both the public and private sectors to prioritise digital skill development, resulting in a digitally competent workforce and fostering a culture that supports digital adoption. Policies in countries such as Thailand, which integrate digital skills into education, contribute to a societal norm that views digital proficiency as essential for career advancement and economic participation. The Theory also emphasises cognitive legitimacy, which refers to the belief that digital practices and technology are appropriate, desirable, and beneficial. Adding to that, high-quality institutions establish frameworks for data protection and cybersecurity, which build public trust in digital systems (Pandey, 2023). In ASEAN, strong data protection laws and reliable institutions, such as Singapore's Personal Data Protection Act (PDPA), create a trusted digital environment that encourages individuals and businesses to engage in digital activities. In contrast, countries with inadequate data protection standards may face public scepticism, limiting the adoption of digital platforms and services. In conclusion, these propositions highlight the crucial role of institutions and governance in providing a supportive environment for digitalisation, as they ensure regulatory stability, promoting digital literacy, and building trust in digital systems throughout ASEAN.

2.2 Hypothesis Development

Within the context of digitalisation in ASEAN, various institutions play crucial roles in enabling, regulating, and promoting digital transformation. Each type of institution plays a unique but interconnected role, contributing to a sustainable ecosystem for digitalisation within ASEAN. Cross-sector collaboration among these institutions is essential for addressing the digital divide, improving digital infrastructure, and enhancing digital literacy across the region (Du & Wang, 2024).

At the country level, national governments across ASEAN countries are primary drivers of digitalisation through formulating policies, developing infrastructure, and setting national digital agendas. For instance, Singapore's Infocomm Media Development Authority (IMDA) and Malaysia's Ministry of Communications and Multimedia are crucial in developing policies that promote digital innovation, smart city initiatives, and the expansion of internet access. Furthermore, national government institutions often set digitalisation goals that align with broader economic development plans (Sari et al., 2024), such as Thailand 4.0 and Making Indonesia 4.0 initiatives. Moreover, these regulatory institutions are essential in establishing a secure and well-regulated digital environment (Jeong, 2023). They are responsible for creating regulations on issues such as data privacy, cybersecurity, and telecommunications. In ASEAN, the role of regulators varies by country but typically includes telecommunications authorities, such as the National Broadcasting and Telecommunications Commission in Thailand, and data protection agencies. These bodies enforce laws on digital transactions, data protection, and network security, all of which are

critical to fostering trust in digital platforms (Kianpour & Raza, 2024). On the other hand, the private sector institutions, such as technology companies, telecommunications firms, and digital service providers, play an important role in driving innovation, investment, and digital service delivery. Companies like Grab and Gojek are prominent examples of private sector players who have not only transformed the digital economy in ASEAN but also promoted financial inclusion through digital payment solutions (Feyen et al., 2021). Private sector institutions often collaborate with governments and regulatory authorities to develop digital infrastructure, improve connectivity, and introduce new technologies.

In addition to national institutions, regional organisations such as the ASEAN Secretariat and the ASEAN Coordinating Committee on E-commerce help member states coordinate and harmonise digitalisation efforts. These organisations build frameworks, such as the ASEAN Digital Integration Framework, to facilitate cross-border digital trade, investment, and data sharing. In addition, international organisations, such as the International Telecommunication Union (ITU) and the World Bank, support ASEAN countries by providing technical assistance, funding, and research on best practices for digital transformation. Strong institutions that provide clear rules and enforceable standards help assist with uncertainty and thereby increase the possibility of technological investment. Therefore, this study proposes the hypothesis below:

H1: There is a positive relationship between institutions and digitalisation.

As digitalisation increases in ASEAN, the need for robust data privacy and protection frameworks becomes essential to safeguard personal data and build trust in digital services (Kianpour & Raza, 2024). However, ASEAN countries vary significantly in their data protection regulations. While countries like Singapore and the Philippines have comprehensive data protection laws, namely Singapore's PDPA and the Philippines' Data Privacy Act, others have less developed frameworks. This inconsistency can hinder cross-border digital services and limit regional integration. A cohesive approach to data protection would promote trust in digital platforms and facilitate digital trade within ASEAN (Mishra & Valencia, 2023). The rise in digital activities brings increased cybersecurity risks, such as cyberattacks and data breaches, which threaten national security and economic stability (Gillani, S., Dermish, A. & Grossman, J. (2022). ASEAN countries differ in their cybersecurity readiness, with Singapore leading in cybersecurity maturity, while other countries may lack the resources and expertise to address these challenges effectively. Policy initiatives like the ASEAN Cybersecurity Cooperation Strategy aim to promote collaboration in strengthening cybersecurity capabilities across the region (Mahusin & Priyadi, 2024). In addition, coordinated efforts in cybersecurity governance are necessary to protect critical infrastructure, secure digital transactions, and foster trust in the digital economy (Radanliev, 2024). Therefore, governance plays a key role in ensuring that digital transformation benefits all segments of society. It includes policies that encourage affordable internet access, digital literacy programmes, and infrastructure investment in underserved areas that are crucial to bridging the digital divide. For instance, Indonesia has initiatives like Palapa Ring to expand internet access in remote regions. Hence, policies and regulations that prioritise digital inclusion help create a more equitable digital economy, supporting sustainable development across ASEAN (Jeong, 2023).

However, there are significant disparities in digital access across ASEAN countries, with rural and low-income communities often left behind. These governance issues highlight the importance of comprehensive, regionally coordinated policies and regulations to drive effective digital transformation in ASEAN. Hence, cross-country cooperation, coupled with strong national policies, can help address these

challenges and promote inclusive and secure digital growth across the region. Effective governance plays a significant role in creating a conducive environment for digitalisation by ensuring regulatory stability, promoting digital literacy, and building trust in digital systems and society. Therefore, the study hypothesises as below:

H2: There is a positive relationship between governance and digitalisation.

Economic growth is the increase in a country's output of goods and services over time, as measured by a change in Gross Domestic Product (GDP). In ASEAN nations, economic growth provides the necessary resources and investments to develop digital infrastructure, improve internet accessibility, and promote technological advancements. As economies expand, higher income levels and government revenues enable greater funding for digitalisation initiatives, driving innovation, enhancing connectivity, and bridging the digital divide across the region. Banik and Padalkar (2021) discern the relationship between economic growth, specifically concerning technological dimensions, and the impact on the economy.

