Quantitative Finance and Economics

QFE, 2(4): 952–980.
DOI: 10.3934/QFE.2018.4.952
Received: 03 October 2018
Accepted: 06 December 2018
Published: 18 December 2018

http://www.aimspress.com/journal/QFE

Research article

Investigation of the asymmetric relationship between financial innovation, banking sector development, and economic growth

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Abstract: With this study, we try to explore new insights about the existence of an asymmetric relationship between financial innovation, banking sector development, and economic growth of Asian countries for the period of 1974Q1 to 2016Q4. In this study, we apply Autoregressive Distributed Lag (ARDL) bound testing to capture long-run association and nonlinear Autoregressive Distributed Lagged (NARDL) to capture the existence of an asymmetric relationship between studied variables. ARDL-bound testing confirms long-run cointegration and nonlinear ARDL confirms the existence of an asymmetric relationship between financial innovation, banking sector development and economic growth of Asian countries. For a directional relationship, we perform Granger-causality under error correction model. Study support feedback hypothesis between financial innovation and economic growth and banking sector development and economic growth both in short and long run. The study suggests, the government should encourage financial innovation in the financial system through technological advancement and institutional integration and formulated economic policy favor of banking sector development by allowing institutional development, enterprise risk management and encouraging healthy competition in the financial system.

Keywords: financial innovation; banking sector development; economic growth; ARDL; NARDL

JEL code: G16, G21, O3, O4

1. Introduction

Economic theory suggests that sound and efficient financial systems—banks, equity markets, and bond markets—which channel capital to its most productive uses are beneficial for economic growth. Sound and efficient financial systems are especially important for sustaining growth because the efficiency of investment will overshadow the quantity of investment as the driver of growth. The importance of well functioned financial system duly recognized towards economic growth by earlier studies (Schumpeter, 1912; Goldsmith, 1969; Greenwood and Jovanovic, 1990; King and Levine, 1993a; Laeven et al., 2014; Jung, 1986). The efficient financial system ensures well-functioning financial intermediaries by allowing efficient mobilization of financial resources, managing financial risk, identifying profitable investment which treated as critical success factors of fostering economic growth and technological innovation in the financial system (Schumpeter, 1912). Progressive economic growth demands efficient financial institutions, financial products, and services towards satisfying market demand. It implies financial liberalization is apparent, in particular. Financial liberalization, moreover, has a positive impact on output growth, employment, capital accumulation, trade facilitation and other import macroeconomic variables in the economy at large.

The well functioned financial system more precisely banking sector become an integral part in the economy for establishing balance financial system through bringing financial stability. The role of the banking sector towards financial development draw immense attraction among researchers, since the 18th century (Smith, 1776; Bagehot, 1873; Schumpeter, 1911). Theoretically, financial development brings efficiency in the financial system by ensuring optimal resource's allocation (Merton, 1992), risk sharing through investment diversification, liquidity to individual and corporate investors, and convert financial resources into real investment (Zang and Kim, 2007) in the economy. Well-developed, according Zaman et al. (2012), the financial sector is the key to sustainable economic growth it is because healthy financial sector assists not only in expediting financial transactions but also for enhancing the level of efficiency of financial institutions, in turn, contribute towards economic growth with financial development.

Financial sector development is the process of bringing together all actors in the financial system to produce better results through the creation of value for the economy and wealth for the economic agents who are performing in the system. Financial development enhances the level of efficiency in the financial system through financial intermediation, capital accumulation, and development of financial institutions in the economy. Key agents performing in the financial system are a central bank, banks, non-bank financial institutions, the stock market, a merchant bank and other market participants (Zaman et al., 2012). Many researcher (Patrick, 1966; De Gregorio and Guidotti, 1995; Khan, 2001; Arestis and Demetriades, 1997; Calderón and Liu, 2003; Greenwood and Jovanovic, 1990; Bwirea and Musiime, 2015; Kyophilavong et al., 2016; Mhadhbi, 2014; Rana and Barua, 2015; Saad, 2014; Shahbaz et al., 2015; Wait et al., 2017) examine the relationships between financial development and economic growth with various econometric methodology and reach conclusion with positive note.

Finance literature suggests financial development can happen either Bank-based or/and Market-based. Bank-based financial development ensures the redistribution of income in the economy. It is possible because banks inject fund in the economy in the form of investment and accumulated fund by collecting household saving through deposit by offering innovative and improved financial assets having lower risk involvement. Banking sector development expands economic activities by

allowing efficient mobilization of economic resources which increase marginal productivity, encouraging savings propensity among households, in turn, expedite capital accumulation. The impact of Banking sector development on economic growth is widely acknowledged and documented. The existing literature suggests a number of a study conducted to investigate the linkage focusing single country to panel time series data. Over the past decade many researchers see (Pradhan et al., 2014a; Chaiechi, 2012; Hsueh et al., 2013; Jalil et al., 2010; Kar et al., 2011; Odhiambo, 2010; Levine and Zervos, 1999; Beck and Levine, 2004; Naceur and Ghazouani, 2007) investigate the effects of banking sector development on economic process taking consider into time series, cross-sectional, and panel data applying various econometric methodology. Sustainable banking sector development demands adaptation and diffusion of innovative financial assets, services, and form of financial institutions in the financial system.

The introduction of new financial assets, better service, and diversification of investment is the output of financial innovation. Financial innovation in the financial system introduces new financial institutions, new financial assets, a new way of financial services, efficient financial intermediation process in the economy, in turn, positively contribute towards economic growth with financial development. Financial innovation reduces financial risk by increasing financial efficiency, in turn, thus increase investment productivity in the financial system at large, and also improve the level of efficiency for monitoring financial investment. Financial innovation, according to Greenwood and Jovanovic (1990), is necessary for endogenous financial intermediation in the financial system which positively influences economic growth. Empirical literatures provide evidence of examining nexus between financial innovation and economic growth see, (Adu-Asare Idun and Q.Q. Aboagye, 2014; Qamruzzaman and Jianguo, 2017; Merton, 1992; Michalopoulos et al., 2009; Michalopoulos et al., 2011) and produce evidence in favor of financial innovation-led economic growth but not in a conclusive way. That is way, a number of adverse opinions available in the finance literature like responsible for recent global financial crisis 2007–2009, financial frugality. The role of financial innovation, however, still unveiled with a conclusive note.

The aim of this article is to empirically investigate there is an association between financial innovation, banking sector development, and economic growth and it is a modest attempt to fulfill existing research gap in empirical studies. We fell there a strong relationship between financial innovation, banking sector development, and economic growth in the Asian economy. Study select eight (08) Asian countries namely, Bangladesh, China, Pakistan, India, Srilanka, Malaysia, Nepal, and Japan over the period of 1974Q1 to 2016Q4. For investigating the long-run association, the study applied the ARDL Bound testing approach proposed by Pesaran et al. (2001). We move further to investigate any existence of nonlinearity between financial innovation, banking sector development, and economic growth applying newly developed ARDL approach under non-linear assumption proposed by Shin et al. (2014).

This research is unique in several aspects. First, several studies conducted focusing on banking sector development and economic growth, but no such research been carried out before by considering financial innovation, banking sector development, and economic growth, especially for Asian countries. With this study, we try to capitalize on the existing research gap and bring new insight into how three variables associated. Second, in this study, we also investigate the existence of an asymmetric relationship between financial innovation, banking sector development, and economic growth. The remaining section of the paper as follows. A literature review regarding financial innovation and banking sector development impact on economic growth explained in section II; Section III contains details

explanation about research variables, a methodology for the study. Section IV represents model outcome with details interpretation, and finally, Section V provides critical comments on research findings with supported empirical findings and policy recommendations for future development and further study.

2. Literature review

2.1. Studies on financial innovation and economic growth

Investment in innovation, continuous research and development, and technological advancement in the economy produce competitive advantages, thus eventually boosts economic growth. In modern dynamic environment demands innovative activaties to keep pace with the changing economic situations around the world. Therefore, Innovation nowadays considers as a prime catalyst of bringing changes in every corner of the economy. In the finance literatures, the connection between innovation and economic growth pointed out by Solow (1956). After that, Schumpeter J (1911) brings new insight into how innovation influence on economic growth, especially technological innovation in the economy. Innovation can be categorized all the scientific, technological, financial and commercial activities necessary to create, refined new product, and services in the economy (OECD, 2002).

Financial innovation is the technological progress in the financial system that accelerates access to information and efficient payment intermediation across the country (Carbó Valverde et al., 2007; Valverde et al., 2016). The idea behind financial innovation is evolvement of financial instruments, financial markets, financial technologies, and efficient allocation of capital which accelerates economic growth. In the view of Fed Chairman Ben Bernanke, *"The increasing sophistication and depth of financial markets promote economic growth by allocating capital where it can be most productive"* (Bernanke, 2007). On the other hand, financial innovation, according to Johnson and Kwak (2009), is the output of information asymmetries which is present in the financial system. Having well-functioning financial institutions and diversified financial assets as consider as a critical element for the financial development with elimination of existing information asymmetries by allowing greater access to informant. In a study, Johnson and Kwak (2012) argued that financial innovation prime role in the economy is to ensure financial intermediation in every corner of the economy in particular, where it did not happen. Moreover, Ansong et al. (2011) explained financial innovation increase saving propensity in the economy by offering improved and diversified financial assets in the economy. Well-developed and robust financial institutions speed-up economic growth by boosting investment rate, savings propensity, and physical capital accumulation.

Financial innovation expands financial activities by transforming the static economy to dynamic, along with the evaluation of financial services, entrepreneurship development, and mobilization of capital (Miller, 1986; Merton, 1992; King and Levine, 1993b; Chou, 2007; Wachtel, 2003). Structural changes in the financial system through a modified payment mechanism, efficient financial institutions, and improved financial instruments is also the output of financial innovation emergence. The emergence of new financial instruments facilitates financial transactions, in particular, some financial instruments designed to facilitate the specific financial transaction like, letter of credit (LC), for promoting trade liberalization (Boot and Marinč, 2001).

The impact of financial innovation on economic growth varies along with the selection of proxy indicator in the study. Apart from that in the finance-led growth hypothesis confirms a positive

association between financial innovation and economic growth around the world irrespective of the economic situation. Over the past decade, researchers, policymakers, financial experts, and academicians showed their keen interest in investigating the nexus between finance-growth focusing financial innovation in both developed and developing countries. A large number of exiting literature explain positive influence on economic growth (Sood and Ranjan, 2015; Odularu and Okunrinboye, 2008; Bara and Mudxingiri, 2016; Bara et al., 2016; Qamruzzaman and Jianguo, 2017). Financial innovation in the financial system ensures resources allocation efficiency by efficient mobilization through financial institutions. On a positive note, financial innovation expands financial services by offering diversified financial products, a way of providing financial services to financial institutions, and investment with diversified portfolios is the key to sustainable financial development in the economy.

Financial development is critical for new investment opportunities in the economy, which always encourage the expansion of economic activities (Bilyk, 2006). The efficient financial system is the critical elements for financial development, it is, because, the financial system is the collection of financial markets, institutions, and regulation which productively organized economic activities (Saqib, 2015; Plosser, 2009).

