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The Effect of Fintech Funding on Bank Profitability: A Case of ASEAN-5

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Abstract: Many reports on fintech prospects in ASEAN predict that fintech plays a critical role in the digital economy and significantly influences the banking industry, attracting many scholars. However, an investigation of the effect of fintech on bank performance across cross-countries has not yet been conducted. Besides, the reports showed that fintech funding had been dramatically rising in recent years, accelerating fintech startup development. Therefore, the authors are concerned about the "How is the effect of fintech funding on bank performance, especially regarding profitability?". These are the motives for conducting the study. Using a sample of 57 banks and data on fintech funding from 2017 to 2021 in Malaysia, Philippines, Thailand, Indonesia, and Vietnam, the dynamic panel model is estimated by Panel Corrected Standard Error. The findings show that the growth of fintech funding negatively influences bank profitability, but its lag effect is positive. The results are mostly validated through multiple additional tests (in the context of Covid-19, sorted by country and bank size) and a robustness check by an alternative estimator (Generalized Least Square). Besides, the authors explored some interesting exceptions. In detail, fintech funding does not influence bank profitability in Malaysia and Indonesia, but it negatively links with ROA in Vietnam, and large banks are not sensitive to the growth of fintech funding.

Keywords: fintech funding, bank profitability, ASEAN-5.

金融科技资金对银行盈利能力的影响：东盟5的案例

摘要:

关于金融科技前景的许多报告预测，金融科技在数字经济中起着至关重要的作用，并显着影响银行业，吸引了许多学者。但是，尚未对金融科技对跨跨场的银行绩效的影响进行调查。此外，报告显示，近年来，金融科技资金急剧上升，加速了金融科技创业的开发。因此，作者担心"金融科技资金对银行绩效的影响，尤其是对盈利能力的影响？"。这些是进行研究的动机。使用57个银行的样本和关于2017年至2021年在马来西亚，菲律宾，泰国，印度尼西亚和越南的金融科技资金数据的样本，由面板校正的标准误估了动态面板模型。研究结果表明，金融科技资金的增长对银行的盈利能力产生了负面影响，但其滞后效应是积极的。结果主要通过多个其他测试（在新冠肺炎的背景下，按国家和银行规模排序），并通过替代估计器

（概括性最低方形）进行稳健性检查。此外，作者探索了一些有趣的例外。详细说明，金融科技资金不影响马来西亚和印度尼西亚的银行盈利能力，但它与越南的资产回报率有负相关，大型银行对金融科技资金的增长不敏感。

关键词：金融科技资金，银行盈利能力，东盟5。

Introduction

Following the works [1-3] on the prediction of fintech in ASEAN, the authors agree that the fintech factor has been playing a critical role in the ASEAN economy, which directly affects the incumbents of the finance industry. In a specific country, the question "how does fintech influence banks?" has attracted many scholars to find the answer. For example, Phan et al.[4] found a negative effect of growing fintech companies on bank performance in Indonesia. Using a Google search to measure the fintech variables, Pham et al. [5] found a mixed impact of fintech on specific bank stock returns in Vietnam. In detail, fintech does not influence bank stock return by the vector autoregression estimator, but by the ordinary least square estimator, the mobile payment and peer-to-peer lending segments of fintech are negative and positive with the stock return, respectively. Using panel data from 2009 to 2016 in Malaysia, Muda et al. [6] explored the negative effect of fintech on banks' income. Islamic banks are more strongly affected by fintech than others. Based on the available data on FAS and the Global Findex database, Banna and Alam [7] developed and calculated the digital financial inclusion index (DFI) used to estimate the relationship with banking stability for Indonesia, Malaysia, the Philippines, and Thailand. The findings show that DFI is not only an acceleration factor of banking stability but also reduces default risk. Besides, other publications researched the link between fintech and banks in various ways in the specific countries in ASEAN, such as [8,9] in Indonesia, [10, 11] in Thailand, [12,13] in the Philippines, [14-16] in Vietnam, etc. However, these existing publications have not yet considered the effect of fintech on bank performance measured by profitability in cross-countries. The authors argue that the international investigation of the impact of fintech on bank profitability will provide meaningful evidence, which enriches the knowledge in this interesting field of the relationship.

According to a 2022 report by UOB [17], ASEAN has emerged as a hub for the digital economy, with fintech are a particularly vibrant sector. As of 2022, there are 4,030 operating fintech companies in Indonesia, Thailand, Philippines, Vietnam, Malaysia, and Singapore, representing a 54.29% increase from the 2,612 companies in 2018. fintech has experienced significant growth, with approximately US$3.5 billion invested in fintech companies during the first nine months of 2021, triple the amount raised in 2020. The payment segment received the most funding with US$1.9 billion, followed by investment tech (US$457 million) and cryptocurrency (US$356 million). The report also notes that fintech has had a significant impact on changing the financial behavior of customers in the Southeast Asia region. Many people have adopted finance apps for their daily activities, such as shopping, paying bills, and transferring money. Overall, the report confirms that Southeast Asia is the most dynamic market for the fintech industry globally.

The UOB report [17] highlights several indicators of fintech company development in ASEAN, including the amount of fintech funding, which reflects the attention of investors on fintech companies. Based on this report, the authors plan to collect figures on fintech funding to measure fintech variables. Additionally, drawing on studies by [8,18] on the impact of fintech funding on bank performance, the authors contend that fintech funding can serve as a proxy for the fintech variable and estimate its effect on bank performance in ASEAN.

This study examines the impact of fintech funding on bank profitability in ASEAN, an emerging market in the fintech industry. By exploring the relationship between fintech and bank performance across countries, this study will generate new insights into the effect of fintech on bank performance. Additionally, given that fintech companies offer alternative financial products that can disrupt incumbents in the finance industry, the authors plan to apply both customer and disruptive innovation theories to explain the effect of fintech funding on bank profitability. As a result, the study will contribute to empirical evidence on the application of these theories in the case of ASEAN-5.

