

Impact of e-government development, economic growth and government management efficiency on financial performance of commercial banks in ASEAN countries

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Received 7 April 2025

Revised 14 May 2025

16 June 2025

24 June 2025

Accepted 14 July 2025

Abstract

Purpose – The purpose of this research is to reveal the influence of the E-Government Development Index (EGDI), Economic Growth (GDPG) and the Worldwide Governance Indicators (WGI) on the financial performance of commercial banks across ten ASEAN countries. The EGDI includes the Telecommunication Infrastructure Index (TII), Human Capital Index (HCI) and Online Services Index (OSI). WGI components consist of Political Stability and Absence of Violence (PVE), Regulatory Quality (RQE), Voice and Accountability (VAE), Control of Corruption (CCE), Government Effectiveness (GEE) and Rule of Law (RLE). In addition, this study aims to assess how digital governance (EGDI) and institutional quality contribute to banking efficiency and profitability of commercial banks in ASEAN, measured by Return on Assets (ROA).

Design/methodology/approach – Research approach according to the Resource-Based View and Institutional Theory, the sample consisted of 113 observations collected from commercial banks in ASEAN from 2016 to 2024, utilizing balanced panel data. The data are collected from the World Bank, United Nations, Global Financial Development and the Alfred.stlouisfed.org. The study uses the Lasso regression model, using R data processing software to identify the factors of EGDI, GDPG and WGI that impact on performance of commercial banks in ASEAN.

Findings – This research suggests that ASEAN governments increasingly recognize the strategic role of digital governance (EGDI) in enhancing bank performance. Among the EGDI components, TII exhibits a significant positive association with ROA, while HCI and OSI do not yet produce comparable effectiveness. The components of WGI, PVE, RQE and VAE positively influence ROA. Conversely, CCE shows a negative effect. Although GEE and RLE do not show significant direct impacts, they remain essential for institutional development through improving the WGI index. Besides, GDPG has a positive impact on ROA, but the level of impact is not significant.

Research limitations/implications – First, the analysis is confined to the period of 2016–2024 and relies on secondary data, potentially introducing biases from pre-aggregated data or measurement errors within the WGI and EGDI indices. Second, the LASSO model does not inherently address endogeneity. Endogeneity, stemming from correlations between independent variables and the error term, leads to biased and inconsistent estimates. Although Lasso selects key variables and shrinks coefficients, the underlying endogeneity persists, resulting in biased estimates. Incorporating bank-specific regulatory controls from ASEAN governments, such as capital adequacy ratios, bank size and non-performing loan (NPL) ratios, can enhance insights.

Practical implications – This research provides a unique contribution by specifically examining the components of the EGDI in ASEAN countries, focusing on a timeframe extending to 2024. The findings indicate that among the EGDI components, the TII has a positive relationship with ROA. However, the HCI and the OSI have not demonstrated equivalent effectiveness. Additionally, several components of the WGI, including PVE, RQE and VAE, had positively impacted ROA. In contrast, CCE has a negative effect, highlighting the need to manage cross-ownership and interest relationships within banks. Furthermore, GEE and RLE do not exhibit a direct or significant relationship in this study.

Social implications – To promote sustainable development within the banking sector, ASEAN governments should formulate long-term strategies aimed at digitizing the sector and implementing systematic, purposeful institutional reforms.

JEL Classification — G21, O16, O23

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Funding: This research was funded by Ho Chi Minh University of Banking, Vietnam.



Originality/value – While the relationship between governance, economic growth and banking performance has been widely studied, this research provides a unique contribution by specifically examining the components of the EGDI in ASEAN countries, focusing on a timeframe extending to 2024. The findings indicate that among the EGDI components, the TII has a positive relationship with ROA. However, the HCI and the OSI have not demonstrated equivalent effectiveness. Additionally, several components of the WGI, including PVE, RQE and VAE, had positively impacted ROA. In contrast, CCE has a negative effect, highlighting the need to manage cross-ownership and interest relationships within banks. Furthermore, GEE and RLE do not exhibit a direct or significant relationship in this study. To promote sustainable development within the banking sector, ASEAN governments should formulate long-term strategies aimed at digitizing the sector and implement systematic, purposeful institutional reforms.

Keywords EGDI, WGI, ROA, Commercial banks, ASEAN

Paper type Research article

1. Introduction

The digital era has brought significant changes across all business sectors, particularly banking, which has been the most strongly impacted (Berges *et al.*, 2016). Over the past few decades, the banking industry has made remarkable strides towards comprehensive digitalization (Manta *et al.*, 2024). This transformation has been driven by artificial intelligence (AI), the development of financial technologies, blockchain technology and big data analytics (Darnida *et al.*, 2024). These innovations enable banks to offer more personalized services (Kaur *et al.*, 2021) while enhancing operational efficiency and improving customer experiences on an unprecedented scale (Varalakshmi and Katta, 2024). According to Omarini (2016), these global trends are not only changing how banks operate but also setting new standards for customer expectations. However, digital transformation poses numerous regulatory and compliance challenges (Vasiljeva and Lukanova, 2016), and the rapid pace of technological development has outstripped regulations and created uncertainty for banks (Valentina and Samoilova, 2024). Banks must ensure that digital improvements comply with both domestic and international regulations, which can often become complex and time-consuming processes (Pazarbasioglu *et al.*, 2020). According to Oyewole *et al.* (2024), banks also face increasingly severe cybersecurity threats due to the rise in online transactions (Stanikzai and Shah, 2021). To mitigate risks, the banking system and regulatory bodies need to continuously enhance security measures and implement appropriate legal deterrents.

In the context of globalization and ongoing digital transformation, the banking sector in various countries faces increasing pressure to adapt to new technologies, improve operational efficiency and meet rising customer expectations (Munira, 2025). Innovation in the banking sector is not only a strategic choice but also a vital requirement for maintaining competitiveness and financial stability, while innovation in banking operations is understood as the process of introducing and applying new technologies, processes, products or business models to optimize operations and enhance customer value (Berges *et al.*, 2016). Since the 2000s, the global banking industry has witnessed a major shift in the way financial services are delivered, from digitizing transactions and applying AI to implementing comprehensive digital banking platforms. Innovation includes product innovation (such as mobile banking), process innovation (automated loan processing) and business model innovation (platform banking) (Sharma, 2019).

In the ASEAN context, banking innovation is fragmented because of differences in economic development and digital infrastructure. The rapid advancement of digital technologies has profoundly reshaped the banking industry. For example, Singapore is considered the fintech hub of the region, while many banks in Myanmar or Laos are still modernizing their basic technology infrastructure (Wang *et al.*, 2024). All of this raises questions about the impact of innovation on banking financial performance in each specific context. Several studies have shown that banking innovation can improve operational efficiency by reducing transaction costs, increasing revenue from new services and improving

customer satisfaction (Mbama *et al.*, 2018; Hakizimana *et al.*, 2023). Currently, as banks transform their operations towards digitalization, governments must take the first steps to support the digitalization of commercial banks. And the EGDI published periodically by the United Nations has become one of the important indicators reflecting the level of technological readiness and public administration efficiency of a country, which can indirectly affect the operations of financial institutions such as commercial banks. Younus *et al.* (2023) found that, by providing best governance practices to citizens, governments need to focus on improving EGDI. Importantly, it is necessary that e-government be understood and initiatives are not just about governance transformation or providing quality services, but also about South Asian countries keeping pace and competing with other countries in the development process (Younus *et al.*, 2023).