Digitalisation, institutions and governance enable economic agents to access information by providing accountability for stakeholders, setting a framework for market activities, and facilitating enforcement (Hanisch et al., 2023). They can have mutually reinforcing growth effects, or they can be suppressed if only one of them is in force. Therefore, this study proposes that high quality institutions and governance facilitate a good digitalisation process, wherein both organisations and appropriate mechanisms are established to support the initiative. An effective policy of digitalisation would enhance the likelihood of an inclusive process that fosters greater growth rates (Labhard & Lehtimäki, 2022). Consequently, the study proposes the following hypotheses:

H3_a: There is a positive relationship between economic growth and digitalisation.

H3_b: Countries with strong institutions and a higher quality of governance promote greater positive growth effects in digitalisation.

This study also includes control variables, human capital, government fiscal expenditure, and inflation to account for macroeconomic influences. The quality of educational institutions profoundly impacts digital literacy and the accessibility of a skilled digital workforce as human capital (Reddy, Chaudhary & Hussein, 2023). Furthermore, fiscal expenditure exemplifies the government's involvement in financing infrastructure, education, and technology, which are essential for promoting digitalisation and strengthening institutional frameworks (Ha, 2022; Yang, Gu, & Albitar, 2024). Meanwhile, inflation serves as an indicator of macroeconomic stability, influencing investment decisions and economic behaviour. Persistently high inflation can impede digital transformation and institutional efficacy by reducing purchasing power, increasing uncertainty, and undermining confidence in public institutions (Ha & Chuah, 2023). By controlling for human capital, fiscal expenditure and inflation, the model more accurately isolates the effects of institutions, governance, and growth effects on digitalisation, providing substantial insights into the dynamics within ASEAN economies.

3. METHODOLOGY

This study asserted that two primary issues emerged from digitalisation: firstly, the accessibility of the internet and various information and communication technologies (ICTs), and secondly, the implications arising from the access to and utilisation of these ICTs. Building accountability and transparency within

the entire system facilitated the positive impact of digitalisation on inclusiveness. Furthermore, economic growth played an essential role in fostering the comprehensive process of digitalisation, as disparities in socio-economics predominantly determine the digital divide between regions within ASEAN. This study employed models as specified in equations (1) and (2).

$$\text{Dig}_{it} = \beta_0 + \beta_1 \text{Gov}_{it} + \beta_2 \text{Ins}_{it} + \beta_3 \text{Eg}_{it} + \beta_4 \text{Controls}_{it} + \varepsilon_{it} \quad (1)$$

$$\text{Digit} = \beta_0 + \beta_1 \text{Govit} + \beta_2 \text{Insit} + \beta_3 \text{Egit} + \beta_4 \text{Growth_effect}_{it} + \beta_5 \text{Controls}_{it} + \varepsilon_{it} \quad (2)$$

Where i denoted an individual ASEAN country and t signified the time period (year). Digitalisation (Dig) captured the individual internet usage and accessibility of the internet, in line with several past studies (Mia, Hossain, & Sangwan, 2024; Ha, Huong, & Thanh, 2022; Ha, 2022; and Myovella et al., 2020). Institutions (Ins) and governance (Gov) represented country-level institutions and governance at the country level based on the World Governance Indicators (WGI). Following Chinoda & Kapingura (2024) and Labhard & Lehtimäki (2022), institutions referred to framework or structure of the institutions, and ε_{it} represents a classical error term. Per capita gross domestic product (GDP) served as a measure of a nation's economic growth (Eg). The growth effects referred to the interaction effects of the relationship between governance and institutions on digitalisation within the current economic condition of a country.

This study employed a sequential approach to identify the most suitable method, taking into account the properties of the variables under investigation. The sample illustrates ASEAN countries that were strongly connected and shared common characteristics resulting from trade liberalisation and economic integration, which influenced technology, economic growth, institutions and governance. Due to that, the sample countries exhibited a significant degree of interdependence. Consequently, this study applied the cross-sectional dependence (CD) approach proposed by Pesaran et al. (2021) to examine the variables for potential common correlations.

Due to the extended time span of the data and the presence of cross-sectional dependence, this study also examined the data for stationarity. To determine their integration order and assess the presence of unit roots, the second-generation method of the cross-sectional Im, Pesaran, Shin (CIPS) was applied. This approach effectively addresses common correlation bias. In addition, the study used the Pesaran and Yamagata (2008) method to test the slope heterogeneity.

Next, the study employed FGLS for short-run estimates and FMOLS for long-run estimates on the equations (1) and (2), aiming to provide robust and comprehensive insights into the influence of governance and institutions on digitalisation in the ASEAN region. As suggested by Bai, Choi, and Liao (2024), FGLS was particularly suitable for short-run analysis as it effectively addressed heteroskedasticity and cross-sectional dependence within panels, thereby facilitating reliable and efficient parameter estimation in dynamic panel settings. Conversely, FMOLS was applied for long-run estimations due to its being specifically designed to handle non-stationarity and cointegration among variables, addressing potential endogeneity and serial correlation issues (Atilgan et al., 2024; Vo & Ho, 2023; Pedroni, 2001). By combining these methods, the study captured both the immediate impacts and the sustained, long-term effects of governance and institutions on digitalisation while accounting for economic growth dynamics.

This dual approach enhanced the robustness and validity of the findings, providing a comprehensive understanding of the relationship within the ASEAN economies.

3.1 Data

The study used yearly data from eight ASEAN countries spanning the years 2000 through 2023. The countries under consideration included Brunei Darussalam, Cambodia, Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Vietnam. The data were compiled from the database of the World Bank, 2024 which is renowned for providing extensive and reliable data sources for measuring the degree of digitalisation and the worldwide governance indicator.

Table 1 presents the descriptions and the measurements of data. This study used three indicators to determine a country's level of digitalisation, in which the first metric is used as a primary variable to determine the level of digitalisation. The first metric was the individual using the Internet (percentage of population), which reflected the necessary condition during the early stages of digitalisation of being able to access and use the Internet as a basic digital environment (Labhard & Lehtimäki, 2022).

Furthermore, the study used other measurements of digitalisation, namely access to fixed broadband subscriptions, to capture the key preconditions for the formation of advanced infrastructure and hence for the current phase of digitalisation, in line with past studies (Mia, Hossian & Sangwan, 2024, and Labhard & Lehtimäki, 2022). To broaden the analysis, this study included the subscription of cellular mobiles, which indicated that the current trend of internet usage correlated with the access of cellular mobiles in the case of a sample of eight ASEAN countries.