The rest of the study consists of a literature review, Methodology, Results and Discussion, and Conclusion. The literature review section reports relevant studies of the effect of fintech on bank performance and provides the customer and disruptive innovation theories used for the hypothesis. The methodology section reveals the research model, data collection, and analysis. The results and discussion section report and discuss the estimation results using various data analysis methods. The conclusion section presents the brief main points of the study and limitations and directions for further research.

1. Literature Review

1.1. Related Literature

The existing publications reveal that the effect of fintech on bank performance is an interesting topic that has attracted vast numbers of scholars. On the one hand, many scholars stated that its effect is negative. For example, the study by Phan et al.[4] used the ratio of net interest income to assets, return on assets, return on equity, and yield on earning assets for proxying bank performance in Indonesia over the period 1998 to 2017 and used the annual number of fintech companies registered for measuring fintech variables. Based on the conventional model of performance determinants, the authors described a dynamic panel model for estimating the effect of fintech on bank performance. Then, the two-step Generalized method of moments (GMM) system dynamic panel estimator is employed to estimate the proposed models. The estimation results of original models and multiple additional tests (sorted by market value, bank age, ownership, and global financial crisis) showed that the growing number of fintech companies is a negative factor in bank performance. In China, from 2013 to 2018, Zhao et al. [19] investigated the effect of fintech on bank performance. Based on the database of Fintech Beta, the authors self-constructed a fintech index for analysis. Besides, patents are also used for proxying fintech variables. Bank performance is measured by capital adequacy, asset quality, management efficiency, earning power, and liquidity ratio. The estimation results by two-step GMM showed that fintech negatively influences bank profitability and asset quality. However, fintech enhances capital adequacy and management efficiency for large state-owned banks. Furthermore, small banks collaborate with fintech innovation with fintech companies. Other scholars have found a negative effect of fintech on bank performance, such as [20-25].

On the other hand, some scholars found a positive effect of fintech on bank performance. Lee, Li, Yu, and Zhao [26] applied the stochastic metafrontier model and principal component analysis for measuring bank cost efficiency and fintech variables, respectively. The ingredients for measuring bank efficiency consist of inputs (labor, physical capital, and borrowed funds) and outputs (total loans, other earning assets, and non-interest revenue). The fintech variables are calculated by the number of fintech companies, total registered capital, financing events, and degree of fintech development. Based on the panel data of 676 firms from 2003 to 2017 and applying the estimator like the study by [4, 26] provide that fintech is a positive factor in enhancing bank cost efficiency and leveling up bank technology systems. Following that, the effect of fintech on bank profitability is positive in the case of China, the second-largest economy and the best dynamically developed fintech market worldwide. Li et al. [18] collected funding from fintech startup companies and investigated its effect on the stock return of 47 US retail banks from 2010 to 2016. Based on the three-factor model of Fama and French [27], panel models of the effect of fintech funding on bank stock return were developed. The estimation results showed that the growth in fintech funding (value and deals) increases bank stock return. Bashayreh and Wadi [28], Dwivedi et al. [29], Mustapha [30], Rega [31], Safiullah and Paramati [32], and Singh et al. [33] also found the evidence of the negative effect of fintech on bank performance.

Other studies also provide significant references about the effect of fintech on bank performance. Chen et al. [34] self-designed questionnaires to survey bank employees and customers. The authors used perceived usefulness and perceived difficulty of use for proxying the fintech variable, while bank performance is presented by customer satisfaction, expectation of assistance, service quality, and work efficiency. Based on the responses of 307 customers and 93 employees, the estimation results showed that the perceived usefulness of fintech products increases customer satisfaction, service quality, and employee work efficiency but decreases the expectation of bank employee assistance, and the perceived difficulty of use of fintech products reduces customer satisfaction. The risk spillovers between two entities investigate the relationship between fintech and banks. Li et al. [35] collected the daily stock returns data of fintech firms and banks in the USA and investigated the risk spillover between two entities from January 2011 to June 2018. The estimation results by the VAR estimator and Granger causality showed that when the risk spillover is higher, the association between the two entities is stronger in the case of downside-to-downside. Besides, fintech risk spillover has a positive effect on banks, especially on bank system risk. Furthermore, studies by Agboola et al. [36], Al-Matari et al. [37], Ky et al. [38], Pu et al. [39], and Stulz [40] provided significant multidimensional perspectives about the effect of fintech on bank performance.

These studies reveal that the effect of fintech on bank performance is heterogeneous. Its effect is both positive and negative. The heterogeneous effect might be due to various variable measurements (e.g., fintech firms, fintech funding, self-constructed fintech index, etc.) and dataset analysis methods (regarding kinds of dataset: panel, time-series, and cross-section) or even due to the investigation environment (e.g., macroeconomic and bank characteristics). Therefore, the authors argue that further research is encouraged to enrich the knowledge in this field. This is also the motive for conducting the study.

1.2. Hypothesis Development

Fintech startup companies provide alternative financial products, penetrating the pie of incumbents in the finance industry, especially in the retail banking market. Fintech companies apply disruptive technologies to deliver products to customers anywhere, anytime. Fintech products on the decentralized peer-to-peer platforms (e.g., lending, payments, etc.) meet the customers' requirements and are appreciated as more advanced in convenience than traditional financial products [41-44]. Based on that, the authors argue that the consumer theory by Aaker and Keller [45] and the disruptive innovation theory by Christensen [46] are applied for explanation in the study.

The customer theory states that with the same needs, the new products might replace the old ones in the market because the new products bring more benefits and experience than the old ones. The disruptive innovation theory states that new entrants quickly apply disruptive technologies to reduce cost and enhance performance; thus, it creates high competition pressure against incumbents in the market. Following two theories, the authors argue that fintech funding is the promotive factor that facilitates fintech development. The increase in fintech funding supports fintech companies in expanding their business scale and launching new products to bring the best experiences to customers. Thus, it might be possible that many bank customers switch to using the fintech product instead of maintaining the banking product, which might lead to decreased bank profit.