In the ASEAN region, differences in the development of e-government and levels of innovation among countries have sparked important questions about how these factors relate to the financial performance of commercial banks. While specific countries such as Singapore and Malaysia have developed e-government ecosystems and a strong digital banking infrastructure, others including Laos, Cambodia and Myanmar are still in the early stages of digital transformation (Curtis *et al.*, 2022). The COVID-19 pandemic accelerated digital adoption and transformation, creating unprecedented demand for online services (e-commerce, digital payments, education and healthcare) in Southeast Asia (Curtis *et al.*, 2022). The study by El-Chaarani *et al.* (2023a, b, c) revealed that the pandemic negatively impacted financial performance, increasing credit risk but not significantly affecting capital adequacy. To address these challenges, banks need to implement effective credit risk management strategies to maintain profitability. Furthermore, research by El-Chaarani *et al.* (2023b) highlighted that liquidity creation and efficient asset management are crucial for sustaining bank profits during difficult times. Additionally, robust corporate governance mechanisms contribute to improved financial performance during crises (El-Chaarani *et al.*, 2022). Moreover, a study by El Nemar *et al.* (2022) emphasized that small and medium-sized enterprises must leverage human capital and social resources to create sustainable competitive advantages. In uncertain times, developing brand reputation and enhancing credibility are vital for success. Thus, digital transformation is not just a trend but a critical factor that enables banks and businesses to navigate challenges, improve performance and strengthen their positions in the market. Despite increasing technology adoption, digital skill levels and literacy in Southeast Asia still lag behind the pace of usage and infrastructure. This is a priority area for post-COVID economic recovery. Anindya *et al.* (2024) showed that ASEAN countries experienced late technological adoption, and that the digital divide and poverty are recurring problems in developing countries in the ASEAN region (aside from Singapore, which was ranked third globally in e-government in 2012). Due to these challenges, it is not uncommon for Southeast Asian countries to have limited or minimal e-government conduct.

While there are many studies assessing the impact of either innovation or e-government alone on banking performance, very few studies integrate both factors into the same analytical model. Nguyen (2019) and Muizzuddin *et al.* (2021) also researched governance factors affecting the operational efficiency of ASEAN commercial banks, but these only address the component indicators of the Worldwide Governance Indicators (WGI) and not the simultaneous impact of EGDI and WGI on the operational efficiency of commercial banks in ASEAN. This is the first research gap that has not been addressed in the ASEAN region.

Some recent studies on the operational efficiency of banks affirm the importance of corporate governance for the operational efficiency and stability of the banking sector (El-Chaarani *et al.*, 2022; El-Abiad *et al.*, 2023; El-Chaarani *et al.*, 2023a, b, c; El-Chaarani and El-Abiad, 2024). Factors such as the board independence and committee effectiveness (such as audit, risk and compliance) all showed a positive impact on the operational efficiency and stability of banks. These studies were conducted in different contexts regarding geographical scope and comparisons between different countries, with various research phases (before, during and after the financial crisis and Covid-19), using different research methods such as

linear regression, the Mann–Whitney U test, fixed effects regression (FEM) and GMM. Some studies focus on the impact of public legal protection and political connections (El-Chaarani *et al.*, 2022, 2023a, b, c), while others concentrate on the construction and testing of GIB.X62 QTDN indices (El-Abiad *et al.*, 2023; El-Chaarani and El-Abiad, 2024). However, these all focus on governance issues in the banking sector, particularly in the context of the financial crisis and COVID-19, to identify factors affecting the operational efficiency of banks, without addressing aspects of e-government or the impact of EGDI component indices on the operational efficiency of banks, especially in the ASEAN region. This is the second gap this research aims to fill.

In ASEAN countries where disparities in technological and administrative development are evident and significant (Anindya *et al.*, 2024), this gap offers a compelling opportunity to examine whether innovation and the advancement of e-government genuinely influence banking financial performance. This paper contributes to that gap by proposing a research model to study the factors of EGDI, WGI affecting the financial performance of commercial banks (ROA) in ASEAN countries. The EGDI includes the telecommunications infrastructure index (TII), Human Capital Index (HCI), Online Services Index (OSI) and WGI, which consist of six components: PVE, RQE, VAE, CCE, GEE and RLE. This study aims to evaluate how digital governance (EGDI) and institutional quality contribute to banking efficiency and profitability, as measured by ROA. The analysis will be conducted on commercial bank data in ten ASEAN countries in the period 2016–2024, using the Least Absolute Shrinkage and Selection Operator (Lasso) technique with R data processing software. By synthesizing related previous studies and providing a quantitative model with the research results obtained, this paper contributes an academic and practical perspective for both policymakers and banking professionals in ASEAN countries.

A review of recent studies in developing countries and the ASEAN region (Majeed, 2020; Mono, 2021; Castro and Lopes, 2022; Curtis *et al.*, 2022; Anindya *et al.*, 2024) reveal that the role of e-government indicators on banking performance in the ASEAN region and the EGDI plays a significant role in enhancing the operational efficiency of banks and the economy as a whole. However, these studies have not investigated the specific role of e-government indicators on banking performance, particularly in the context of the ASEAN region, which is undergoing a strong digital transformation with many countries investing in communication to improve public services (Fitriyanti, 2024; Erh, 2023; Chuc and Anh, 2023; Do *et al.*, 2022). Furthermore, studies in the ASEAN region have yet to clarify the interplay of WGI components and EGDI on the ROA of banks (see Appendix). Moreover, expanding the dataset to 2024 is essential to capture timely changes in the context of post-COVID digital transformation, when the demand for online services surged. This acceleration has placed substantial pressure on banks to enhance performance and meet rising customer expectations. Therefore, this study aims to provide valuable insights into the relationship between EGDI, WGI and the financial performance of commercial banks in the ASEAN region.

Thus, this research investigates the impact of EGDI, GDPG and WGI on the financial performance of commercial banks in ASEAN countries. The objective is to provide policy implications for ASEAN governments in formulating long-term strategies to digitize the banking sector, designing purposeful and systematic institutional reforms and implementing coherent policies related to the EGDI and WGI. These efforts aim to support sustainable development within the region's banking industry.

The structure of the paper is as follows: Section 2 enunciates the literature on theoretical framework, including the Resource-Based View (RBV) and Institutional Theory, and examines the relationships among the EGDI, GDPG and WGI in relation to bank performance, measured by ROA. Section 3 outlines the research model, data sources and methodology. Section 4 presents the empirical findings and provides an interpretation. Finally, Section 5 summarizes the main results, discusses policy implications, notes research limitations and suggests directions for future studies.

2. Literature review

2.1 Theoretical framework

2.1.1 *The Resource-Based View (RBV)*. This theory (Barney, 1991) offers a framework for understanding how a firm achieves and sustains a competitive advantage. The RBV suggests that sustainable competitive advantage stems from a firm's selection of resources and its ability to build capabilities. This includes a mix of both tangible and intangible assets, such as managerial skills, organizational processes and routines, as well as the information and knowledge that the firm possesses (Barney, 2001). In essence, this perspective claims that differences in profitability among companies can be traced to variations in their resource portfolios. Čater and Čater (2009) further argued that resources and capabilities can also create internal linkages within an organization.