Data on institutions and governance was obtained from the Worldwide Governance Indicators (WGI) Kaufmann, D. & Kraay, A. (2023) and released in 2024. The WGI had six aspects that characterised institutional quality (Kaufmann et al., 2011). This study referred institutions as framework or structure of the institutions. Institutional indicators include control over corruption, government effectiveness, political stability and absence of violence, as well as voice and accountability. Meanwhile, governance referred to the governance aspect of how the institutions are run, which included control of corruption, regulatory quality, and rule of law. This classification enabled the study to evaluate the total influence and relative importance of governance and institutions, as proposed by Labhard & Lehtimäki (2022) and Chinoda & Kapingura (2024).

The WGI described the voice and accountability indicator as measuring perceived participation in the selection of government, as well as freedom of expression, association, and media. The political stability and absence of violence indicator assessed the likelihood of violence, including terrorism. The government effectiveness indicator measured the quality of public services and civil services and their independence from political pressures; the quality of policy formulation and implementation; as well as the credibility of the government's adherence to such policies. Meanwhile, the regulatory quality indicator assessed the government's capacity to formulate and implement sound policies and regulations that permit and promote private sector development. The rule of law indicator referred to a society's regulation, including contract enforcement, property rights, police and courts, and the risk of crime and violence. Finally, the control of corruption indicator measured the use of public authority for private benefit and the interference of elites and private interests.

Table 1. Data description

Variables	Data Description
Dependent Variables	Digitalisation
Digital Usage	i. Internet Usage Score (% of population)
Digital Access	ii. Fixed broadband subscriptions (per 100 people)
	iii. Mobile cellular subscriptions (per 100 people)
Independent Variables:	
Institutional Quality	All Worldwide Governance Indicators (WGI) score as an Index
Institutions	i. Voice and Accountability, WGI score
	ii. Political Stability and Absence of Violence/Terrorism, WGI score
	iii. Government Effectiveness, WGI score
Governance	i. Regulatory Quality, WGI score
	ii. Rule of Law, WGI score
	iii. Control of Corruption, WGI score
Economic growth	GDP per capita (annual %)
Trade	Trade volume (% of GDP)
Fiscal	Government expenditure final consumption (% of GDP)
Human Capital	Government expenditure on education, total (% of GDP)
Inflation	Inflation, Consumer Price Index (annual %)

Source: World Bank (2024). World Development Indicators. Retrieved from: [//databank.worldbank.org/source/world-development-indicators](https://databank.worldbank.org/source/world-development-indicators) (Accessed 10th October 2024).

Previous studies had included several common control variables discussed in the literature, including human capital, fiscal expenditure, trade and inflation. Human capital was measured by primary school enrolment (% gross), fiscal expenditure referred to the annual final consumption expenditure by the government percentage of GDP, and inflation rate was measured by the consumer price index.

4. FINDINGS AND DISCUSSIONS

Tables 2 and 3 provide a comprehensive overview of the study's variables, including digitalisation, governance, institutions and others. The study used standard deviation in the 'between' and 'within' options to explain deviations from the mean value across countries and over time. Table 2 shows the descriptive

statistics of digitalisation variables. The within standard deviations for individuals using the Internet and mobile cellular subscriptions were higher than spatial, indicating substantial variability over time of the sample countries for both variables. In contrast, the spatial standard deviation for fixed broadband subscriptions was slightly higher than within, showing a wide range of the fixed broadband subscriptions across the sample countries.

Table 2. Descriptive statistics of digitalisation variables

Variable		Mean	SDev.	Min	Max
Individual using the Internet (% of population)	overall	42.2565	30.7407	0.04702	99
	spatial		20.4342	18.4006	73.0749
	over time		24.0358	-8.8363	95.6485
Fixed Broadband subscriptions (per 100 people)	overall	6.7934	8.0638	0.0003	28.5393
	spatial		6.5240	0.6305	21.4557
	over time		5.2523	-12.9523	22.23
Mobile cellular subscriptions (per 100 people)	overall	98.6534	51.1187	0.9981	181.7670
	spatial		17.0871	74.7854	128.6224
	over time		48.5418	-6.3696	180.6960

Source: Authors' compilation

Table 3 (see Appendix) shows the independent variables used in the study. Similarly, the spatial standard deviation for all variables of interest was remarkably high, showing significant heterogeneity among the sample countries and implying strong liberalisation and integration among the ASEAN countries. Except for inflation, where the within standard deviation was higher than the spatial, reflecting the variability of inflation within the sample countries.

At this stage, this study used pairwise correlations across all variables to elucidate the unrestricted relationships. Next, this study assessed the cross-sectional dependency of each variable in question by employing the Pesaran (2021) approach. Table 4 (see Appendix) presents the CD test statistics in Column 2 and the second generation of the panel unit root in Column 3. The coefficients of the CD test statistics for digitalisation, economic growth, and human capital were considerably high, exceeding a value of 0.5 and demonstrating statistical significance, which suggested a robust correlation facilitated by economic and political integrations. The findings demonstrate the presence of cross-sectional dependence across all variables in the models. Considering the significant cross-sectional dependency, the study applied the second-generation panel unit-root approach to determine the order of integration. The results indicated that

digitalisation was non-stationary at a level, but it became stationary at first difference, suggesting that its lag value played an important role in explaining the subsequent years.

Furthermore, Table 5 provides the empirical findings related to the slope homogeneity test using equations (1) and (2), the method established by Pesaran and Yamataga (2008). The findings validated the presence of slope heterogeneity for all models. Consequently, this study considered the FMOLS estimation for the long run to be more appropriate than the OLS estimation.

Table 5: Empirical results from the slope homogeneity test

Digitalisation Proxy	Equation (1)		Equation (2)			
			Ins-growth effect		Gov-growth effect	
	Test statistics	p-value	Test statistics	p-value	Test statistics	p-value
Individual using the Internet (% of population)	8.952	0.0000	8.017	0.0000	7.886	0.0000
Fixed Broadband subscriptions (per 100 people)	8.797	0.0000	7.656	0.0000	7.490	0.0000
Mobile cellular subscriptions (per 100 people)	8.271	0.0000	7.086	0.0000	7.234	0.0000

Source: Authors' compilation.

Table 6 (see Appendix) presents the short-term effects using FGLS estimation for equations (1) and (2). The estimation results using three measurements of digitalisation are presented in Panel A: Individuals using the Internet (percent of population), Panel B: Fixed broadband subscriptions (per 100 people), and Panel C: Mobile cellular subscriptions (per 100 people).