Besides, following the studies by Almulla and Aljughaiman [20], Elsaid [47], and Yudaruddin [48], the customer and disruptive innovation theories are highly appreciated for explaining the effect of fintech on bank performance. In line with the main content of the theories, the growth of fintech startup companies through fintech funding will be a threat and negatively influence bank performance.

Consequently, following these arguments above, in this study, the authors expect a negative effect of fintech funding on bank profitability in the ASEAN region.

2. Methodology

The main steps of the research process are summarized in Fig. 1. First, the research gap and hypothesis were proposed based on a review of existing publications. Second, the research model was developed. Third, the data were gathered on the basis of the availability of data and the ability to collect it. Fourth, suitable methods were employed for estimation. Finally, the estimation results were combined with the hypothesis for discussion.

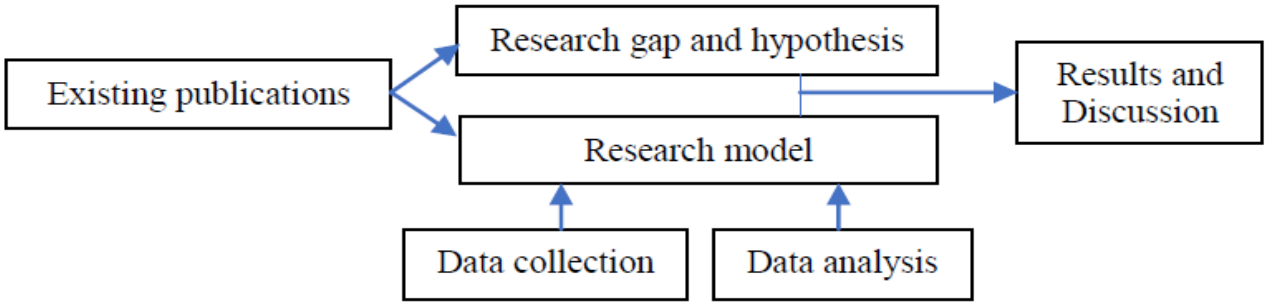

Fig. 1 Flowchart of research methodology (The authors' elaboration)

2.1. Model

Following the study by Lee et al. [26], Phan et al. [4], Wu and Yuan [25], and Zhao et al. [19], the authors describe the dynamic panel model including the fintech variable, which illustrates the fintech effect and its lag effect on bank profitability. The models are proposed

$$PRO_{it} = \alpha_i + \beta_1 FIN_t + \gamma PRO_{i,t-1} + \delta BANK_{it} + \theta MAR_t + \varepsilon_{it} \quad (1)$$

$$PRO_{it} = \alpha_i + \beta_2 FIN_{t-1} + \gamma PRO_{i,t-1} + \delta BANK_{it} + \theta MAR_t + \varepsilon_{it} \quad (2)$$

Here, PRO_{it} is bank-level dependent variables that comprise return on total assets and return on equity of bank i at time t. FIN_t is the fintech variable that proxies fintech funding at time t. $BANK_{it}$ are the set of bank-level variables that play the control variables proxied by size, leverage, loans, and deposits of bank i at time t. MAR_t is the macroeconomic condition that consists of the growth rate of gross domestic production and the consumer price index at time t. $\varepsilon_{it} = \mu_i + \sigma_{it}$ is the bank-specific effect and idiosyncratic error term.

Table 1 Variable definition (The authors' elaboration)

Variable		Definition	Source
ROA	Bank profitability (PRO)	Return on assets	Financial statements
ROE		Return on equity	
FIN	Fintech funding	The logarithm of the value of funding deals	UOB Group
SIZE	Bank characteristics (BANK)	The logarithm of total assets (million US dollars)	Financial statements
LEV		The ratio of liability to equity	

Continuation of Table 1

LOAN		The ratio of loans to total assets	
DEPO		The ratio of deposits to total assets	
GDP	Macroeconomics (MAR)	The annual percentage growth rate of GDP	World Bank
INF		The annual consumer price index	
COV	COVID-19 pandemic	Equals 1 if the year is after 2020 and 0 otherwise	

Since early 2020, COVID-19 has spread worldwide, which has affected many social and economic aspects [49-51]. Bao and Huang [52] and Demirgüç-Kunt et al. [53] provided that COVID-19 significantly influences the fintech and banking industry; thus, in this study, the COVID-19 effect is considered to investigate the relationship between fintech funding and bank profitability, which follows the models:

$$PRO_{it} = \alpha_i + \beta_3 FIN_t * \text{COV} + \beta_4 FIN_t * (1 - \text{COV}) + \gamma PRO_{i,t-1} + \delta BANK_{it} + \theta MAR_t + \varepsilon_{it} \quad (3)$$

$$PRO_{it} = \alpha_i + \beta_5 FIN_{t-1} * \text{COV} + \beta_6 FIN_{t-1} * (1 - \text{COV}) + \gamma PRO_{i,t-1} + \delta BANK_{it} + \theta MAR_t + \varepsilon_{it} \quad (4)$$

Here, COV is a dummy variable that equals 1 if the year is after 2020 and 0 otherwise.

All variables are defined and denoted in detail in Table 1.

The estimation result of β_1, β_2, β_3, β_4, β_5, and β_6 will be used for discussing the effect of fintech funding on bank profitability and its effect in the context of the Covid-19 pandemic, which is the main task of this study. Following this hypothesis$\beta_1\beta_2$, β_3, β_4, β_5, and β_6 are expected to be negative (<0). Besides that, the values of pair-coefficients of β_3 and β_4, and β_5 and β_6 are used for comparison. The difference between these coefficients reveals the impact of fintech on bank profitability pre- and during COVID-19.