2.1.2 *Institutional theory*. According to Greif (2006), institutions are systems of intangible social factors (rules, beliefs, norms and organizations) that constitute patterns of behavior. North (1990) posits that institutions can explain human behavior by enacting and enforcing laws and can regulate behavior, perceptions and choices, while Haggard and Tiede (2011) argued that stable and robust institutions stimulate economic growth. Rodrik *et al.* (2004) have demonstrated that institutions are more important than factors related to culture or geography and have a significant influence on the development of nations (Robinson, 2012). Effective economic institutions encompass a commitment to and guarantee of secure property rights, freedom of enterprise, promotion of competition, dispute resolution and facilitation of innovation (El-Chaarani *et al.*, 2023a, b, c). Conversely, ineffective institutions create monopolies, lack dispute resolution mechanisms and generate barriers to market entry (Acemoglu *et al.*, 2014). Institutions impact investor behavior when participating in the market (investing capital, human resources and technology in business operations) and affect the distribution of wealth, thereby stimulating economic development (Acemoglu *et al.*, 2014). Institutions contribute to: reducing transaction costs; sharing risks; creating spillover effects through the sharing of information and knowledge between individuals and communities; fostering community cohesion; and protecting the ecological environment, thereby ensuring sustainable development (World Bank, 2012a, b). They also motivate individuals within banks to comply with relevant regulations and laws (Elamer *et al.*, 2020). Moreover, the characteristics of institutions in each country correlate with the level of risk undertaken by banks (Nguyen, 2022; El-Chaarani and El-Abiad, 2024).

The theoretical foundation of this research is derived from the integration of the RBV and Institutional Theory. RBV emphasizes the strategic importance of internal capabilities and resource configuration in enhancing organizational performance. Within this framework, advancements in e-government are conceptualized as significant external resources, as they provide access to critical information, public services and channels for engagement that can influence organizational operations. Additionally, macroeconomic conditions, specifically economic growth, contribute to a more resource-rich and supportive environment, while proficient government governance facilitates the equitable and effective allocation of these resources. This study employs RBV to investigate the influence of external factors, such as e-government development and economic expansion, on the financial performance of commercial banks, particularly considering how these institutions strategically manage their reliance on such resources to improve outcomes.

On the other hand, Institutional Theory asserts that organizations conform to prevailing institutional norms, values and regulatory frameworks to secure legitimacy and access to essential support from state entities, which subsequently affects their performance. In this context, EGDI, GDPG and governmental effectiveness are identified as salient institutional dimensions. E-government initiatives are associated with increased transparency, improved accountability and streamlined administrative processes, which collectively compel organizations to adapt to evolving institutional expectations (El-Chaarani *et al.*, 2023a, b, c). Economic growth tends to stabilize the institutional environment, while effective governance introduces clear regulatory standards and norms. Organizations that strategically

align with these institutional elements are more likely to experience enhanced financial performance, as legitimacy fosters investor confidence and institutional compliance promotes operational efficiency. Together RBV and Institutional Theory form a robust theoretical framework to explain the digital capability transformation of the banking sector and digital government activities in ASEAN governments and the banking industry. RBV emphasizes the importance of internal resources, such as technology and human capital, when enhancing banking performance. Meanwhile, Institutional Theory provides the institutional context, demonstrating that political, legal and social environments influence the ability to adopt digital technologies (Sukarno and Nurmandi, 2023). This combination enables banks to effectively leverage resources, driving innovation and service improvements. Hence, the hypotheses are:

- H1. EGDI had a positive impact on the ROA of commercial banks in ASEAN countries.
- H2. WGI has an impact on the ROA of commercial banks in ASEAN countries.
- H3. GDPG had a positive impact on the ROA of commercial banks in ASEAN countries.

2.2 E-government development index and banking performance

According to the [United Nations E-Government \(2018\)](#), EGDI is understood to be a composite measure that assesses the level of e-government development in a country, based on three main components: TII, HCI and OSI. Every two years, the Division for Public Institutions and Digital Government under the United Nations Department of Economic and Social Affairs (UNDESA) provides an overview of the e-government development ranking of 193 UN member states. EGDI reflects the government's readiness to apply information technology to deliver public services, enhance management efficiency and improve interactions between the government and citizens and businesses ([United Nations, 2022](#)). This index reflects the overall digital environment of a country, which is a decisive factor for the development of electronic banking services and financial technology innovation. In countries with high EGDI, the government usually plays a supportive role in the digitalization process of the private sector through policies, infrastructure and digital ecosystems, which can promote the development of digital banking, reduce legal risks and increase market accessibility. Conversely, countries with low EGDI may create barriers to banking innovation due to a lack of supporting systems ([Nambassa and Nurmandi, 2024](#)).

In the context of contemporary globalization, the quality of governance in countries is increasingly recognized as a crucial factor affecting the financial performance of businesses, including banks. The trend of digitalization in the financial sector has prompted amendments to banking laws to adapt to changes in technology and geopolitics ([Afanasiev and Kandinskaia, 2021](#)). This includes adjusting the legal framework to support digital technologies and address challenges in the digital context ([Yang and Gu, 2021](#)). In addition to complying with international governance standards to ensure sustainability and competitiveness, promoting the growth of commercial banks is essential as governments enhance their digital capabilities. [Haruna and Alhassan \(2022\)](#) provide compelling evidence that digitalization is related to a reduction in the informal economy in Africa, which indicates that EGDI positively influences banking performance by improving the reliability and accessibility of financial services. Furthermore, [Alhassan \(2023\)](#) shows that achieving a level of digital infrastructure development in government is crucial for effective participation of migrants, reducing transaction costs and enhancing formal entrepreneurship based on remittances through the banking system, thereby aiding economic growth in these countries. [Sukarno and Nurmandi \(2023\)](#) showed that the biggest challenge for countries in the ASEAN region (except for Singapore and Brunei Darussalam) is to improve their infrastructure to enable the use of digital mobile governance in the public sector.

However, in ASEAN, there are not many studies focusing on this relationship in the specific context of commercial banks. This research will analyze the impact of EGDI on the performance

of commercial banks, clarifying the relationship between government digitalization policies and bank performance, particularly as ASEAN governments enhance digital transformation to improve competitiveness in the context of global economic integration.

Accordingly, the hypothesis is defined as follows:

H1a. The OSI had a positive impact on the ROA of commercial banks in ASEAN countries.

H1b. The TII had a positive impact on the ROA of commercial banks in ASEAN countries.

H1c. The HCI had a positive impact on the ROA of commercial banks in ASEAN countries.

2.3 Worldwide Governance Indicators and financial performance of commercial banks in the era of digital transformation

In the era of digital transformation, the quality of national governance plays an increasingly important role in the financial performance of commercial banks, particularly in the ASEAN region. The trend of banking digitalization is currently growing strongly in ASEAN countries. An effective governance system with transparent laws and good oversight mechanisms helps banks operate stably, attract investment and minimize compliance costs. In this context, the WGI becomes a crucial metric. The WGI, developed by the World Bank, measures six key aspects: Political Stability and Absence of Violence (PVE), Regulatory Quality (RQE), Voice and Accountability (VAE), Control of Corruption (CCE), Government Effectiveness (GEE) and Rule of Law (RLE). These factors reflect the institutional and legal environment of a country, which is a vital foundation that directly influences banking operations (Kaufmann and Kraay, 2024).

