Empirical Analysis on the Impact of Financial Technology at the Financial System, Bank Age and Size, GDP and Inflation towards the Performance of Commercial Banks in Malaysia, From 2004 to 2023

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ABSTRACT

This study examined the impact of financial technology (fintech) on the performance of commercial banks in Malaysia. It evaluated the profitability of commercial banks, specifically looking at return on equity (ROE), after integrating fintech into daily banking operations. The research framework included ROE as the dependent variable, with fintech application, bank size, and bank age as independent variables, while Gross Domestic Product (GDP) and inflation were controlled variables. To conduct the analysis, quantitative methods were employed using secondary data from the financial reports of individual commercial banks between 2004 and 2023. A sample of eight local banks was selected, and the data were gathered from their financial statements over this period. Statistical software such as Stata was utilized to analyse the data. A key focus of this study was the application of financial technology, which was assessed using the Digital Innovation Index. To assess the effects of fintech application, bank size and age, GDP and inflation towards the bank performance, panel data analysis was applied. The analysis process began with unit root tests, followed by the diagnostic tests, including checks for autocorrelation, normality, stability, heteroskedasticity, and multicollinearity to ensure the reliability and validity of the model. The results indicated that financial technology, bank size, and GDP positively and significantly influenced the performance of commercial banks, while bank age and inflation were found to have no significant impact.

Keywords: financial technology, digital innovation index, performance, panel data

INTRODUCTION

Financial Technology (Fintech) is well-known as an application of technology within the financial industry that covers a wide range of activities such as contactless payment, collecting financial data, performing financial analysis, implementing financial software, practising digitized processes and electronic payment platforms (Arner, Barberis & Buckley, 2015; Chong et al., 2019). These activities aren't just being widely applied by endusers for daily transactions, but also executed by financial institutions for daily operations as well.

The modern financial business began to take shape globally with the introduction of the first Automated Teller Machine (ATM) in 1967, after the invention of key technologies such as telegraphs, railroads, canals, and steamships that designed to accelerate financial transactions and facilitate the rapid transmission of financial information (Arner et al., 2015). It marked the start of Fintech 2.0, a period from 1967 to 1987, during which the financial services industry shifted from analogue to digital operations. Togetherness, this transformation accelerated with the advent of mobile phones and the expansion of internet access that catalysed the digital revolution (Mickalowski et al., 2008; Capatina & Draghescu, 2016), robo-advisory financial services such as

Wealthfront that offers automated investment (Otinga, 2023), blockchain technology such as Bitcoin that runs on decentralized ledger system, digital payment platform such as Square that provides mobile payment solutions (Imam, 2019; James, 2018) that acted as the main categories of fintech application in financial system during Fintech 3.0.

Moreover, Fintech developments were even more significant when entering the era of Fintech 3.5. M-Pesa was introduced in Kenya, Alibaba from China began offering loans to small and medium-sized enterprises (SMEs) on its e-commerce platform, Lufax as a peer-to-peer lending and wealth management platform was launched (Arner, Barberis & Buckley, 2015). According to reports from KPMG (2017) and Leong & Sung (2018), investments in FinTech companies reached $24.7 billion across 1,076 deals in 2016. The global cryptocurrency market capitalization also tripled since 2016, reaching nearly $25 billion by March 2017 (Hileman & Rauchs, 2017; Leong & Sung, 2018). Additionally, the global crowdfunding industry reached $34 billion in 2015, equivalent to £27 billion, representing a 2.1-fold growth compared to 2014 (Hobey, 2015; CrowdfundingHub, 2016; Leong & Sung, 2018). This highlights how deeply fintech has permeated the financial business landscape.

In Malaysia, the first ATM was launched by Malayan Banking Berhad in 1981. This instalment has made a change in banking activities, from physical dealings to semi-automated functions until the digitalized transactions. Along the transition of aging technology to innovative products, every commercial bank in Malaysia is facing different level of obstacles in absorbing the fintech application because the age of commercial banks is a crucial factor influencing their growth, as older institutions often face challenges such as the liability of newness, difficulties in adapting to changing business strategies, and increased inertia and organizational rigidities (Ikechukwu & Boniface, 2016; Coad et al., 2014). Referring to the present condition, the COVID-19 pandemic acted as a catalyst for the digitalization of Malaysia's financial system, bridging the gap across different age groups. The government-imposed lockdown further accelerated the significant rise in mobile app downloads and usage across many commercial banks in Malaysia as they were eager to embrace new technologies in order to sustain, enhance, or even boost their business and performance.

As Malaysia moves towards globalization, digital innovation has become a key factor in driving economic growth because it helps the financial sector remain competitive (Konasilan & Murugiah, 2020; Bakar & Nordin, 2020; Khin & Ho, 2018; Tan et al., 2016). Digitalization reduces the operational workload and minimizes the number of employees required in commercial banks, leading to cost savings on space and rent that would otherwise be spent on expanding physical branches, which directly leaving an impact on internal economies of scale (Fitriani & Renny, 2019). On the other hand, external economies of scale occur when commercial banks expand their networks internationally, positioning themselves as multinational corporations seeking profit. By establishing subsidiaries, these banks can tap into cheaper labour and grow their market share in host countries (Mas, 2009). Thus, the size of commercial banks reflects their market power, allowing them to influence market conditions, such as setting interest rates, dominating certain financial services, and leveraging economies of scale.