2.2. Data Collection

The amount of fintech funding in millions of US dollars is obtained from the UOB Group [54], which illustrates the fintech funding in ASEAN-6, including Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam from 2017 to 2021.

Bank-level data are collected from audited financial statements, which are disclosed on the bank website. Based on the data collection capability and data availability, the authors initially obtained data from ASEAN-6, which holds over 80% of the total assets of the ASEAN banking industry [55]. However, Singapore is a developed country, where the financial market is dramatically higher than others, which might produce bias estimation results in the sample [7]. Hence, the sample for investigation includes 5 countries, called ASEAN-5, including Indonesia, Malaysia, Philippines, Thailand, and Vietnam (excluding Singapore). Furthermore, regarding the bank size variable, to ensure data uniformity, the authors used the currency exchange rate on Google on 24th May 2022 (UTC 13:45-13:50) to convert the national currency unit to USD before analysis. In detail, USD/VND (Vietnam) = 23,220.01; USD/THB (Thailand) = 34.14; USD/PHP (Philippines) = 52.33; USD/MYR (Malaysia) = 4.40; USD/IDR (Indonesia) = 14,645.10.

Table 2 Descriptive statistics [54]

ASEAN-5					**Malaysia**				
Variable	**Mean**	**Std. Dev**	**Min**	**Max**	**Variable**	**Mean**	**Std. Dev**	**Min**	**Max**
ROA	.015227	0098118	-.0378471	.0469816	ROA	.0112506	.0059819	-.0204697	.0180077
ROE	.1380351	.0901	-.4040902	.3423277	ROE	.1080848	.0630745	-.2234388	.1851476
FIN	3.933224	1.97508	0	6.807294	FIN	3.061464	1.569013	.3576744	4.761917
SIZE	9.95687	1.194094	6.024508	12.21532	SIZE	10.87293	.8692008	9.482151	12.21532
LEV	8.870634	3.723201	2.92407	23.61981	LEV	8.691778	1.366388	6.214879	11.52453
LOAN	.6317094	.0923201	.2969801	.7931857	LOAN	.673379	.0499534	.5977756	.7737126
DEPO	.7123989	.0920203	.4417849	.8838887	DEPO	.7323931	.0515323	.6492881	.8220487
GDP	.0327592	.0434976	-.0957303	.0707579	GDP	.0251009	.0422351	-.0564694	.0581272
INF	.023240	.0144665	-.011387	.052116	INF	.0135144	.0172517	-.011387	.038712
Philippines					**Thailand**				
Variable	**Mean**	**Std. Dev**	**Min**	**Max**	**Variable**	**Mean**	**Std. Dev**	**Min**	**Max**
ROA	.0150714	.0066577	.0006166	.0469816	ROA	.016514	.0089234	-.0021049	.0348604
ROE	.1396047	.0675941	.0048665	.3423277	ROE	.1331416	.0695534	-.0214516	.3094484
FIN	4.583001	1.273341	2.287471	5.875577	FIN	3.699413	1.25752	2.267994	5.373425
SIZE	9.578516	1.021224	7.504522	11.14544	SIZE	10.3353	1.090157	8.817085	11.75137
LEV	8.412424	3.0234	4.29456	18.58786	LEV	7.339021	1.182406	4.913099	9.653922
LOAN	.5611424	.0844585	.3637228	.7053493	LOAN	.6907528	.0704027	.5133452	.7931857
DEPO	.7682315	.0762651	.5952203	.8838887	DEPO	.682609	.080377	.4628728	.805965
GDP	.0308787	.0639378	-.0957303	.0693099	GDP	.0123167	.038401	-.0609898	.0418959
INF	.033603	.010131	.0248028	.052116	INF	.0056414	.0074335	-.0084594	.012304
Indonesia					**Vietnam**				
Variable	**Mean**	**Std. Dev**	**Min**	**Max**	**Variable**	**Mean**	**Std. Dev**	**Min**	**Max**
ROA	.0162373	.0156771	-.0378471	.039655	ROA	.0158651	.0089741	.001465	.04086
ROE	.0854422	.1278783	-.4040902	.2253602	ROE	.1912986	.0741608	.0119829	.3297934
FIN	5.67668	.6672109	4.739701	6.807294	FIN	2.844179	2.597033	0	5.995208

Continuation of Table 2									
SIZE	9.707424	1.707843	6.024508	11.67699	SIZE	9.684994	.7554771	8.483371	11.23677
LEV	5.697366	2.027367	2.92407	12.55196	LEV	12.60183	4.208378	4.891617	23.61981
LOAN	.6259485	.0869914	.2969801	.7469075	LOAN	.6311858	.0931197	.3188186	.7880603
DEPO	.7166046	.0589582	.5904647	.81157	DEPO	.6723891	.1174887	.4417849	.8837326
GDP	.0337724	.0280503	-.0206954	.0517429	GDP	.052789	.0208764	.0258322	.0707579
INF	.0270377	.0084433	.0156013	.038088	INF	.0298227	.006381	.0183472	.0353963

The macroeconomic data are collected from the World Bank database.

The characteristics of the variables are illustrated in Table 2.

2.3. Data Analysis

We apply the correlation matrix for the multicollinearity test of the baseline models. Table 3 shows that the absolute maximum correlation value between pairs of variables is 0.7993 (less than a threshold of 0.8), belonging to two dependent variables of the regression model; hence, the authors can conclude that the baseline models do not have the multicollinearity issue [56]. All variables are eligible for the next analysis.

