NEXUS FINANCIAL INNOVATION AND ECONOMIC GROWTH IN THAILAND

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Abstract

It is notable that technological changes are essential for financial innovation when reflecting on economic growth. Directions of the relationships at the nexus of financial innovation and economic growth are still hazy, especially in developing countries. This study therefore focusses on analyzing the relationship between financial innovation and economic growth in Thailand, based on quarterly data from 2010 – 2020, using the Autoregressive Distributed Lag (ARDL) and Granger causality test. The cointegration result was in the same direction and financial innovation was found to be the cause of change in economic growth in Thailand. Hence, by increasing the efficiency of financial intermediaries, financial innovation is the driving force for long-term growth in the Thai economy. Accordingly, policymakers should encourage the development of financial innovation as well as promote access to financial services for sustainable growth of the Thai economy.

Keywords: Financial innovation, Economic growth, ARDL

1. INTRODUCTION

The financial system is an important mechanism for a country's economic development. Banks act as an intermediary connecting businesses with the financial sector both domestically and internationally. Regarding the economy, there are also monetary policy implications for Central Banks (Guru & Yadav, 2019). Schumpeter (1934) illustrated a unidirectional relationship between financial development and financial innovations. Summaries from Goldsmith (1969) and Greenwood & Jovanovic (1990) showed that financial improvements diminish bank costs and contribute to better capital allocation. The important processes contributing to financial development and economic growth are capital accumulation and financial innovation (Levine, 1997). Remarking on the effect of the financial role on economic growth, Robinson (1952) and Lucas (1988) stated that where lenders are not participating in the real economy, their effect is negligible, resulting in a decrease in the amount of credit which is not related to economic growth. This concept has been studied extensively to expound the emerging relationships; such study includes the work of Ndlovu (2013), Saeed et al. (2020), and Sanaphanh & Sethapramote (2021).

The financial economists Arestis & Demetriades (1997) suggested that financial development favors economic growth. Likewise, financial innovation is a key contributor to financial development as well as the financial system (Napier, 2010). Aghion et al. (2005) indicated financial innovation as the basis for economic growth. Furthermore, empirical studies have revealed

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that financial innovation is a driving instrument in economic development (Laeven et al., 2015), while banks' performance as financial intermediaries is essential for economic growth (Johnson & Kwak, 2012). These former studies are consistent with the rapid economic development which results from financial innovation leading to changes in banking services to offer convenient transactions (both domestically and internationally), as well as improved investment, consumption, and savings (Chou, 2007) including through service initiation to advocate customer necessities (Tahir et al., 2018). This also results in the promotion of a more efficient financial system and enhanced competitiveness which influences economic growth in both developed and developing countries (Beck et al., 2016; Azimova & Mollaahmetoğlu, 2017).

Financial innovation plays an essential role in Thailand's monetary system particularly for transactions which take place via platforms such as mobile banking and internet baking. Such services lead to the generation of funds and more efficient fund allocation, in turn resulting in the country's economic expansion. However, speculation of financial innovation can be appraised by the value of electronic payments (e-payment) (Tahir et al., 2018; Adesete et al., 2021). The value of e-payment increased from 2.54 percent in 2017 to 6.41 percent in 2019, while the volume of e-payment increased from 29.77 percent in 2017 to 46.63 percent in 2019 (Bank of Thailand, 2021a). This increase in the value of electronic payments indicates greater access to financial services which helps stimulate economic activities and impels economic growth. The number of loans in 2019 amounted to THB 15.53 trillion, or 91.15 percent of the gross domestic product, while the growth rate of gross domestic product increased by 3.23 percent in 2019 (Bank of Thailand, 2021b).

Previous studies from several countries across Asia (Qamruzzaman & Jianguo, 2018; Nazir et al., 2021), Africa (Bara et al., 2016; Yinusa et al., 2021), and other developed and developing countries (Mollaahmetoğlu & Akçalı, 2019), along with 56 countries across the globe (Laeven et al., 2015) have emphasized the relationship between financial innovation and economic growth. Similar studies in Thailand were found in the research of Majid (2007) and Luangpituksa (2019) which considered financial development and financial efficiency, but disregard financial innovation. Therefore, this study aims to fill the research gap regarding the nexus of financial innovation and economic growth in Thailand and to support policy in promoting and driving the development of financial innovations in Thailand. To obtain the objectives, the Autoregressive Distributed Lag (ARDL) by Pesaran et al. (2001) was used to analyze the cointegration, while the Granger causality test was used to display the empirical results and impacts of financial innovation on the economic development of Thailand.