Problem Statement

The rise in financial technology has led to the modernization of various financial instruments. Even though fintech has certainly made a significant impact, but traditional commercial banks could not be replaced. Instead, technology adoption has allowed banks to innovate and operate in new ways. The integration of technologies such as mobile banking, internet banking, P2P lending, crowdfunding, robo-advisors, artificial intelligence (AI), machine learning, and cloud computing has reduced the need for customers to physically visit bank branches, providing more convenient alternatives (Malaysia Fintech Report 2021; Yusof et al., 2022; Varma et al., 2022; Velmurugan, 2019). Additionally, blockchain, cryptocurrency, and stock exchange apps have emerged as alternative investment options, giving customers more control over their financial decisions. These fintech innovations have not only made financial services more accessible but also increased the customer base, injecting more funds into commercial banks, thereby strengthening their financial positions and enabling them to invest in assets and generate higher profits (Almulla & Aljughaiman, 2021).

This increase in asset investments and the overall digitalization of the financial system can have broader economic implications, impacting macroeconomic variables such as GDP and inflation. Investment serves as an injection into the economy, stimulating GDP growth. However, as the circulation of money increases due to fintech adoption, inflation tends to rise in line with GDP growth. A rapid expansion of the financial sector can drive economic growth, but it may also lead to higher inflation, which can depress financial activity and increase long-term costs, negatively affecting future growth and GDP (Andres et al., 2004). Rising inflation leads to higher prices for goods and services, indirectly increasing the cost of living. This, in turn, can reduce demand for financial products like savings accounts, as inflation erodes the real returns on savings (Choi, Smith & Boyd, 1996). Furthermore, excessive money creation can reduce the real return on assets, leading to lower trading volumes in equity markets over time (Huybens & Smith, 1999). Consequently, commercial banks may face a decline in profitability.

Additionally, integrating fintech with financial services is not a straightforward task. It is highly regulated, and the development of digital solutions comes at a high cost (Beccalli, 2007). Commercial banks in Malaysia are facing rising costs due to large capital investments in research and development as they work to remain competitive in technology (Konasilan & Murugiah, 2020). This aligns with findings by Gutu (2014), who noted that digital innovation often has negative effects on commercial banks' performance by increasing operational costs, which can erode market share and reduce profits for commercial banks. This may prompt commercial banks to take on more risk, potentially undermining their financial stability (Safiullah & Paramati, 2022).

Moreover, fintech's emergence has particularly impacted larger commercial banks, which face challenges in adapting to digital innovation due to the costs of restructuring legacy systems. In contrast, smaller commercial banks may have an advantage as they can more quickly adapt to new technology and changes in the market environment. However, other studies (Monika et al., 2021) argue that larger commercial banks benefit from economies of scale, which help them minimize costs and improve profitability because they possess the resources, expertise, and commitment to technological innovation. (Alex & Ngaba, 2018; Ripain & Ahmad, 2018).

The age of a commercial bank can also influence its performance, with younger banks typically being more adaptable to technology (Phan, Narayan & Hutabarat, 2018; Ikechukwu & Boniface, 2016). Younger banks are generally more open to technological innovations and willing to reorganize their operations to align with new advancements. In contrast, older banks may struggle with inefficiencies and rigidities as they age, leading to slower growth and increased operational costs (Coad et al., 2014; Loderer & Waelchli, 2010).

These challenges highlight the need for a digital innovation index tailored to evaluate the performance of commercial banks, especially in the context of fintech integration. The absence of such an index underscores the importance of creating a comprehensive framework that can assess how effectively commercial banks are adopting and leveraging digital technologies. Thus, this research aims to fill this gap by developing a digital innovation index for evaluating the impact of fintech, aligned with the changes in age and size of commercial banks towards the performance of commercial banks in Malaysia.

Research Objectives

The specific research objectives of this study are:

1. To evaluate the impact of fintech application (digital innovation index) on the performance of the commercial banks in Malaysia.
2. To measure the impact of the size and the age of commercial banks on the performance in the commercial banks in Malaysia.
3. To measure the impact of GDP and inflation as the controlled variables that can influence the performance in the commercial banks in Malaysia.

LITERATURE REVIEW

Underlying Theories – Theory of Demand and Supply

Digital innovation within the financial sector is influenced by both demand and supply factors. On the demand side, consumer awareness of fintech and the perceived value of its development saw a dramatic increase in demand as fintech improves user experiences, greater convenience, higher speed, and user-friendly features, (Haddad & Hornuf, 2018). This growth has surpassed the pace of traditional financial services, driving the creation of new fintech products, including robo-advisor, artificial intelligence and machine learning, insurtech and regtech (Shapiro et al., 2022). Furthermore, the demand for fintech services is closely tied to consumer expectations, particularly among the tech-savvy generation, with the invention of smartphones and abundant supply of internet.