Table 3. Correlation matrix (The authors' elaboration)

Variable	ROA	ROE	FIN	SIZE	LEV	LOAN	DEPO	GDP	INF
ROA	1.0000								
ROE	0.7993	1.0000							
FIN	0.0148	-0.1738	1.0000						
SIZE	0.2331	0.1912	-0.0310	1.0000					
LEV	-0.3369	0.2078	-0.3175	-0.0450	1.0000				
LOAN	0.2103	0.1808	-0.1408	0.2071	0.0049	1.0000			
DEPO	-0.2417	-0.1367	0.1173	0.0191	0.1819	0.0444	1.0000		
GDP	0.0368	0.1240	-0.2167	-0.1196	0.1944	-0.0009	-0.0666	1.0000	
INF	0.0402	0.1121	-0.0145	-0.2687	0.1892	-0.2753	0.1062	0.5301	1.0000

Next, following Gujarati and Porter [57], the authors apply the fixed effect approach (FE) and random effect approach (RE) to examine the effect of fintech funding on bank profitability. Additionally, through the Hausman test, the estimation results of all models by FE are more appreciated than by RE. However, the estimation results by FE have heteroskedasticity and autocorrelation issues, which are confirmed by the Wald and Wooldridge tests, respectively. Based on Beck and Katz [58], to overcome these issues, the Panel Corrected Standard Error method (PCSE) is applied to provide evidence of the effect of fintech funding on bank profitability. Furthermore, according to Blackwell [59] and Parks [60], the Generalized least squares (GLS) is also applied as an alternative estimator, which is considered the robustness check.

3. Results and Discussion

3.1. Effect of Fintech Funding on Bank Profitability Sorted by Country

The existing publications showed that the effect of fintech on bank performance is heterogeneous, which might be caused by the distinction between the investigation scope (between countries). Based on this, further analysis is conducted to examine the effect of fintech on bank profitability sorted by country. Table 5 presents the value and P-value of fintech coefficients, which show the effect of fintech funding on bank profitability in a specific country. The regression models take the following form:

$$PRO_{it} = \alpha_i + \beta_1 FIN_t + \gamma PRO_{i,t-1} + \delta_1 SIZE_{it} + \delta_2 LEV_{it} + +\delta_3 LOAN_{it} + \delta_4 DEPO_{it} + \theta_1 GDP_t + \theta_2 INF_t + \varepsilon_{it} \quad (5)$$

$$PRO_{it} = \alpha_i + \beta_2 FIN_{t-1} + \gamma PRO_{i,t-1} + \delta_1 SIZE_{it} + \delta_2 LEV_{it} + +\delta_3 LOAN_{it} + \delta_4 DEPO_{it} + \theta_1 GDP_t + \theta_2 INF_t + \varepsilon_{it} \quad (6)$$

$$PRO_{it} = \alpha_i + \beta_3 FIN_t * COVID_i + \beta_4 FIN_t * (1 - COVID_i) + \gamma PRO_{i,t-1} + \delta_1 SIZE_{it} + \delta_2 LEV_{it} + +\delta_3 LOAN_{it} + \delta_4 DEPO_{it} + \theta_1 GDP_t + \theta_2 INF_t + \varepsilon_{it} \quad (7)$$

$$PRO_{it} = \alpha_i + \beta_5 FIN_{t-1} * COVID_i + \beta_6 FIN_{t-1} * (1 - COVID_i) + \gamma PRO_{i,t-1} + \delta_1 SIZE_{it} + \delta_2 LEV_{it} + +\delta_3 LOAN_{it} + \delta_4 DEPO_{it} + \theta_1 GDP_t + \theta_2 INF_t + \varepsilon_{it} \quad (8)$$

In the regression, PRO is measured by ROA and ROE; the control variables are mentioned above. The estimation method is Panel Corrected Standard Errors. The table shows the values of β_1, β_2, β_3, β_4, β_5, and β_6.

Table 5 The effect of fintech funding on bank profitability sorted by country (The authors' elaboration)

	Malaysia		Philippines		Thailand		Indonesia		Vietnam	
Variable	ROA	ROE	ROA	ROE	ROA	ROE	ROA	ROE	ROA	ROE
FIN	.000269	.003489	.003364***	.02091***	-.00121***	-.01508***	-.01495	.0456244	-.00080***	-.0026928
	0.64	0.81	2.95	2.69	-5.94	-8.81	-0.24	0.07	-4.99	-1.31
FIN_{t-1}	-.0010282	-.013332	.355423***	.20902***	.00197***	.02462***	-.00041	.001241	-.00040***	-.0013489
	-0.64	-0.81	2.95	2.69	5.94	8.81	-0.24	0.07	-4.99	-1.31

Continuation of Table 5										
FIN*COV	-.001165*	-.007143	.000732	.002575	-.0000545	-.00311**	-.00739	-.046004	.00024***	.00271***
	-1.75	-1.03	1.39	0.73	-0.28	-2.00	-0.85	-0.55	5.06	4.09
FIN*(1-COV)	.0002021	.0029921	-.00087***	-.00855***	-.00055***	-.00823***	-.00759	-.043604	-.00011**	.00088*
	0.48	0.69	-5.44	-8.35	-3.70	-7.77	-0.75	-0.44	-2.36	1.93
FIN_{t-1}*COV	-.0015547	-.014921	.00372***	.031406***	.00454***	.062284***	-.00336	-.02389	-.00042***	-.0011684
	-1.58	-1.51	23.22	22.72	5.03	9.28	-1.12	-0.89	-4.81	-1.04
FIN_{t-1}*(1-COV)	-.0006364	-.012149	.002233***	.022198***	.009355***	.1328***	-.00175	-.010226	-.00090***	.003231
	-0.30	-0.56	5.23	8.07	4.50	8.81	-0.77	-0.46	-3.24	0.88

Note: *, **, and *** are significant values at 10%, 5%, and 1%, respectively.

Some interesting findings were obtained. First, all $\beta^{Malaysia}$ and $\beta^{Indonesia}$ are insignificant; thus, there is no evidence to conclude the relationship between fintech funding and bank profitability in Malaysia and Indonesia, which is different from the study by [4, 7]. the authors discuss that it might be explained by the fintech funding value being very small compared with the scale of banks in Malaysia and Indonesia, or the inefficient fintech funding investment could not influence the banks.