2. LITERATURE REVIEW

Economic growth is the determined gold for development in every country but with differing implementation. Banks are considered as the most effective economic development tool as they are responsible for financial resource allocation, capital allocation, investments, trading, and capital accumulation, which are the most essential features of economic development (Levine, 1997; Ndlovu, 2013). Financial innovation helps to secure the cost of service by banks (Frame & White, 2004) and generates new financial services i.e., electronic payment (e-payment), and internet and mobile banking (Sabandi & Noviani, 2015). While financial innovation offers convenient services, it also improves the efficiency level of banks as financial intermediaries (Merton, 1992; Blair, 2010) which impels economic development and solves economic problems (Kotsemir & Abroskin, 2013).

According to the endogenous growth theory by Schumpeter (1934), financial innovation enhances financial services resulting in economic development (Aghion & Howitt, 1992). Nevertheless, there are

many determinants that can result in economic growth. Harrod (1939) and Domar (1946) explained that investment is essential to economic growth since investments come from saving and capital accumulation. On the one hand, the neoclassical model of Solow (1956) stated that economic growth is advocated by capital and the labor force (Aghion & Festré, 2017), which can be seen as an extension of the study by Harrod and Domar. Other, more explicit important determinants of economic growth must also be taken into consideration such as government expenditure, foreign direct investment, trade openness, gross fixed capital formation, and domestic credit in the private sector (Pece et al., 2015; Bernier & Plouffe, 2019; Mtar & Belazreg, 2021).

There has been academic argument regarding the relationship between financial innovation and economic growth, with Arnaboldi & Rossignoli (2015) sharing their view that financial innovation is a double-edge sword, whereby efficient financial innovation navigates towards economic growth, but inappropriate financial innovation may lead to the overall economy facing negative impacts. Beck et al. (2016) shared the same view from their study of 32 developed countries where economic fluctuation could be seen as the outcome of financial innovation, owing to credit expansion risk by banks. For example, the financial crisis that occurred in 2007 was the consequence of financial innovation (Allen, 2012). In the opinion of Laeven et al. (2015), financial innovation was essential to the economic development in 56 countries due to the improvement in financial services and payment which provided greater access to financial services and stimulated national savings (Azimova & Mollaahmetoğlu, 2017) and investment accumulation, which is part of economic growth in both developed and developing countries (Mollaahmetoğlu & Akçalı, 2019).

According to Qamruzzaman & Jianguo (2017), economic growth in Bangladesh is driven by financial innovation. Likewise, the study by Nazir et al. (2021) in China, India, and Pakistan reveals results consistent with the study of Qamruzzaman & Jianguo (2018) in Bangladesh, India, Pakistan, and Sri Lanka, as well as another study of 17 countries in Africa (Yinusa et al., 2021). Although, the study indicated that there is an absence of a relationship between financial innovation and economic growth in 15 countries of The Southern African Development Community (SADC), Bara et al. (2016) had concluded that financial innovation is essential to future economic growth. Similarly, the research by Bernier & Plouffe (2019) from a study of 23 countries demonstrated that financial innovation enhances capital accumulation, leading to economic development (Levine, 1997). Bara & Mudzingiri (2016) described financial innovation to be an economic growth-driven force in Zimbabwe, demonstrating simultaneous development of financial innovation and economic growth in a bidirectional causality. This coincides with the feedback hypothesis seen in Spain and Sweden (Mtar & Belazreg, 2021). However, there are many other hypotheses such as the supply led hypothesis which indicates financial innovation as a driving force of economic growth; the demand led hypothesis which indicates that economic growth contributes to the development of financial innovation; and the neutral hypothesis, which explains situations of non-affection between financial innovation and economic growth (Luangpituksa, 2019).

Considerable research has indicated a unidirectional influence of financial innovation on economic growth. Pece et al. (2015) confirmed the unidirectional relationship in a study of Poland, Hungary, and the Czech Republic, while Mtar & Belazreg (2021) confirmed the same result in the United Kingdom, Norway, and Turkey, and Pradhan et al. (2016) demonstrated the same with 18 European countries. Similarly, developing countries such as Ghana (Idun & Aboagye, 2014), Cameroon (Satia & Okle, 2020), and India and Pakistan (Xu et al., 2021) have also been shown to demonstrate the same relationship. Past research has highlighted efficiency enhancement and

financial systems derived from financial innovation, which has led to financial products and equipment as well as supervising new financial service channels to yield economic growth which has in turn led to financial development and a sustainable economy.