On the supply side, fintech innovation is primarily supported by technological advancements, such as internet application programming interfaces (APIs), smartphones for mobile banking, digital currencies, cloud computing, and blockchain technology (Carstens, 2018). Mobile banking apps now have billions of users, becoming an essential part of e-commerce services, including food delivery, ordering, and ride-hailing. Additionally, lower entry barriers for fintech intermediaries and the increasing willingness to adopt fintech innovations have fuelled the supply of these services, helping balance the financial market (Shapiro et al., 2022).

Underlying Theories – Theory of Innovation

The theory of innovation is also central to this research. The technological revolution has led to the establishment of a new technological paradigm that impacts all major economic functions. Several key innovation theories have been influential in shaping the global economy, including Schumpeter's concepts of creative destruction, Kondratieff's long waves, the Diffusion of Innovation theory, Open Innovation, and Disruptive Innovation.

Schumpeter's concept of creative destruction emphasizes the importance of innovation in driving economic change. He argued that innovative entrepreneurship and technological advancements are central to economic development (Naqshbandi & Garib Singh, 2015). Schumpeter believed that the ability to innovate is linked to the size of the enterprise. He initially posited that smaller enterprises possess greater innovative potential due to their agility and responsiveness to market changes. However, he later recognized that larger firms who benefiting from economies of scale, access to capital and research capabilities would often have superior capacity to develop and implement new technologies. This dual perspective provides a theoretical basis for examining bank size as a factor in the relationship between fintech adoption and bank performance. Larger banks may have greater financial and technological resources to invest in fintech innovations, while smaller banks may rely on flexibility and niche adaptation to remain competitive.

Kondratieff's "long waves" theory highlights long-term cyclical fluctuations in commodity prices, rent, interest, foreign trade, coal mining, and other sectors such as mass transportation, mass production, and communication (Allianz Global Investors Capital Market Analysis, 2010). These waves reflect significant cycles in economic activity, where changes in basic capital investments, while costly and time-consuming, bring long-term benefits. Kondratieff theorized that each of these long cycles includes a cluster of innovations, driven by advancements in science, technology, social conditions, and economic relations. These cycles are continuous processes that are deeply connected to the prevailing economic conditions and innovations in various fields. In the context of modern banking, fintech capabilities such as data analytics, blockchain, and mobile platforms serve as strategic resources that enable banks to sustain competitive advantage during periods of technological transition. Banks that effectively integrate fintech innovations are better positioned to leverage the opportunities presented by the ongoing digital transformation wave.

Rogers' Diffusion of Innovation theory explores the way innovation spreads over time through a social system via specific communication channels (Naqshbandi & Garib Singh, 2015). This theory examines what factors influence invention, the rate at which innovations are adopted, and how new ideas are accepted within a given culture (Dongol, 2021). Chesbrough's Open Innovation model contrasts with traditional theories by advocating that businesses benefit from using both internal and external knowledge. Open innovation encourages companies to use external sources of information to enhance internal innovation processes and expand markets for external applications (Naqshbandi & Garib Singh, 2015). From a fintech perspective, the diffusion process within the banking industry is shaped by both internal and external factors. Internally, bank-specific characteristics such as organizational size, structure, and age influence the rate and depth of fintech adoption. Larger banks may have more resources and infrastructure to experiment with innovative technologies, while smaller banks may adopt selectively but with greater agility and responsiveness. Externally, factors such as regulatory frameworks, customer digital readiness, and economic conditions can either accelerate or hinder the diffusion process (Dongol, 2021). This interplay between internal readiness and external context determines the trajectory of fintech adoption and its ultimate impact on bank performance.

Finally, Disruptive Innovation theory, as articulated by Christensen, explains the way new technologies or business models can disrupt existing markets, replacing established products or services with superior alternatives. Christensen focused on how disruptive technologies create new markets and networks, gradually displacing older technologies and altering established industries. This theory highlights how technological advancements can upend the status quo, leading to the replacement of outdated products and systems with more innovative solutions. From a fintech perspective, disruptive innovation provides a theoretical foundation for understanding the way emerging financial technologies challenge the traditional banking systems. Fintech innovations such as peer-to-peer (P2P) lending, blockchain-based transactions, mobile payments, and digitalonly banking platforms exemplify the disruptive process. Initially, these technologies catered to unbanked or underbanked populations and small enterprises excluded from conventional financial systems. But however, they have increasingly captured mainstream markets while threatening to erode the dominance of traditional banks as fintech solutions have matured. This process mirrors Christensen's model where disruptive entrants exploit new technologies and cost efficiencies to challenge incumbent institutions.