Second, the authors find the excellent reaction of the Philippines banks to the rise of fintech, which is confirmed by the most significant positive of fintech coefficients, except for the significant negative of $\beta^{Philippines}_{FIN*(1-COV)}$. The authors argue that at the time pre-Covid-19, banks focused on technology investment, increasing cost, and reduced profit. Besides, the authors find that the fintech effect plays a role less critical than its lag effect ($\beta^{Philippines}_{FIN_{t-1}} > \beta^{Philippines}_{FIN_t}$) in the Philippines.

Third, the signs of $\beta^{Thailand}$ are similar with $\beta^{ASEAN-5}$; thus, the authors discuss that Thailand mirrors the effect of fintech funding on bank profitability in ASEAN-5, which might be explained as mentioned above. Most $\beta^{Vietnam}$ are negative significant, which supports the hypothesis of the negative effect of fintech funding on bank profitability. However, $\beta^{Vietnam}_{FIN*COV}$ is a positive significant, which might be explained by the effectiveness of the Zero-Covid strategy (Vietnam applied the Zero-Covid strategy from 2020 to 2021, starting in 2022 as the Non-Zero-Covid). Vietnamese commercial banks gained more profits during the lockdown [61].

3.2. Effect of Fintech Funding on Bank Profitability Sorted by Bank Scale

Haller and Siedschlag [62], Phan et al. [4], and Scott et al. [63] stated that smaller firms are more sensitive to transformation costs with technology innovation than larger firms. Based on that, in the high pressure of fintech development, the authors argue that the effect of fintech on the profitability of small banks is stronger than that of large banks. Therefore, further analysis is conducted to examine the effect of fintech on profitability between small and large banks. The estimation results are reported in Table 6.

A large bank is defined by the top half of banks measured by total assets (median is 18,217 million US dollars), and a small bank belongs to the bottom half.

The regression models take the following form:

$$\mathrm{PRO_{it}} = \alpha_i + \beta_1 \mathrm{FIN_t} + \gamma \mathrm{PRO_{i,t-1}} + \delta_1 \mathrm{SIZE_{it}} + \delta_2 \mathrm{LEV_{it}} + +\delta_3 \mathrm{LOAN_{it}} + \delta_4 \mathrm{DEPO_{it}} + \theta_1 \mathrm{GDP_t} + \theta_2 \mathrm{INF_t} + \varepsilon_{it} \quad (9)$$

$$\mathrm{PRO_{it}} = \alpha_i + \beta_2 \mathrm{FIN_{t-1}} + \gamma \mathrm{PRO_{i,t-1}} + \delta_1 \mathrm{SIZE_{it}} + \delta_2 \mathrm{LEV_{it}} + +\delta_3 \mathrm{LOAN_{it}} + \delta_4 \mathrm{DEPO_{it}} + \theta_1 \mathrm{GDP_t} + \theta_2 \mathrm{INF_t} + \varepsilon_{it} \quad (10)$$

$$\mathrm{PRO_{it}} = \alpha_i + \beta_3 \mathrm{FIN_t} * \mathrm{COVID_i} + \beta_4 \mathrm{FIN_t} * (1 - \mathrm{COVID_i}) + \gamma \mathrm{PRO_{i,t-1}} + \delta_1 \mathrm{SIZE_{it}} + \delta_2 \mathrm{LEV_{it}} + +\delta_3 \mathrm{LOAN_{it}} + \delta_4 \mathrm{DEPO_{it}} + \theta_1 \mathrm{GDP_t} + \theta_2 \mathrm{INF_t} + \varepsilon_{it} \quad (11)$$

$$\mathrm{PRO_{it}} = \alpha_i + \beta_5 \mathrm{FIN_{t-1}} * \mathrm{COVID_i} + \beta_6 \mathrm{FIN_{t-1}} * (1 - \mathrm{COVID_i}) + \gamma \mathrm{PRO_{i,t-1}} + \delta_1 \mathrm{SIZE_{it}} + \delta_2 \mathrm{LEV_{it}} + +\delta_3 \mathrm{LOAN_{it}} + \delta_4 \mathrm{DEPO_{it}} + \theta_1 \mathrm{GDP_t} + \theta_2 \mathrm{INF_t} + \varepsilon_{it} \quad (12)$$

In the regression, PRO is measured by ROA and ROE; the control variables are mentioned above. The estimation method is Panel Corrected Standard Errors with the year and country-fixed effect. The table shows the values of β_1, β_2, β_3, β_4, β_5, and β_6.

Table 6 The effect of fintech funding on bank profitability sorted by bank scale (The authors' elaboration)

	Small Bank		**Large Bank**	
Variable	**ROA**	**ROE**	**ROA**	**ROE**
FIN	-.0009859***	-.0071014***	-.000529	-.004204
	-2.96	-2.67	-1.29	-1.54
FIN_{t-1}	.0027635***	.0190309***	.0004553	.0030251
	4.24	3.54	0.63	0.51
FIN*COV	-.0028025***	-.0194095**	-.0013561**	-.0049185
	-4.65	-2.02	-2.27	-1.17
FIN*(1-COV)	-.0005029	-.0035121	-.0002659	-.0039797
	-1.53	-0.95	-0.60	-1.61
FIN_{t-1}*COV	.002528***	.0157642***	.0003981	.0033492
	3.69	2.96	0.54	0.50
FIN_{t-1}*(1-COV)	.002945***	.0211893**	.0005353	.0025081
	3.76	2.49	0.52	0.42

Note: *, **, and *** are significant values at 10%, 5%, and 1%, respectively.

Following Phan et al. [4], the total assets (after being converted from national currency to US dollars) are sorted and split at the median (18,217 million US dollars). The top half is the large banks, and the small ones are at the bottom. Table 6 shows that the signs of most $\beta^{smallbank}$ are similar to $\beta^{ASEAN-5}$ and significant at a 1%-5% level, while most $\beta^{largebank}$ are insignificant. It reveals that small banks are more sensitive to the fintech effect than large banks, and they are proactive in collaboration with fintech companies to enhance their performance. Besides, there is no evidence of an association between fintech funding and large bank profitability, which might be caused by the small economic scales of fintech companies compared with large banks.