The findings in Panel A suggested that institutions and governance had important short-term effects on digitalisation. Institutional and governance factors contributed positively to digitalisation in the ASEAN region. It implied that strong institutions ensured policy stability, effective regulation, and support for infrastructure development. The findings corroborated the studies by Jeong (2023) and Mondejar et al. (2021) which suggested those factors were necessary to promote technology growth and digital adoption. However, their impact may diminish when isolated in the interaction models, as evidenced by estimated results in all panels. This study suggested the potential presence of a governance rigidity effect, wherein stringent regulatory frameworks may hinder innovation and digital adoption (Mettler et al., 2024; Hanisch et al., 2023), particularly in countries with limited economic capacity. In addition, the positive coefficients of interaction between governance and institutions with economic growth indicated that during economic expansion, the resources generated, such as investment, income, and technology capacity, enabled governance systems and institutional frameworks to work effectively (Banik & Padalkar, 2021), amplifying their role in driving digitalisation.

This study additionally performed tests using both conventional and alternative proxies of digitalisation, namely fixed broadband subscriptions (per 100 people) and mobile cellular subscriptions

(per 100 people), as presented in panels B and C, respectively. Panel B indicates that the governance aspect strongly influenced digitalisation. The interaction of institutions and governance with economic growth had demonstrated a favourable and significant impact on digitalisation. Fixed broadband subscriptions signified a more infrastructure-intensive measure of digitalisation (Briglauer, Krämer & Palan, 2024). It required substantial policy-driven investments in physical networks, including fibre-optic and fixed-line services. Consequently, governance, characterised by regulatory efficiency and transparency (Kianpour & Raza, 2024), played a direct and significant role in enabling large-scale infrastructure initiatives. Infrastructure-intensive efforts, such as fixed broadband expansion, depended more on short-term policy decisions and governance efficacy than on extensive institutional reforms (Du & Wang, 2024).

Similarly, when governance and institutions interacted with economic growth, the outcomes were positive, as economic growth supplied essential resources, such as fiscal capacity, investment incentives, and technological readiness. This amplified the effectiveness of governance and institutions. For example, economic growth funded broadband infrastructure initiatives, enhanced regulatory implementation, and incentivised private investments in digitalisation (Nchake & Shuaibu, 2022), enabling governance and institutions to function synergistically.

Panel C presents the estimation findings utilising the digitalisation proxy of mobile cellular subscription (100 of population). It indicated that both institutions and governance had an insignificant impact on digitalisation. Mobile cellular subscriptions were typically driven by market demand, competition, and affordability, rather than the quality of governance or institutional frameworks (Javaid et al., 2024). In addition, mobile networks were easier and less costly to implement than fixed broadband infrastructure, as they required less reliance on large-scale regulatory or institutional intervention. In ASEAN, countries with relatively weaker governance or institutions, such as Cambodia, Laos, had still achieved widespread mobile penetration due to low costs, private sector competition, and strong consumer demand (Sefrina, 2024). When economic growth interacted with governance and institutions, it amplified their positive effects on digitalisation because it provided the financial resources and technological capabilities necessary for better outcomes. For instance, economic growth enabled governments to enhance telecommunication infrastructure, upgrading to 4G or 5G networks, and extend services to underserved regions. This created an environment in which governance reforms and institutional stability enhanced digital adoption. In these contexts, effective governance and strong institutions facilitated this process by ensuring competitive markets, consumer protection, and investment incentives, leading to improved digitalisation outcomes.

Table 7 (see Appendix) presents the long-term coefficients derived from FMOLS estimations for equations (1) and (2). The estimations utilising three measurements of digitalisation are reported in Panel A: Individuals using the Internet (percent of population), Panel B: Fixed broadband subscriptions (per 100 people), and Panel C: Mobile cellular subscriptions (per 100 people). The results showed that all coefficients for institutional variables exhibited positive and significant long-term effects on digitalisation. The various aspects of digitalisation, indicated by individuals' Internet usage, mobile cellular subscriptions, and fixed broadband subscriptions, strengthened the argument for the importance of institutions in driving long-term digital transformation. Nonetheless, the findings also indicated that, in the case of ASEAN, governance had long-term adverse and substantial effects on digitalisation. A possible explanation was that, in the long-term, governance frameworks in ASEAN may encounter structural challenges, such as corruption or inefficiency, that hinder the full realisation of digitalisation objectives (Chen & Kimura,

2024). The study further found consistent results on the interaction of institutions, governance and economic growth in influencing digitalisation over the long run. The coefficients were significant and negative for the ASEAN sample. The findings corroborated previous studies by Jeong (2023) and Labhard & Lehtimäki (2022). Overall, in ASEAN, despite favourable economic growth, institutional weaknesses and governance inefficiencies continued to slow digitalisation progress over time.

Finally, empirical results for control variables across all models showed consistent results in both the short and long-run. In the long run, economic growth and fiscal expenditure had a positive and significant impact on digitalisation. Favourable economic development enabled the government to increase investment in digital infrastructure. However, human capital exhibited a negative impact on digitalisation. The findings suggested a need for qualitative improvements in education systems, rather than only increasing the quantity of human capital. This may result in reforms aimed to align educational outcomes with digital economy needs (Ha & Chuah, 2023). In the short run, most of the control variables were significant across the models. Nonetheless, the findings showed a negative and significant impact of human capital, trade and inflation on digitalisation. The disparities in educational quality among ASEAN countries led to gaps in basic digital skills that prevent the effective use of digital technologies. Whilst ASEAN economies may still rely heavily on manufacturing and agriculture, not integrating digital technologies can also slow down digital adoption (Sefrina, 2024). Lastly, high inflation can reduce the purchasing power of consumers and businesses, hindering investment in digital technologies and essential infrastructure.

5. CONCLUSION

This study examined the short-term and long-term impacts of institutions and governance on digitalisation across eight ASEAN countries. It also investigated how institutions and governance factors interacted with economic growth to influence digitalisation. This empirical study yielded three main key findings. First, in the short term, improvements in institutions and governance facilitated regulatory clarity and improve administrative efficiency, leading to quick gains in digital adoption and transformation. In addition, economic growth enhanced the ability of the institutions to implement digitalisation initiatives more quickly by providing required financial and human resources. Without significant economic growth, governance improvements may not yield immediate benefits for digitalisation due to bureaucratic rigidity or resource constraints, particularly in developing ASEAN economies. Second, with strong economic growth, governance may impose regulatory constraints or stringent policies that hindered the rapid adoption and expansion of digital infrastructure. Consequently, institutions, including public and private institutions, in ASEAN countries may become rigid in response to economic expansion, prioritising traditional sectors over the digital economy, resulting in slower digital adoption in the long term. Third, when economic growth accelerated in ASEAN countries, interaction with governance and institutions may lead to saturation effects. High economic growth initially promotes digital adoption, but in the long run, further growth may result in diminishing returns on digitalisation, particularly if institutions fail to adapt to changing needs.