Fintech Adoption in Malaysia

As the demand for digital finance and fintech products continues to rise, Malaysia is embracing the digital transformation. According to the 12th Malaysian Plan, it is expected that the digital economy will contribute 25.55% to the country's GDP by 2025 (Fintech Roundtable Report, 2021). To support this shift, the Malaysian government launched "MYDIGITAL," the Malaysian Digital Economy Blueprint, aiming to establish Malaysia as a digitally-driven nation in the global economy.

According to Bank Negara Malaysia, the penetration rates of internet banking and mobile banking had reached

119.5% and 69.7%, respectively, by September 2021. Internet banking penetration grew from 97.6% in 2019 to 112.5% in 2020, and continued to rise to 119.5% in 2021. Meanwhile, mobile banking penetration increased from 52.9% in 2019 to 61.8% in 2020, and reached 69.7% by September 2021. Additionally, the number of individuals making digital payment transactions reached 13.1 million, and the total annual revenue from digitally-enabled consumer payments had grown to RM12.3 million as of January 2021. The value of internet banking transactions also saw consistent growth from 2016 to 2020, with amounts increasing from RM494.4 billion in 2016 to RM1,060.9 billion in 2020 (source: Bank Negara Malaysia, Statista 2021). Similarly, mobile banking transactions more than doubled over the same period, growing from RM36.2 billion in 2016 to RM458.9 billion in 2020.

A VISA study revealed that Malaysia ranked second in Southeast Asia for the adoption rate of cashless payments, at 96% (Visa Consumer Payments Attitude Study 2021). Since the onset of the Covid-19 pandemic, digital and mobile wallets such as GrabPay, Boost, and Touch 'n Go have become increasingly popular and are now the norm in Malaysia. The contribution of the digital economy to GDP grew to 20% in 2020, up from 19.1% in 2019 (Department of Statistics Malaysia, Bank Negara Malaysia). The number of consumers using digital and mobile wallets for online and in-store shopping has also surged, making these payment methods the third most commonly used after cash/bank transfers and credit cards. According to Bank Negara Malaysia, bank transfers accounted for 28% of the 2020 e-commerce payment mix, followed by credit cards at 17%, and digital/mobile wallets at 14%. Other payment methods, including cash on delivery, direct debit, and debit cards, each made up

12%, with charge/deferred debit cards and prepaid cards contributing 2% and 1%, respectively. The remaining 2% accounted for other payment methods.

METHODOLOGY

The study relies on quantitative approach using the panel data analysis to measure the impact of fintech application, bank size and age, GDP and inflation towards the performance of commercial banks in Malaysia, from 2004 to 2023. The eight selected local commercial banks are Affin Bank Berhad, Alliance Bank Malaysia Berhad, Ambank Berhad, CIMB Bank Berhad, Hong Leong Bank Berhad, Malayan Banking Berhad, Public Bank Berhad and RHB Bank Berhad. The data was collected on an annual basis from financial statements of selected commercial banks and sources from Bank Negara Malaysia**.**

Initially, the data undergo preliminary testing to verify its reliability and accuracy. To verify the robustness of the regression analysis, the panel data was first tested using the Pooled Ordinary Least Squares (OLS) model as an initial assessment, followed by the Breusch-Pagan LM test to confirm the suitability of the panel structure. Once the correct model framework was determined, the Hausman test was conducted to decide between the fixed effects and random effects models. The fixed effects model accounts for time-invariant characteristics specific to each country, whereas the random effects model assumes no correlation between these characteristics and the explanatory variables. Based on the Hausman test results, the study adopts the fixed effects model if it proves more appropriate. Otherwise, the random effects model is utilized. Next, Levin, Lin and Chu (LLC) unit root test is applied to check for stationary to avoid any spurious regression. If the LLC test reveals non-stationarity, the data will be converted to first difference or higher degree difference to make it stationary.

To confirm the reliability of the regression results, the study performs diagnostic tests to detect potential issues such as multicollinearity, heteroskedasticity, and autocorrelation. Multicollinearity is assessed using the Variance Inflation Factor (VIF), heteroskedasticity is tested with Breusch-Pagan Test and autocorrelation is examined through the Baltagi-Wu LBI Test. If any of these problems are identified, the study applies suitable corrections, either by using robust standard errors or the generalized least squares method to ensure the validity of the statistical inferences

Digital Innovation Index

The digital innovation index is constructed using three main components, which include technological innovation, growth potential, and mobile banking penetration. In this study, technological innovation is assessed by examining the bank's expenditure on computers, software, and equipment, as it reflects the adoption of new technologies to enhance existing services and products. Growth potential is a commonly used indicator of financial performance, is measured through earnings per share (EPS), which provides insight into the bank's future expansion prospects. Meanwhile, mobile banking penetration which represents the extent of mobile banking adoption within the financial system, is measured by the volume of mobile banking transactions per capita. The weightage assigned to technological innovation, growth potential and penetration of mobile banking is 30%, 20% and 50% respectively.