3.3. Alternative Estimator Using the Generalized Least Square Method

We use an alternative estimator to confirm robustness. The reason for selecting the Generalized Least Square method (GLS) is that GLS can alternative the PCSE to fix heteroskedasticity and autocorrelation issues [59, 60, 64].

The regression models take the following form:

$$PRO_{it} = \alpha_i + \beta_1 FIN_t + \gamma PRO_{i,t-1} + \delta_1 SIZE_{it} + \delta_2 LEV_{it} + +\delta_3 LOAN_{it} + \delta_4 DEPO_{it} + \theta_1 GDP_t + \theta_2 INF_t + \varepsilon_{it} \quad (13)$$

$$PRO_{it} = \alpha_i + \beta_2 FIN_{t-1} + \gamma PRO_{i,t-1} + \delta_1 SIZE_{it} + \delta_2 LEV_{it} + +\delta_3 LOAN_{it} + \delta_4 DEPO_{it} + \theta_1 GDP_t + \theta_2 INF_t + \varepsilon_{it} \quad (14)$$

$$PRO_{it} = \alpha_i + \beta_3 FIN_t * COVID_i + \beta_4 FIN_t * (1 - COVID_i) + \gamma PRO_{i,t-1} + \delta_1 SIZE_{it} + \delta_2 LEV_{it} + +\delta_3 LOAN_{it} + \delta_4 DEPO_{it} + \theta_1 GDP_t + \theta_2 INF_t + \varepsilon_{it} \quad (15)$$

$$PRO_{it} = \alpha_i + \beta_5 FIN_{t-1} * COVID_i + \beta_6 FIN_{t-1} * (1 - COVID_i) + \gamma PRO_{i,t-1} + \delta_1 SIZE_{it} + \delta_2 LEV_{it} + +\delta_3 LOAN_{it} + \delta_4 DEPO_{it} + \theta_1 GDP_t + \theta_2 INF_t + \varepsilon_{it} \quad (16)$$

In the regression, PRO is measured by ROA and ROE; the control variables are mentioned above. The estimation method is the Generalized Least Square with the fixed effect of year and country. The table shows the values of β_1, β_2, β_3, β_4, β_5, and β_6

Table 7 The effect of fintech funding value on bank profitability by GLS

Variable	ROA	ROA	ROA	ROA	ROE	ROE	ROE	ROE
FIN	-.000399***	-	-	-	-.0022514	-	-	-
	-3.12	-	-	-	-1.57	-	-	-
FIN_{t-1}	-	.0011919***	-	-	-	.009422***	-	-
	-	4.78	-	-	-	4.76	-	-
FIN*COV	-	-	-.00198***	-	-	-	-.01149***	-
	-	-	-6.27	-	-	-	-4.18	-
FIN*(1-COV)	-	-	-.0000851	-	-	-	-.000061	-
	-	-	-0.60	-	-	-	-0.04	-
FIN_{t-1}*COV	-	-	-	.0012551***	-	-	-	.009672***
	-	-	-	4.47	-	-	-	4.00
FIN_{t-1}*(1-COV)	-	-	-	.0011212***	-	-	-	.0090824***
	-	-	-	3.85	-	-	-	3.95

Note: *, **, and *** are significant values at 10%, 5%, and 1%, respectively.

The estimation results by GLS are presented in Table 7, which confirms the effect of fintech funding on bank profitability as in Table 8.

The regression models take the following form:

$$PRO_{it} = \alpha_i + \beta_1 FIN_t + \gamma PRO_{i,t-1} + \delta_1 SIZE_{it} + \delta_2 LEV_{it} + +\delta_3 LOAN_{it} + \delta_4 DEPO_{it} + \theta_1 GDP_t + \theta_2 INF_t + \varepsilon_{it} \quad (17)$$

$$PRO_{it} = \alpha_i + \beta_2 FIN_{t-1} + \gamma PRO_{i,t-1} + \delta_1 SIZE_{it} + \delta_2 LEV_{it} + +\delta_3 LOAN_{it} + \delta_4 DEPO_{it} + \theta_1 GDP_t + \theta_2 INF_t + \varepsilon_{it} \quad (18)$$

$$PRO_{it} = \alpha_i + \beta_3 FIN_t * COVID_i + \beta_4 FIN_t * (1 - COVID_i) + \gamma PRO_{i,t-1} + \delta_1 SIZE_{it} + \delta_2 LEV_{it} + +\delta_3 LOAN_{it} + \delta_4 DEPO_{it} + \theta_1 GDP_t + \theta_2 INF_t + \varepsilon_{it} \quad (19)$$

$$PRO_{it} = \alpha_i + \beta_5 FIN_{t-1} * COVID_i + \beta_6 FIN_{t-1} * (1 - COVID_i) + \gamma PRO_{i,t-1} + \delta_1 SIZE_{it} + \delta_2 LEV_{it} + +\delta_3 LOAN_{it} + \delta_4 DEPO_{it} + \theta_1 GDP_t + \theta_2 INF_t + \varepsilon_{it} \quad (20)$$

In the regression, PRO is measured by ROA and ROE; the control variables are mentioned above. The estimation method is Panel Corrected Standard Errors.