Based on these findings, this study underscored the importance of developing and enforcing clear and transparent regulatory frameworks to shape the development of digital technologies. The suggestion offered by Ha & Chuah (2023) to have a policy framework that is aligned with regional and international requirements would certainly be important given the significant disparity of maturity in digital development across ASEAN. In addition, establishing region-wide standards for digital governance, data privacy, and cybersecurity can foster a cohesive and predictable regulatory environment across ASEAN, essential for

driving digital transformation and economic integration. ASEAN can draw valuable insights from other regional frameworks, for instance, the EU's General Data Protection Regulation (GDPR), which serves as a benchmark for comprehensive and enforceable data protection laws. Such a framework could include clear guidelines on data collection, storage, and usage, alongside stringent penalties for non-compliance. Additionally, it would promote trust and confidence among ASEAN's citizens and businesses, incentivising greater investment in digital infrastructure and services.

In addition, slow institutional responses to technological advancements create barriers to digital services providers. Meanwhile, governance frameworks focusing on economic stability may conflict with policies promoting rapid technological development, leading to negative effects on digitalisation. Therefore, it is crucial that the governments enhance digital innovation by incentivising collaborations between the public and private institutions to accelerate digital adoption. Designing incentive and opportunity for public-private collaborations can accelerate digital infrastructure development, foster innovation, and drive new solutions to local challenges.

Further, it should be noted that emerging technologies such as Artificial Intelligence (AI) and 5G internet connectivity have the potential to significantly accelerate digitalisation efforts in ASEAN countries. For instance, Singapore's Smart Nation initiative, which integrates AI and Internet of Things (IoT) technologies to enhance public services, serves as a successful model of how clear governance and institutional support can drive digital innovation. Another initiative, Vietnam's application of AI-powered health diagnostics, demonstrates how such technologies can address healthcare disparities. Similarly, 5G connectivity can support the development of smart cities, as seen in Malaysia's Smart Selangor initiative, by enabling advanced applications in transportation, education, and public safety. Governments should incorporate these technologies into national and regional policy discussions to bridge digital divides and address disparities in digital maturity across ASEAN member states.

The present study was limited by the fact that it primarily relied on internet usage and accessibility as indicators of digitalisation, which captured only the communication and connectivity dimension and do not encompass broader aspects such as Internet-of-Things (IoT) Technologies, the quality of digital services, or digital literacy. Additionally, while the study focused on ASEAN countries, the findings may not be generalised to regions with different institutional, economic, or cultural contexts. Those keen on undertaking research in this area in the future may want to consider examining a broader range of digitalisation metrics, incorporating qualitative aspects such as user experiences and societal impacts. Additionally, comparative studies across regions could provide further insight into how emerging technologies like AI and 5G interact with institutional and governance frameworks to drive digitalisation.

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7. CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

8. AUTHORS' CONTRIBUTIONS

Ruhaini Muda: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Writing – original draft, review and editing. **Anetta Čaplánová:** Conceptualization, Methodology, Validation, Writing – review and editing and validation. **Azlina Hanif:** Conceptualization, Data curation, Validation, Writing – review and editing.

9. DATA AVAILABILITY/SUPPLEMENTARY MATERIALS

The datasets generated during the current study are available in the Zenodo repository, <https://doi.org/10.5281/zenodo.14808272>.

10. ETHICS STATEMENT

This study used publicly available secondary data from the World Bank, and Worldwide Governance Indicators(WGI). Ethical approval and informed consent were therefore not required.

11. REFERENCES

- Asia Competitiveness Institute (2023). Digital Inclusion and Integration in ASEAN: A competitive analysis, Lee Kuan Yew School of Public Policy, National University of Singapore, e-ISBN 978-981-18-6782-8. Retrieved at <https://lkyspp.nus.edu.sg/docs/default-source/aci/digital-inclusion-and-integration-in-asean-a-competitiveness-analysis.pdf>. (Date of access: 10.10.2024)
- Atilgan, E., Ertuğrul, H.M., Baycan, O. & Ulucan, H. (2024). Health-led growth hypothesis and health financing systems: An econometric synthesis for OECD countries. *Frontier in Public Health*, 12,1437304. DOI: <https://doi.org/10.3389/fpubh.2024.1437304>
- Bai, J., Choi, S. H., and Liao, Y. (2024). Standard Errors for Panel Data Models with Unknown Clusters, *Journal of Econometrics*, 240(2). DOI: <https://doi.org/10.1016/j.jeconom.2020.08.006>
- Banik, N., & Padalkar, M. (2021). The spread of gig economy: Trends and effects. *Foresight and STI Governance*, 15(1), 28–38. DOI: 10.17323/2500-2597.2021.1.19.29
- Bennich, A. (2024). The digital imperative: Institutional pressures to digitalise, *Technology in Society*, 76, 102436. DOI: <https://doi.org/10.1016/j.techsoc.2023.102436>
- Briglaue, W., Krämer, J. & Palan, N. (2024). Socioeconomic benefits of high-speed broadband availability and service adoption: A survey, *Telecommunications Policy*, 48(7), 102808. DOI: <https://doi.org/10.1016/j.telpol.2024.102808>
- Chen, L. & Kimura, F. (2024). Introduction: Digital Government in ASEAN Digital Transformation in Chen, L. and F. Kimura (eds.). *Empowering Online Public Service in Asia: The Digital Frontier*. Jakarta: ERIA, 1-17. Retrieved