Estimation Model

To examine the impact of fintech application, bank size and age, GDP and inflation towards the performance of commercial banks in Malaysia, this study transformed the economic functions into a static panel as below:

$$Y_{it}= \beta_0 + \beta_{1it}X_{1it} + \beta_{2it}X_{2it} + \beta_{3it}X_{3it} + \beta_{4it}X_{4it} + \beta_{5it}X_{5it} + \varepsilon_{it}$$

Y_{it} represents the financial performance, measured by Return on Equity (ROE), calculated as net income divided by shareholders' equity. X_{1it} denotes the digital innovation index, which consists of three components: technological innovation (measured by expenditure on computers, software, and equipment), growth potential (measured using earnings per share), and mobile banking penetration (measured by mobile banking transaction volume per capita). X_{2it} refers to the size of commercial banks, measured by total assets, while X_{3it} represents

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the age of the banks, measured by the number of years in operation. X_{4it} and X_{5it} correspond to GDP and inflation, respectively, both serving as control variables. β_0 is the intercept of the regression, indicating the baseline level of Y_{it} when all independent variables are zero. β_1 through β_5 are the coefficients of the explanatory variables, each reflecting the marginal effect of a one-unit change in its corresponding variable while holding others constant. The subscript i denotes the cross-sectional unit (different commercial banks), and t represents the time dimension (years). Finally, ε_{it} is the error term, capturing unobserved factors at a 5% confidence level.

Hypotheses

Based on the underlying theories and the previous empirical studies, the hypotheses derived in the study are as follows:

H_{a1}: Fintech applications can influence the performance of the commercial banks in the short run and long run in Malaysia.

H_{a2}: Size of commercial banks can influence the performance of the commercial banks in the short run and long run in Malaysia.

H_{a3}: Age of commercial banks can influence the performance of the commercial banks in the short run and long run in Malaysia.

H_{a4}: GDP can influence the performance of the commercial banks in the short run and long run in Malaysia.

H_{a5}: Inflation can influence the performance of the commercial banks in the short run and long run in Malaysia.

FINDINGS

Hausman Test Result

The hypothesis for the Hausman test is stated that H_0: Random effects model is preferred (individual effects are uncorrelated with regressors), while H_1: Fixed effects model is preferred (individual effects are correlated with regressors).

Table 6.1 shows the test statistics for the Hausman test

Statistic	Value
Chi-Square (χ^2)	3.54
Degrees of Freedom (df)	6
p-value	0.7392

Since the p-value (0.7392) > 0.05, the study fails to reject the null hypothesis. This means that the Random Effects (RE) model is appropriate for the analysis. The Hausman test results indicate that the random effects model is more suitable than the fixed effects model for examining the impact of fintech application, bank size and age, GDP and inflation towards the performance of commercial banks in Malaysia.

Preliminary Testing Result.

Table 6.2 shows the Unit Root test results at level, first difference and second difference

Variables	At level	At First Difference	At Second Difference
Technological Innovation	-4.4921*** (0.0000)	-	-

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Earning per Share	-2.0792**	-	-
	(0.0188)		
Mobile Banking	13.3863 (1.0000)	1.7023 (0.9556)	-1.9658** (0.0247)
Total Asset	1.1227 (0.8692)	-1.2229 (0.1107)	-4.7246*** (0.0000)
Age	-2.8284 (0.9977)	-7.5167*** (0.0000)	
GDP	-3.5227*** (0.0002)	-	-
Inflation	-6.2185*** (0.0000)	-	-
Return on Equity	2.6841 (0.9964)	-0.0004 (0.4998)	-4.1131*** (0.0000)

p-values are presented in parentheses, where ***, ** and * indicate significance at 1%, 5% and 10% level respectively.

Table 6.2 presents the results of the unit root analysis using the Levin, Lin, and Chu (2002) test, which is a panel unit root test conducted to examine the null hypothesis of a unit root against the alternative hypothesis of stationarity, considering cross-sectional interdependence among the data. The test result indicates that only four variables, technological innovation, GDP and Inflation are stationary at 1% significance level, while earning per share is stationary at 5% significance level. In contrast, mobile banking, total asset, age and return on equity are not stationary at level. The probability value (p-values) held by the non-stationary variables are all near to 0.10 (10% significance level). Thus, it concludes that there is a unit root within the data of these variables. The probability values (p-values) of those non-stationary variables are 1.0000 for mobile banking, 0.8692 for total asset, 0.9977 for age and 0.9964 for return on equity. All the p-values are near to the maximum significance level of 10% or 0.1.

Therefore, using the same panel unit root test of Levin, Lin and Chu (2002) the transformed data of first difference is tested for stationarity. The first difference result shows that age is stationary at 1% significance level and does not contain unit root given the p-values of 0.0000. The second difference result shows that all the variables in the study are stationary and do not contain unit root given the p-values of 0.0247 for mobile banking, 0.0000 for total asset and 0.000 for return on equity. The p-values at the second difference are stationary at 5% significance level for mobile banking, while 1% significance level for total asset and return on equity. Thus, the analysis could proceed to the diagnostic tests to confirm the reliability of the regression results.