Table 8 The effect of fintech funding on bank profitability by PSCE (The authors' elaboration)

Variable	ROA				ROE			
FIN	-.000656***	-	-	-	-.00387***	-	-	-
	-2.92	-	-	-	-2.57	-	-	-
FIN_{t-1}	-	.001658***	-	-	-	.010761***	-	-
	-	3.78	-	-	-	3.49	-	-
FIN*COV	-	-	-.002138***	-	-	-	-.0110693**	-
	-	-	-4.47	-	-	-	-2.55	-
FIN*(1-COV)	-	-	-.0002041	-	-	-	-.0017144	-
	-	-	-0.84	-	-	-	-0.87	-
FIN_{t-1}*COV	-	-	-	.0016851***	-	-	-	.0111869***
	-	-	-	3.00	-	-	-	2.66
FIN_{t-1}*(1-COV)	-	-	-	.001628***	-	-	-	.010336***
	-	-	-	3.19	-	-	-	2.97
PRO_{t-1}	.6855819***	.673525***	.643297***	.66987***	.747035***	.7050478***	.7371328***	.7025802***

	Continuation of Table 8							
	3.78	3.61	3.40	3.56	3.90	3.36	3.79	3.33
SIZE	.0009119	.0009541	.0010397	.0009651	.0066831	.0078027	.0069364	.0078695
	1.40	1.42	1.53	1.43	1.24	1.34	1.28	1.35
LEV	-.0006506**	-.0006807**	-.0007088**	-.0006872**	-.0010093	-.0012589	-.0009683	-.0012699
	-2.32	-2.34	-2.46	-2.34	-0.75	-0.85	-0.70	-0.86
LOAN	.008466	.0078566	.006731	.0080399	.0353202	.0326998	.0250604	.0346091
	1.11	1.00	0.89	1.01	0.58	0.51	0.41	0.51
DEPO	-.0040978	-.0040517	-.0029954	-.0041673	-.0281771	-.0271829	-.0228377	-.0287332
	-1.11	-1.07	-0.80	-1.04	-0.79	-0.72	-0.66	-0.78
GDP	-.045914***	-.10793***	-.07564***	-.10878***	-.22213**	-.6410084***	-.367462***	-.6551594***
	-3.06	-3.75	-4.84	-3.73	-2.12	-2.99	-2.78	-2.96
INF	-.0271611	-.1272077**	-.138964***	-.1291017*	-.3871974	-1.031937**	-.9375709*	-1.062008*
	-0.50	-2.04	-3.14	-1.72	-0.84	-2.21	-1.86	-1.90
Cons	.0004421	-.0049137	.0107151	-.0050296	-.0204848	-.059581	.03081	-.0608585
	0.06	-0.62	1.28	-0.63	-0.27	-0.71	0.35	-0.71
Countries fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Statistic	30032.77***	34961.96***	498652.64***	35226.85***	23458.90***	157507.60***	2.73e+06***	149974.23***

Note: *, **, and *** are significant values at 10%, 5%, and 1%, respectively.

From these discussions above, the authors conclude that the proposed hypothesis is partly accepted, which means that there is a negative effect of fintech funding on bank profitability. However, the lag effect of fintech funding is positive. Besides, the authors explore that the lag effect of fintech is stronger than its effect. In general, the authors argue that the growth of fintech funding plays a positive role in bank performance; it increases bank profitability in the case of ASEAN-5.

4. Conclusion

Motivated by reports about the rise of fintech startup companies in the ASEAN region and the gap in the effect of fintech on bank performance in the cross-country, this study is conducted to fill the gap and provide empirical evidence about the link between banks and fintech in the digital era. Following consumer and disruptive innovation theories, the authors develop the hypothesis that there is a negative effect of fintech development measured by fintech funding value on bank profitability in the ASEAN region. The dataset is obtained from various sources, namely the report of the UOB group (fintech funding), audited financial statements of banks (bank-level data), and the World Bank database (macroeconomic indicators). With the strongly balanced panel data of 57 banks of ASEAN-5 (Malaysia, Indonesia, Thailand, Philippines, and Vietnam) from 2017 to 2021, the dynamic panel models including the context of Covid-19 and the effect of fintech funding on bank profitability are estimated by the PSCE method. Besides the estimator by the PSCE method, the study employs multiple additional tests (sorted by country and bank scale) and an alternative estimator by the GLS method for estimation robustness. The aggregating estimation results in various ways allow concluding that the proposed hypothesis is partly rejected by the mixed effect of fintech funding on bank profitability. The fintech variable negatively influences bank profitability, but its lag is a positive factor. Sorted by country, there is no evidence about the link between fintech and bank profitability in Malaysia and Indonesia, but fintech funding is mostly positive in the Philippines and negative in Vietnam. Besides, the authors found that small banks are more sensitive to profitability to fintech development than large banks.

This paper is novel because it contributes to the current debate in the literature regarding the effect of fintech on bank performance. First, it investigates the effect of fintech on bank performance across countries where the fintech industry has been rapidly growing, thereby adding significant knowledge. Second, the findings suggest a negative effect of fintech funding on bank profitability, with a positive lag effect. Third, the authors found mixed results across countries, indicating differences in the effect of fintech funding on bank profitability in the ASEAN-5 region.

The study has some limitations that might be directions for further research. First, the scope of this study only focused on the ASEAN-5 region (Southeast Asia), which is the most dynamic market for the fintech industry. However, other regions such as South Asia, Asia, or Africa should also be considered for investigation as they are interesting directions for further research. The context of fintech company development in other regions might provide interesting reasons for the differences in the effect of fintech funding on bank performance between regions. Second, this study only used the amount of fintech funding for fintech measurement, while other measures could also be considered for further research, such as the number of newly established fintech companies, registered capital of fintech companies, or the popularity of fintech companies on social media or outlook reports of consultant organizations. Multiple-dimensional measurements will provide a holistic effect of fintech companies on bank performance. Third, due to limitations in data collection, the authors have not yet considered the effect of endogenous and exogenous variables in the panel data model, which may result in biased estimation. The Generalized Method of Moments (GMM) is a method that can overcome these issues, as mentioned above. Thus, the authors suggest that further research should collect more variables and extend the sample size. The GMM estimation resultsare able to provide insights into the relationship between

fintech and bank performance.

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