- from: https://www.eria.org/uploads/01_Introduction-rev_.pdf. (Date of access: 09.10.2024)
- Chinoda, T. & Kapingura, F.M. (2024). Digital financial inclusion and economic growth in Sub-Saharan Africa: the role of institutions and governance, *African Journal of Economic and Management Studies*, 15(1), 15-30. DOI: <https://doi.org/10.1108/AJEMS-09-2022-0372>
- Du, Z. & Wang, Q. (2024). Digital infrastructure and innovation: Digital divide or digital dividend?, *Journal of Innovation & Knowledge*, 9(3), 100542. DOI: <https://doi.org/10.1016/j.jik.2024.100542>
- Feyen, E., Frost, J., Gambacorta, L., Natarajan, H. & Saal, M. (2021). Fintech and the digital transformation of financial services: implications for market structure and public policy. BIS Papers No. 117, The Bank for International Settlements and the World Bank Group 2021. ISSN 1682-7651. Retrieved from: <https://www.bis.org/publ/bppdf/bispap117.pdf>. (Date of access: 10.10.2024)
- Gillani, S., Dermish, A. & Grossman, J. (2022). The role of cybersecurity and data security in the digital economy, the UNCDF Policy Accelerator. Retrieved from: <https://policyaccelerator.uncdf.org/all/brief-cybersecurity-digital-economy>. (Date of access: 10.10.2024)
- Golubtsov, D., Kedziora, J., Kozhakhmetova, A., & Kedziora, D. (2025). Assessing the impact of digital technologies and artificial intelligence (AI) on the efficiency of supply chain. *Economics and Sociology*, 18(1), 149-173. DOI: <https://doi.org/10.14254/2071-789X.2025/18-1/8>
- Ha, H. & Chuah, P.C.K. (2023). Digital economy in Southeast Asia: challenges, opportunities and future development, *Southeast Asia: A Multidisciplinary Journal*, 23(1), 19-35. DOI: <https://doi.org/10.1108/SEAMJ-02-2023-0023>
- Ha, T.L. (2022). Effects of digitalisation on financialization: Empirical evidence from European countries, *Technology in Society*, 68, 101851. DOI: <https://doi.org/10.1016/j.techsoc.2021.101851>
- Ha, L.T., Huong, T.T.L., & Thanh, T.T. (2022). Is digitalisation a driver to enhance environmental performance? An empirical investigation of European countries, *Sustainable Production and Consumption*, 32, 230–247. DOI: <https://doi.org/10.1016/j.spc.2022.04.002>
- Hanisch, M., Goldsby, C.M., Fabian, N.E. & Oehmichen, J. (2023). Digital governance: A conceptual framework and research agenda, *Journal of Business Research*, 162. DOI: <https://doi.org/10.1016/j.jbusres.2023.113777>
- Hinings, B., Gegenhuber, T. & Greenwood, R. (2018). Digital innovation and transformation: An institutional perspective, *Information and Organization*, 28(1), 52-61. DOI: <https://doi.org/10.1016/j.infoandorg.2018.02.004>
- Isono, I. & Piliadi, H. (2023) ASEAN's digital integration: Evolution of framework documents. Economic Research Institute for ASEAN and East Asia (ERIA). ISBN:978-6025-460-48-7. <https://www.eria.org/uploads/media/Books/2023-ASEAN-Digital/ASEAN-Digital-Integration-ERIA-23Aug.pdf>. (Date of access: 10.10.2024)
- Javaid, M., Haleem, A., Singh, R.P. & Sinha, A.K. (2024). Digital economy to improve the culture of industry 4.0: A study on features, implementation and challenges, *Green Technologies and Sustainability*, 2. DOI: <https://doi.org/10.1016/j.grets.2024.100083>
- Jeong, Y. (2023). Regulatory approaches to strengthen digital, platform, and data economies, ADB Sustainable Development Working Paper Series No. 91, December 2023. Asian Development Bank. DOI: <http://dx.doi.org/10.22617/WPS230602-2>. (Date of access: 10.11.2024)
- Kaufmann, D. & Kraay, A. (2023). Worldwide Governance Indicators. 2023. Retrieved from: <https://www.govindicators.org>. (Date of access: 20.09.2024)
- Kaufmann, D., A. Kraay, A. & Mastruzzi, M. (2011). The worldwide governance indicators: Methodology and

- analytical issues, Hague Journal on the Rule of Law, 3(2), 220-246. DOI: <https://doi.org/10.1017/S1876404511200046>
- Kianpour, M., Raza, S. (2024). More than malware: unmasking the hidden risk of cybersecurity regulations. *International Cybersecurity Law Review*, 5, 169–212. DOI: <https://doi.org/10.1365/s43439-024-00111-7>
- Labhard, V. & Lehtimäki, J. (2022). Digitalisation, Institutions and Governance, and Growth: Mechanisms and Evidence. ECB Working Paper No. 2022/2735. Retrieved from: <https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2735~0173124e9e.en.pdf>. (Date of access: 10.10.2024)
- Mahusin, M. & Prilliadi, H. (2024). Strengthening ASEAN's Cybersecurity: Collaborative Strategies for Enhanced Resilience and Regional Cooperation, Economic Research Institute for ASEAN and East Asia: Policy Brief No. 2024-06. ISSN: 2086-8154. Retrieved from: <https://www.eria.org/uploads/Strengthening-ASEAN-Cybersecurity.pdf>. Date of access: 10.10.2024)
- Martinus, M. & Seth, F.N. (2023). Current key drivers of ASEAN Integration: Digital skills and mobilities, Perspective: ISEAS Yusof Ishak Institute (48), ISSN 2335-6677. Retrieved from: https://www.iseas.edu.sg/wp-content/uploads/2023/05/ISEAS_Perspective_2023_48.pdf. (Date of access: 11.10.2024)
- Mettler, T., Miscione, G., Claus, D. J. & Guenduez, A.A. (2024). Same same but different: How policies frame societal-level digital transformation, *Government Information Quarterly*, 41(2). DOI: <https://doi.org/10.1016/j.giq.2024.101932>
- Mia, M.A., Hossain, M.I & Sangwan, S. (2024). Determinants of digitalisation: Evidence from Asia and the Pacific countries. *Digital Transformation and Society*, 3(4), 340-358. DOI: <https://doi.org/10.1108/DTS-10-2023-0097>
- Mondejar, M.E., Avtar, R., Diaz, H.L.B., Dubey, R.K., Esteban, J., Gómez-Morales, A., Brett, H., Mbungu, N.T., Okolo, C.C., Prasad, K. A., She, Q., & Garcia-Segura, S. (2021). Digitalisation to achieve sustainable development goals: Steps towards a Smart Green Planet, *Science of The Total Environment*, 794. DOI: <https://doi.org/10.1016/j.scitotenv.2021.148539>
- Myovella, G., Karacuka, M. & Haucap, J. (2020). Digitalisation and economic growth: A comparative analysis of Sub-Saharan Africa and OECD economies, *Telecommunications Policy*, 44(2). DOI: <https://doi.org/10.1016/j.telpol.2019.101856>
- Nchake, M.A. & Shuaibu, M. (2022). Investment in ICT infrastructure and inclusive growth in Africa, *Scientific African*, 17. DOI: <https://doi.org/10.1016/j.sciaf.2022.e01293>
- Pandey, P. (2023). Navigating the Future: Building Trust in Digital Government Services Through Emerging Technologies, *The Workshop on Building Trust in Digital Government Services*, held from 11 to 12 September 2023 in Beirut, Lebanon. United Nations Economic and Social Commission for Western Asia (ESCWA). Retrieved from: <https://www.unescwa.org/sites/default/files/event/materials/BackgroundPaper-Trust-EmergTechs-En.pdf>. (Date of access: 10.10.2024)
- Paul, J., Ueno, A., Dennis, C., Alamanos, E., Curtis, L., Foroudi, P., Kacprzak, A., Kunz, W. H., Liu, J., Marvi, R., Nair, S. L. S., Ozdemir, O., Pantano, E., Papadopoulos, T., Petit, O., Tyagi, S., & Wirtz, J. (2024). Digital transformation: A multidisciplinary perspective and future research agenda. *International Journal of Consumer Studies*, 48(2). DOI: <https://doi.org/10.1111/ijcs.13015>
- Pedroni, P. (2001). Fully Modified OLS for Heterogeneous Cointegrated Panel, *Advances in Econometrics*, 15. DOI: [https://doi.org/10.1016/S0731-9053\(00\)15004-2](https://doi.org/10.1016/S0731-9053(00)15004-2)
- Pesaran, M.H. (2021). General diagnostic tests for cross-sectional dependence in panels, *Empirical Economics*, 60 (1), 13-50. DOI: <https://doi.org/10.1007/s00181-020-01875-7>