Diagnostic Test Result.

The diagnostic test results for multicollinearity, heteroscedasticity, and serial correlation assess the selected data and its components to identify any potential issues that may affect the reliability and accuracy of the study's findings. The Mean Variance Inflation Factor (VIF) indicates the extent to which the variance of a regression coefficient is inflated due to correlations among the predictor variables. If the value is 1, it indicates that there is no correlation between the predictors. If the value of VIF is above 5 or 10, it indicates problematic multicollinearity. In this study, the Mean Variance Inflation Factor (VIF) value is 1.06, which is well below the

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threshold of 10, indicating that the independent variables are not strongly correlated with one another. Therefore, the regression coefficients can be interpreted with a high level of confidence. (Refer to Table 6.2).

Heteroscedasticity refers to the condition where the variance of errors is not constant across all levels of an independent variable. The Breusch-Pagan Test checks for this issue in a regression model. The test statistics result revealed a value of 282.06 (p-value = 0.0000) which is smaller than 0.05 threshold of significance. It can be stated that there is significant evidence of heteroskedasticity in the model. Thus, Cluster Robust Standard Errors (CRSE) is applied. After the statistical adjustment made by CRSE, the Wald chi^2 gives a value of 83.99 with p-value of 0.0000. This means the variance of the residual is constant across observations and it confirms the assumption of homoscedasticity. (Refer to Table 6.3)

Serial Correlation occurs when the residual errors from the regression model are correlated across the observations, which can violate the regression assumptions. The Baltagi-Wu LBI's test statistics of -3.4189 (pvalue = 0.0112). This indicates a serial correlation in the model's residual. Serial correlation takes place when the errors from one period is correlated with those from another period, which can lead to unbiased estimation. Thus, Feasible Generalized Least Square (FGLS) is applied to address serial correlation problem detected. After the statistical adjustment made by FGLS, the Wald chi2 gives a value of 50.53 with p-value of 0.0000. This means it has no serial correlation in the model residuals, the model's error terms are independent and the regression result are reliable. (Refer to Table 6.3)

Table 6.3 shows the diagnostic test results

Diagnostic Test	**Test Statistics**	**p-value**	**Hypothesis**
Variance Inflation Factor (VIF)	Mean VIF = 1.06	-	Accept Ho. There is no multicollinearity
Cluster Robust Standard Error (CRSE)	83.99	0.0000	Accept Ho. There is no heteroscedasticity
Feasible Generalized Least Square (FGLS)	50.53	0.0000	Accept Ho. There is no serial correlation

Model Estimation Result.

Table 6.4 shows the model estimation results

Independent Variables	**Coefficient (Standard error)**	**Hypothesis**
Technological Innovation	26.000 (0.331)	Fail to reject Ho at 10% significance level
Earning per Share	-0.1270** (0.019)	Reject Ho at 5% significance level
Mobile Banking	7.870* (0.0776)	Reject Ho at 10% significance level
Total Asset	0.0849*** (0.001)	Reject Ho at 1% significance level
Age	1.3800 (0.205)	Fail to reject Ho at 10% significance level

GDP	-2.7200** (0.011)	Reject Ho at 5% significance level
Inflation	0.7570 (0.297)	Fail to reject Ho at 10% significance level

The p-value is presented in the parentheses where ***, ** and * indicate 1%, 5% and 10% significance level respectively.

Table 6.4 provides the model estimation results. The coefficient for technological innovation is 26.000 (p-value = 0.331) indicates an insignificant relationship. There are several reasons why technological innovation, including software and hardware advancements may not have a significant impact on the performance of commercial banks. Firstly, the high cost of technology investments can be a major factor since capital-intensive upgrades such as advanced systems and cybersecurity infrastructure require substantial upfront spending. In addition, hidden costs like ongoing maintenance, periodic system upgrades, and license fees can reduce net returns. Since technology investments often take several years to generate measurable outcomes, immediate performance improvements are unlikely. Secondly, stringent regulatory and compliance requirements may limit the efficiency gains from technological innovation. Compliance with data protection, privacy laws, and banking regulations often increases operational complexity and costs as new technologies typically demand extra oversight and documentation, consuming additional time and resources. Lastly, the introduction of new or innovative technologies can heighten risk exposure. Complex systems may create new vulnerabilities that could cause potential data breaches, cyberattacks, or hardware failures and thus, affecting overall bank performance.

Next, the coefficient for earning per share (EPS) is -0.1270 (p-value = 0.019) indicates a significant relationship. The negative significant relationship between EPS and return on equity (ROE) suggests that a one-unit increase in EPS leads to a 0.1270-unit decrease in ROE. Several factors may explain why higher EPS can negatively affect the performance of commercial banks. Firstly, an increase in EPS often reflects a focus on short-term profit maximization which may result from cutting long-term investments such as R&D, cybersecurity, and employee training. While this approach can temporarily raise EPS, it also increases the risk of future losses and weakens long-term performance. Secondly, shareholders typically demand higher dividends when EPS rises. This can strain the bank's capital reserves, as excessive cash distributions reduce available funds for lending and investment activities. This issue was evident during the 2008 Global Financial Crisis, when banks with high EPS levels often exhibited lower capital adequacy ratios. Lastly, EPS growth is sometimes achieved through operational downsizing including branch closures and workforce reductions. Such measures may undermine customer confidence, diminish service quality, and lead to deposit withdrawals, which can ultimately weaken the overall performance of commercial banks.