2.2. Studies on banking sector development and economic growth

The role of the well-developed banking sector is the key to enhancing financial efficiency. It is because efficient financial system mitigates investment risk, ensure liquidity, and accelerate long-term investment in the economy (Burzynska, 2009). Many researchers including Foo (2005), Abubakar and Gani (2013), and King and Levine (1993a) suggest well-developed banking sector can stimulate economic growth through easy access to external financing, liquidity in the financial system, and accelerate the process of capital accumulation by easing financial intermediation process. Financial intermediation ensures optimal allocation of economic resources in the economy by establishing a bridge between surplus units and deficit units with the help of efficient financial institutions. Fadare (2010) and Mhadhbi et al. (2017) argued that efficient financial institutions, especially banking institutions, play a critical role in the intermediation process and can bring long-run financial stability in the economy.

Over the past couple of decade, the nexus between banking sector development and economic growth attract a large number of researchers to investigate the linkage. In that process, a more substantial number of empirical studies explore the positive association between banking sector development and economic growth across the world (Hondroyiannis et al., 2005; Arestis and Demetriades P, 1997; Levine and Zervos, 1998; Mhadhbi et al., 2017; Sami, 2013; Nyasha and Odhiambo, 2016; Nyasha and Odhiambo, 2015; Nyasha and Odhiambo, 2014; Ahmed, 2010; Sibindi and Bimha, 2014; Petkovski and Kjosevski, 2014; Kjosevski, 2013). In the opinion of Goyal and Sarkar (2014), financial sector especially banking industry accelerate not only financial assets mobilization but also ensure integration of the financial system with economic activities with a positive influence on expanding economic activities. Nonetheless positive attitude by significant studies, existing literature also explained different view towards banking sector development and economic growth with negative or/and indifference impact (Lin and Sun, 2009; Law and Singh, 2014; Singh, 2008; Petkovski and Kjosevski, 2014; Koetter and Wedow, 2010).

While investigating causality between banking sector development and economic growth, no conclusive directional causality established by established yet. Existing literature advocate three distinct

hypothesis of investigating causality between banking sector development and economic growth. First, supply leading hypothesis (SLH) confirms unidirectional causality from banking sector development to economic growth. SLH postulate that banking sector development can cause economic growth through efficient capital accumulation and increase domestic investment rate by increasing the propensity to save in the economy. On the other hand, demand leading hypothesis (DLH) states economic growth demand new and improve financial service, assets and financial institution in the economy. Finance scholars including Colombage (2009), Nyasha and Odhiambo (2016), Kar et al. (2011), Liang and Jian-Zhou (2006), Mukhopadhyay et al. (2011), Ang and McKibbin (2007), and Panopoulou (2009) provide evedacne in favor of demand leading hypothesis. Moreover, finally, Feedback hypothesis confirm the existence of bidirectional causality, where each variable influence on another variable. Many empirical confirm bidirectional causality including Pradhan et al. (2014c), and Pradhan et al. (2014d).

The banking sector development plays a catalyst role in the development process by ensuring efficient financial intermediation, reduction of transaction cost, and most importantly supply credit facility in the financial system (Ang, 2008; Ang and McKibbin, 2007; Fuente and Marin, 1996). On the other hand, Moradi et al. (2016) advocate banking sector development reduce income inequality through reallocation of economic resources in productive investment across the country, such allocation creates an opportunity to generate income throughout the economy instead investment in the single area. Productive investment requires capital availability in the economy, in this regards, bank paly intermediaries role by collecting savings and generate capital from savings and inject in the economy in the form of capital. Apart from that banking sector development also ensure liquidity in the economy along with lower long-term investment risk (Beck, 2010).

2.3. Study on financial innovation, banking sector development, and economic growth

Existing literature does not provide any conclusive evidence of empirical studies focusing on investigating the nexus between financial innovation, banking sector development, and economic growth. However, with this study, we try to capitalize on the existing research gap and proceeds to investigate their relationship in the Asian economy.

3. Data and methodology of the study

3.1. Data definition and sources

Quarterly time series date uses in this study for the period of 1974Q1 to 2016Q4. Data collected from world development indicators published by (World Bank, 2017), World Economic Outlook (2017) published by the International Monetary Fund (IMF). Variables used in the study are economic development as the dependent variable, financial innovation, and banking sector development as explanatory variables. Table 1 reports the details descriptions of research variables with expected sign.

As a proxy for economic growth of Asian countries, we select widely used macroeconomic indicator Real GDP per capital as a proxy for economic growth, by following Rana and Barua (2015), Duasa (2014) and Ndlovu (2013).

Banking sector development is the process to improve the quality and quantity of financial product and efficiency at providing financial services to the banking industry in the financial

system. and Ang and McKibbin (2007) explain that there is no broad consensus among economists as to which of the proxies of financial development is the best measurement and more so these proxies are highly correlated. Therefore, it is really difficult to have a single measure of financial development that could highlight all the aspects of the financial system (Huang, 2011). Therefore, we use two different indicators as a proxy of bank-based financial development in the economy and these are a domestic credit to private sector (DCP) and domestic credit provided by the financial sector (DCF). Following, Nyasha and Odhiambo (2016), Pradhan et al. (2014a), and Abu-Bader and Abu-Qarn (2008).

Table 1. Definition of variables with the expected sign.

Variables	Definition	Notation	sign
GDP par capital	The percentage change in per capita gross domestic product, used as our indicator of economic growth.	Y	N/A
Domestic credit to Private Sector	Refers to financial resources provided to the private sector, such as through loans, purchases of nonequity securities, trade credits and other accounts receivable that establish a claim for payment.	DCP	+
Domestic Credit from Financial Sector	For gross credit from the financial system to the private sector. It isolates credit issues to the private sector, as opposed to credit issued to the government, government agencies, and public enterprises.	DCF	+
Ratio Between Broad to Narrow money	The ratio between Broad money to narrow money supply in the financial system.	FI	+/−

Note: All monetary measures are in real US dollars. All variables above are defined in the World Development Indicators and published by the World Bank.

Similarly, financial innovation, according to Chou and Chin (2011) and Wachtel (2003), introduce new financial institutions, new financial products, and improved financial services which lead to financial intermediation process effective and efficient. There is no single indicator of best explaining the impact of financial innovation on economic growth. However, many scholars including Ansong et al. (2011), Bara and Mudxingiri (2016), Bara et al. (2016), Odularu and Okunrinboye (2008) and Qamruzzaman and Jianguo (2017) consider the ratio of Narrow-to-Broad money as an indicator of financial innovation. By following empirical studies, in this study, we also consider the same for capturing the effect of financial innovation on economic growth. Table 2 represents the Summary of descriptive statistics along with pairwise correlation.

Table 2. Summary statistics of the variables.

	Descriptive statistics						Correlation Matrix			
Variables	Mean	Max	Min	Std.	Skew	Kur	lnY	lnFI	lnDCP	lnDCF
	Bangladesh									
lnY	0.87	4.94	−3.72	1.12	−1.8	9.32	1			
lnFI	3.34	4.19	2.08	0.56	−0.1	1.97	0.12**	1		
lnDCP	2.78	3.79	0.61	0.81	−0.84	3.02	0.06	0.15	1	
lnDCF	3.34	4.12	2.22	0.52	0.08	1.82	0.09**	0.13	0.08*	1
	China									
lnY	1.99	2.61	−1.52	0.66	−3.72	1.64	1			
lnFI	4.47	5.05	3.9	0.35	−0.28	1.83	0.26	1		
lnDCP	4.52	5.37	3.63	0.45	−0.3	2.09	0.28*	0.11*	1	
lnDCF	4.47	5.33	3.18	0.66	−0.49	1.9	0.11*	0.02	0.16	1

Continued on next page

	Descriptive statistics						Correlation Matrix			
Variables	Mean	Max	Min	Std.	Skew	Kur	lnY	lnFI	lnDCP	lnDCF
	India									
lnY	1.42	2.27	0.65	0.53	−0.56	2.51	1			
lnFI	3.99	4.38	3.54	0.28	0.06	1.51	0.08**	1		
lnDCP	3.46	3.96	3.03	0.32	0.48	1.53	0.16	0.11**	1	
lnDCF	4.01	4.35	3.62	0.2	0.27	1.93	0.06**	0.12**	0.17	1
	Pakistan									
lnY	0.84	2.62	−1.98	0.76	−0.93	3.8	1			
lnFI	3.74	4.36	2.96	0.44	−0.41	1.57	0.36	1		
lnDCP	3.4	4.05	2.66	0.3	−0.61	3.34	0.21**	0.21	1	
lnDCF	3.77	4.37	2.97	0.34	−0.88	2.97	0.20*	0.13	0.05**	1
	SriLanka									
lnY	1.24	2.28	−2.25	0.71	−2.64	12.2	1			
lnFI	3.52	4.05	2.87	0.23	−0.53	3.76	0.24	1		
lnDCP	3.12	3.85	2.05	0.41	−0.67	2.72	0.2**	0.03	1	
lnDCF	3.7	4.28	3.07	0.26	−0.27	3.28	0.03	0.24	0.13	1
	Nepal									
lnY	0.83	2.29	−4.63	0.84	−2.92	17.6	1			
lnFI	3.76	4.63	2.69	0.47	−0.13	2.15	0.03	1		
lnDCP	3.05	4.22	1.26	0.78	−0.42	2.3	0.11**	0.02	1	
lnDCF	3.55	4.35	2.07	0.53	−0.72	3.32	0.27*	0.12	0.15**	1
	Malaysia									
lnY	1.5	2.45	−0.73	0.42	−1.39	8.25	1			
lnFI	4.68	4.95	4.06	0.24	−0.95	2.56	0.17**	1		
lnDCP	4.47	5.08	3.51	0.4	−1.01	3	0.2	0.09**	1	
lnDCF	4.67	5.11	4.02	0.3	−0.88	2.55	−0.3	0.11	0.21*	1
	Japan									
lnY	0.68	4.55	−2.94	0.99	−0.93	6.71	1			
lnFI	5.22	5.5	4.73	0.19	−0.67	2.46	0.21*	1		
lnDCP	5.12	5.4	4.79	0.17	−0.59	2.11	0.31**	0.01**	1	
lnDCF	5.54	5.91	4.97	0.24	−0.59	2.29	0.11**	0.09*	0.12**	1

Note: Max: Maximum; Min: Minimum; Std: Standard Deviation; Skew: Skewness; and Kur: Kurtosis. Y: Economic growth; DCP: Domestic Credit to Private Sector; DCF: Domestic Credit from Financial Sector; and FI: Financial Innovation.

3.2. Methodology

This prime focus of the study is to investigate both long-run and short-run association between financial innovation, banking sector development and economic growth of Bangladesh from 1974Q1 to 2016Q4. With the consideration of empirical literature (see, section 2), we can establish the long run relationship among variables in linear form, with an intention to capture long run, short run relationship, and causality among variable.

$$lnY_t = \alpha_0 + \beta_1 lnFI_t + \beta_2 lnDCP_t + \beta_3 lnDCF_t + \varepsilon_t \quad (1)$$

where t is for the period, $\ln(y_t)$ is natural log of Gross Domestic Product per capital, $\ln DCP_t$ is for domestic credit to the private sector, $\ln DCF_t$ is natural log domestic credit from the financial sector, $\ln FI_t$ is natural log of financial innovation, α_0 is a constant term, $\beta_{1,}\beta_2$ and β_3, are the coefficients of model and ε_t denotes error correction term. Now we transform equation (1) into the generalized form of ARDL estimation in equation (2) as follow:

$$\Delta \ln(Y)_{ti} = C_0 + \theta_1 \Delta ln(FI)_{t-1} + \theta_2 \Delta ln(DCP)_{t-1} + \theta_3 \Delta ln(DCF)_{t-1} + \beta_4 \Delta \log(Y)_{t-1} + \lambda_0 \log(Y)_{t-1} + \lambda_1 \log(FI)_t + \lambda_2 \log(DCP)_t + \lambda_3 \log(DCF)_t + \varepsilon_t \quad (2)$$

where i represents the country, Δ indicates differencing of variables, while ε_t is the error term (white noise), and (t-1) is for lathe gged period, $\lambda_0 \; to \; \lambda_3$ is long run coefficient and $\beta_1 \; to \; \beta_4$ for short-run coefficients.