The development of banks is not only related to advancements in banking technology in the digital context but also depends on compatibility with the government's governance system. Elamer *et al.* (2020) showed that the existence of defined political, economic and financial regulations motivates banking actors to comply with regulations and laws. In countries with low WGI, banks are more prone to legal risks, technological fraud and lack of trust from users, all factors that diminish profitability and competitiveness (Afanasiev and Kandinskaia, 2021).

Moreover, technological innovation is occurring faster than policy adjustments, putting pressure on financial authorities to establish appropriate legal frameworks (Abikoye *et al.*, 2024). Therefore, countries need to invest in specialized resources to stay ahead of new business models. According to the World Bank (2012a, b), improving transparency and accountability (a component of WGI) will support banks' development in a stable business environment. At the same time, high-quality governance from the government contributes to favorable conditions for banks to effectively adopt technology (Huang, 2022).

Thus, WGI can be considered an important factor affecting the financial performance of banks in the digital age. Improvements in governance not only enhance market confidence but also help commercial banks operate more sustainably in the face of increasingly fierce global competition (Mia *et al.*, 2024).

Accordingly, the hypotheses are stated as follows:

H2a. PVE has an impact on the ROA of commercial banks in ASEAN countries.

H2b. RQE has an impact on the ROA of commercial banks in ASEAN countries.

H2c. VAE has an impact on the ROA of commercial banks in ASEAN countries.

H2d. CCE has an impact on the ROA of commercial banks in ASEAN countries.

H2e. GEE has an impact on the ROA of commercial banks in ASEAN countries.

H2f. RLE has an impact on the ROA of commercial banks in ASEAN countries.

3. Research methodology**3.1 Research model and data**

The data for this research are secondary data, collected from banks in ten ASEAN countries, including Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam from 2016 to 2024. In this study, data processing software R is used, and the proposed research model is as follows:

$$\begin{aligned} \text{ROA}_{it} = & \beta_1 + \beta_2 \text{OSI}_{it} + \beta_3 \text{TII}_{it} + \beta_4 \text{HCI}_{it} + \beta_5 \text{CCE}_{it} + \beta_6 \text{RLE}_{it} + \beta_7 \text{VAE}_{it} + \beta_8 \text{PVE}_{it} \\ & + \beta_9 \text{GEE}_{it} + \beta_{10} \text{RQE}_{it} + \beta_{11} \text{GDPG}_{it} + \beta_{12} \text{INF}_{it} + e_{it} \end{aligned} \quad (3.1)$$

where:

The E-Government Development Index (EGDI) includes the OSI, TII and HCI collected from the United Nations (<https://publicadministration.un.org>); WGI includes RLE, CCE, VAE, PVE, GEE and RQE collected from the World Bank; GDPG is the GDP growth rate ($\text{GDP}_t - \text{GDP}_{t-1} / \text{GDP}_{t-1}$) collected from World Bank; INF is the inflation rate measured by the Consumer Price Index ($(\text{CPI}_t - \text{CPI}_{t-1}) / \text{CPI}_{t-1}$) collected from World Bank. Data on the ROA were averaged across all commercial banks in each country and were collected from Global Financial Development and Alfred.stlouisfed.org.

The sample consisted of 113 observations collected from commercial banks in the ASEAN region from 2016 to 2024 using balanced panel data, selected for their representativeness and diversity in terms of size, business models and geographical locations. The period from 2016 to 2024 was chosen to analyze the comprehensive impact of digital transformation in governments on the operational efficiency of banks in ASEAN countries. This timeframe includes significant milestones in the digitization efforts of ASEAN governments, ranging from initial e-government initiatives to more recent and extensive digital transformation strategies. By examining data within this period, the study aims to identify emerging trends in e-government development, assess the effectiveness of various government initiatives and understand how digital transformation affects the operational efficiency of banks. Additionally, this timeframe allows for an examination of the economic context, including the EGDI and GDP growth, and their influence on the operational efficiency of banks in the ASEAN region.

Moreover, the period from 2016 to 2024 marks significant milestones in the digitalization efforts of ASEAN governments, especially after the COVID-19 pandemic. Most countries in the region have accelerated their digital transformation and the development of online public services, applying digital technology to enhance healthcare services and support businesses. Specifically, during and after the pandemic, Singapore developed the [Digital Government Blueprint \(2020\)](#) to improve public services. Malaysia launched the (MyDIGITAL) ([Government of Malaysia, 2021](#)), aimed at promoting the digital economy and enhancing online public services, with the goal of a developed digital economy and high income. Indonesia implemented the National Digital Transformation Strategy (2020), focusing on digital infrastructure and ecosystem, contributing positively to the national digital transformation strategy, especially during 2020–2021. Thailand executed the Thailand 4.0 strategy to enhance economic competitiveness. Vietnam introduced the National Digital Transformation Program until 2025, with orientation toward 2030 ([Government of Vietnam, 2020](#)), outlining specific goals for the national digital transformation process, along with the E-Government Development Strategy 2021–2025, vision toward 2030 ([Government of Vietnam, 2021](#)). The Philippines launched the [National Broadband Plan \(2020\)](#) to develop Internet infrastructure, with various phases to improve Internet connectivity in the country. Myanmar focused on the Myanmar Digital Economy Roadmap (2019) while the Myanmar Digital Economy Roadmap 2030, with efforts starting in 2020–2021 to enhance digital infrastructure and services ([Digital Economy Development Committee, 2019](#); [Ministry of](#)

Commerce & Digital Economy Development Committee, 2024). These policies reflect the efforts of governments to promote digital transformation and modernize public services, aiming for a sustainable, developed digital economy.

There are several methods to measure the operational efficiency of banks, including Return on Assets (ROA), Return on Equity (ROE) and Net Interest Margin (NIM) (Loan *et al.*, 2024). However, during the data collection process for researching the operational efficiency of banks in ASEAN, it was found that only the ROA data have the longest and most comprehensive time series available for the banking sector from 2016 to 2024. Therefore, to measure the operational efficiency of banks in ASEAN, ROA is used, as this metric is comprehensive for this period on Alfred.stlouisfed.org for banks in the region.

The data in the research were collected from many sources and were all highly reliable (e.g. UN, WB). However, to ensure data accuracy, the study performed data cleaning, checking consistency in measurements and detecting/handling missing values. An alternative method was used to estimate missing WGI values for 2024. Specifically, the EGDI has been collected and published biennially since 2001 under the United Nations E-Government Survey: Benchmarking E-government Development initiative. Based on available information, EGDI reports have been released every two years, with most underlying data sources updated annually, although a few are updated every two to three years. To ensure data synchronization, this study relies on the years in which the EGDI was published (specifically 2016, 2018, 2020, 2022 and 2024) across the ten ASEAN countries. Regarding the WGI data, it was updated biennially from 1996 to 2002. Since 2002, it has been updated annually. However, in this study, WGI data were collected in alignment with the EGDI index every two years. Therefore, the 2023 WGI figures are based on that year's data as the World Bank has not updated the WGI index for 2024 to align with the data collected under the EGDI.