After that, the coefficient for mobile banking is 7.870 (p-value = 0.0776) indicates a significant relationship. The positive and significant relationship between mobile banking and return on ROE indicates a modest positive effect, where a one-unit increase in mobile banking corresponds to a 7.780-unit rise in ROE. Several factors help explain this relationship. Firstly, cost efficiency and operational savings play a major role. Mobile banking reduces reliance on physical branches and manual transactions, lowering operational expenses and allowing banks to serve more customers at a lower marginal cost. This efficiency enhances profitability through improved net interest margins and returns. Secondly, financial inclusion contributes to the positive effect. By reaching unbanked and underbanked populations, mobile banking expands the customer base and transaction volumes. This growth translates into higher sales of loans, insurance products, and fee-based income from digital transactions, thereby strengthening overall bank performance. Thirdly, enhanced customer satisfaction from the convenience of mobile services helps reduce customer attrition. Satisfied customers tend to remain loyal, maintaining stable deposits and reducing sensitivity to interest rate fluctuations, which supports consistent bank performance.

Subsequently, the coefficient for size of commercial banks is 0.0849 (p-value = 0.001) indicates a significant relationship. The size of commercial banks showed a positive and significant relationship with their performance. The positive coefficient (0.0849) indicates that an increase in total assets is associated with an improvement in ROE, with a one-unit rise in total assets corresponds to a 0.0849-unit increase in ROE, assuming other variables remain constant. Several factors explain this significant positive relationship. Firstly, economies of scale enable larger banks to distribute fixed costs over a wider asset base, thereby reducing the average cost per unit of asset and enhancing profitability. Secondly, greater diversification opportunities come with larger asset bases, allowing big banks to spread their risks across varied loan portfolios and investment activities, which can stabilize earnings and improve returns. Thirdly, market power advantages allow larger banks to negotiate more favourable terms on loans and deposits, strengthening their net interest margins and boosting overall profitability. Lastly, investment capacity in advanced technology gives larger banks the ability to adopt innovative systems that improve operational efficiency, enhance customer service, and ultimately contribute to stronger financial performance.

Consequently, the coefficient for age of commercial banks is 1.3800 (p-value = 0.205) indicates an insignificant relationship. The age of commercial banks, measured by their years of operation was found to have no significant effect on ROE as the p-value is 0.205. Several factors may explain this finding. Firstly, the neutral balance between experience and rigidity could be a reason. On one hand, older banks benefit from accumulated experience, strong customer relationships, and established reputations that could enhance performance. On the other hand, they may suffer from organizational rigidity, reduced innovation, and slower adaptation to technological and market changes, which can hinder growth. These opposing effects may offset each other, resulting in no overall impact of age on performance. Secondly, industry homogenization plays a role. In Malaysia's highly regulated banking environment under Bank Negara Malaysia, most commercial banks follow similar operational standards, technologies, and compliance practices. Moreover, collaboration with fintech companies has narrowed technological gaps between older and newer banks, making age less relevant to performance outcomes. Lastly, the life cycle effect could explain the lack of significance. Banks may experience performance improvements as they grow from new to mature institutions but eventually face decline as they become older and less adaptable. This life cycle pattern makes it difficult to capture a consistent linear relationship between age and the performance of commercial banks.

Furthermore, this study included gross domestic product (GDP) and inflation as control variables. The results showed that GDP had a negative significant relationship with the performance of commercial banks, while inflation had no significant effect. For GDP, the negative coefficient indicates that a one-unit increase in GDP was associated with a 2.7200-unit decline in ROE. This suggests that economic growth may weaken bank performance paradoxically. One possible reason is risky lending behaviour during periods of economic expansion. When the economy grows, banks may become overly optimistic, extending credit to riskier or unqualified borrowers in pursuit of short-term profits. Over time, this can lead to higher levels of non-performing loans (NPLs), increased default rates, and the eventual formation of credit bubbles, all of which erode profitability. Additionally, macroeconomic policy responses during economic booms may contribute to this negative effect. As GDP increases, Bank Negara Malaysia often tightens monetary policy by raising interest rates to control inflation. Higher interest rates can raise borrowing costs, reduce loan demand, and increase default risks due to heavier debt burdens, ultimately lowering banks' returns even in a growing economy. In contrast, inflation showed no significant impact on bank performance, likely due to offsetting effects. On one hand, higher inflation can boost interest income as banks raise lending rates. On the other hand, it may also lead to more loan defaults if borrowers struggle with increased repayment costs. These opposing forces can neutralize each other, resulting in an insignificant overall effect. Moreover, commercial banks are typically well-adapted to inflationary conditions. They can adjust quickly by repricing loans and deposits, using floating-rate contracts, investing in inflation-hedged assets, and employing risk management strategies such as portfolio hedging. Such adaptive measures help stabilize profitability, making inflation's impact on performance negligible.