- Pesaran, M.H. and Yamagata, T. (2008). Testing slope homogeneity in large panels. *Journal of Econometrics*, 142 (1), 50-93. DOI: <https://doi.org/10.1016/j.jeconom.2007.05.010>
- Radanliev, P. (2024). Cyber diplomacy: defining the opportunities for cybersecurity and risks from Artificial Intelligence, IoT, Blockchains, and Quantum Computing, *Journal of Cyber Security Technology*, 10018. DOI: <https://doi.org/10.31224/3528>
- Reddy, P., Chaudhary, K. & Hussein, S. (2023). A digital literacy model to narrow the digital literacy skills gap, *Heliyon*, 9. DOI: <https://doi.org/10.1016/j.heliyon.2023.e14878>.
- Sari, I.K., Winasis, S., Pratiwi, I. Nuryanto, U.W. & Basrowi (2024). Strengthening digital literacy in Indonesia: Collaboration, innovation, and sustainability education, *Social Sciences & Humanities Open*, 10. DOI: <https://doi.org/10.1016/j.ssho.2024.101100>
- Sefrina, N. (2024). An Inclusive Digital Economy in the ASEAN Region. ERIA Discussion Paper Series No. 505. Economic Research Institute for ASEAN and East Asia. Retrieved at <https://www.eria.org/uploads/An-Inclusive-Digital-Economy-in-the-ASEAN-Region.pdf>. (Date of access: 10.11.2024)
- Vo, D.H. & Ho, C.M. (2023). The growth effects of financial integration in the ASEAN countries, *International Journal of Emerging Markets*, 1746-8809. DOI: <https://doi.org/10.1108/IJOEM-02-2022-0224>
- Xu, Q., Zhong, M. & Li, X. (2022). How does digitalisation affect energy? International evidence, *Energy Economics*, 107. DOI: <https://doi.org/10.1016/j.eneco.2022.105879>
- Yang, C., Gu, M. & Albitar, K. (2024). Government in the digital age: Exploring the impact of digital transformation on governmental efficiency, *Technological Forecasting & Social Change*, 208. DOI: <https://doi.org/10.1016/j.techfore.2024.123722>
- Asian Development Bank. (2024, September). Asian Development Outlook (ADO): September 2024. Asian Development Bank. <https://www.adb.org/sites/default/files/publication/995536/asian-development-outlook-september-2024.pdf>. (Date of access: 10.11.2024)



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12. APPENDIX

Table 3: Descriptive Statistics

Variable		Mean	SDev.	Max	Min
Institutions	overall	-0.1329	1.8044	3.6762	-2.9912
	spatial		1.8349	3.3760	-2.0720
	overtime		0.5427	1.9138	-2.0010
Governance	overall	0.2789	2.5976	6.1858	-3.1152
	spatial		2.7290	5.8005	-2.7320
	overtime		0.4439	1.9700	-1.0673
Ins-growth effect	overall	-4.5641	22.8592	41.9349	-50.4277
	spatial		22.9819	37.5992	-30.2287
	overtime		7.6141	20.0489	-35.9238
Gov-growth effect	overall	-0.5859	32.1063	70.7679	-46.9398
	spatial		33.5584	64.5908	-40.0123
	overtime		6.3451	18.7051	-22.8832
Economic growth (ln)	overall	13.1132	2.6979	17.8927	10.1155
	spatial		2.8642	17.3281	10.4238
	overtime		0.2503	13.6779	12.4498
Human capital (ln)	overall	4.65893	0.0830	4.9748	4.5065
	spatial		0.0671	4.8027	4.5939
	overtime		0.0540	4.8310	4.5224
Fiscal	overall	11.81299	5.2925	29.3985	3.4603
	spatial		5.3259	22.7794	5.5926
	overtime		1.7494	18.4320	6.1745
Trade (ln)	overall	4.791347	0.5706	6.0806	3.4956

	spatial		0.5886	5.8798	3.8884
	overtime		0.1443	5.1716	4.3985
Inflation	overall	3.259238	3.6057	24.0968	-2.3149
	spatial		1.9536	5.9731	0.5647
	overtime		3.1054	23.5158	-4.2359

Source: The sample is from 2000-2023 for eight ASEAN countries. Authors' compilation.

Table 4: Cross sectional dependency and order of integration

Variable	(2) Cross sectional dependency test		(3) Second generation panel unit-root		
	CD test	ρ	CIPS (level)	CIPS (1 st difference)	Order of integration
Individual using the Internet (% of population)	24.15***	0.931	-1.719	-3.590***	I(1)
Fixed Broadband subscriptions (per 100 people)	22.31***	0.861	-1.151	-2.699***	I(1)
Mobile cellular subscriptions (per 100 people)	24.27***	0.936	-2.376**	-4.259***	I(0)
Institutions	7.34***	0.283	-2.169	-4.588***	I(1)
Governance	5.84***	0.225	-1.886	-4.563***	I(1)
Ins-growth effect	7.26***	0.280	-2.207	-4.599***	I(1)
Gov-growth effect	5.01***	0.193	-2.632***	-4.627***	I(0)
Economic growth (ln)	13.28***	0.512	-2.091	-4.117***	I(1)
Human capital (ln)	-0.51	-0.020	-1.349	-3.198***	I(1)
Fiscal	5.92***	0.229	-1.540	-4.124***	I(1)
Trade (ln)	3.94****	0.152	-1.393	-3.944***	I(1)
Inflation	11.44***	0.441	-3.161***	-4.966***	I(0)

Note: Symbols of ***, **, and * indicate 1%, 5% and 10% significance levels, respectively. Authors' compilation.