Although the data were collected from reliable sources (e.g. UN, WB), to ensure the accuracy of the regression model and minimize errors, multicollinearity diagnostics were conducted to adjust or eliminate unnecessary variables (Gujarati, 2021). The presence of potential multicollinearity among independent variables is a concern in this study, particularly when considering composite variables such as EGDI and WGI. EGDI comprises components such as TII, HCI and OSI, which are closely interrelated. For instance, developed TII can directly influence the quality of HCI through improved access to information and education, while also affecting the quality and prevalence of OSI, thereby leading to a high degree of correlation among these components.

Similarly, the WGI encompasses six indicators related to governance and government effectiveness: PVE, RQE, GEE, VAE and CCE. These indicators often reflect similar aspects of economic development and governance, creating strong linkages. In the context of ASEAN countries, political, economic and social factors are frequently interconnected, increasing the likelihood that the component indicators of WGI and EGDI are not independent but rather mutually related (Nguyen, 2019; Thach *et al.*, 2021). This significantly heightens the potential for multicollinearity within the model.

To address this issue, multicollinearity diagnostics was conducted and the correlation statistics among the variables were examined using a correlation matrix to determine the strength and direction of the relationships between independent and dependent variables, thereby gaining a clearer understanding of how these variables interact (Gujarati, 2021). Following data cleaning, transformations and multicollinearity diagnostics, the study performed regression analyses using the Lasso method with R data processing software, with detailed results presented in Section 4.

3.2 Research method

To mitigate the potential issue of multicollinearity among independent variables, this study employed the Least Absolute Shrinkage and Selection Operator (Lasso) technique. Lasso serves as a regularization method that simultaneously conducts variable selection and

regularization, thereby effectively reducing the coefficients of less significant variables toward zero (Tibshirani, 1996). This approach facilitates the identification of the most relevant variables within the model while reducing the detrimental impact of multicollinearity (Altelbany, 2021; Enwere et al., 2023). According to Altelbany (2021), in a study comparing multiple regression techniques – specifically Ridge, Elastic Net and Lasso regression – for their effectiveness in addressing varying levels of multicollinearity, one key finding indicates that the Lasso method produces the most accurate coefficient estimates when the dataset exhibits severe multicollinearity and the sample size is below 10,000 observations. Thus, the regression technique used is also dependent on the type of data and parameters being considered (Abhishek, 2021; Enwere et al., 2023).

The Lasso technique has the capability to improve the predictive power and interpretability of statistical models with multiple input variables. While traditional linear regression can be adversely affected by too many independent variables or high correlations among them, Lasso provides an efficient solution through normalization and variable selection. One of Lasso's prominent strengths is its ability to perform two tasks simultaneously: shrinkage and variable selection. By adding a constraint (L1) to the loss function, specifically the sum of the absolute values of the regression coefficients, Lasso can force some coefficients to be exactly zero. This means that Lasso not only reduces the complexity of the model but also automatically eliminates unimportant variables, making the model more interpretable and helping to avoid overfitting (Thach and Diep, 2022). Lasso regression is ideal for panel data, given its ability to manage temporal variation and diversity across entities. Thus, Lasso regression is appropriate for panel data because it effectively addresses both temporal variation and cross-sectional diversity. This capability enables the study of variables through time and across nations, thereby providing an in-depth analysis of evolving trends and interconnections among variables. The LASSO estimator minimizes the following objective function:

$$\min \beta \left[\sum_{i=1}^n \left(y_i - \sum_{j=1}^p \beta_j x_{ij} \right)^2 + \lambda \sum_{j=1}^p |\beta_j| \right] \quad (3.2)$$

where y_i is the dependent variable (ROA) for observation i ; x_{ij} is the value of the j -th independent variable for observation i ; β_j is the coefficient for the j -th independent variable; λ is the tuning parameter that controls the strength of the regularization; n is the number of observations; and p is the number of independent variables (Thach and Diep, 2022).

In addition, the interesting point of the Lasso method can solve the multi-community problem. Lasso can handle multicollinearity:

Lasso performs regularization by adding an L_1 penalty term to the loss function:

$$\min \sum_{i=1}^n (y_i - y_i) + \lambda \sum_{j=1}^p |\beta_j| \quad (3.3)$$

When the independent variables exhibit multicollinearity (high correlation), Lasso tends to: (1) keep one variable from a group of highly correlated variables; and (2) eliminate (shrink to zero) the remaining correlated variables. As a result, Lasso both reduces the number of variables (feature selection) and mitigates the impact of multicollinearity.

Compared to ridge regression, a well-known regression technique that uses L2 regularization, Lasso has a distinct advantage in variable selection. Ridge regression only shrinks coefficients toward zero without eliminating them, resulting in a model that is not as streamlined as those produced by Lasso. In scenarios where the number of variables exceeds the number of samples ($p > n$) or when many variables are insignificant, Lasso typically yields better results in terms of both predictive performance and interpretability. With its ability to automatically reduce data dimensionality, Lasso helps save computational resources and improve algorithm efficiency. Given these advantages, the Lasso method was employed to

address the regression model (3.1). Moreover, multiple independent variables such as the component indicators of EGDI, the component indicators of WGI, GDPG and INF were also used. Lasso regression helps identify and select the most important variables among the component factors of EGDI and WGI, minimizing the influence of unnecessary variables and thereby focusing on the key factors that impact financial performance. The results are presented in the research findings.

4. Research findings

The results in [Table 1](#) indicate that the variables in the research model exhibit significant differences in mean values, standard deviations and ranges of variation, reflecting the level of volatility among ASEAN countries during the period from 2016 to 2024. Key descriptive statistics are summarized as follows:

Beyond presenting mean values, standard deviations and ranges of variation which reflect the level of volatility among the variables, [Table 1](#) also reports the Variance Inflation Factor (VIF) values to detect and quantify the extent of multicollinearity within the multiple regression model. The results indicate that, although the VIF value for RLE is under 10 at 9.49, a VIF above 5 is generally considered an indication of significant multicollinearity ([Gujarati, 2021](#)). The 9.49 VIF coefficient of RLE also suggests a strong linear correlation between RLE and other independent variables in the model. Similarly, GEE also has a VIF of 9.01, very close to the threshold of 10. This signifies a considerable degree of multicollinearity, potentially affecting the reliability and stability of the estimated coefficients for GEE and RLE. However, as discussed in [Section 3.2](#), the Lasso method will be employed to address this multicollinearity issue.

[Table 2](#) presents the results of the correlation matrix, highlighting several noteworthy relationships among the variables. Specifically, GEE exhibits a high correlation with RLE, with a coefficient of 0.8810, indicating that improvements in governmental management are closely associated with stronger legal institutions. Similarly, GEE shows a strong correlation with the OSI, at 0.8275, suggesting a significant link between government effectiveness and the development of online public services. The correlation between GEE and PVE is also high, at 0.8934, implying that enhanced government management can lead to improved public sector efficiency. On the other hand, ROA demonstrates relatively weak correlations with variables such as OSI and the TII, suggesting the need for further investigation through regression analysis in [Table 3](#) to better understand the relationship between financial performance and technology-related factors.

The regression results in [Table 3](#) indicate that the Lasso regression eliminates variables with coefficients equal to or near zero, in contrast to the Ridge regression method. The findings

Table 1. Descriptive statistics of variables

Variable	Mean	Std. dev	Min	Max	Mean	VIF
ROA	113	1.1006	0.5562	0.0002	2.5425	–
OSI	113	0.4838	0.2749	0.0236	1.0000	6.19
TII	113	0.3655	0.2994	0.0026	0.9881	4.06
HCI	113	0.7276	0.1235	0.4608	0.9362	2.68
CCE	113	–0.3070	1.0326	–1.6728	2.3011	6.50
GEE	113	0.0568	1.0395	–1.7528	2.4697	9.01
PVE	113	–0.1396	0.8732	–2.1957	1.4775	5.12
RLE	113	–0.2751	0.9152	–1.7363	1.8354	9.49
RQE	113	–0.1984	1.0089	–2.3486	2.3086	6.50
VAE	113	–0.7872	0.7836	–2.2080	1.2480	3.61
GDPG	113	8.7608	8.4230	13.5220	15.870	1.52
INF	113	4.1819	6.5783	–5.1400	12.643	1.68

Source(s): Results from R software

Table 2. Correlations matrix

	ROA	OSI	TII	HCI	CCE	GEE	PVE	RLE	RQE	VAE	GDPG	INF
ROA	1.0000											
OSI	0.1891	1.0000										
TII	0.1971	0.6634	1.0000									
HCI	0.2026	0.5329	0.1338	1.0000								
CCE	0.2457	0.6363	0.6637	0.5136	1.0000							
GEE	0.2342	<i>0.8275</i>	0.6924	0.5610	0.7418	1.0000						
PVE	0.0541	0.4244	0.5052	0.1839	0.6885	<i>0.8934</i>	1.0000					
RLE	0.2869	0.2111	0.6948	0.5446	0.6640	<i>0.8810</i>	0.6314	1.0000				
RQE	0.2651	0.6761	0.6436	0.4925	0.6759	0.6155	0.6016	0.6018	1.0000			
VAE	0.4593	0.6125	0.3805	0.4430	0.5889	0.6582	0.1052	0.5968	0.6212	1.0000		
GDPG	-0.1942	-0.3132	-0.3924	0.1543	-0.2710	-0.2284	-0.2114	-0.2322	-0.2221	-0.2121	1.0000	
INF	-0.4643	-0.4203	0.2784	-0.2300	-0.3176	0.4073	-0.0960	-0.3865	-0.4200	-0.5150	0.3418	1.0000

Note(s): Italic values are automatically highlighted by the software (R) to indicate relatively high correlation coefficients (above 0.80).

Source(s): Results from R software

Table 3. Lasso regression results

	Ridge regression Coef.	$P > t $	Lasso regression Coef.	$P > t $
(Intercept)	1.81679	0.000	1.92211	0.000
OSI	-0.52367	0.216	-0.35405	0.012
TII	0.45308	0.002	0.27803	0.084
HCI	-0.38937	0.469	-0.54138	0.002
CCE	0.00185	0.049	-0.20300	0.056
GEE	0.06670	0.807	0	-
PVE	0.16210	0.150	0.10102	0.084
RLE	-0.16830	0.647	0	-
RQE	0.12732	0.245	0.07552	0.074
VAE	0.41427	0.000	0.37040	0.000
GDPG	0.00185	0.001	0.00045	0.094
INF	-0.02647	0.000	-0.02480	0.074

Source(s): Results from R software

reveal that the EGDI has not significantly enhanced the ROA of ASEAN commercial banks. Specifically, two components of EGDI (OSI and HCI) have a negative impact on ROA, while the remaining component, TII, has a positive effect. This suggests that upgrading TII has positively influenced the ROA of banks in ASEAN. However, the enhancement of TII has not been adequately matched by improvements in HCI and the synchronization of OSI. Consequently, the overall improvement of the EGDI has not been fully aligned and has not positively impacted the ROA of banks.

The results presented in [Table 3](#) are consistent with the advantages of the Lasso method. The findings indicate that among the highly correlated variables, Lasso regression retains only the PVE variable, while the coefficients of GEE and RLE are reduced to zero (and are thus excluded from the model) to mitigate multicollinearity issues. This outcome further demonstrates that the Lasso method effectively addresses high correlation and multicollinearity among variables in the research model ([Altelbany, 2021](#)).

The results in [Table 3](#) demonstrate that the TII has a significant positive correlation with the ROA of commercial banks in ASEAN. This finding supports RBT and is consistent with current practices. A country with a well-developed TII, extensive coverage, high connection speeds and affordable costs enables the swift implementation of government regulations relevant to commercial banks. A robust TII is essential for the development and delivery of effective e-government services ([Von Haldenwang, 2004](#); [Kibria and Hong, 2024](#)). The research findings also indicate that the HCI and OSI have a negative impact on ROA. This suggests that the scope and quality of public services offered online by the government, as well as the extent to which information and communication technology is employed to communicate with commercial banks in ASEAN countries, have yet to produce positive outcomes. This aligns with the situation in ASEAN nations, because among the ten countries in this study, only Singapore is classified and ranked as a developed nation; the remaining nine countries- Malaysia, Thailand, Indonesia, the Philippines, Vietnam, Brunei, Laos, Cambodia and Myanmar – are all developing nations and at various stages of developing online services, ranging from providing basic information to facilitating complete transactions.

The results in [Table 3](#) show that three components of the WGI index (PVE, RQE and VAE) have a positive impact on the ROA of banks in ASEAN. This finding contrasts with [Nguyen \(2019\)](#), who also examined the impact of WGI components (PVE and VAE) on the operational efficiency of banks in ASEAN. Similarly, [Muizzuddin et al. \(2021\)](#) found that VAE and PVE had a negative impact on the operational efficiency of Asian commercial banks from 2011 to 2019. The dataset used in this study did not find any significant effect from the two WGI

components, GEE and RLE. This result is consistent with those of [Muizzuddin et al. \(2021\)](#), who also found no impact from RLE but did find that GEE affected the operational efficiency of commercial banks. This demonstrates that different research periods reveal different impacts of the component factors of the WGI. This result further supports institutional theory and RBT, suggesting that the development of e-government contributes to enhancing government management efficiency through the establishment of clear rules and norms, and the rapid dissemination of legal regulations to commercial banks via EGDI. This contributes to increasing the confidence of bank managers in the government's legal system (PVE, RQE), allowing them to freely participate in relevant organizations, express themselves and simultaneously monitor bank operations against existing and newly enacted government regulations (VAE). The finding in this study regarding the positive impact of CCE on the operational efficiency of banks is also consistent with the findings in [Muizzuddin et al. \(2021\)](#), which indicates that ASEAN governments have gradually improved the level of corruption control, contributing to improved operational efficiency in banks in ASEAN.

The results in [Table 3](#) also show that the negative impact of CCE on the ROA of banks in ASEAN countries, as identified in this study, is a noteworthy finding that contrasts with the results of [Thach et al. \(2021\)](#). CCE reflects the efficiency of governmental administration and public governance ([Tehulu et al., 2025](#)) and, when CCE is low, political and administrative instability may elevate operational risks for the banking sector and political connections; increased cross-ownership among bank managers will lead to politically pressured lending, increasing bad debts ([El-Chaarani and Lombardi, 2022](#)).

This result aligns with the current context of the ASEAN region, where political transitions and social reforms have not been substantial enough to induce significant improvements in banking operations. Except for countries such as Singapore, Brunei, Indonesia, Malaysia and Vietnam – which have maintained a relatively stable political environment – several ASEAN member states continue to experience political instability. Notable examples include: (1) Myanmar, which remains in a deep crisis following the military coup in 2021, with ongoing violent clashes between the military, resistance forces and ethnic minority groups; (2) armed conflict between Thailand and Cambodia, which led the Cambodian government to maintain troops in the Mom Bei area of Preah Vihear province, asserting territorial claims following a border skirmish with Thailand on May 28, 2025; (3) the Philippines continues to face internal challenges such as corruption, drug trafficking and insurgency activities, all of which undermine political stability; and (4) Cambodia and Laos, which are increasingly dependent on major powers (e.g. China) and grappling with governance issues and a weak business and investment environment, contributing to latent political instability. These instabilities may erode investor and customer confidence, thereby adversely affecting the ROA of banks operating in the ASEAN region.

Findings in [Table 3](#) further indicate that both the HCI and the OSI exert a negative yet statistically insignificant influence on bank profitability, as measured by ROA, across ASEAN countries. The HCI represents the quality of human capital and access to education, whereas the OSI evaluates the effectiveness of online government services ([Sukarno and Nurmandi, 2023](#)). A low HCI suggests that banks may encounter difficulties in recruiting and retaining highly skilled personnel, which can lead to suboptimal performance. Similarly, the provision of digital public services remains limited in many ASEAN countries ([Anindya et al., 2024](#)). This limitation reveals that banks continue to face significant obstacles in conducting and managing digital transactions, as uneven technological advancement and delayed adoption of digital solutions present major challenges for ASEAN governments. These findings are consistent with observations by [Anindya et al. \(2024\)](#) in their research on the EGDI in the ASEAN context.

Additionally, the control variables GDPG and INF also impact the ROA of commercial banks in the ASEAN region. The results presented in [Table 3](#) indicate that GDPG has a positive effect on ROA, which aligns with the findings of [Bui \(2020\)](#) and [Azura et al. \(2024\)](#). However, this positive impact is not statistically significant. This result is consistent with the current

context in ASEAN countries, where the per capita GDP remains relatively low compared to developed economies. Although ASEAN economies have experienced impressive GDP growth rates recently, the scale of the economy and the financial markets in the ASEAN region remain modest (Anindya *et al.*, 2024). Moreover, a bank's profitability may be more strongly influenced by internal factors, such as risk management, operational efficiency and business strategy, as well as institutional factors such as governance quality and corruption control (El-Chaarani *et al.*, 2022; El-Chaarani *et al.*, 2023a, b). This indicates that overall GDP growth is not the sole determining factor for bank profitability.

The results in Table 3 also indicate that INF negatively affects ROA. This is consistent with the studies of De Leon (2020), Khan *et al.* (2021) and Azura *et al.* (2024), which highlight the significant negative impact of inflation on the operational efficiency of banks in the ASEAN region. These findings reveal the complex relationship between inflation and bank profitability, particularly in the context of ASEAN economies during the period from 2016 to 2024. During this time, the ASEAN region experienced various inflationary fluctuations, transitioning from relatively stable levels to those exacerbated by the COVID-19 pandemic, which disrupted global supply chains and led to rising inflation rates. High inflation may erode the real value of long-term loans, thereby decreasing the ROA of banks if lending rates do not adjust promptly to the increased cost of capital. Furthermore, a high inflation environment often accompanies rising operational costs for banks, including personnel, technology and management expenses, which diminishes a banks' net profits and negatively impacts ROA.

5. Conclusion

5.1 Theoretical implications

This research not only provides policy insights but also has significant theoretical implications, particularly in refining the RBV theory and enriching the Institutional theory in the context of emerging economies and digital governance (EGDI).

5.1.1 Refining the RBV in a digital governance context. The RBV emphasizes that sustainable competitive advantage for organizations stems from effectively leveraging unique resources and capabilities. This study demonstrates that digital capabilities (measured by EGDI) are not just a resource but a critical strategic capability shaping bank performance (ROA) in the ASEAN region. Specifically, a developed EGDI, especially its TII components, helps banks optimize processes, reduce costs and expand customer reach, thereby improving ROA. This research extends the RBV by indicating that external resources related to national governance (WGI) are not merely environmental factors but also hidden or potential resources that banks can leverage to build a competitive advantage. A stable political environment (PVE), regulatory quality (RQE) and citizen participation (VAE) create a conducive setting for exploiting banks' internal resources and boosting performance. Conversely, deficiencies in corruption control (CCE) can act as barriers, eroding the effectiveness of internal resources, which reinforces the notion that the institutional context is an indispensable part of the resource base organizations rely on for sustainable competitive advantage.

5.1.2 Advancing institutional theory in emerging economies. This study enriches Institutional Theory by providing empirical evidence of how institutional factors (WGI) interact with EGDI to influence organizational performance (ROA) in emerging economies such as those in the ASEAN region. The findings regarding the impact of WGI components on ROA suggest that institutional quality is a crucial determinant of whether banks can effectively harness the potential of digital transformation. In emerging economies, where institutions might be weaker or evolving, the role of good governance (including political stability, regulatory quality and corruption control) becomes paramount in mitigating risks, fostering transparency and promoting innovation, thereby directly affecting the operational efficiency of financial institutions. The research also highlights that the implementation of e-government (EGDI) is a significant form of institutional change, creating a more favorable environment for the development of the financial sector, which illustrates the interplay between institutional

reforms (as captured by WGI and EGDI) and bank performance, an area warranting deeper exploration in transitional economies.

The results support the RBV theory and Institutional Theory and indicate that, while the relationship among governance, economic growth and banking performance has been widely studied, this research makes a unique contribution by specifically examining the components of the EGDI in ASEAN countries, focusing on a timeframe extending to 2024. The findings indicate that, among the EGDI components, the TII has a positive relationship with ROA, but the HCI and the OSI have not demonstrated equivalent effectiveness. Additionally, several components of the WGI, including PVE, RQE and VAE, positively impacted ROA. In contrast, CCE has a negative effect, highlighting the need to manage cross-ownership and interest relationships within banks. Furthermore, GEE and RLE do not exhibit a direct or significant relationship in this study. It is essential to improve the coordination and efficiency of online services in both the public and private sectors. This will help create a stable, secure and user-friendly digital environment for businesses and consumers, thereby contributing to a safer operational framework for the banking system. To ensure that the EGDI effectively enhances bank performance, it is crucial to advance three components: TII, HCI and OSI, in an integrated and balanced manner. ASEAN governments should formulate long-term strategies aimed at digitizing the sector and implement systematic, purposeful institutional reforms.

5.2 Practical implications

This study examines the effects of the EGDI, GDPG and WGI on the financial performance of commercial banks, which is measured by ROA in ASEAN countries. Using the Lasso regression method, the analysis is based on a dataset comprising 113 observations gathered from commercial banks across ten ASEAN nations between 2016 and 2024. The research findings indicate that EGDI has a positive impact on the financial performance of commercial banks in the ASEAN region (supporting hypothesis H1). Furthermore, the study confirms that the WGI has a significant impact on the ROA in ASEAN countries (supporting hypothesis H2), with several components of the WGI, including PVE, RQE and VAE, are found to have specific positive impacts on ROA. In contrast, CCE demonstrates a negative impact, suggesting the need for enhanced oversight of cross-ownership and related-party transactions within banks. While GEE and RLE do not exhibit a direct or significant relationship in this study, they remain fundamental to strengthening broader institutional frameworks. Finally, GDP demonstrates a positive relationship with ROA, although the magnitude of this impact is not statistically significant (supporting hypothesis H3), and INF has a negative impact on ROA. The results indicate that ASEAN governments have become increasingly aware of the significance of digital transformation across all economic sectors, including e-government management. The results also reveal that improvements in the TII have positively influenced banks' ROA in the ASEAN region. These results provide specific policy and management implications for policymakers, banking regulators in ASEAN countries, as follows:

- (1) *Fostering Government Digital Transformation and Digital Infrastructure:* ASEAN governments must intensify investment in critical TII, which has demonstrated a positive impact on bank ROA. This includes expanding broadband, developing 5 G/6G networks and establishing data centers through public-private partnerships. However, given the current disparity between TII advancements and the quality of HCI and OSI, governments should simultaneously reform and upgrade the quality of the digital workforce. Developing comprehensive training strategies and advancing technological skills within the banking sector and related industries is crucial to fully harness the benefits of digital transformation. Recognizing the uneven EGDI development with Singapore as a leader, other ASEAN countries need to strengthen cooperation, learn from and exchange experiences with Singapore on EGDI implementation and operation through a multi-stakeholder approach involving governments, the private sector and civil society. A strategic cooperation roadmap

between the remaining ASEAN countries and Singapore is essential to foster sustainable and inclusive digital development. Nations with advanced EGDI scores can play a vital role in assisting less developed countries by sharing expertise and technology and through joint training programs and initiatives. The ultimate goal is to enhance banking operational efficiency and promote economic growth, while encouraging governments to adopt long-term, sustainable digital technology policies aimed at strengthening the efficiency of financial and banking systems.

- (2) *Enhancing the National Governance Environment:* Governments in ASEAN countries must focus on governance factors that positively impact ROA, in particular, strengthening PVE, establishing transparent RQE and encouraging VAE, which are essential for the sustainable development of the banking sector. Conversely, the CCE negatively affects ROA, indicating that persistent corruption remains a significant barrier. Therefore, enhanced oversight of cross-ownership and related-party transactions within banks is crucial. To improve CCE, three strategic initiatives are recommended: prioritizing public–private partnerships in digital infrastructure development; adopting transparent e-governance frameworks (digital transaction records, blockchain-based procurement, open-access data portals) to reduce corruption opportunities; and establishing regional anti-corruption task forces and cross-border compliance standards by banking regulators to promote institutional integrity and boost investor confidence. Governments must also take stronger measures in order to mitigate improper relationships within banks, especially where cross-ownership facilitates preferential lending. Long-term, effective anti-corruption initiatives are vital for cultivating a fair and transparent business environment. Although GEE and RLE did not show a significant direct impact in the current study, they remain foundational to economic stability and financial system efficiency, and thus should be continuously reinforced.
- (3) *Managing Macroeconomic Factors and Inflationary Risks:* ASEAN governments need to proactively manage macroeconomic factors. The study’s results indicate inflation’s negative impact on ROA, necessitating that banks adjust their asset-liability management and risk strategies to maintain profitability in a challenging macroeconomic environment. To address inflationary pressures, governments in these countries should collaborate closely with central banks to control inflation through prudent monetary policies (adjusting interest rates, managing money supply) and fiscal policies (controlling public spending and taxation) aimed at achieving price stability. Such coordinated efforts are essential to foster a favorable macroeconomic environment that supports the banking sector’s operations and overall economic health in the region. Simultaneously, maintaining steady GDP growth is a pivotal factor for enabling sustainable development in the banking sector.

5.3 Research limitations and future perspectives

Although research offers significant empirical insights into the impact of EGDI, GDPG and WGI on the ROA of commercial banks in ASEAN countries, it is not without limitations. First, the analysis is confined to the period of 2016–2024 and relies on secondary data, potentially introducing biases from pre-aggregated data or measurement errors within the WGI and EGDI indices. The EGDI indices were collected from the United Nations and the data from the World Bank; however, these datasets are not updated annually, but rather biennially, which may result in indices that do not accurately reflect the current situation.

Second, the Lasso regression model does not inherently address endogeneity. Endogeneity, stemming from correlations between independent variables and the error term, leads to biased and inconsistent estimates, for example, endogeneity potentially being influenced by factors

including GEE and GDPG. Conversely, ROA might also affect investment decisions in technology and government efficiency. Furthermore, EGDI could potentially impact GDPG and the WGI and vice versa. Although Lasso selects key variables and shrinks coefficients, underlying endogeneity persists, resulting in biased estimates. The application of Lasso, a shrinkage technique primarily designed for variable selection and overfitting prevention through coefficient penalization, cannot rectify this bias.

Consequently, to address the limitations mentioned above, future studies should expand the timeframe and scope of analysis to gain a more comprehensive understanding of the fluctuations and trends affecting EGDI and WGI in the banking and digital governance sectors. Additionally, when examining variables with multiple component factors such as EGDI and WGI, subsequent research may consider employing elastic net regression or Bayesian variable selection methods as suitable alternatives, as these approaches can effectively address multicollinearity issues and ensure consistency in the selection of variable groups. Therefore, when researching variables with multiple component factors, such as EGDI and WGI, elastic net regression and Bayesian variable selection methods offer several advantages over the Lasso method. First, the elastic net combines both L1 and L2 penalties, which helps better address multicollinearity issues by retaining multiple variables in the model and adjusting their weights, thereby improving the accuracy of estimates. Second, this method allows researchers to adjust the ratio between the two penalties, optimizing the model for specific situations. Third, Bayesian variable selection provides a comprehensive approach to assessing uncertainty in variable selection, enhancing consistency in model choice. These advantages indicate that elastic net and Bayesian variable selection are viable options for future research in the fields of banking and digital governance.

Furthermore, the inclusion of bank-specific regulatory controls implemented by ASEAN governments (e.g. capital adequacy ratios, bank size, non-performing loan ratios, single performance measure, cross-country comparability issues) could offer additional perspectives. Capital adequacy influences banks' lending and investment capacities, affecting GDP growth. Bank size can impact financial stability and resilience to economic shocks, thereby influencing CPI and elevated NPL ratios can restrict lending and impede economic growth. Integrating these factors would yield a more nuanced understanding of the interplay between government policies, banking sector stability and macroeconomic performance in the ASEAN region, representing a promising direction for future research.

Supplementary material

The supplementary material for this article can be found online.

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