Past studies on the nexus of financial innovation and economic growth have mainly considered monetary supply or the volume of money in the economic system, including banking sector credit supplied to the private sector (Bara & Mudzingiri, 2016; Qamruzzaman & Jianguo, 2017; Nazir et al., 2021). Providing credit is the most crucial role that banks play as a financial intermediary, thus continuous development in service provision and the financial system are necessary. Therefore, banking sector credit provided to the private sector could be considered as a financial innovation proxy. Technological development leads to financial innovation and ushers research interest in the field, mainly focused on financial innovation proxies such as e-payment, internet banking, mobile banking, Automated Teller Machines (ATM), Point of Sale (POS), and Cheque (Tahir et al., 2018). Studies from the Republic of Botswana (Motsatsi, 2016), Zimbabwe (Abel & Le Roux, 2019), and Pakistan (Saeed et al., 2020) have focused on financial innovation proxies. Nevertheless, results from Adesete et al. (2021) discovered that mobile banking transactions highly affected economic growth in Nigeria, while the same result was displayed in 15 countries in the Southern African Development Community (SADC) (Bara et al., 2016).

3. METHODOLOGY

3.1 Data and Variables

This study focuses on analyzing the nexus of financial innovation and economic growth, using quarterly data from the years 2010 to 2020, taken from the Bank of Thailand, World bank and the Office of National Economics and Social Development Council. The study uses the real gross domestic product per capita (GDPC) as a proxy for economic growth, consistent with Bara & Mudzingiri (2016), and Nazir et al. (2021).

Proxies for financial innovation used in previous studies include the ratio of bank sector credit for the private sector to GDP (BCP) (Bara et al., 2016; Qamruzzaman & Jianguo, 2018), as credit dilation is considered as financial innovation, and the value of electronic payment (EPAY) including internet and mobile banking, automatic teller machines (ATM), point of sale payment (POS) and electronic money (e-money) (Okafor et al., 2017; Abel & Le Roux, 2019; Adesete et al., 2021).

Table 1 Variables and Hypothesis

Category	Variables	Definition	Expected Sign
Economic growth	GDPC	Real GDP per capita (million baht)	
Financial innovation	EPAY	Value of electronic payment (trillion baht)	+/-
	BCP	Bank sector credit in the private sector to GDP (%)	+
Macro-economics	DCP	Domestic credit in the private sector to GDP (%)	+
	GFCF	Gross fixed capital formation (trillion baht)	+
	GEXP	Government expenditure: Government final consumption expenditure (trillion baht)	+
	TRO	Trade openness: Exports + imports to GDP (%)	+
	CPI	Inflation: Consumer price index (%)	-

This study also uses other macroeconomic indicators as control variables i.e., domestic credit in the private sector to GDP (DCP) (Motsatsi, 2016; Pradhan et al., 2016), government final consumption expenditure (GEXP) (Idun & Aboagye, 2014; Bernier & Plouffe, 2019), trade openness (TRO) (Satia & Okle 2020; Qamruzzaman et al., 2021), inflation (CPI) (Guru & Yadav, 2018; Yinusa et al., 2021), and gross fixed capital formation (GFCF), which indicates capital accumulation according to Solow (1956). A list of the variables is presented in Table 1.

3.2 Research Model

Laeven et al. (2015) developed the AHM model (Aghion et al., 2005) to explain the impact of financial innovation on economic growth. This model, can be represented as:

$$g - g_1 = b_0 + b_1 F + b_2 (y - y_1) + b_3 F(y - y_1) + b_4 X + b_5 fi + + b_6 fi(y - y_1) + u \quad (1)$$

Where $g - g_1$ is the average growth rate of per capita income relative to U.S. growth over the period 1960 – 1995, $y - y_1$ is the log of per capita income relative to U.S. per capita income, F is financial development, fi is financial innovation, X is a control variable, and u is the error term (Laeven et al., 2015). This study analyzed the model (Eq.1) by dropping the comparative study between countries, focusing only on Thailand (Bara & Mudzingiri, 2016; Bara et al., 2016). It was decided to remove the comparison of model variables and use suitable variables that can measure financial innovation according to the situation. The financial innovation variable was also appended with control variables. The model used in this study can be presented as:

$$\overbrace{GDPC_t}^{Y} = \overbrace{EPAY_t, BCP_t}^{fi} + \overbrace{GDPC_{t-1}}^{y_{t-1}} + \overbrace{\underbrace{DCP_t}_{F}, GFCF_t, GEXP_t, TRO_t, CPI_t}^{X} \quad (2)$$

where Y is economic growth and X is a macroeconomic variable. Therefore (Eq.2) can be re-written as two equations:

Model 1: EPAY as a financial innovation proxy

$$lnGDPC_t = \beta_0 + \beta_1 lnEPAY_t + \beta_2 lnGDPC_{t-1} + \beta_3 lnDCP_t + \beta_4 lnGFCF_t + \beta_5 lnGEXP + \beta_6 lnTRO_t + \beta_7 lnCPI_t + u_t \quad (3)$$

Model 2: BCP as a financial innovation proxy

$$lnGDPC_t = \beta_0 + \beta_1 lnBCP_t + \beta_2 lnGDPC_{t-1} + \beta_3 lnDCP_t + \beta_4 lnGFCF_t + \beta_5 lnGEXP + \beta_6 lnTRO_t + \beta_7 lnCPI_t + u_t \quad (4)$$

where *ln* is the natural logarithm of the dependent variable or explanatory variable (Table 1).

3.3 Data Analysis

This study applied the Autoregressive Distributed Lag (ARDL) by Pesaran et al. (2001), to analyze the cointegration or Bounds Test when the variable attributes are already at I(0) or I(1). Moreover, analysis can also be performed according to the Error Correction Model (ECM) which can be written in the form of the equation:

$$\Delta y_t = \alpha + \sum_{i=1}^{p} \gamma_i \Delta y_{t-i} + \sum_{j=0}^{q} \beta_j \Delta x_{t-j} - \lambda(ECT_{t-1}) + u_t \quad (5)$$

where $ECT_{t-1} = y_{t-1} - \hat{\beta} x'_{t-1}$ is the error correction term. The speed of adjustment analysis by ECM is speculated by λ at values greater than -1 but less than 0 ($-1 < \lambda < 0$). This indicates the speed of adjustment to cointegration, presented in equation (Eq. 5):

$$\Delta y_t = \alpha + \sum_{i=1}^{p} \gamma_i \Delta y_{t-i} + \sum_{j=0}^{q} \beta_j \Delta x_{t-j} + \lambda_1 y_{t-1} + \lambda_2 x_{t-1} + u_t \quad (6)$$

where y_t is the dependent variable, x_t is the vector of the explanatory variable, α is a constant, γ is a coefficient, β is the short-run

coefficient vector, λ is the long-run coefficient vector, and u_t is the error term (white noise). The following hypotheses were presented for the cointegration test in the models.

$H_0 : \lambda_1 = \lambda_2 = 0$ (no cointegration)

$H_1 : \lambda_1 \neq \lambda_2 \neq 0$ (cointegration)

The hypotheses were based on the comparison between the F-statistic test and the critical value by Pesaran et al. (2001), but in cases where the sample size is lower than 100 the critical value of Narayan (2005) is used as additional comparison. The suitable optimal lag length is considered from the smallest Akaike information criterion (AIC) due to the lower standard deviation compared to the Schwarz information criterion (SIC) (Pesaran & Pesaran, 1997). The analysis of non-stationary time series data may cause spurious regression, thus, unit root tests must be applied before the cointegration test. It was decided to apply the Augmented Dickey-Fuller (ADF) test and Kwiatkowski Phillips Schmidt Shin (KPSS) test as stationary data tests to contrast with the main hypothesis.

Cointegration was confirmed by ARDL, while the Granger causality test (Granger, 1969) was used to confirm the nexus between financial innovation and economic growth. The equation can be written as:

$$EG_t = \sum_{i=1}^{n} \alpha_i EG_{t-i} + \sum_{j=1}^{m} \beta_j FI_{t-j} + \varepsilon_t$$

$$FI_t = \sum_{i=1}^{n} \alpha_i FI_{t-i} + \sum_{j=1}^{m} \beta_j EG_{t-j} + \eta_t \quad (7)$$

where α_i and β_j are coefficients, and ε_t and η_t are error terms (white noise) which are uncorrelated. From eq. 7 the main hypothesis testing can be confirmed by the F-statistic to determine the directional causality of the 2 variables, namely, financial innovation (FI) does not Granger cause economic growth (EG), and EG does not Granger cause FI or $H_0 : \beta_j = 0$.

4. RESULTS AND DISCUSSION

Results from the study of the nexus of financial innovation and economic growth in Thailand from 2010-2020 quarterly data, are presented in three sections.

4.1 Descriptive statistics

The real GDP per capita, based on financial innovation and economic growth of Thailand over the past 11 years, has been reported as THB 0.146 million (economic growth), rated by the World Bank as an upper middle-income country. Regarding financial innovation, the average value of electronic payment (EPAY) system is stated as THB 89.841 trillion, while the average banking sector credit provided to the private sector (BCP) has increased to 110.374%. The stated values demonstrate the necessity of financial innovation in the current economic operation of Thailand. The economic growth of domestic credit in the private sector (DCP) and trade openness (TRO) have increased to 141.702% and 123.908% respectively. These values also illustrate the essential role of the financial sector in the Thai economy which mainly relies on international trade. Furthermore, the average of the gross fixed capital formation (GFCF) and government final consumption expenditure (GEXP) are at THB 3.359 trillion and THB 2.31 trillion respectively, while the consumer price index, as inflation, is at 99.002%. All descriptive statistics and descriptive log form statistics are shown in Table 2.

The investigation of the unit root test by ADF and KPSS illustrated the following results from the 8 variables. Stationary data at the I(0) level include government final consumption expenditure (lnGEXP) and consumer price index (lnCPI), while stationary data at the First Difference or I(1) level include economic growth (lnGDPC), electronic payment (lnEPAY), banking sector credit in the private sector (lnBCP), domestic credit in the private sector (lnDCP),

Table 2 Descriptive Statistics

Variables	Average	S.D.	Max	Min	C.V.
GDPC	0.146	0.014	0.172	0.118	0.094
EPAY	89.841	19.654	127.967	51.147	0.219
BCP	110.374	9.047	132.446	89.009	0.082
DCP	141.702	11.721	169.768	113.611	0.083
GFCF	3.359	0.359	3.941	2.435	0.107
GEXP	2.309	0.369	3.045	1.638	0.160
TRO	123.908	12.206	149.533	93.164	0.099
CPI	99.002	3.328	102.963	91.853	0.034
lnGDPC	11.885	0.095	12.053	11.676	0.008
lnEPAY	4.814	0.103	5.008	4.534	0.021
lnBCP	4.950	0.085	5.134	4.733	0.017
lnDCP	15.021	0.112	15.187	14.706	0.008
lnGFCF	4.700	0.084	4.886	4.489	0.018
lnGEXP	14.639	0.166	14.929	14.309	0.011
lnTRO	18.288	0.228	18.667	17.750	0.013
lnCPI	4.5946	0.034	4.634	4.520	0.007

S.D. and C.V. refer to standard deviation and the coefficient of variation, respectively.

Table 3 Unit Root Tests

Variables	ADF		KPSS		Conclusion
	Level	First diff.	Level	First diff.	
lnGDPC	-1.693	-13.054***	0.767***	0.217	I(1)
lnEPAY	-2.873*	-10.389***	0.840***	0.339	I(1)
lnBCP	-2.325	-7.220***	0.643**	0.167	I(1)
lnDCP	-2.671*	-7.181***	0.663**	0.169	I(1)
lnGFCF	-1.897	-3.039**	0.738**	0.351*	I(1)
lnGEXP	-4.389***	-	0.242	-	I(0)
lnTRO	-2.641*	-7.963***	0.409	0.332	I(1)
lnCPI	-4.952***	-	0.202	-	I(0)

*, ** and *** represent statistical significance at the 0.10, 0.05, and 0.01 levels respectively

gross fixed capital formation (lnGFCF), and trade openness (lnTRO) (see Table 3).

4.2 Results of the Autoregressive Distributed Lag (ARDL)

Analysis of the nexus of financial innovation and economic growth in Thailand, via the Autoregressive Distributed Lag (ARDL), indicated variables possessing both the properties of I(0) and I(1), therefore, ARDL can be considered as a suitable tool for analysis. AIC is the appropriate optimal lag length selected by the researchers. The appropriate optimal lag length for model 1 according to the financial innovation variable with the value of electronic payment (EPAY) is ARDL (3,3,3,2,2,3,1), while the appropriate optimal lag length for model 2 according to the financial innovation variable with bank sector credit in the private sector (BCP) is ARDL (2,4,0,4,4,4,1). The corresponding F-test results were found to be 18.916 and 16.637 respectively, indicating positive cointegration for the nexus of financial innovation and the economic growth in Thailand, therefore, the values are at the upper critical bounds or I(1) Bound with statistical significance at the 0.01 level (Table 4)

Table 4 The Cointegration Results Under ARDL

Model	F-Stat	10%		5%		1%		Co-integration
		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	
EPAY	18.916	2.120[a]	3.230[a]	2.450[a]	3.610[a]	3.150[a]	4.430[a]	Present
BCP	16.637	2.327[b]	3.541[b]	2.764[b]	4.123[b]	3.790[b]	5.411[b]	Present

[a], [b] represent critical values is Pesaran et al. (2001) and Narayan (2005)

4.2.1 Financial Innovation

The result of the financial innovation cointegration coefficient corresponded to model 1 indicating that financial innovation according to the value of electronic payment (lnEPAY) showed a unidirectional relationship with economic growth in Thailand at the 0.10 statistical significance level. In other words, an increase in the value of electronic payment by 1% results in an increase of economic growth at 0.152%. This is consistent with studies from Cameroon and Nigeria (Satia & Okle, 2020; and Adesete et al., 2021). Additionally, a study by Abel & Le Roux (2019) and Motsatsi (2016) revealed that the value of electronic payment improves access to financial services for the people, facilitating economic activities, which resulted in the economic expansion of Zimbabwe and Botswana. Model 2, which examined financial innovation via banking sector credit in the private sector (lnBCP) showed a unidirectional relationship with economic growth in Thailand at the 0.05 statistical significance level. In other words, an increase in banking sector credit in the private sector of 1% will result in an increase of economic growth at 0.850%. This result is consistent with Bara et al. (2016) who explained that an increase in banking sector credit in the private sector or improved monetary supply results in coercion to decrease the interest rate. This explanation matches the loanable fund theory (Mankiw, 2019), which describes the stimulation of investment and economic expansion in 15 countries of the Southern African Development Community (SADC) including Ghana, (Idun & Aboagye, 2014), and in Bangladesh, India Pakistan, and Sri Lanka (Qamruzzaman & Jianguo, 2018). Financial innovation influences economic growth in the long run. This result is supported by the studies of Laeven et al. (2015); Qamruzzaman & Jianguo (2017); Nazir et al. (2021); Saeed et al. (2020); Xu et al. (2021); and Yinusa et al. (2021), which explain that financial innovation helps to enhance financial service efficacy and increases credit accessibility for both the private sector and households as well as encouraging savings which cause various economic activities (Table 5).

4.2.2 Macroeconomic

The result of the cointegration coefficient of macroeconomic determinants indicates that according to model 1, domestic credit in the private sector (lnDCP) affects economic growth in the opposite direction without statistical significance. This result is supported by several scholars such as Bara et al. (2016); Bernier & Plouffe (2019); Sanaphanh & Sethapramote (2021); and Mtar & Belazreg (2021). This leads to the conclusion that credit extension increases risk to the financial sector and retards economic growth. Model 2 indicates that domestic credit affects economic growth in the same direction without statistical significance. This result is consistent with a study in Zimbabwe by Bara & Mudzingiri (2016) where credit provided by banking institutions and non-banking institutions was seen to enhance economic expansion, consistent with the findings of Pradhan et al. (2016); Guru & Yadav (2018); and Satia & Okle (2020) (Table 5).

The results regarding government final consumption expenditure (lnGEXP) according to model 1 indicate that economic growth is in the same direction with statistical significance of 0.05, i.e. an increase of 1% in government spending will lead to 0.174% economic growth. However, model 2 presents no statistical significance. This result is

Table 5 Estimated Long-Run Coefficients Under ARDL and ECM

Variables	Model 1 (EPAY)		Model 2 (BCP)	
	Coefficient	**S.E.**	**Coefficient**	**S.E.**
C	2.022***	0.653	0.655	0.789
lnEPAY	0.152*	0.079	-	-
lnBCP	-	-	0.850**	0.352
lnDCP	-0.121	0.087	0.542	0.376
lnGFCF	0.394***	0.076	0.305***	0.079
lnGEXP	0.174**	0.063	0.043	0.068
lnTRO	0.207***	0.065	0.242***	0.070
lnCPI	-0.991***	0.335	-0.278	0.382
ECT_{t-1}	-0.952***	0.120	-0.880***	0.100
Diagnostic tests				
Normality	0.061 (0.970)		0.049 (0.976)	
Serial correlation	0.393 (0.684)		0.096 (0.909)	
Heteroskedasticity	1.190 (0.366)		0.284 (0.997)	
Functional form	0.304 (0.765)		0.047 (0.832)	

*, ** and *** indicate statistical significance at the 0.10, 0.05 and 0.01 levels respectively. Diagnostic test p-values are given in parentheses.

supported by the studies of Bara & Mudzingiri (2016); Bara et al. (2016); and Qamruzzaman & Jianguo (2017) which determined that government spending is an instrument to manage the overall economy. Although government spending may suppress crowding in the private sector, it is practical that government spending generates economic development more than the private sector, consistent with Keynesian economics (Mankiw, 2019). Likewise, government spending will drive the long-term development of financial innovation via research expenditure and the development of financial institutions. The consumer price index (lnCPI) in model 1 indicates an effect on the economic growth of Thailand in the opposite direction with statistical significance of 0.01. Thus, an increase in the consumer price index of 1% will decrease economic growth by 0.991%, which is consistent with the findings of Motsatsi (2016); Nazir et al. (2021); Yinusa et al. (2021) which explain that an increase in the consumer price index or inflation rate leads to a decrease in customer purchasing power and ultimately results in economic deceleration. In contrast, model 2 does not present any statistical influence (Table 5).

Trade openness (lnTRO) affects economic growth in the same direction with a 0.01 level of statistical significance in both models 1 and 2. Thus, an increase in trade openness of 1% will lead to economic growth of 0.207% or 0.242% respectively due to the reliance on international trade, especially exports. International trade is an essential contributor to long-term economic growth. This result is supported by Motsatsi (2016); Qamruzzaman & Jianguo (2018); Qamruzzaman et al. (2021); and Mtar & Belazreg (2021). The gross fixed capital formation (lnGFCF) also affects economic growth in the same direction with statistical significance at the 0.01 level in both model 1 and model 2. Therefore, a 1% increase in gross fixed capital formation will lead to economic growth of 0.394% or 0.305% respectively. An increase in gross fixed capital formation will result in increased productivity in the economy. This result supports the Theory of Solow (1956) and is also consistent with Qamruzzaman & Jianguo (2017); Nazir et al. (2021); and Sanaphanh &

Sethapramote (2021). Thereby, gross fixed capital formation is related to economic growth in the same direction, as supported by Majid (2007) (Table 5).

The analysis of speed of adjustment toward the long-run equilibrium according to ECM revealed speed of adjustment in both models. When there is a short-run shock that causes Thailand's economic growth to deviate from the long-run equilibrium, models 1 and 2 will suppress the speed of adjustment by 95.2% and 88.0% respectively toward a long-run equilibrium at a 0.01 level of statistical significance (Table 5).

Furthermore, the model used to analyze the cointegration should possess robustness and stability without econometric problems. The results revealed a normal distribution for the residual series, while tests for serial correlation, and heteroskedasticity also revealed no problems. Additionally, the Ramsey Reset Test in models 1 and 2 confirmed the model construct for cointegration analysis (Table 5). The stability test of Cumulative Sum of Recursive Residuals (CUSUM) and CUSUM of Square (CUSUMSQ) indicated a stability of coefficient and variance of error in both models. Since CUSUM and CUSUMSQ are at 95% reliability (Figure 1 and 2 respectively), the estimated models can be assumed to be stable.

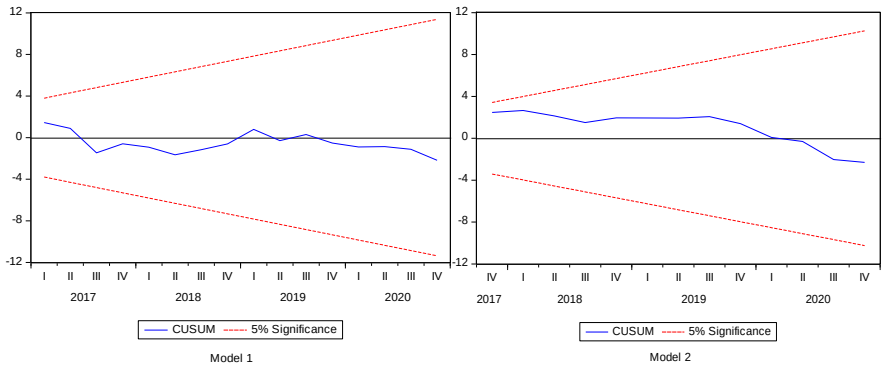

Figure 1 Cumulative Sum of Recursive Residuals (CUSUM)

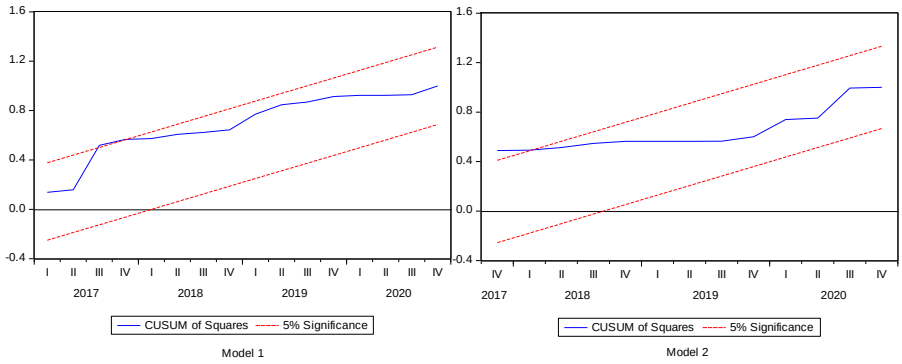

Figure 2 CUSUM of Square (CUSUMSQ)

4.2.3 Granger Causality Tests

Cointegration was confirmed by ARDL, before conducting Granger causality tests to detect directional causality. The results for model 1 illustrate bidirectional causality between financial innovation and economic growth at a 0.05 level of statistical significance. The study of Saeed et al. (2020) explains the nexus of financial innovation and economic growth using a feedback hypothesis, with results supporting model 1 when considering the value of electronic payment (lnEPAY) as the variable for the study. Model 2 considered bank sector credit in the private sector (lnBCP) as the variable, with the result illustrating unidirectional causality between changes in financial innovation as a cause of dynamic growth at a 0.01 level of statistical significance. The results of model 2 are distinct from those of Idun & Aboagye (2014), and Qamruzzaman & Jianguo (2018), who explained that financial innovation and economic growth have a bidirectional relationship. However, the results of the study support the supply lead hypothesis and results of Okafor et al. (2017), and Nazir et al. (2021). Thus, the results of the causality tests for both models indicate a bidirectional relationship between financial innovation and economic growth in Thailand, consistent with studies in Zimbabwe (Bara & Mudzingiri, 2016), and Spain and Sweden (Mtar & Belazreg, 2021), as well as other studies in Asia, which include Bangladesh, India, Pakistan, Sri Lanka, Brunei, and Nepal (Qamruzzaman et al., 2021; Xu et al., 2021) (Table 6).

5. CONCLUSION AND SUGGESTION

Financial innovation plays an essential role in economic activities. Financial innovation is optimized and developed continuously to enhance the services offered by banks which are ultimately essential to the economic growth of the host country. The present study investigated the nexus of financial innovation and economic growth in Thailand considering 2 variables i.e., the value of electronic payment (EPAY) and banking sector credit in the private sector (BCP) using ARDL by Pesaran et al. (2001) and Granger causality with quarterly data from 2010 to 2020. The results elucidated understanding of the empirical nexus of financial innovation and economic growth in Thailand. Financial innovation significantly possesses cointegration with economic growth in the same direction along with the speed of adjustment. The Granger causality test revealed EPAY, as the financial innovation proxy, and economic growth in Thailand to have bidirectional causality. The effect of EPAY is due to easy access to financial services which thus causes economic growth. Likewise, economic growth can influence higher spending, causing a corresponding increase in EPAY, supporting the feedback hypothesis. BCP as a financial innovation proxy is the cause of change in economic growth, as the amount of credit provided increases the monetary supply in the economic system. Thus, credit dilation results in economic growth and corresponds to the supply lead hypothesis. Thailand's economic growth also depends on macroeconomic variables and significantly possesses the same direction of cointegration with gross fixed capital formation, trade openness, and government final consumption expenditure while the consumer price index is in opposite direction. Thus, the hypotheses were accepted.

It can be stated that the nexus of financial innovation and economic growth are in the same direction. The role of financial

Table 6 Granger Causality

Model	Null Hypothesis	F-Statistic	Probability	Conclusion
1	Financial Innovation (lnEPAY)	3.388	0.029	FI ↔ EG
	Economic Growth (lnGDPC)	3.958	0.016	
2	Financial Innovation (lnBCP)	5.593	0.002	FI → EG
	Economic Growth (lnGDPC)	1.827	0.150	

innovation is to enhance banks' potential as financial intermediaries for activities such as fundraising, allocation of funds as savings or credit, financial transaction facilities, and other economic activities. Meanwhile, economic growth also drives the development of innovative financial services and assets according to the real economy in the digital age. It is recommended that governments and policymakers encourage financial innovation and strengthen the financial environment by imposing competitive policies and recognizing opinions from the private sector. On the other hand, banks should adopt financial innovation to provide financial services through various channels, especially e-payment. Furthermore, financial transactions caused by financial innovation reduce risks and costs as well as promoting the development of Thailand's financial system to accrue stability and future economic growth.

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