Table 6: Estimation results on the short-term effects using FGLS method

Digitalisation	Panel A: Individual using the Internet (% of population)		
	Equation (1)	Equation (2) : Institutions-growth effect	Equation (2): Governance- growth effect
Institutions	0.15071* (0.0862)	-1.9804*** (0.2159)	0.1996** (0.0805)
Governance	0.1766** (0.0768)	0.1459** (0.0614)	-1.8659*** (0.2687)
Ins-growth effect		0.1810*** (0.0164)	
Gov-growth effect			0.1714*** (0.0216)
Economic growth (ln)	0.0632 (0.0683)	0.2233*** (0.0568)	0.2489*** (0.0600)
Human capital (ln)	-3.2822*** (1.2068)	-1.8491** (0.9362)	-1.6541 (1.1112)
Fiscal	0.0252 (0.0176)	0.0365** (0.0156)	0.0453*** (0.0172)
Trade (ln)	-0.0924 (0.2172)	0.2774 (0.1829)	0.2237 (0.1980)
Inflation	0.0084 (0.0086)	0.0032 (0.0071)	0.0016 (0.0083)
Constant	17.4132*** (5.7992)	7.3234 (4.6319)	6.41234 (5.4195)
Obs	192	192	192
Wald Chi	116.03	737.34	469.53
P-value	0.0000	0.0000	0.0000
Digitalisation	Panel B: Fixed Broadband subscriptions (per 100 people)		
	Equation (1)	Equation (2) : Institutions- growth effect	Equation (2): Governance- growth effect
Institutions	0.0922 (0.1885)	-3.6152*** (0.6884)	0.1232 (0.1944)
Governance	0.5033***	0.5040***	-2.0809***

	(0.1598)	(0.1629)	(0.7495)
Ins-growth effect		0.3085***	
		(0.0512)	
Gov-growth effect			0.2206***
			(0.0622)
Economic growth (ln)	0.1185	0.4131***	0.3759***
	(0.1335)	(0.1179)	(0.1273)
Human capital (ln)	-5.5351**	-2.9311	-4.1462*
	(2.3402)	(2.3592)	(2.4107)
Fiscal	0.0190	0.5797*	0.0428
	(0.0295)	(0.0316)	(0.0299)
Trade (ln)	-0.2821	0.4594	0.1210
	(0.4541)	(0.4509)	(0.4469)
Inflation	0.0077	0.0058	0.0079
	(0.0161)	(0.0168)	(0.0166)
Constant	25.1337**	6.0836	13.9384
	(11.1527)	(11.3161)	(11.5501)
Wald Chi	82.46	248.9	138.9
P-value	0.0000	0.0000	0.0000

Digitalisation	Panel C: Mobile cellular subscriptions (per 100 people)		
	Equation (1)	Equation (2) : Institutions-growth effect	Equation (2): Governance-growth effect
Institutions	0.1118	-1.5929***	0.1317*
	(0.0758)	(0.3348)	(0.0788)
Governance	0.0659	0.0649	-1.0766***
	(0.0649)	(0.0645)	(0.3507)
Ins-growth effect		0.1481***	
		(0.0278)	
Gov-growth effect			0.1006***
			(0.0296)
Economic growth (ln)	0.0088	0.1449***	0.1142*
	(0.0607)	(0.0552)	(0.0603)

Human capital (ln)	1.9869** (1.0269)	-1.1199 (1.0403)	-1.4433 (1.0424)
Fiscal	0.0029 (0.0121)	0.0109 (0.0122)	0.0089 (0.0124)
Trade (ln)	-0.1879 (0.1923)	0.0073 (0.1879)	-0.1373 (0.1912)
Inflation	0.0103 (0.0071)	0.0075 (0.0072)	0.0092 (0.0073)
Constant	14.0201* ** (4.8590)	7.6056 (4.9661)	10.1492 (4.9907)
Wald Chi	25.22	85.75	52.92
P-value	0.0000	0.0000	0.0000

Note(s): Standard errors are in parentheses; the symbols of ***, **, and * statistically significant at 10, 5, and 1 percent, respectively. Source: Authors' compilation.

Table 7: Estimation results on the long-term effects using FMOLS method

Digitalisation	Panel A: Individual using the Internet (% of population)			Panel B: Fixed Broadband subscriptions (per 100 people)			Panel C: Mobile cellular subscriptions (per 100 people)		
	(1)	(2) :	(2):	(1)	(2) :	(2):	(1)	(2) :	(2):
		Ins- growth effect	Gov- growth effect		Ins- growth effect	Gov- growth effect		Ins- growth effect	Gov- growth effect
Institutions	0.18***	2.83***	0.15***	0.08***	17.62***	0.04***	0.07**	12.67***	0.06***
	4.53	7.62	6.03	-3.42	10.75	-2.53	2.54	15.67	4.38
Governance	-0.11	-0.11***	5.11***	-0.59***	-0.70***	7.69***	-0.04***	-0.15***	-8.54***
	1.56	-4.47	5.50	-3.73	-9.86	3.32	-9.41	-11.07	-4.29
Ins-growth effect		-0.23***			-1.28***			-0.73***	
		-7.18			-10.66			-15.47	

Gov-growth effect			-0.36***			-0.66***		0.67***	
			-5.58			-3.66		3.92	
Economic growth (ln)	1.89***	65.19***	2.91***	4.86***	4.40***	12.32***	2.41***	0.11***	5.23***
	56.45	-15.32	46.02	45.13	25.07	36.65	57.90	27.79	44.89
Human capital (ln)	-0.13***	-0.11***	-0.22***	0.59***	0.03***	-1.85***	1.02***	0.12***	-1.02***
	-9.16	-15.32	-3.61	-14.68	-11.63	-9.27	-14.53	-11.51	-5.33
Fiscal	0.03***	0.02	0.02***	0.11***	0.09*	0.10***	0.02***	0.01***	0.00
	-6.15	1.10	3.31	-7.51	-1.93	-3.41	-10.59	-2.65	-0.88
Trade (ln)	0.25	0.26***	0.15	-0.34***	-0.45***	-0.65***	-0.83***	-0.90***	-0.94***
	0.76	10.94	1.63	-9.22	-12.39	-18.61	-17.36	-19.15	-18.28
Inflation	-0.01***	-0.01	-0.01***	0.02**	-0.01***	0.01**	0.01***	0.00***	0.01***
	-4.91	-18.01	-6.79	2.23	-6.49	-2.20	6.94	5.64	9.23

Note(s): t-statistics are in parentheses; the symbols of ***, **, and * statistically significant at 10, 5, and 1 percent, respectively. Authors' compilation.