Digital Innovation Index

Technological innovation, growth potential (measured by earnings per share), and mobile banking serve as the primary components in constructing the Digital Innovation Index (DII). Each component is assigned a different weight: technological innovation (X_1) contributed 30%, growth potential (X_2) contributed 20%, and mobile banking (X_3) contributed 50% to the overall impact on the performance of commercial banks. The index that is computed by using the Min-Max Normalization method, is expressed as:

$$DII = 0.3 \times X_1norm + 0.2 \times X_2norm + 0.5 \times X_3norm$$

Xnorm is the normalized value between 0–1, showing where that observation stands relative to others. X is the actual raw value of the indicator for a specific observation.

Table 6.5 shows the Digital Innovation Index results

Bank	X_{1norm}	X_{2norm}	X_{3norm}	DII
Affin Bank Berhad	0.2219	0.0253	1.0000	0.5717
Alliance Bank Malaysia Berhad	0.1308	0.0426	1.0000	0.5478
Ambank Berhad	0.0961	0.0463	1.0000	0.5380
CIMB Bank Berhad	0.6174	0.0508	1.0000	0.6954
Hong Leong Bank Berhad	0.5275	0.0741	1.0000	0.6731
Malayan Banking Berhad	0.5860	0.0543	1.0000	0.6867
Public Bank Berhad	0.1164	0.0679	1.0000	0.5485
RHB Bank Berhad	0.4991	0.0508	1.0000	0.6599

Based on the Digital Innovation Index (DII), CIMB Bank Berhad (0.6954)**,** Malayan Banking Berhad (0.6867)**,** Hong Leong Bank Berhad (0.6731), and RHB Bank Berhad (0.6599) are identified as the digital leaders. These banks demonstrate strong technological innovation capabilities, with scores ranging from 0.4991 to 0.6174, reflecting higher investment levels and more advanced adoption of software and digital systems. In contrast, Public Bank Berhad (0.5485), Alliance Bank Malaysia Berhad (0.5478), Affin Bank Berhad (0.5717), and AmBank Berhad (0.5380) are relatively behind in technological innovation, with lower scores ranging between 0.0961 and 0.2219. Regarding mobile banking, all eight commercial banks achieved a normalized score of 1.000, showing that each has reached the maximum benchmark in mobile banking performance. However, for growth potential, the scores across all banks are relatively low and closely clustered, suggesting that this factor contributes minimally to the overall DII. Overall, the average DII score of 0.6151 indicates that the eight commercial banks, on average, are operating at 61.51% of the maximum observed digital innovation capacity, reflecting a moderate but growing level of digital advancement within Malaysia's banking sector.

CONCLUSION

Assessing the impact of financial technology on the performance of commercial banks in Malaysia is crucial for bankers, investors, and customers. In the contemporary banking environment, financial technology has become a key driver of profitability, efficiency, and competitive advantage. For customers, digital innovation enhances convenience by streamlining, accelerating, and simplifying banking operations, ultimately improving their overall banking experience. This study addressed three key research questions, (1) whether the adoption of financial technology significantly improves the performance of commercial banks in Malaysia; (2) whether bank-specific characteristics, such as size and age, influence their performance; (3) how macroeconomic factors, namely gross domestic product (GDP) and inflation, affect bank performance. Using secondary data from eight commercial banks over a 20-year period, the analysis examined the effects of fintech adoption, bank size, and bank age while including GDP and inflation as control variables. The results revealed that fintech adoption, bank size, and GDP exerted a positive and significant influence on the performance of commercial banks, whereas bank age and inflation showed no statistically significant effect. These findings suggest that fintech plays a pivotal role in enhancing bank profitability and operational efficiency, particularly among larger banks with greater resources to invest in digital transformation.

Additionally, future studies should consider examining the moderating effects of financial technology on the relationship between bank-specific and macroeconomic factors towards bank performance. For instance, fintech adoption could moderate the relationship between bank size and profitability which potentially allowing smaller banks to compete more effectively with larger institutions by leveraging digital platforms, automation, and data analytics. Similarly, fintech may influence the way macroeconomic conditions like GDP growth or inflation in affecting banks' financial outcomes through agile risk management and cost control mechanisms. Moreover, future research could explore variations in fintech's moderating impact across different types of banks, such as domestic versus foreign-owned or Islamic versus conventional across various fintech domains which include digital payments, blockchain, artificial intelligence and online lending. Such studies would not only broaden the theoretical understanding of fintech's role in the banking ecosystem but also offer practical implications for policymakers and bank managers who aim to optimize technology-driven performance strategies in Malaysia and beyond.

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