To investigate both the long run and the short-run relation between financial innovation, banking sector development, and economic growth, need to pass through various steps. In a financial and econometric analysis based on time series data, it is pertinent to investigate the characteristics of research variables of ascertaining their order of integration (I), either variables are integrated at the level I(0) or after first difference I(1). This study, however, applied the Augmented Dickey-Fuller (ADF) proposed by Dickey and Fuller (1979), PP test proposed by Phillips and Perron (1988), and KPSS proposed by Kwiatkowski et al. (1992) tests to detect the level of stationary. Non-stationary data, according to Gujarati and Porter (2009), in the research may produce an adverse outcome from the study. To apply ARDL bound testing, one needs to confirm that all the variables are integrated either in I (0), I (1) or both but none of them integrated at I (2).

Various cointegration test developed and applied, among those, Engle and Granger (1987) and Johansen-Juselius (1990) widely used. However, both models associated with few limitations, therefore may not suitable in cases, especially when variables integrated in mixed order. To overcome limitation exist in the previous cointegration model, initially, Pesaran and Shin (1998) offer new cointegration testing model. After that, an extended version of the new model proposed by Pesaran et al. (2001) for testing cointegration having variables order of integration either I(0), I(1) or both is widely known as Autoregressive Distributed Lag(ARDL) bounds testing approach. Proposed ARDL has several advantages over the existing approach. First, prior co-cointegration approaches are sensitive to sample size, but ARDL is capable of managing small sample size to investigate long-run association. Second, ARDL approach can apply for variables which are integrated either I (0), I (1) or mixed whereas, other approaches require a same order of integration; (3) different lags for variables can apply under ARDL approach.

Considering advantages produce by ARDL approach over existing cointegration testing, in this study, we are applying ARDL bound testing developed by Pesaran et al. (2001). To capture long-run cointegration among variables, we formulate unrestricted error correction model (UECM) under ARLD approach considering each variable as the dependent variable to estimate the best-fitted model for further analysis as shown Equation 2.

$$\begin{bmatrix} \Delta ln\,(Y)_t \\ \Delta ln\,(dcp)_t \\ \Delta ln\,(dcf)_t \\ \Delta\, ln(fi)_t \end{bmatrix} =$$

$$\begin{bmatrix} \delta_1 \\ \delta_2 \\ \delta_3 \\ \delta_4 \end{bmatrix} + \begin{bmatrix} \Delta ln\,(y)_{t-1} \\ \Delta ln\,(dcp)_{t-1} \\ \Delta ln\,(dcf)_{t-1} \\ \Delta\, ln(fi)_{t-1} \end{bmatrix} \begin{bmatrix} \theta_{11}\;\theta_{12}\;\theta_{13}\theta_{14} \\ \theta_{21}\;\theta_{22}\;\theta_{23}\theta_{24} \\ \theta_{31}\;\theta_{32}\;\theta_{33}\theta_{34} \\ \theta_{41}\;\theta_{42}\;\theta_{43}\theta_{44} \end{bmatrix} + \sum_{s=1}^{q} \begin{bmatrix} \mu_{11}\;\mu_{12}\;\mu_{13}\mu_{14} \\ \mu_{21}\;\mu_{22}\;\mu_{23}\mu_{24} \\ \mu_{31}\;\mu_{32}\;\mu_{33}\mu_{34} \\ \mu_{41}\;\mu_{42}\;\mu_{43}\mu_{44} \end{bmatrix} \begin{bmatrix} \Delta ln\,(y)_{t-s} \\ \Delta ln\,(dcp)_{t-s} \\ \Delta ln\,(dcf)_{t-s} \\ \Delta\, ln(fi)_{t-s} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{bmatrix} \quad (3)$$

where Δ is the first difference; δ_1 to δ_4 for the constant term; θ_{11} to θ_{44} For the long run coefficients; to test both short run and long run association among variables in equation 3. For, investigating long-run association, testing hypothesizes are H_0; there is no long-run association [θ_t= 0], and H_1 there is a long

run association [$\theta_t \neq 0$]. However, for short-run testing relations, the hypothesis for short-run testing is that; H_0= there is no short-run relationship[$\mu_s = 0$], and H_1= there is a short run relationship [$\mu_s \neq 0$].

To reach a conclusive decision regarding testing of hypothesis, Pesaran et al. (2001) proposed the following condition to testify;
(1) If F-statistics is higher than upper bound of critical value, it confirms the existence of cointegration.
(2) If F-statistics is lower than lower bound of critical value, then no cointegration.
(3) If F-statistics is higher than lower bound but lower than higher bound of critical value, so the decision is not inconclusive.

Once, the long run association established, the next two steps need to be executed to estimate long run and short run coefficients of the proposed ARDL models. The long-run ARDL (m, n, q, t, v, x, p) equilibrium model is as follows:

$$\ln gdp_t = \sigma_0 + \sum_{k=1}^{m} \beta_k \ln(Y)_{t-k} + \sum_{k=0}^{q} \delta_k \ln(DCP)_{t-k} + \sum_{k=0}^{t} \mu_k \ln(FI)_{t-k} + \sum_{k=0}^{v} \pi_k \ln(DCF)_{t-k} + \varepsilon_t \quad (4)$$

The legs length of ARDL model to be estimated using the Akaike Information Criterion (AIC). Using time series data for the study, Pesaran et al. (2001) proposed maximum lag length 2. The short-run elasticities can derive by formulating error correction model as follow.

$$\Delta \ln (Y)_t = \sigma_0 + \sum_{k=1}^{n} \beta_k \Delta \ln(Y)_{t-k} + \sum_{k=0}^{n} \delta_k \Delta \ln(DCP)_{t-k} + \sum_{k=0}^{n} \mu_k \Delta \ln(FI)_{t-k} + \sum_{k=0}^{n} \pi_k \Delta \ln(DCF)_{t-k} + \varphi ECT_{t-1} + \omega_t \quad (5)$$

where error correction term can be express as:

$$ECT_t = \ln (Y)_t - \sigma_0 - \sum_{k=1}^{m} \beta_k \Delta \ln(Y)_{t-k} - \sum_{k=0}^{q} \delta_k \Delta \ln(DCP)_{t-k} - \sum_{k=0}^{t} \mu_k \Delta \ln(DCF)_{t-k} - \sum_{k=0}^{v} \pi_k \Delta \ln(FI)_{t-k} \quad (6)$$

However, for investigating directional causality among research variables, the following Vector error correction model (VECM) to be employed in the later analysis.

$$\begin{bmatrix} \Delta \ln (Y)_t \\ \Delta \ln (dcp)_t \\ \Delta \ln (dcf)_t \\ \Delta \ln (fi)_t \end{bmatrix} = \begin{bmatrix} \xi_1 \\ \xi_2 \\ \xi_3 \\ \xi_4 \end{bmatrix} + \sum_{g=1}^{q} \begin{bmatrix} \mu_{11}\ \mu_{12}\ \mu_{13}\mu_{14} \\ \mu_{21}\ \mu_{22}\ \mu_{23}\mu_{24} \\ \mu_{31}\ \mu_{32}\ \mu_{33}\mu_{34} \\ \mu_{41}\ \mu_{42}\ \mu_{43}\mu_{44} \end{bmatrix} \begin{bmatrix} \Delta \ln (Y)_{t-g} \\ \Delta \ln (dcp)_{t-g} \\ \Delta \ln (dcf)_{t-g} \\ \Delta \ln (fi)_{t-g} \end{bmatrix} + \begin{bmatrix} \gamma_1 \\ \gamma_2 \\ \gamma_3 \\ \gamma_4 \end{bmatrix} ECT_{t-1} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{bmatrix} \quad (7)$$

With this study move, one steps further of examining the existence of an asymmetric relationship between financial innovation, banking sector development, and economic growth by applying newly proposed nonlinear ARDL proposed by Shin et al. (2014). To construct nonlinear regression equation, we developed two new series of data considering both positive and negative variation in each independent variables by following existing empirical studies (Delatte and López-Villavicencio, 2012; Verheyen, 2013; Bahmani-Oskooee and Mohammadian, 2016). We decompose positive and negative changes for financial innovation (FI), domestic credit to private sector (DCP) and domestic credit from the financial sector (DCF) denoted by FI^+ and FI^-,

DCP^+ and DCP^-, and DCF^+ and DCF^-, respectively. Decomposition series can generate the following ways:

$$\begin{cases} POS(FI)_t = \sum_{M=1}^{t} lnFI_M^+ = \sum_{M=1}^{T} MAX(\Delta lnFI_k, 0) \\ NEG(EX)_t = \sum_{M=1}^{t} lnFI_M^- = \sum_{M=1}^{T} MIN(\Delta lnFI_k, 0) \end{cases} \quad (8)$$

$$\begin{cases} POS(DCP)_t = \sum_{k=1}^{t} lnDCP_k^+ = \sum_{K=1}^{T} MAX(\Delta lnDCP_k, 0) \\ NEG(DCP)_t = \sum_{k=1}^{t} lnDCP_k^- = \sum_{K=1}^{T} MIN(\Delta lnDCP_k, 0) \end{cases} \quad (9)$$

$$\begin{cases} POS(DCF)_t = \sum_{k=1}^{t} lnDCF_k^+ = \sum_{K=1}^{T} MAX(\Delta lnDCF_k, 0) \\ NEG(DCF)_t = \sum_{k=1}^{t} lnDCF_k^- = \sum_{K=1}^{T} MIN(\Delta lnDCF_k, 0) \end{cases} \quad (10)$$

Now we insert newly developed positive and negative variables in the equation (2) to construct nonlinear form and can be rewritten as follows in equation (11):

$$\Delta lnY_t = \alpha_0 + \sum_{i=1}^{n} \mu_1 \Delta lnY_{t-i} + \sum_{i=0}^{n} \mu_2^+ \Delta lnPOS(FI)_{t-i} + \sum_{i=0}^{n} \mu_2^- \Delta lnNEG(FI)_{t-i} + \sum_{i=0}^{n} \mu_3^+ \Delta lnPOS(DCP)_{t-i} + \sum_{i=0}^{n} \mu_3^- \Delta lnNEG(DCP)_{t-i} + \sum_{i=0}^{n} \mu_4^+ \Delta lnPOS(DCF)_{t-i} + \sum_{i=0}^{n} \mu_4^- \Delta lnNEG(DCF)_{t-i} + \gamma_0 lnY_{t-1} + \gamma_1^+ lnPOS(FI)_{t-1} + \gamma_1^- lnNEG(FI)_{t-1} + \gamma_2^+ lnPOS(FI)_{t-1} + \gamma_2^- lnNEG(FI)_{t-1} + \gamma_3^+ lnPOS(FI)_{t-1} + \gamma_3^- lnNEG(FI)_{t-1} + \omega_t \quad (11)$$

In the opinion of Shin et al. (2014), for long-run cointegration assessment in equation (11) also applicable the critical value proposed by Pesaran et al. (2001). Since two additional components namely positive and negative changes include, that is why it is called nonlinear ARDL.

4. Data analysis and interpretation

4.1. Unit root test

The study uses three widely use stationary testing techniques, including Augmented Dickey-Fuller test (ADF) proposed by Dickey and Fuller (1979), P-P test proposed by Phillips and Perron (1988), and KPSS test proposed by Kwiatkowski et al. (1992) for ascertaining order of integration. Gujarati and Porter (2009) suggest non-stationary data is not suitable for regression estimation because estimation can produce spurious results. Moreover, to perform bound testing variables order of integration still important because if any variable confirms stationarity after second difference I(2), regression can produce spurious results. Moreover, also F-statistics from bound testing is not valid since bound testing assume variables order of integration at the level I(0) or/and I(1) (Pesaran et al., 2001). Therefore, it is essential to ascertain none of the variables integrated after second difference I(2) (Ahmad and Qayyum, 2008). Table 3 reports unit root results. The study revealed mixed order of integration level, it is implying that few variables are integrated as level I(0), and few variables are integrated after first difference I(1), but no variable is shown the order of integration after second difference I(2). Results suggest that variables are mutually integrated either zero or one or both, which motivate us to move in the next section of estimating long-run cointegration applying ARDL bound testing proposed by Pesaran et al. (2001).

Table 3. Unit Root Tests.

Variables	ADF	P-P	KPSS	ADF	P-P	KPSS
	Bangladesh			China		
lnY	−1.85	−6.93**	1.38**	−3.36**	−3.54**	1.36**
lnDCP	−2.36*	−1.42*	1.54**	−0.28	−0.47	1.52**
lnDCF	−0.93	−0.37	1.52**	−0.11	−0.26	0.84
lnFI	−0.84	−0.317	1.64**	−1.29	−1.13	1.62**
ΔlnY	−5.56**	−7.78**	0.077	−4.78**	−5.91**	0.57
ΔlnDCP	−3.01**	−6.77**	0.123	−3.61**	−5.91**	0.47
ΔlnDCF	−3.22**	−7.84**	0.12	−3.83**	−6.31**	0.39
ΔlnFI	−4.9**	−7.64**	0.119	−3.64**	−6.52**	0.47
	India			Pakistan		
lnY	−2.477	−2.77	0.94**	−2.67	−4.62**	0.67**
lnDCP	−1.657	−2.34	1.46**	−2.32	−1.47	0.42**
lnDCF	−1.536	−2.88	1.44**	−2.76	−1.75	0.66**
lnFI	−1.425	−2.24	1.61**	−1.65	−0.78	1.58**
ΔlnY	−4.79**	−11.38**	0.82	−4.11**	−3.84**	0.84
ΔlnDCP	−6.85**	−7.39**	0.15	−3.73**	−5.56**	0.88
ΔlnDCF	−6.78**	−7.59**	0.15	−7.19**	−6.05**	0.07
ΔlnFI	−8.11**	−5.91**	0.17	−3.85**	−6.73**	0.56
	Srilanka			Nepal		
lnY	−2.97	−3.82**	0.833**	1.437	1.77	1.68**
lnDCP	−2.19	−1.66	1.021**	−0.736	0.56	1.27**
lnDCF	−2.14	−1.75	0.74**	−1.314	−2.59	1.41**
lnFI	−1.35	−1.019	1.35**	−0.256	0.37	1.39**
ΔlnY	−4.38**	−10.93**	0.72	−5.66**	−4.26**	0.79**
ΔlnDCP	−3.53**	−6.72**	0.43	−3.59**	−5.94**	0.54
ΔlnDCF	−3.64**	−6.97**	0.76	−5.65**	−5.43**	0.18**
ΔlnFI	−3.22**	−6.75**	0.74	−4.17**	−6.75**	0.69
	Japan			Malaysia		
lnY	−2.73	−5.28**	0.87**	−1.79	−3.22	1.63**
lnDCP	−1.77	−1.22	0.88**	−2.38	−3.12	1.61**
lnDCF	−1.65	−2.32	1.575**	−2.22	−2.82	1.22**
lnFI	−1.57	−2.18	1.436**	−2.23	−2.87*	1.51**
ΔlnY	−4.93**	−6.21**	0.106	−3.57**	−3.43**	0.37
ΔlnDCP	−2.38*	−5.77**	0.22	−2.95	−6.41**	0.47
ΔlnDCF	−3.85**	−5.8**	0.89	−3.66**	−6.55**	0.16

Note: ADF for Augmented Dicky-Fuller test, P-P for Philips-Perron test, and KPSS for Kwiatkowski–Phillips–Schmidt–Shin (KPSS) tests. ADF critical values: −3.47 (1%), −2.88 (5%), and −2.57 (10%); KPSS 0.216 (1%), 0.146 (5%), and 0.11 (10%); and P−P critical value: 1% level −3.46 (1%), −2.87 (5%), and −2.57 (10%). all the variables convert into natural logarithm for estimations. * and ** indicates the level of significance at 5%, and 1% respectively. y for Economic Growth, DCP for domestic credit to private sector, DCF is domestic credit provided by the financial sector, FI for Financial innovation.

4.2. ARDL bound testing

In this section, we proceed to investigate long-run cointegration using equation (2), where each variable tested as the dependent variable of each country. The calculated F-statistics report in Table 4. The estimated F-statistics of ARDL bound testing to be compared with the critical value proposed by both Pesaran Pesaran et al. (2001) and Narayan (2004). The study observed, there are some F-statistics which are greater than upper bound of critical values. It signifies the existence of long-run cointegration in the model. In particular, when economic growth (Y) server as the dependent variable, the F-statistics of all countries[$F_{BD} = 17.50, F_{CHN} = 8.77, F_{IND} = 16.91, F_{JAP} = 2.03, F_{MAL} = 8.41, F_{NPL} = 8.86, F_{PAK} = 16.71, and\ F_{SL} = 9.81$] is greater than critical value at 1% significance level. So, one can conclude that

financial innovation, banking sector development and economic growth move together in the long-run for the period 1974Q1–2016Q4. Moreover, we also found F-statistics, when financial innovation sever as dependent variable, for Bangladesh, China, India, Malaysia and Nepal is higher than upper bound critical value. It is implying that economic growth can cause in the long run with the development of financial innovation and banking sector development in the financial system, it is, because, financial development play a critical role in endogenous economic growth at large.

Table 4. ARDL long-run cointegration results.

	Country							
	BD	CHN	IND	JAP	MAL	NPL	PAK	SL
Model	F-statistics							
$F_Y(Y\|DCP, DCF, FI)$	17.50**	8.77*	16.91*	12.03**	8.41*	8.86*	16.17*	9.81**
$F_{DCP}(DCP\|Y, DCF, FI,)$	1.68	3.55	1.97	2.19	4.75	1.89	4.01	2.74
$F_{DCF}(DCF\|DCP, Y, FI,)$	2.98	4.19	5.01	7.95	5.15	2.33	1.27	4.18
$F_{FI}(FI\|DCP, DCF, Y)$	7.85*	7.19**	6.18*	7.11	6.96*	7.16*	2.15	1.05
Critical value @ 1% level of significance								
			K	I(0)	I(1)			
Pesaran et al. (2001)			3	4.29	5.61			
Narayan (2004)			3	4.27	5.41			

Note: GDP for Gross Domestic par Capital, DCP for domestic credit to private sector, DCF is domestic credit provided by financial sector, FI for Financial innovation. BD for Bangladesh, CHN for China, IND for India, JAP for Japan, MAL for Malaysia, NPL for Nepal, PAK for Pakistan, and SL for Srilanka, respectively. K is the number of regressors.

4.3. Long run and short run estimation

ARDL bound testing to confirm the existence of a long-run association of model equation having GDP is the dependent variable. Now, we proceed further to estimate long-run elasticity by taking account the following ARDL (m, q, t, and v) model and long-run model result exhibits in Table 5.

$$\ln GDP_t = \beta_0 + \sum_{k=1}^{m} \beta_k \ln (GDP)_{t-k} + \sum_{k=0}^{q} \beta_k \ln (DCP)_{t-k} + \sum_{k=0}^{t} \beta_k \ln (DCF)_{t-k} + \sum_{k=0}^{v} \beta_k \ln (FI)_{t-k} + \varepsilon_t \quad (12)$$

We found the long-run coefficient of financial innovation is positive and statistically significant at 1% and 5% level of significance, except Nepal. This finding is the line with Mwinzi (2014), Bara and Mudxingiri (2016), Bara et al. (2016), and Qamruzzaman and Jianguo (2017). Financial innovation in the economy entice financial development by the emergence of new and improved financial assets, financial institutions, eventually assist in accelerating capital formation, and technologic innovation leads to sustainable economic growth.

On the other hand, we use two proxy indicators namely, domestic credit to private sector (DCP) and domestic credit from the financial sector (DCF) for investigating banking sector development impact on economic growth in the Asian country. For DCP, we found a positive impact on the economic growth of Bangladesh, China, Nepal, Pakistan, and Malaysia. However, India, Japan, and

Srilanka experience negative contribution. For DCF, the economy of China, India, Japan, Nepal, and Srilanka positively influence by domestic credit form the financial sector. Simultaneously, the economic growth of Bangladesh, Malaysia, and Pakistan negatively influence. The impact of banking sector development on economic growth is not conclusive still plays an important role in economic growth. The bank-based financial development allows access to capital for long-term investment, financial efficiency, enhancement of productivity with reduction of cost (Fuente and Marin, 1996), and increase financial intermediation efficiently in the financial system (Ho and Odhiambo, 2013).

Table 5. Long-run coefficients for the period 1974Q1–2016Q4.

Repressor	BD	CHN	IND	JAP	MAL	NPL	PAK	SL
lnFI	0.28**	1.21**	0.24**	1.16**	0.99**	1.41	0.26*	3.17**
lnDCP	1.74**	0.21**	−5.84*	−0.41	1.97**	1.14**	0.44	−0.75*
lnDCF	−0.41	0.71	2.48**	1.91**	−0.82	0.15*	−1.97	2.47
Constant	−1.95**	−7.71*	−7.71**	−2.32**	−3.08	−7.4**	−0.65*	−0.83**

Note: BD for Bangladesh, CHN for China, IND for India, JAP for Japan, MAL for Malaysia, NPL for Nepal, PAK for Pakistan, and SL for Srilanka, respectively.

Table 6. Short-Run Coefficient for the period 1980–2016.

	Sample countries							
Repressor	BD	CHN	IND	JAP	MAL	NPL	PAK	SL
ECT_{t-1}	-.78**	-0.71**	-.87**	-0.83*	-0.72**	-0.77**	-0.79**	-0.68**
ΔlnFI	0.11**	.02**	0.18**	0.07**	0.21**	-0.06**	0.11**	0.26**
ΔlnDCP	0.05**	0.15**	0.41	0.12	0.51	0.45	0.28	0.23**
ΔlnDCF	0.73**	0.06*	0.42**	0.01**	0.39**	0.22*	0.47	0.16**
Diagnostic test								
$\overline{R_2}$	0.86	0.79	0.86	0.93	0.89	0.83	0.87	0.81
δ	0.58	0.27	0.21	0.27	0.12	0.28	0.25	0.22
x^2_{Auto}	2.04(0.15)	0.22(0.78)	3.25(0.09)	1.25(0.27)	0.71(45)	2.21(0.16)	089(0.52)	2.31(0.11)
x^2_{ARCH}	1.78(0.21)	2.07(0.07)	1.67(0.15)	1.41(0.19)	1.73(14)	1.83(0.13)	1.57(0.10)	
$x^2_{\text{Normality}}$	6.22(0.45)	8.43(0.14)	1.57(0.11)	1.38(0.15)	1.37(0.15)	2.63(0.11)	1.59(0.11)	
x^2_{RESET}	1.39(0.12)	0.46(0.55)	1.46(0.14)	1.19(0.11)	1.14(0.15)	1.73(0.11)	1.79(0.12)	
Stability	S	S	S	S	S	S	S	S

Note: Y for Gross Domestic par Capital, DCP for domestic credit to private sector, DCF is domestic credit provided by the financial sector, FI for Financial innovation. BD for Bangladesh, CHN for China, IND for India, JAP for Japan, MAL for Malaysia, NPL for Nepal, PAK for Pakistan, and SL for SriLanka, respectively. All monetary measures are in real US dollars. (*) and (**) for statistical significance at 5% and 1% respectively.

For the short-run, we estimate short-run elasticities by using equation (5). The short-run calculation reports in Table 6. The existence of short-run association in the equation signify the error correction term. To confirm the short-run relationship, the coefficient of error correction term should be negative and statistically significant as suggested by Pahlavani et al. (2005). We found that (see Table 6) the coefficient of error correction term of each country is negative and statistically significant at 1% level of significance. The finding implies the existence of a short-run association between financial innovation, banking sector development and economic growth of Asian countries.

The coefficient of ECT_{t-1} represents the speed of adjustment toward long-run equilibrium from a prior-year shock. We observed the coefficient of each model ECT_{t-1} ranger between −0.68 to −087,

which indicate the convergence to long-run equilibrium after a shock to financial innovation and banking sector development is rapid in the Asian economy.

In the short-run elasticity. For financial innovation, we found all the countries, except Nepal, experience positive contribution in the development process. However, the coefficient elasticity on economic growth rate from 0.02 to 0.26. So one can conclude, though financial innovation can produce a positive impact on overall economic growth magnetite is nominal. For banking sector development, we revealed mix influence from both proxy indicators. For domestic credit to private sector (DCP), we observed the positive influence on the economic growth of Asian country, but only the coefficient Bangladesh, China, and Srilanka are statistically significant. On the other hand, the domestic indicator credit from the financial sector (DCF) also expresses similar behavior towards economic growth and coefficients also statistically significant except for Pakistan.

As suggested by empirical studies (see Narayan and Narayan (2005)), short-run model pass through several residual diagnostic tests. Test of autocorrelation confirms studied models are very from serial correlation. The Jarque-Bara test confirms errors normally distributed and the F-statistics of RESET support consistency in the model construction. Finally, adjusted R2 indicate model is sufficiently capable of explaining the variance rage from 79% to 93%.

4.4. Nonlinear ARDL estimation for the period 1974Q1-2016Q4

In this section, we move to investigate the existence of an asymmetric relationship between financial innovation, banking sector development and economic growth of Asian countries by using equation (11) constructed in accordance to newly developed Non-linear ARDL model proposed by Shin et al. (2014). The full information of NARDL estimations reports in Table 7. Having volume of information, we segregate information into four (04) panel.

Before we judge a dynamic relationship in the studied variables, we perform several model diagnostic test, namely test of Autocorrelation, a test of normality, a test of heteroscedasticity and the RESET test, of confirming model estimation robustness and stability. Table 7 (panel –D) reports the results of the various residual diagnostic test. Test of autocorrelation (x^2_{Auto}) estimation confirms free from serial correlation, and test of heteroscedasticity (x^2_{Hete}) ascertain that there is no ARCH effects. On the other hand, Jarque-Bera test (x^2_{Nor}) confirms normal distribution of the error terms and the RESET test (x^2_{RESET}) confirms model construction validity of this study. Moreover, the coefficient of adjusted R2 explain the model capability to explain variance. We observe the coefficients of each country specific model is significantly high range from 69% to 87%. This residual diagnostic test confirm estimation reliability and validity.

Now, we proceed to investigate long-run cointegration between financial innovation, banking sector development and economic growth in Asian countries for the period 1974Q1 to 2016Q4 in the model (7). From Table 7 (panel-B), we found strong evidence in favor of long-run cointegration in the model (7). More specifically, we observed the calculated F-statistic of each country, ($\mathrm{F_{pssBD}} = 14.19$), ($\mathrm{F_{pssCHN}} = 19.11$), ($\mathrm{F_{pssIND}} = 17.60$), ($\mathrm{F_{pssJAP}} = 12.51$), ($\mathrm{F_{pssMAL}} = 9.86, = 19.18$), ($\mathrm{F_{pssPAK}} = 19.88$), and ($\mathrm{F_{pssSL}} = 15.46$), is significantly higher than upper bound of critical value at 1% level of significance. Thus confirm all the variables move together in the long-run.

We further proceed with the asymmetric test by applying Wald test. The coefficient of W_{LR} for long-run and W_{SR} for short-run. For the long-run, the null hypothesis of symmetric long-run relationship between financial innovations, banking sector development and economic growth. In the Table 7

(panel – C), we observed the coefficient of W_{LR} of each country is statistically significant at 1%, and 5% level of significance. This is implying rejection of null hypothesis, rather one can conclude existence of asymmetric relationship in the long-run between studied variables. For the short-run, the rejection null hypothesis of existence of symmetric relationship support for all country, except for India and Malaysia. More specifically, the coefficients of W_{SR} of each country is statistically significant at 1% level of significance of each variables.

In the long-run (see Panel – A), the positive shock in financial innovation show positive coefficient with statistically significant. This implying that any positive development in financial innovation promotes long-run economic growth in the Asian economy. On the other hand, we observe negative shock of financial innovation negatively associated with the economic growth of all countries except Srilanka. The study suggests monetary expansion policy of promoting financial innovation in the economy, which eventually leads sustainable economic growth at large. For banking sector development, we observe the proxy indicators shown the mixed impact on economic growth from both positive and negative shock in the long-run. For Domestic credit to the Private sector (DCP), the positive shock boosts the economic growth of India, Malaysia, Nepal, Pakistan, and Srilanka and adverse behavior exposed for Bangladesh, China, and Japan. On the other hand, negative shock produces a favorable effect on economic growth of Bangladesh, China, Japan, and Nepal respectively. For Domestic credit from the financial sector (DCF), we found positive shock bring positive changes in the economic growth of Asian countries, whereas, negative shock stimulate economic growth of Japan, Malaysia and Nepal.

Table 7. Dynamic Asymmetric estimation for the period of 1974Q1–2016Q1.

	Sample Countries							
	BD	CHN	IND	JAP	MAL	NPL	PAK	SL
Panel – A: long-run estimation								
C	−1.49*	−1.35	−1.48*	−0.23**	−0.46**	−0.94**	−0.05*	0.97*
lnY(-1)	−0.59**	−1.1**	−0.32**	−1.26**	−0.3**	−0.55**	−1.11*	−0.11*
lnFI_P(-1)	0.082**	0.06*	1.58**	1.44**	0.87**	0.17**	0.99**	0.08**
lnFI_N(-1)	−1.81**	−1.41**	−0.35**	−1.77*	−0.2***	−0.06*	−1.38**	0.41**
lnDCP_P(-1)	−0.37*	−0.05**	0.40**	−0.52**	0.12*	−1.04*	0.42*	0.14*
lnDCP_N(-1)	0.61**	0.49*	−1.48**	0.12**	−0.51**	0.84*	−0.35**	−0.05**
lnDCF_P(-1)	0.16**	0.11**	1.145	0.05**	0.39**	0.87*	0.23**	0.09**
lnDCF_N(-1)	−4.41**	−1.14**	−0.31**	1.91*	0.23**	−1.75**	−0.65**	0.07**
Panel – B: Short-run estimation								
ΔlnY(-1)	0.43**	0.4**	0.26**	0.32**	0.72**	0.47**	0.53*	0.31**
ΔlnY(-2)	0.32**	0.19**	0.23*	0.18**	0.35	0.17	0.22**	0.15**
ΔlnY(-3)	0.33*	0.14*	0.21**	0.17*	0.09**	0.07	0.13	0.17*
ΔlnY(-4)	0.09**	−0.11*	−0.58**		−0.14**	−0.45**	−0.17**	−0.56
ΔlnFI_P(-1)		0.56	−6.70**	9.07**				1.43**
Δ lnFI_P (-2)			−5.77				1.02**	
Δ lnFI_P (-3)	−2.19**						1.71	
Δ lnFI_P (-4)	4.70**	2.32**	3.24**	3.98**	1.33**		1.19**	0.79**
ΔlnFI_N(-1)								
Δ lnFI_N (-2)	−4.12**							
Δ lnFI_N(-3)	−4.03**				1.35**			
Δ lnFI_N(-4)	−5.92**	7.15**		−10.28	−1.27**	5.18**		1.74**
ΔlnDCP_P(-1)		−1.16**	6.64**	7.42		−2.18**	3.68	
ΔlnDCP _P (-2)	−1.88**		2.40**	5.78				
ΔlnDCP _P (-3)	−5.57**		2.87**	3.61		1.03**		
ΔlnDCP _P (-4)	8.47*		−3.31					−0.96**

Continued on next page

	Sample Countries							
	BD	CHN	IND	JAP	MAL	NPL	PAK	SL
ΔlnDCP _N(-1)			2.72**	−4.11**				
ΔlnDCP _N (-2)								0.42**
ΔlnDCP _N(-3)	2.76**				5.4**			
Δ lnDCP _N(-4)		6.69**	−9.54	1.53**	1.74**	−7.66**	3.15**	0.76**
Δ lnDCF _P(-1)								
Δ lnDCF_P (-2)				−1.37**			−1.37*	0.64**
Δ lnDCF _P (-3)	4.21**		−3.45	−17.31*			−2.45*	
Δ lnDCF _P (-4)	−8.35**	−0.54		−9.55	−1.5	5.46*	5.73	1.74**
Δ lnDCF _N(-1)	6.18**	−0.51**	−3.12**			7.93**	2.47	−1.05*
Δ lnDCF _N(-2)	8.28							−1.31
Δ lnDCF _N(-3)	3.53*				−4.75**			−0.93*
Δ lnDCF _N(-4)	4.37**	−9.06**	8.57**	7.6***	0.72*	0.47**	−4.11**	−1.09**
Panel – C: Symmetric Estimation								
F_{pss}	14.19	19.11	17.60	12.51	9.86	19.18	19.88	15.46
L_{FI}^{+}	0.13**	0.05**	4.83**	1.14**	2.83**	0.3**	0.89**	0.75*
L_{FI}^{-}	−3.03**	−1.28**	−1.08**	−1.39**	−0.65**	−0.12**	−1.24*	3.6**
L_{DCP}^{+}	−0.61**	−0.04*	1.23*	−0.41*	0.39*	−1.86*	0.38*	1.28**
L_{DCP}^{-}	1.02*	0.45**	4.53**	0.11**	1.66**	1.51**	0.31**	0.49**
L_{DCF}^{+}	0.27**	0.1**	3.50**	−0.04**	−1.27**	1.57**	0.21**	−0.81**
L_{DCF}^{-}	−7.4*	−1.03**	−0.97**	−0.11**	0.77**	−3.14*	−0.59*	0.62*
$W_{LR,FI}$	22.78**	11.85**	6.29**	11.62**	7.88**	3.69**	9.13**	2.57*
$W_{SR,FI}$	37.18**	8.78**	11.45*	9.74**	16.25*	15.26**	6.29**	6.49**
$W_{LR,DCP}$	7.38**	7.45**	15.25**	16.90*	9.79**	19.11**	25.18**	8.41**
$W_{SR,DCP}$	8.01*	10.45**	12.15**	19.19**	6.58**	16.62*	10.19*	5.78*
$W_{LR,DCF}$	12.55**	8.19**	16.19*	10.18**	27.91**	9.61**	16.22**	12.29**
$W_{SR,DCF}$	17.48*	9.52**	15.75**	22.75**	11.79**	13.11*	17.01**	16.45*
R^2	0.87**	0.76**	0.69	0.71	0.82	0.69	0.83	0.85
Panel – D: Residual Diagnostic test								
x_{Auto}^2	0.13(0.89)	2.13(0.18)	1.75(0.18)	1.49(0.24)	1.42(0.25)	1.43(0.23)	1.12(0.32)	1.86(0.16)
x_{Hete}^2	0.68(0.35)	1.45(0.17)	2.29(0.11)	1.12(0.14)	1.16(0.30)	0.46(0.41)	2.02(0.11)	2.26(0.28)
x_{Nor}^2	1.12(0.14)	4.18(0.11)	0.89(0.75)	1.86(0.16)	1.58(0.25)	1.49(0.24)	1.18(0.31)	1.82(0.11)
x_{RESET}^2	1.78(0.19)	1.35(0.17)	1.2.(0.26)	1.43(0.23)	1.18(0.25)	1.04(0.29)	1.18(0.21)	0.39(0.53)
Stability	S	S	S	S	S	S	S	S

Note: BD for Bangladesh, CHN for China, IND for India, JAP for Japan, MAL for Malaysia, NPL for Nepal, PAK for Pakistan, and SL for SriLanka, respectively. The superscript "+" and "–" denote positive and negative change, respectively. ** and * indicate level of significance at 1% and 5%, respectively. The coefficient of L^{+} for long-run positive variation and L^{-} for long-run negative variation, respectively. W_{LR} and W_{SR} for Wald test coefficient for null hypothesis of long-run and short-run symmetry test. The coefficient F_{pss} is F-statistics for bound testing. "S" for stable.

4.5. Granger-causality under VECM

The existence of cointegration between financial innovation, banking sector development, and economic growth induce to go further for investigating directional influence among the research variables. We apply Granger-causality under vector error correction (ECM), to investigate directional causality both for short run and long run. Causality test results reported in Table 8. Long-run causality of the model is specifying the coefficient of ECT $_{(-1)}$ by two essential properties; the coefficient should be negative and statistically significant. We found some long-run causal relationship, especially when economic growth considers as the dependent variable in the equation, which confirms the existence of long-run causality between financial innovations, banking sector development, and economic growth of Asian countries (see Table 8). The summary of short-run

causality exhibits in Table 9 between economic growth, financial innovation, Domestic credit to private sector, and domestic credit from financial sector.

Table 8. The VECM Granger causality test.

	Type of causality					
Dependent	Short run causality					Long-run
Variables	ΔlnY_{t-1}	$\Delta lnFI_{t-1}$	$\Delta lnDCP_{t-1}$	$\Delta lnDCF_{t-1}$	$ECT_{(-1)}$	Inference
		Bangladesh				
ΔlnY_t	--	0.66*	2.89*	1.48	−0.41**	Present
$\Delta lnFI_t$	12.17*	---	8.50	12.68**	−0.14**	Present
$\Delta lnDCP_t$	2.79*	12.94**	---	10.77	0.43	
$\Delta lnDCF_t$	6.38	42.14	0.31*	---	0.45	
		China				
ΔlnY_t		6.06**	13.41**	7.75	−0.78**	Present
$\Delta lnFI_t$	5.27**		0.14**	1.31**	−0.07**	Present
$\Delta lnDCP_t$	4.15**	0.22		0.11	−0.08*	Present
$\Delta lnDCF_t$	4.37	0.60**	0.26		−0.10	
		India				
ΔlnY_t		6.07**	4.36	8.13**	-0.44**	Present
$\Delta lnFI_t$	0.47**		0.32*	0.41	0.50	
$\Delta lnDCP_t$	0.64	2.06*		3.20	-0.13**	Present
$\Delta lnDCF_t$	1.59	3.73*	0.86		0.014	
		Japan				
ΔlnY_t		2.24**	0.34	0.99	−0.2***	Present
$\Delta lnFI_t$	2.76**		1.07	0.15**	0.61	
$\Delta lnDCP_t$	0.2	2.27**		0.01	−0.14***	Present
$\Delta lnDCF_t$	0.04	4.54**	0.11		0.29	
		Malaysia				
ΔlnY_t		0.78**	2.74	2.21	−0.51**	Present
$\Delta lnFI_t$	4.91**		7.49**	5.92	−0.28**	Present
$\Delta lnDCP_t$	0.44**	0.93		4.93	−0.18**	Present
$\Delta lnDCF_t$	4.75	1.2	6.7**		−0.25	
		Nepal				
ΔlnY_t		2.48**	1.61	2.13	-0.14**	Present
$\Delta lnFI_t$	0.16		0.59**	0.42	-0.34**	Present
$\Delta lnDCP_t$	2.39**	3.04		0.21**	0.64	
$\Delta lnDCF_t$	4.04	0.97**	0.02		-0.76**	Present
		Pakistan				
ΔlnY_t		0.25**	1.12	0.01	-0.52**	Present
$\Delta lnFI_t$	0.22		0.31**	0.69**	0.79**	Present
$\Delta lnDCP_t$	1.11**	1.24		0.59	-0.22**	Present
$\Delta lnDCF_t$	0.38	0.31**	0.96		0.19	
		Srilanka				
ΔlnY_t		0.06**	0.16	1.22**	−0.17**	Present
$\Delta lnFI_t$	0.28*		0.18	0.14	0.158	
$\Delta lnDCP_t$	0.49**	0.11		0.16	−0.81**	Present
$\Delta lnDCF_t$	0.12	0.24	0.26**		−0.31**	Present

Note: GDP for Gross Domestic par Capital, DCP for domestic credit to private sector, DCF is domestic credit provided by the financial sector, FI for Financial innovation. (*) and (**) for statistical significance at 5% and 1% respectively. ECT_{t-1} represents error correction (long run coefficient in the model).

Table 9. Summary of short-run causalities**.**

Causality	BD	CHN	IND	PAK	JAP	MAL	SRI	NPL
Y vs. FI	Y←→FI	Y←→FI	Y←→FI	FI→Y	Y←→FI	FI←→Y	Y←→FI	FI→Y
Y vs. DCP	DCP←→Y	DCP←→Y	DCP←→Y	Y→DCP		Y→DCP	Y→DCP	Y→DCP
Y vs. DCF	DCF→Y	DCF←→FI	DCF→Y	DCF←→FI	DCF→Y	-	DCF→Y	
FI vs. DCP	FI→DCP	DCP→FI	-	DCP→FI		DCP→FI	-	DCP←→FI
FI vs. DCF	DCF→FI	-	FI→DCF	-	FI→DCF	-	-	
DCP vs. DCF	DCF←DCP	-	-	-		DCP→DCF	DCF←DCP	DCF←DCP

For Bangladesh, we revealed bidirectional causality between financial innovation and economic growth [Y←→FI] and domestic credit to private sector and economic growth [DCP←→Y]. Moreover, we also found unidirectional causality from domestic credit from financial sector to economic growth [DCF→Y], financial innovation to domestic credit to private sector [FI→DCP], domestic credit from financial institutions to financial innovation [DCF→FI], and domestic credit to private sector to domestic credit from financial institutions [DCF←DCP].

For China, we explore bidirectional causality between economic growth and financial innovation [Y←→FI], domestic credit to private sector and economic growth [DCP←→Y], and domestic credit from the financial sector and financial innovation [DCF←→FI]. Apart from that we also found unidirectional causality from domestic credit to private sector to financial innovation [DCP→FI].

For India, we unveiled bidirectional causality between economic growth and financial innovation [FI←→Y] and financial innovation and domestic credit to private sector [DCP←→FI] On the other side, we found several unidirectional causalities from domestic credit to financial sector to economic growth [DCF→Y] and financial innovation to domestic credit to financial sector [FI→DCF].

For Pakistan, we revealed bidirectional causality between domestic credit from the financial sector and financial innovation [DCF←→FI]. On the other hand, we also experience unidirectional causality from financial innovation to economic growth [FI→Y], domestic credit to private sector to financial innovation [DCP→FI], and economic growth to domestic credit to the private sector [Y→DCP].

For Japan, we exposed bidirectional causality between financial innovation and economic growth [Y←→FI]. We also detected unidirectional causality from domestic credit to private sector financial innovation [DCP→FI] and domestic credit to private sector to domestic credit from financial sector [DCP→DCF].

For Malaysia, we disclosed bidirectional causality between financial innovation and economic growth [FI←→Y]. Other than bi-directional, we also found unidirectional causality from domestic credit to private sector to financial innovation [DCP→FI], economic growth to domestic credit to the private sector [Y→DCP], and domestic credit to private sector to domestic credit form financial sector [DCP→DCF].

For Srilanka, we unveiled bidirectional causality between financial innovation and economic growth [Y←→FI].We also found unidirectional causality from economic growth to domestic credit to the private sector[Y→DCP], domestic credit from the financial sector to economic growth [DCF→Y], and domestic credit to private sector to domestic credit from financial sector [DCF←DCP].

For Nepal, we found bidirectional casualty between domestic credit from the financial sector and financial innovation. Moreover, we observed unidirectional causality from financial innovation to economic growth [FI→Y], economic growth to domestic credit to the private sector [Y→DCP], and domestic credit to private sector to domestic credit from financial sector [DCP→DCF].

In summary, we found conclusive evidence supporting bidirectional causality between financial innovation and economic growth both in the short-run and long-run. This implies that any positive and negative shock in economic growth and financial innovation cause each other both in the short-run and long-run. For banking sector development, we observed in the unidirectional causality form both proxy to economic growth in the short-run and long-run.

4.6. Model Robustness diagnostic test

Model robustness is one of the keys to validate studied model estimation and also established confidence about findings. Existing literature strongly advocate employee two model robustness techniques for validation, is commonly known as cumulative sum (CUSUM) and cumulative sum squares (CUSUMSQ) which proposed by Borensztein et al. (1998). Large number empirical studies extensively also applied in their work (Pesaran et al. 2001; Suleiman, 2013). Table 6 and Table 7 reports model stability test results. We found under both assumption model test fall between boundary line at 5% level of significance as denoted “S”.

4.7. Forecast error variance decomposition

In this section, we estimate variance decomposition of economic growth, financial innovation, and banking sector development of Asian counters and reverse. Table 10 reports full information of estimation. We purposively consider period 10^{th} for long-run and period 3^{rd} for short-run variation. For the long-run, when economic growth serves as the dependent variable, forecast variance of financial innovation explains 17.7% of economic growth variance in China. These percentages are; 18.86% in Japan, 13.08% in Malaysia, 12.42% in Bangladesh, 9.89% in India, 5.05% in Nepal, 14.04 in Pakistan, and 12.24 in Srilanka. On the other hand, noticeable variance from domestic credit to private sector observed in Srilanka by 10.33% and China for 7.97%. We also found domestic credit to financial sector explain the variance of economic growth by 16.54% in India, 16.40% in Nepal, and 21.56 in Srilanka.

Finding suggests that in the long-run both financial innovation and banking sector development can explain variance in the economic growth of Asian countries. Thus confirms contribution in the development process from financial innovation and banking sector development.

5. Conclusion and policy

Sustainable economic growth demands financial development along with efficient financial institutions. In the process of financial development, banking sector plays a crucial role in the optimal reallocation of economic resources and financial stability. Efficient financial institutions ensure full

coverage of financial service with improved and diversified financial assets. It is possible through financial innovation, which promotes not only efficiency in the financial system but also accelerates economic growth through financial development. With this study, we try to explore new evidence regarding the nexus between financial innovation, banking sector development and economic growth of Asian countries for the period of 1974Q1–2016Q4. For assessing the long-run dynamic relationship, we use newly developed both linear ARDL proposed by Pesaran et al. (2001) and nonlinear ARDL approach proposed by Shin et al. (2014). For capturing the effect of financial innovation on economic growth, the study uses the ratio of Broad to narrow money as a proxy indicator for financial innovation. For banking sector development, two proxy indicators select namely, domestic credit to private sector (DCP) and domestic credit from the financial sector (DCF) as a percentage of Gross Domestic Product.

For long-run cointegration, both ARDL and NARDL provide substantial evidence to support the existence of a long-run association between financial innovation, banking sector development and economic growth of Bangladesh, China, India, Pakistan, Japan, Nepal, Malaysia, and Srilanka. Motsatsi (2016) advocated that Financial innovation in the financial system constitute a development of financial institutions, risk reduction with diversified investment, and accelerate financial development by offering improved financial services by financial institutions with business innovation and technological innovation.

Nonlinear ARDL confirms the existence of an asymmetric relationship between financial innovation, banking sector development and economic growth of Asian country both in long-run and short-run.

For investigating directional causality of the cointegrated model, we apply VECM-Granger causality test. For causality between financial innovation and economic growth, we observed bi-directional causality [GDP < == > FI] both in short and long run. These findings are consistent with Bara and Mudxingiri (2016), Bara et al. (2016) and Mlachila (2013). It implies that encouragement of financial innovation in the financial system brings changes by causing financial development, including the market for consumers, debt structure and government rules and regulation in turn, thus, promotes economic growth in long run. It is, because, financial development can cause sustainable economic development either directly or indirectly (Shan and Morris, 2002). In case of directional causality between banking sector development and economic growth, study revealed unidirectional causality both in short and long run, i.e., [GDP < == DCP] & [GDP< == DCF]. These findings are on the line with Ho and Odhiambo (2013), Nyasha and Odhiambo (2016), Pradhan et al. (2014b), and Obradović and Grbić (2015). The bank-based financial development provides an efficient channel for mobilizing economic resource, management of investment risk, reduction of cost of acquiring capital, can accelerate sustainable economic growth in long run.

Table 10. Forecast error variance decomposition.

	Dependent variable lnY				Dependent variable lnFI				Dependent variable lnDCP				Dependent variable lnDCF			
	China															
Time	lnY	lnFI	lnDCP	lnDCF	lnY	lnFI	lnDCP	lnDCF	lnY	lnFI	lnDCP	lnDCF	lnY	lnFI	lnDCP	lnDCF
1	100.00	0.00	0.00	0.00	8.37	91.62	0.00	0.00	2.26	34.92	62.80	0.00	4.33	66.64	15.97	13.04
3	93.97	5.58	0.35	0.09	9.11	90.88	0.00	0.00	5.55	36.11	57.97	0.36	5.32	63.23	15.45	15.98
5	86.23	12.37	1.25	0.13	10.65	89.32	0.00	0.01	11.02	35.48	52.27	1.21	6.77	58.24	15.64	19.33
10	74.04	17.70	7.97	0.27	11.36	88.00	0.58	0.05	27.58	31.05	37.85	3.50	7.87	48.42	18.43	25.26
	Japan															
1	100.00	0.00	0.00	0.00	9.40	90.59	0.00	0.00	0.01	17.41	82.57	0.00	5.26	5.81	9.22	79.69
3	95.01	4.80	0.14	0.02	9.93	89.83	0.18	0.04	0.05	21.88	78.06	0.00	5.58	11.35	7.71	75.35
5	87.25	12.31	0.33	0.09	9.94	89.27	0.72	0.06	0.17	27.39	72.42	0.00	6.15	18.00	6.10	69.73
10	80.32	18.68	0.55	0.43	7.26	90.54	2.07	0.12	1.03	36.05	62.84	0.05	6.74	29.31	3.47	60.46
	Malaysia															
1	100.00	0.00	0.00	0.00	3.92	96.07	0.00	0.00	6.65	72.82	20.52	0.00	8.93	83.23	4.29	3.52
3	94.39	5.09	0.32	0.17	5.05	93.73	0.41	0.79	8.10	67.60	23.59	0.68	11.09	76.23	3.76	8.90
5	88.01	10.16	0.91	0.89	8.02	87.38	1.40	3.19	11.26	58.96	27.20	2.56	14.83	65.00	3.39	16.76
10	80.97	13.08	2.38	3.55	43.24	49.30	1.94	5.49	35.16	26.58	34.78	3.46	41.75	30.36	4.76	23.11
	Bangladesh															
1	100.00	0.00	0.00	0.00	3.27	96.72	0.00	0.00	11.96	28.30	59.73	0.00	3.01	50.39	21.45	25.13
3	94.41	5.05	0.37	0.16	0.98	97.73	1.05	0.22	5.93	32.72	60.79	0.54	0.83	56.01	17.70	25.44
5	90.62	7.12	1.66	0.58	0.54	94.97	3.83	0.65	2.95	38.50	56.56	1.98	0.85	61.85	13.25	24.03
10	84.51	12.42	2.29	0.76	1.74	86.64	10.65	0.95	2.80	45.89	46.38	4.91	4.33	65.58	6.84	23.23
	India															
1	100.00	0.00	0.00	0.00	23.50	76.49	0.00	0.00	40.28	24.61	35.10	0.00	24.31	16.92	23.24	35.52
3	93.10	2.63	0.02	4.23	13.10	86.80	0.00	0.08	23.27	35.83	40.03	0.85	10.12	29.24	26.66	33.96
5	78.44	8.34	0.17	13.03	7.77	92.13	0.00	0.08	13.20	41.83	43.30	1.65	4.25	35.58	27.03	33.11
10	72.57	9.89	0.98	16.54	3.80	96.00	0.04	0.14	6.08	42.82	49.64	1.43	1.52	35.60	25.17	37.69
	Nepal															
1	100.00	0.00	0.00	0.00	3.62	96.37	0.00	0.00	0.40	16.59	83.00	0.00	3.66	23.17	48.10	25.05
3	97.82	0.72	0.02	1.42	2.66	97.22	0.01	0.09	0.41	24.76	74.68	0.13	1.78	32.02	44.42	21.77
5	92.28	2.62	0.16	4.92	1.95	97.65	0.04	0.34	0.22	33.09	66.27	0.39	1.11	40.91	39.20	18.76
10	76.62	5.02	1.94	16.40	0.94	97.68	0.22	1.14	3.43	46.74	49.39	0.42	16.11	49.16	20.83	13.88

Continued on next page

	Dependent variable lnY				Dependent variable lnFI				Dependent variable lnDCP				Dependent variable lnDCF			
	Pakistan															
1	100.00	0.00	0.00	0.00	0.85	99.14	0.00	0.00	1.04	7.50	91.45	0.00	3.75	17.14	20.31	58.77
3	95.85	4.00	0.09	0.05	1.30	98.44	0.12	0.11	0.39	11.26	87.79	0.54	5.15	18.73	26.59	49.51
5	89.48	10.01	0.19	0.30	1.68	97.53	0.29	0.49	0.14	15.13	83.23	1.47	6.13	20.71	31.59	41.56
10	83.47	14.04	0.11	2.36	2.65	95.28	0.76	1.29	0.06	21.40	73.67	4.85	8.75	23.20	41.12	26.91
	SriLanka															
1	100.00	0.00	0.00	0.00	7.81	92.18	0.00	0.00	4.41	20.24	75.34	0.00	0.02	23.76	16.96	59.24
3	98.99	0.13	0.42	0.44	5.41	94.45	0.10	0.03	1.69	20.41	77.78	0.10	0.78	26.78	15.40	57.02
5	84.41	10.68	2.26	2.63	3.68	95.83	0.37	0.10	0.77	20.29	78.64	0.27	2.90	28.98	13.40	54.70
10	55.84	12.25	10.33	21.56	1.58	96.85	1.02	0.52	1.17	19.27	78.83	0.71	6.45	31.04	11.28	51.21

By conjecture of empirical study findings, we wished-for the following recommendations for economic development by speeding up financial innovation and bank-based financial development in Asian countries. First, financial innovation should be encouraged in the financial system through co-operation in the financial development process by infrastructure enhancement, technological advancement, and financial integration among financial institutions. Second, critical financial policies to be formulated for institutional cooperation development, healthy completion, financial risk management and financial instrument development. The congenial environment is the key towards banking sector development; the government should ensure so that banking sector can optimize their full potential with efficient payment mechanisms and improved financial services. Improvement in the banking sector can experience the economy with more contribution in the economic development process. This study is not out of limitation, we consider only one proxy indicator for financial innovation having a positive association, but findings might be different by incorporating more indicators in future studies, such as mobile banking contribution, microfinance impact and credit instruments of debt service used by financial institutions. On the other hand, banking sector development can measure by developing banking sector development index reflecting more bank-based financial development somewhat separate indicators for banking sector development impact on economic growth.

Acknowledgments

We would like to thanks two anonymous reviews for their thoughtful and constructive comments in reviewing process of this article and assist immensely for further development. We are grateful to editor-in-chief and Assistant editor for their generous consideration and responsive approach during this publication process. We also claim that this paper represents the authors' personal opinions and all remaining errors are, of course, our own.

Conflict of Interest

We, hereby, declaring that no support from any organization for the submitted work; no financial relationships with any organizations that might have an interest in the submitted work; no other relationships or activities that could appear to have influenced the submitted work.

References

Abu-Bader S, Abu-Qarn A (2008) Financial Development and Economic Growth: Empirical Evidence from MENA Countries. *Rev Dev Econ* 2: 803–817.

Abubakar A, Gani IM (2013) Impact of Banking Sector Development on Economic Growth: Another Look at the Evidence from Nigeria. *J Bus Management Soc Sci Res* 2: 47–57.

Adu-Asare Idun A, Q.Q. Aboagye A (2014) Bank competition, financial innovations and economic growth in Ghana. *Afr J Econ Management Stud* 5: 30–51.

Ahmad I, Qayyum A (2008) Effect of government spending and macro-economic uncertainty on private investment in services sector: Evidence from Pakistan. *Eur J Econ, Financ Administrative Sci* 84–96.

Ahmed AD (2010) Financial liberalization, financial development and growth linkages in Sub-Saharan African countries: An empirical investigation. *Stud Econ Financ* 27: 314–339.

Ang JB (2008) A Survey Of Recent Developments In The Literature Of Finance And Growth. *J Econ Surv* 22: 536–576.

Ang JB, McKibbin WJ (2007) Financial liberalization, financial sector development and growth: evidence from Malaysia. *J Dev Econ* 84: 215–233.

Ansong A, Marfo-Yiadom E, Ekow-Asmah E (2011) The Effects of Financial Innovation on Financial Savings: Evidence From an Economy in Transition. *J Afr Bus* 12: 93–113.

Arestis P, Demetriades P (1997) Financial development and economic growth: assessing the evidence. *Econ J* 107: 783–799.

Bagehot W (1873) *Lombard Street: A description of the money market*, Scribner, Armstrong & Company.

Bahmani-Oskooee M, Mohammadian A (2016) Asymmetry Effects of Exchange Rate Changes on Domestic Production: Evidence from Nonlinear ARDL Approach. *Aust Econ Pap* 55: 181–191.

Bara A, Mudxingiri C (2016) Financial innovation and economic growth: evidence from Zimbabwe. *Invest Management Financ Innovations* 13: 65–75.

Bara A, Mugano G, Roux PL (2016) Financial Innovation and Economic Growth in the SADC. *Econ Res South Afr* 1: 1–23.

Beck T (2010) Financial Development and Economic Growth: Stock Markets versus Banks. *Private Sector Dev* 5: 23–25.

Beck T, Levine R (2004) Stock markets, banks, and growth: Panel evidence. *J Bank Financ* 28: 423–442.

Bernanke B (2007) Regulation and Financial Innovation. Financial Markets Conference.

Bilyk V (2006) Financial Innovations and the Demand for Money in Ukraine. National University.

Boot AW, Marinč M (2012) 22 Financial innovations, marketability and stability in banking. *Res handbook int bank gov* 395.

Borensztein E, De Gregorio J, Lee J-W (1998) How does foreign direct investment affect economic growth? *J Int Econ* 45: 115–135.

Burzynska K (2009) Financial Development and Economic Growth: The Case of Chinese Banking Sector. Lund University.

Bwirea T, Musiime A (2015) Financial Development-Economic Growth Nexus: Empirical Evidence from Uganda. *J Soc Sci* 4: 1–18.

Calderón C, Liu L (2003) The direction of causality between financial development and economic growth. *J Dev Econ* 72: 321–334.

Carbó Valverde S, López Del Paso R, Rodríguez Fernández F (2007) Financial Innovations in Banking: Impact on Regional Growth. *Reg Stud* 41: 311–326.

Chaiechi T (2012) Financial development shocks and contemporaneous feedback effect on key macroeconomic indicators: A post Keynesian time series analysis. *Econ Model* 29: 487–501.

Chou YK (2007) Modelling Financial Innovation and Economic Growth. *J Bus Management* 2: 1–36.

Colombage SR (2009) Financial markets and economic performances: empirical evidence from five industrialized economies. *Res Int Bus Financ* 23: 339–348.

De Gregorio J, Guidotti PE (1995) Financial development and economic growth. *World Dev* 23: 433–448.

Delatte A-L, López-Villavicencio A (2012) Asymmetric exchange rate pass-through: Evidence from major countries. *J Macroecon* 34: 833–844.

Dickey DA, Fuller WA (1979) Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *J Am Stat Assoc* 74: 427–431.

Duasa J (2014) Financial Development and Economic Growth:The Experiences of Selected OIC Countries. *Int J Econ Management* 8: 215–228.

Engle R, Granger C (1987) Cointegration and error correction representation: estimation and testing. *Econom* 55.

Fadare (2010) Recent banking sector reforms and economic growth in Nigeria. *Middle Eastern Financ Econ* 1: 146–160.

Foo JP (2005) Have banking and financial reforms in transition countries been effective? *Managerial Financ* 31: 1–22.

Fuente AdL, Marin J (1996) Innovation, bank monitoring, and endogenous financial development. *J Monetary Econ* 38: 269–301.

Goldsmith RW (1969) *Financial Structure and Development*, New Haven CN: Yale Univ. Press.

Goyal A, Sarkar S (2014) The benefits and costs of financial market liberalization. *Macroecon and Financ Emerging Market Econ* 7: 205–207.

Greenwood J, Jovanovic B (1990) Financial Development, Growth, and the Distribution of Income. *J Polit Econ* 98: 1076–1107.

Gujarati D, Porter D (2009) *Basic econometrics*, New York: McGraw-Hill.

Ho S, Odhiambo N (2013) Banking Sector Development And Economic Growth In Hong Kong: An Empirical Investigation. *Int Bus Econ Res J* 12: 519–533.

Hondroyiannis G, Lolos S, Papapetrou E (2005) Financial markets and economic growth in Greece, 1986–1999. *J Int Financ Mark Inst Money* 15: 173–188.

Hsueh S-J, Hu Y-H, Tu C-H (2013) Economic growth and financial development in Asian countries: A bootstrap panel Granger causality analysis. *Econ Model* 32: 294–301.

Jalil A, Feridun M, Ma Y (2010) Finance-growth nexus in China revisited: New evidence from principal components and ARDL bounds tests. *Int Rev Econ Financ* 19: 189–195.

Johansen-Juselius (1990) Maximum Likelihood Estimation and Inference on Cointegration-With Applications to the Demand for Money. *Oxf Bull Econ Stat* 51: 169–210.

Johnson S, Kwak J (2009) Finance: Before the Next Meltdown. *Democracy* 19–24.

Johnson S, Kwak J (2012) Is Financial Innovation Good For The Economy? In: Lerner J and Scott Stern (eds), *Innovation Policy and the Economy*, USA: University of Chicago Press, 1–15.

Jung WS (1986) Financial Development and Economic Growth: International Evidence. *Econ Dev Cult Change* 34: 333–346.

Kar M, Nazlıoğlu Ş, Ağır H (2011) Financial development and economic growth nexus in the MENA countries: Bootstrap panel granger causality analysis. *Econ Model* 28: 685–693.

Khan A (2001) Financial development and economic growth. *Macroecon dyn* 5: 413–433.

King RG, Levine R (1993a) Finance and growth: Schumpeter might be right. *Q J Econ* 108: 717–737.

King RG, Levine R (1993b) Finance entrepreneurship, and growth: theory and evidence. *J Monetary Econ* 32: 513–542.

Kjosevski J (2013) Banking Sector Development and Economic Growth in Central and Southeastern Europe Countries. *Transition Stu Rev*19: 461–473.

Koetter M, Wedow M (2010) Finance and growth in a bank-based economy: Is it quantity or quality that matters? *J Int Money Finan* 29: 1529–1545.

Kwiatkowski D, Phillips P, Schmidt P, et al. (1992) Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? *J Econom* 54: 159–178.

Kyophilavong P, Uddin GS, Shahbaz M (2016) The Nexus between Financial Development and Economic Growth in Lao PDR. *Globl Bus Rev* 17: 303–317.

Laeven L, Levine R, Levine R (2014) Financial Innovation and Endogenous Growth. Stanford University.

Law SH, Singh N (2014) Does too much finance harm economic growth? *J Bank Financ* 41: 36–44.

Levine R, Zervos S (1998) Stock Markets, Banks, and Economic Growth. *Am Econ Rev* 88: 537–558.

Levine R, Zervos S (1999) *Stock markets, banks, and economic growth*, The World Bank.

Liang Q, Jian-Zhou T (2006) Financial development and economic growth: Evidence from China. *China Econ Rev* 17: 395–411.

Lin JY, Sun X (2009) Banking structure and economic growth: Evidence from China. *Frontiers Econ China* 4: 479–504.

Merton RC (1992) Financial Innovation and Economic Performance. *J Appl Corporate Financ* 4: 12–24.

Mhadhbi K (2014) Financial Development and Economic Growth: A Dynamic Panel Data Analysis. *Int J Econ Financ Management* 2: 48–58.

Mhadhbi K, Terzi C, Bouchrika A (2017) Banking sector development and economic growth developing countries: A bootstrap panel Granger causality analysis. 1–21.

Michalopoulos S, Laeven L, Levine R (2009) Financial innovation and endogenous growth. NBER Working Paper No. 15356.

Michalopoulos S, Laeven L, Levine R (2011) Financial Innovation and Endogenous Growth. USA: National Bureau of Economic Research 1–33.

Miller MH (1986) Financial Innovation: The Last Twenty Years and the Next. *J Financ Quantity Analysis* 10: 12–22.

Mlachila M, Park SG, Yabara M (2013) Banking in subSaharan Africa: the macroeconomic context. *Intl Monetary Fund* 25–40.

Moradi ZS, Mirzaeenejad M, Geraeenejad G (2016) Effect of Bank-Based or Market-Based Financial Systems on Income Distribution in Selected Countries. *Procedia Econ Financ* 36: 510–521.

Motsatsi JM (2016) Financial Sector Innovation and Economic Growth in the Context of Botswana. *Int J Econ Financ* 8: 291–300.

Mukhopadhyay B, Pradhan RP, Feridun M (2011) Finance-growth nexus revisited for some Asian countries. *Appl Econ Lett* 18: 1527–1530.

Mwinzi DM (2014) The Effect of Finanical Innovation on Economic Growth in Kenya. Kenya: University of Nairobi.

Naceur SB, Ghazouani S (2007) Stock markets, banks, and economic growth: Empirical evidence from the MENA region. *Res Int Bus Financ* 21: 297–315.

Narayan PK (2004) *Reformulating Critical Values for the Bounds F-statistics Approach to Cointegration: An Application to the Tourism Demand Model for Fiji*, Australia: Monash University 1–40.

Narayan S, Narayan PK (2005) An empirical analysis of Fiji's import demand function. *J Econ Stud* 32: 158–168.

Ndlovu G (2013) Financial Sector Development and Economic Growth: Evidence from Zimbabwe. *Int J Econ Financ Issues* 3: 435–446.

Nyasha S, Odhiambo NM (2014) Bank-based financial development and economic growth. *J Financ Econ Policy* 6: 112–132.

Nyasha S, Odhiambo NM (2015) Banks, stock market development and economic growth in South Africa: a multivariate causal linkage. *Appl Econ Lett* 22: 1480–1485.

Nyasha S, Odhiambo NM (2016) Banks, Stock Market Development and Economic Growth in Kenya: An Empirical Investigation. *J Afr Bus* 18: 1–23.

Obradović S, Grbić M (2015) Causality Relationship between Financial Intermediation by Banks and Economic Growth: Evidence from Serbia. *Prague Econ Pap* 24: 60–72.

Odhiambo NM (2010) Finance-investment-growth nexus in South Africa: an ARDL-bounds testing procedure. *Econ Change Restructuring* 43: 205–219.

Odularu GO, Okunrinboye OA (2008) Modeling the impact of financial innovation on the demand for money in Nigeria. *Afr J Bus Management* 3: 39–51.

Centre for Co-operation with Economies in Transition (2002) OECD economic surveys: the Russian Federation. Organisation for Economic Co-operation and Development.

Pahlavani M, Wilson E, Worthington AC (2005) Trade-GDP nexus in Iran: An application of the autoregressive distributed lag (ARDL) model. Faculty of Commerce-Papers 144.

Panopoulou E (2009) Financial variables and euro area growth: a non-parametric causality analysis. *Econ Model* 26: 1414–1419.

Patrick HT (1966) