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The relationship between technology infrastructure and bank credit: How should management promote ASEAN economies?

1. Introduction

Nowadays, the global economy is significantly influenced by improvements in technology infrastructure, particularly in information and communications technologies (ICT) (Pradhan et al., 2015a). ICT is a term that combines information and communication technologies, focusing on technologies that enable users to create, access, and manipulate information. Apparently, ICT is recognized as a crucial component of modern technology infrastructure, with numerous applications widely used across the world (Pradhan et al., 2015b). Technology infrastructure is considered a fundamental prerequisite for economic development, as demonstrated by the following channels: (1) Technology infrastructure enhances collaboration within the economy (Fitjar & Rodríguez-Pose, 2013) and creates new employment opportunities (Nair & Vaithilingam, 2012); (2) Technology infrastructure allows households and businesses easier access to information and resources for business development (Quibria

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et al., 2002), even overcoming geographical barriers (Pradhan et al., 2015b); (3) Technology infrastructure improves access to products and services at reasonable costs (Tang et al., 2007); (4) Technology infrastructure can contribute to improving firm productivity (Entner, 2008); (5) Technology infrastructure enhances a country's potential for innovation (Nair & Shariffadeen, 2009), promotes economic restructuring (Lee & Brahmasrene, 2014), and notably improves governance capabilities in an economy's public and private sectors (Kalam, 2003).

Additionally, economic growth is considerably dependent on bank credit. Indeed, bank credit is a key indicator of banking development, playing a crucial role in financing investment and production, which in turn promotes economic growth (Schumpeter, 1911). Empirical evidence shows that banking development can affect economic growth through the following channels: (1) Banks reallocate resources from less productive sectors to more productive ones, thereby fostering economic growth (Patrick, 1966); (2) Banks facilitate the promotion of savings and investment within the economy (King & Levine, 1993); (3) Banks make it easier for individuals and businesses to obtain capital, especially by lowering the cost of capital (Alfaro et al., 2004); (4) Banks can assist borrowers in improving risk management, thereby reducing uncertainty in the economy (Greenwood & Jovanovic, 1990).

Moreover, there may exist a causal relationship between technology infrastructure and bank credit. For instance, improvements in technology infrastructure can help banks more easily collect and disseminate information to various stakeholders, reducing information asymmetry (Morck et al., 2000). It also enables banks to provide products and services more quickly and efficiently (Pradhan et al., 2015a). Generally, bank credit services rely heavily on technology infrastructure, covering stages of loan approval, disbursement and monitoring. Conversely, bank credit provides essential financial resources for countries to improve their technology infrastructure, even fostering business activities. This, in turn, motivates countries to enhance their technology infrastructure to support business operations (Pradhan et al., 2015a). Thus, technology infrastructure and bank credit may be causally related. However, there is limited empirical research examining this relationship. Notable studies include the research of Shamim (2007), which found a bidirectional relationship between ICT infrastructure and financial sector development, and Pradhan et al. (2015a), which identified a causal link between ICT infrastructure and financial development.

Empirical evidence shows that the impact of technology infrastructure and bank credit on economic growth has been examined in a large number of studies. These studies primarily focus on the supply-leading hypothesis, suggesting that technology infrastructure and bank credit are prerequisites for economic growth (Pradhan et al., 2015a). However, a major limitation of the existing empirical research is the insufficient consideration of the causal relationship between technology infrastructure and bank credit in analyzing their effects on economic growth. Pradhan et al. (2015a), who examined data from Next-11 countries, is one of the few empirical studies on this issue. It is evident that the causal relationship between technology infrastructure and bank credit can potentially alter the individual impact of each factor on economic growth. Therefore, the lack of adequate consideration of this causal relationship when analyzing the effects of technology infrastructure and bank credit on economic growth represents a significant gap in the current literature. Moreover, the results on this issue may vary across different regions, highlighting the need for gathering empirical evidence from diverse areas of the world to enrich the existing literature.

To address this gap, this study aims to analyze the causal relationship between technology infrastructure and bank credit, while also examining the impact of this relationship on economic growth in ASEAN economies. In other words, the study concentrates on answering the following questions: (1) What is the impact of technology infrastructure and bank credit on economic growth in ASEAN economies? (2) Is there a causal relationship between technology infrastructure and bank credit in ASEAN economies? (3) How does the causal relationship between technology infrastructure and bank credit affect economic growth in ASEAN economies? By addressing these questions, the relationship between technology infrastructure and bank credit, as well as their impact on economic growth in ASEAN economies, will be fully and comprehensively examined. The findings are also expected to provide ASEAN economies with valuable and meaningful insights.

2. Literature review

The origins of economic growth are a common topic in classical theories and empirical research. The determinants of economic growth can be categorized into three main groups: (1) The first group focuses on capital accumulation, which includes human and physical capital; (2) The second group emphasizes industrial innovation and related technologies; (3) The third group addresses spillover

and impacts from external economies. In this study, the authors concentrate on examining the first two groups, specifically the impacts of technology infrastructure and bank credit on economic growth. Furthermore, the authors also investigate the causal relationship between technology infrastructure and bank credit in these effects.

2.1. The relationship between technology infrastructure and bank credit

The relationship between technology infrastructure and bank credit has been explored in several empirical studies. These studies suggest that improvements in technology infrastructure have facilitated banks in collecting and disseminating information to various stakeholders, thereby mitigating information asymmetry (Morck et al., 2000). Moreover, strong technology infrastructure enables banks to quickly and effectively supply products and services (Pradhan et al., 2015a). In fact, the development of technology infrastructure significantly boosts bank credit activities, which are stages of loan approval, disbursement, and monitoring. In other words, bank credit services rely substantially on technology infrastructure. On the other hand, bank credit provides significant financial resources for countries to advance their technology infrastructure and foster technological innovation. Furthermore, credit financing can stimulate business activities, thus motivating countries to further improve their technology infrastructure in order to facilitate business operations (Pradhan et al., 2015a).

It is evident that there can be a causal relationship between technology infrastructure and bank credit. However, there are very few empirical studies examining this relationship. One notable study by Shamim (2007) examined the relationship between ICT infrastructure and financial sector development in 61 countries. This study found that ICT infrastructure had a positive impact on financial sector development in 49 of the 61 countries included. It also revealed the influence of financial sector development on ICT infrastructure in the Netherlands, Nigeria, Spain, Switzerland, Thailand, and the USA. Furthermore, the study demonstrated a bidirectional causal relationship between ICT infrastructure and financial sector development in Austria, China, France, Italy, Korea, and Malaysia. In another study, Sassi and Goaied (2013) argued that ICT infrastructure positively impacts economic growth in MENA countries. However, financial sector development negatively affects economic growth in these countries. Notably, ICT infrastructure can reinforce the role of the financial sector in promoting economic growth within

MENA nations. Subsequently, Pradhan et al. (2015b) found a positive effect of ICT infrastructure and financial development on economic growth in Asian countries in both the short and long term. A further study by Pradhan et al. (2015a) examined the causal relationship among ICT infrastructure, financial development, and economic growth in Next-11 countries. This study revealed a close relationship between ICT infrastructure and financial development, indicating that they mutually support each other. Additionally, each of them exhibited a positive correlation with economic growth.

2.2. The impact of technology infrastructure on economic growth

The impact of technology infrastructure on economic growth is a topic explored in numerous empirical studies. Theoretically, technology infrastructure is considered an exogenous factor influencing economic growth, as demonstrated by various economic growth theories (Pradhan et al., 2015b). Empirical research on the effects of technology infrastructure on economic growth primarily aligns with the supply-leading hypothesis (Pradhan et al., 2015a).

The proponents of the supply-leading hypothesis argue that technology infrastructure is a prerequisite for economic growth (Pradhan et al., 2015b). Specifically, technology infrastructure facilitates greater access to information, products, services, and markets for individuals and enterprises (Asongu & Odhiambo, 2020). This access enables them to improve productivity, foster innovation, and create wealth, thereby promoting economic growth (Pradhan et al., 2015a). In other words, technology infrastructure supports the production process (Gosavi, 2018) and increases savings as well as investment (Asongu & Odhiambo, 2020), which are critical foundations for driving economic growth (Vu, 2019). The positive effect of technology infrastructure on economic growth has also been reported in several empirical studies. For instance, Yousefi (2011) noted a significant positive effect of technology on economic growth, which was particularly strong in developed countries. In agreement, Kumar et al. (2015) asserted that investment in technology is essential for promoting economic growth in the Fiji Islands. Providing a more detailed perspective, Kumar and Stauvermann (2016) affirmed that mobile technology positively affects economic growth in both the short and long term, which is particularly significant for the education, healthcare, and agriculture sectors. Hussain et al. (2021) demonstrated that the level of internet penetration plays a more crucial role than mobile subscription penetration in promoting economic growth across four

South Asian economies including India, Pakistan, Bangladesh, and Sri Lanka. Nguyen and Doytch (2022) found a positive impact of technology patents on economic growth in 26 advanced economies; however, this effect was negative in 17 emerging economies. More recently, Bakry et al. (2023) argued that declines in ICT infrastructure could lead to severe consequences for economic growth in 27 countries worldwide.

2.3. The impact of bank credit on economic growth

Bank credit is an important indicator representing the development of banking and the financial system within each country. Furthermore, bank credit plays a vital role in financing investment and production, ultimately contributing to economic growth (Schumpeter, 1911). In fact, the development of banks greatly influences economic stability (Bagehot, 1873) and even helps countries navigate financial crises and other non-economic crises (Pradhan et al., 2015a). Therefore, the impact of bank credit on economic growth is extensively explored in numerous empirical studies. Among these, the focus is primarily on the supply-leading hypothesis. Specifically, this hypothesis emphasizes the importance of financial sector development in general, and banking development in particular, in promoting economic growth (Pradhan et al., 2015a). Accordingly, banking development can influence economic growth through the following ways: (1) Banks play a role in reallocating resources from less productive sectors to more productive industries, thereby promoting economic growth (Patrick, 1966); (2) Banks facilitate savings and investment within the economy (King & Levine, 1993); (3) Banks support households and companies to access capital, particularly by minimizing the cost of capital (Alfaro et al., 2004); (4) Banks can help borrowers in improving their risk management capabilities, which will lessen economic uncertainty (Greenwood & Jovanovic, 1990). The positive impact of bank credit on economic growth has been found in several empirical studies. For instance, Schumpeter (1934) was at the forefront of proposing the hypothesis regarding the impact of financial sector development on economic growth. Subsequently, the positive effects of bank credit have been demonstrated in numerous empirical studies, including those by Wolde-Rufael (2009), Khoutem et al. (2014), Menyah et al. (2014), Abdulsalam et al. (2015), Samargandi and Kutan (2016), Thierry et al. (2016), Ibrahim and Alagidede (2018), Botev and Jawadi (2019), Wang et al. (2019), and Ho and Saadaoui (2022).

Despite this, some empirical studies have revealed a negative impact of bank credit on economic growth. For instance, Levine (2005) concluded that excessive

credit growth, if not used effectively, could hinder long-term economic growth. This finding was also supported by Pagano and Pica (2012) in their analysis of OECD countries, as well as by Cournède and Denk (2015) in their study of both OECD and G20 countries.

3. Research methodology

The existing literature proves that economic growth can be influenced by technology infrastructure (Bakry et al., 2023; Hussain et al., 2021; Kumar et al., 2015; Kumar & Stauvermann, 2016; Nguyen & Doytch, 2022; Yousefi, 2011) and bank credit (Abdulsalam et al., 2015; Botev & Jawadi, 2019; Ho & Saadaoui, 2022; Ibrahim & Alagidede, 2018; Khoutem et al., 2014; Menyah et al., 2014; Samargandi & Kutan, 2016; Sassi & Goaied, 2013; Thierry et al., 2016; Wang et al., 2019; Wolde-Rufael, 2009). Also, technology infrastructure and bank credit may be causally associated (Pradhan et al., 2015a; Shamim, 2007). Based on this foundation, the authors model the simultaneous relationship of these factors using the PVAR method developed by Abrigo and Love (2015). This approach was also adopted by Pradhan et al. (2015a). In particular, the variables in the model were first-differenced to eliminate the correlation between country-specific effects and the explanatory variables, following what Arellano and Bond (1991) suggested. Therefore, the research model proposed by the authors has the following equations:

$$DEG_{it} = \sum_{k=1}^{n} \delta_{1k} DEG_{it-k} + \sum_{k=1}^{n} \delta_{2k} DTI_{it-k} + \sum_{k=1}^{n} \delta_{3k} DBC_{it-k} + \sum_{k=1}^{n} \delta_{4k} DCV_{it-k} + \varepsilon_{1it} \quad (1)$$

$$DBC_{it} = \sum_{k=1}^{n} \alpha_{1k} DBC_{it-k} + \sum_{k=1}^{n} \alpha_{2k} DTI_{it-k} + \sum_{k=1}^{n} \alpha_{3k} DEG_{it-k} + \sum_{k=1}^{n} \alpha_{4k} DCV_{it-k} + \varepsilon_{1it} \quad (2)$$

$$DTI_{it} = \sum_{k=1}^{n} \beta_{1k} DTI_{it-k} + \sum_{k=1}^{n} \beta_{2k} DBC_{it-k} + \sum_{k=1}^{n} \beta_{3k} DEG_{it-k} + \sum_{k=1}^{n} \beta_{4k} DCV_{it-k} + \varepsilon_{3it} \quad (3)$$

In particular, D represents the first difference of the variables in the research model. Economic growth (EG) is measured using the logarithm of GDP per

capita, aligning with the previous suggestions of Pradhan et al. (2015a, 2015b) and Asongu and Odhiambo (2020). Technology infrastructure (TI) specifically refers to ICT infrastructure and is determined using principal component analysis (PCA), which is based on three component indicators including fixed telephone subscriptions (% of population), mobile cellular subscriptions (% of population), and individuals using the internet (% of population) (Pradhan et al., 2015a, 2015b). Bank credit (BC) is represented by domestic credit to the private sector by banks (% of GDP) (Ho & Saadaoui, 2022; Pradhan et al., 2015a, 2015b). The control variables (CV) include government expenditure as a percentage of GDP (GE), foreign direct investment (net inflows) as a percentage of GDP (FDI), and trade as a percentage of GDP (TRA). These control variables are identified based on the studies of Ibrahim and Alagidede (2018), Botev and Jawadi (2019), and Asongu and Odhiambo (2020).

The measurement of the variable TI using the PCA method is described in table 1 as follows:

Table 1. Description of the measurement of technology infrastructure (TI)

Component	Fixed telephone subscriptions	Mobile cellular subscriptions	Individuals using the internet	TI
Weighting	20.79%	36.11%	43.10%	100%

Source: own study

The dataset utilized in this study comprises 10 ASEAN economies including Brunei Darussalam, Indonesia, Cambodia, Lao PDR, Myanmar, Malaysia, the Philippines, Singapore, Thailand, and Vietnam in the period from 1995 to 2021. The data for the variables were collected from the World Development Indicators (WDI) database of the World Bank.

4. Results

The data were collected from 10 ASEAN economies from 1995 to 2021. Figure 1 illustrates that GDP per capita, bank credit, and technology infrastructure in these ASEAN economies experienced a significant upward trend throughout the study period. Furthermore, this increased trend indicates a close relationship between these variables, particularly during the 2006-2021 period.

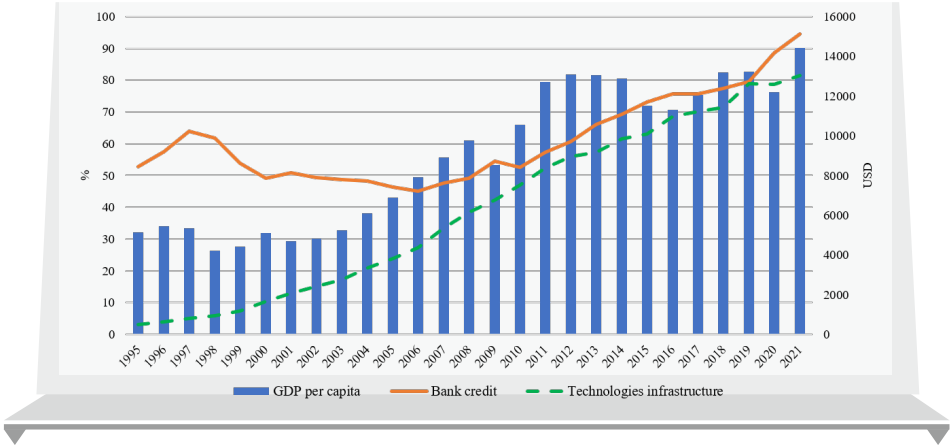

Figure 1. The average values of GDP per capita, bank credit, and technology infrastructure in ASEAN economies

Source: own study

Table 2. Results of the stationarity tests

Variable		LLC	IPS
I(0)	EG	0.49 (0.69)	4.53 (1.00)
	TI	-0.23 (0.41)	5.75 (1.00)
	BC	2.35 (0.99)	1.95 (0.97)
	GE	0.33 (0.63)	0.89 (0.81)
	FDI	-3.27*** (0.00)	-3.72*** (0.00)
	TRA	0.09 (0.53)	0.95 (0.83)

I(1)	DEG	-4.67*** (0.00)	-6.55*** (0.00)
	DTI	-3.81*** (0.00)	-7.16*** (0.00)
	DBC	-2.07** (0.02)	-4.93*** (0.00)
	DGE	-3.61*** (0.00)	-7.97*** (0.00)
	DFDI	-8.01*** (0.00)	-9.51*** (0.00)
	DTRA	-4.42*** (0.00)	-7.44*** (0.00)

Note: *** $p \leq 0.01$, ** $p \leq 0.05$.

Source: own study

Next, the authors applied the Levin-Lin-Chu (LLC) and Im-Pesaran-Shin (IPS) tests to determine the stationarity of the variables, as proposed by Levin et al. (2002) and Im et al. (2003). Table 2 shows that all of the variables are stationary at the first difference, i.e., I(1). Therefore, the authors used the variables at the first difference to estimate the research model.

For the optimal lag of the variables, the authors estimated the model using a first-order PVAR. This approach is based on the optimal lag selection criteria of Andrews and Lu (2001), where the first-order PVAR is identified at the smallest MBIC, MAIC, and MQIC values (table 3).

Table 3. Results of the optimal lag selection criteria

lag	CD	J	J pvalue	MBIC	MAIC	MQIC
1	0.79	121.04	0.18	-456.45	-94.96	-241.10
2	0.87	75.78	0.36	-309.21	-68.22	-165.65
3	0.66	35.70	0.48	-156.79	-36.30	-85.01
4	0.69	-	-	-	-	-

Source: own study

The results of the Granger causality test reveal a close relationship between technology infrastructure, bank credit, and economic growth. Specifically, technology infrastructure and bank credit are associated with economic growth. There is also a causal relationship between technology infrastructure and bank credit (table 4). This suggests that economic growth is not only affected by technology infrastructure and bank credit but also depends on the relationship between these two variables.

Table 4. Results of the panel VAR-Granger causality Wald test

Inferences of causality	Results	
Technologies infrastructure → Economic growth	11.80*** (0.00)	Yes
Bank credit → Economic growth	6.62*** (0.01)	Yes
Technologies infrastructure → Bank credit	13.67*** (0.00)	Yes
Bank credit → Technologies infrastructure	16.56*** (0.00)	Yes

Note: *** $p \leq 0.01$.

Source: own study

Then, the authors employed the impulse response function to further clarify the relationships between the variables, with the results presented in figure 2. Accordingly, economic growth is positively influenced by technology infrastructure, with this effect being clearly observed at a lag of approximately one period. Meanwhile, the positive impact of bank credit on economic growth is negligible, and there even exists a negative effect in the short term. Regarding the relationship between technology infrastructure and bank credit, figure 2 shows that bank credit positively affects technology infrastructure, with this effect becoming evident at a lag of one period. Conversely, the positive impact of technology infrastructure on bank credit is strongly observed at a lag of two periods. As for the control variables, government spending and foreign direct investment positively influence economic growth at a lag of one period, while

the positive impact of trade on economic growth is observed at a lag of three periods.

5. Discussion

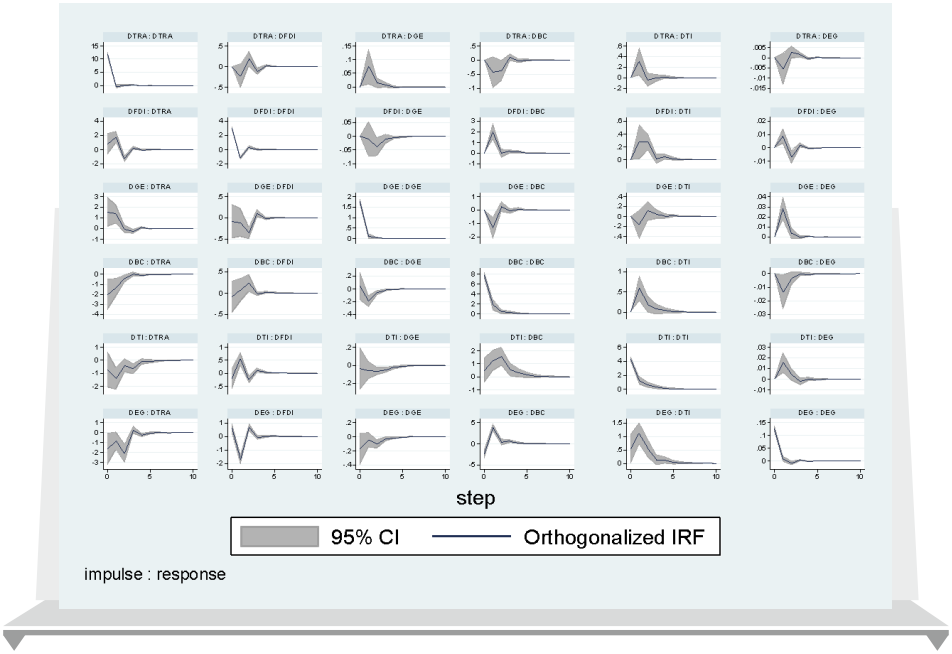

Figure 2. Impulse response function of DEG, DTI, DBC, DGE, DFDI, and DTRA

Source: own study

The impact of technology infrastructure on economic growth: The estimation results indicate that economic growth is positively influenced by technology infrastructure, with this effect being clearly observed at a lag of approximately one period. These findings are completely consistent with previous conclusions by Yousefi (2011), Kumar et al. (2015), Kumar and Stauvermann (2016), Hussain et al. (2021), Nguyen and Doytch (2022), and Bakry et al. (2023). Moreover, these results confirm the validity of the supply-leading hypothesis. According to this view, technology infrastructure can significantly contribute to promoting savings

and investment, helping companies reduce costs and enhance productivity. At the national level, technology infrastructure supports the improvement of a country's production capacity, strengthens the connection between domestic production activities and global value chains, and ultimately promotes economic growth.

The impact of bank credit on economic growth: The estimation results reveal that the role of bank credit in economic growth is insignificant. Bank credit may even impede economic growth in the short term. These findings align with the previous observations made by Sassi and Goaied (2013). Furthermore, they imply that bank credit may not be directly and significantly associated with economic growth; instead, it could exert an indirect influence by allocating credit to production activities and enhancing technology infrastructure.

The relationship between technology infrastructure and bank credit: The findings confirm a close correlation between technology infrastructure and bank credit. Specifically, bank credit positively impacts technology infrastructure, with this effect being obvious at a lag of one period. Conversely, the positive impact of technology infrastructure on bank credit is strongly evident at a lag of two periods. In other words, technology infrastructure and bank credit are closely linked, which aligns with what Shamim (2007), and Pradhan et al. (2015a) concluded. However, the findings exhibit certain differences compared to earlier research. Notably, technology infrastructure has a positive effect on both bank credit and economic growth. Meanwhile, bank credit plays a crucial role in improving technology infrastructure and even promoting economic growth through technology infrastructure. Thus, it can be concluded that bank credit appears to be ineffective in the direct effect on economic growth; instead, its impact is manifested indirectly through technology infrastructure. This represents an intriguing finding of this study.

6. Conclusion

This study achieves its research objectives by elucidating the relationship between technology infrastructure and bank credit, as well as their impact on economic growth in the ASEAN economies. Specifically, the findings indicate a positive correlation between technology infrastructure and bank credit. In addition, technology infrastructure plays an essential role in promoting economic growth. Meanwhile, bank credit can indirectly influence economic growth through technology infrastructure, which sets this study apart from previous research. Regarding control variables, economic growth is

significantly affected by government spending, foreign direct investment, and trade.

Based on the findings, the ASEAN economies have a reliable foundation to formulate appropriate policies related to the management of technology infrastructure and bank credit to promote economic growth. In specific, the ASEAN economies need to make further efforts to improve technology infrastructure, as this is a key factor in driving economic growth. This is also aligned with current global trends. Furthermore, these countries need to maintain the primary role of bank credit by ensuring the provision of capital to the economy. It is essential to carefully manage this capital to allocate it to appropriate projects, particularly those related to improving technology infrastructure and promoting economic growth. Moreover, they should focus on improving domestic conditions, such as enhancing the efficiency of government spending and encouraging foreign direct investment to supplement domestic capital for economic growth. Further efforts should also be made to liberalize trade coupled with each country's characteristics and competitive advantages.

This study has achieved certain success in identifying the relationship between technology infrastructure and bank credit, as well as their impact on economic growth in the ASEAN economies. However, there are some limitations. For instance, technology infrastructure is a relatively broad issue, but this study is limited to the scope of ICT infrastructure. Furthermore, the study has not yet analyzed the model for each individual country. Therefore, future studies could address these limitations, opening more intriguing research directions.

Abstract

Purpose: This study aims to analyze the causal relationship between technology infrastructure and bank credit, as well as the impact of this relationship on economic growth in ASEAN economies.
Design/methodology/approach: To achieve this objective, the authors model the simultaneous relationship between these factors using a panel vector autoregressive (PVAR) approach.
Findings: The estimation results indicate a positive correlation between technology infrastructure and bank credit. Furthermore, technology infrastructure plays a crucial role in promoting economic growth, while bank credit can indirectly influence economic growth through technology infrastructure,

a novel finding compared to previous studies. Besides, the authors identify significant effects of government spending, foreign direct investment, and trade on economic growth. The findings provide a reliable foundation for the ASEAN economies to develop appropriate policies regarding the management of technology infrastructure and bank credit to stimulate economic growth.

Originality/value: This study aims to analyze the causal relationship between technology infrastructure and bank credit, while also examining the impact of this relationship on economic growth in ASEAN economies. The findings are also expected to provide ASEAN economies with valuable and meaningful insights.

Key words: *ASEAN, bank credit, technologies infrastructure.*

JEL codes: F65, G15, M15.

References

Abdulsalam, A., Salina, H. J. K., & Mohammed, B. Y. (2015). Financial development, human capital accumulation and economic growth: Empirical evidence from the economic community of West African States. *Procedia - Social and Behavioral Sciences,* 172(27), 96-103. https://doi.org/10.1016/j.sbspro.2015.01.341.

Abrigo, M. R. M., & Love, I. (2016). Estimation of panel vector autoregression in Stata. *The Stata Journal: Promoting Communications on Statistics and Stata*, 16(3), 778-804. https://doi.org/10.1177/1536867X1601600314.

Alfaro, L., Chanda, A., Kalemli-Ozcan, S., & Sayek, S. (2004). FDI and economic growth: the role of local nancial markets. *Journal of International Economics,* 64, 89-112. https://doi.org/10.1016/S0022-1996(03)00081-3.

Andrews, D. W. K., & Lu, B. (2001). Consistent model and moment selection procedures for GMM estimation with application to dynamic panel data models. *Journal of Econometrics*, 101(1), 123-164. https://doi.org/10.1016/S0304-4076(00)00077-4.

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies*, 58(2), 277. https://doi.org/10.2307/2297968.

Asongu, S. A., & Odhiambo, N. M. (2020). Foreign direct investment, information technology and economic growth dynamics in Sub-Saharan

Africa. *Telecommunications Policy,* 44(1), 101838. https://doi.org/10.1016/j.telpol.2019.101838.
Bagehot, W. (1873). *Lombard Street*. Homewood, IL: Richard D. Irwin.
Bakry, W., Nghiem, X.-H., Farouk, S., & Vo, X. V. (2023). Does it hurt or help? Revisiting the effects of ICT on economic growth and energy consumption: A nonlinear panel ARDL approach. *Economic Analysis and Policy, 78*, 597-617. https://doi.org/10.1016/j.eap.2023.03.026.
Botev, J., & Jawadi, F. (2019). The nonlinear relationship between economic growth and financial development: Evidence from developing, emerging and advanced economies. *International Economics,* 160, 3-13. https://doi.org/10.1016/j.inteco.2019.06.004.
Cournède, B., & Denk, O. (2015). *Finance and economic growth in OECD and G20 countries*. OECD Economics Department Working Papers, 1223. Paris: OECD Publishing.
Entner, R. (2008). *The increasingly important impact of wireless broadband technology and services on the US economy*. A Study for CTIA-The Wireless Association.
Fitjar, R. D., & Rodríguez-Pose, A. (2013). Firm collaboration and modes of innovation in Norway. *Research Policy,* 42, 128-138. https://doi.org/10.1016/j.respol.2012.05.009.
Gosavi, A. (2018). Can mobile money help firms mitigate the problem of access to finance in Eastern sub-Saharan Africa. *Journal of African Business,* 18(4), 343-360. https://doi.org/10.1080/15228916.2017.1396791.
Greenwood, J., & Jovanovic, B. (1990). Financial development, growth and the distribution of income. *The Journal of Political Economy,* 98, 1076-1107.
Ho, S.-H., & Saadaoui, J. (2022). Bank credit and economic growth: A dynamic threshold panel model for ASEAN countries. *International Economics,* 170, 115-128. https://doi.org/10.1016/j.inteco.2022.03.001.
Hussain, A., Batool, I., Akbar, M., & Nazir, M. (2021). Is ICT an enduring driver of economic growth? Evidence from South Asian economies. *Telecommunications Policy,* 45(8), 102202. https://doi.org/10.1016/j.telpol.2021.102202.
Ibrahim, M., & Alagidede, P. (2018). Effect of financial development on economic growth in Sub-Saharan Africa. *Journal of Policy Modeling,* 40(6), 1104-1125. https://doi.org/10.1016/j.jpolmod.2018.08.001.
Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, 115(1), 53-74.
Kalam, A. P. J. (2003). Citizen centric e-governance: Technology and management policy. *Finance India, XVII*, 1273-1277.
Khoutem, B. J., Thouraya, B., & Kamel, H. (2014). Financial development and economic growth: New evidence from Tunisia. *Journal of Policy*

Modeling, 36(5), 883-898. https://doi.org/10.1016/j.jpolmod.2014.08.002.
King, R., & Levine, R. (1993). Finance and growth: Schumpeter might be right. *The Quarterly Journal of Economics,* 108(3), 717-737.
Kumar, R. R., & Stauvermann, P. J. (2016). Dataset for an analysis of tourism and economic growth: A study of Sri Lanka. *Data in Brief,* 8, 723-725. https://doi.org/10.1016/j.dib.2016.06.066.
Kumar, R. R., Kumar, R. D., & Patel, A. (2015). Accounting for telecommunications contribution to economic growth: A study of small Pacific Island states. *Telecommunications Policy*, 39(3-4), 284-295. https://doi.org/10.1016/j.telpol.2014.08.005.
Lee, J. W., & Brahmasrene, T. (2014). ICT, CO2 emissions and economic growth: Evidence from a panel of ASEAN. *Global Economic Review,* 43(2), 93-109. https://doi.org/10.1080/1226508X.2014.917803.
Levine, R. (2005). *Finance and growth: Theory and evidence*. Handbook of Economic growth.
Levine, A., Lin, C. F., & Chu, C. S. (2002). Unit root tests in panel data: asymptotic and finite sample properties. *Journal of Econometrics,* 108(1), 1-24.
Menyah, K., Nazlioglu, S., & Wolde-Rufael, Y. (2014). Financial devel opment, trade openness and economic growth in African countries: New insights from a panel causality approach. *Economic Modelling,* 37(C), 386-394. https://doi.org/10.1016/S0304-405X(00)00071-4.
Morck, R., Yeung, B., & Yu, W. (2000). The information content of stock markets: why do emerging markets have synchronous stock price movement? *Journal of Financial Economics,* 58, 215-260. https://doi.org/10.1016/S0304-405X(00)00071-4.
Nair, M. S., & Shariffadeen, T. M. A. (2009). *Managing innovation in the net work economy: Lessons for countries in the Asia-Pacific region*. Digital Review of Asia Pacific 2009-2010.
Nair, M., & Vaithilingam, S. (2012). *Innovative use of ICT among urban poor communities: challenges and opportunities*. In: Ramasamy, R. (Ed.), ICT Strategic Review 2012/2013. PIKOM and MOSTI, Malaysia.
Nguyen, P., & Doytch, N. (2022). The impact of ICT patents on economic growth: An international evidence. *Telecommunications Policy,* 46(5), 102291. https://doi.org/10.1016/j.telpol.2021.102291.
Pagano, M., & Pica, G. (2012). Finance and Employment. *Economic Policy,* 27(69), 5-55.
Patrick, H. T. (1966). Financial development and economic growth in underdeveloped countries. *Economic Development and Cultural Change,* 14, 174-189. http://www.jstor.org/stable/1152568.

Pradhan, R. P., Arvin, M., Nair, M., Bennett, S., & Bahmani, S. (2015a). ICT-finance-growth nexus: Empirical evidence from the Next-11 countries. *Cuadernos de Economía,* 40, 115-134.

Pradhan, R. P., Arvin, M. B., & Norman, N. R. (2015b). The dynamics of information and communications technologies infrastructure, economic growth, and financial development: Evidence from Asian countries. *Technology in Society,* 42, 135-149. https://doi.org/10.1016/j.techsoc.2015.04.002.

Quibria, M. G., Tschang, T., & Reyes-Macasaquit, M.-L. (2002). New information and communication technologies and poverty: Some evidence from developing Asia. *Journal of the Asia Pacific Economy, 7*, 285-309. https://doi.org/10.1080/1354786022000007852.

Samargandi, N., & Kutan, A.M. (2016). Private credit spillovers and economic growth: evidence from BRICS countries. *Journal of International Financial Markets, Institutions, and Money,* 44, 56-84. https://doi.org/10.1016/j.intfin.2016.04.010.

Sassi, S., & Goaied, M. (2013). Financial development, ICT diffusion and economic growth: Lessons from MENA region. *Telecommunications Policy*, 37(4-5), 252-261. https://doi.org/10.1016/j.telpol.2012.12.004.

Schumpeter, J. A. (1911). *The theory of economic development*. Cambridge: Harvard University Press.

Schumpeter, J. A. (1934). *The theory of economic development*. Cambridge: Harvard University Press.

Shamim, F. (2007). The ICT environment, financial sector and economic growth: A cross-country analysis. *Journal of Economic Studies,* 34, 352-370. https://doi.org/10.1108/01443580710817452.

Tang, Z., Smith, M. D., & Montgomery, A. (2007). *The impact of shopbot use on prices and price dispersion: Evidence from online book retailing*. Heinz Research, paper 47. https://doi.org/10.1016/j.ijindorg.2010.03.014.

Thierry, B., Jun, Z., Eric, D. D., Yannick, G. Z. S, & Landry, K. Y. S. (2016). Causality relationship between bank credit and economic growth: Evidence from a time series analysis on a vector error correction model in Cameroon. *Procedia - Social and Behavioral Sciences,* 235, 664-671. DOI:10.12928/optimum.v12i2.6137.

Vu, K. (2019). The internet-growth link: An examination of studies with conflicting results and new evidence on the network effect. *Telecommunications Policy,* 43(5), 474-483. https://doi.org/10.1016/j.telpol.2019.04.002.

Wang, C., Zhang, X., Ghadimi, P., Liu, Q., Lim, M. K., & Stanley, H. E. (2019). The impact of regional financial development on economic growth in Beijing–Tianjin–Hebei region: A spatial econometric analysis. *Physica*

A: Statistical Mechanics and its Applications, 521, 635-648. https://doi.org/10.1016/j.physa.2019.01.103
Wolde-Rufael, Y. (2009). Re-examining the nancial development and economic growth nexus in Kenya. *Economic Modelling*, 26, 1140-1146. https://doi.org/10.1016/j.econmod.2009.05.002.
Yousefi, A. (2011). The impact of information and communication technology on economic growth: evidence from developed and developing countries. *Economics of Innovation and New Technology,* 20(6), 581-596. https://doi.org/10.1080/10438599.2010.544470.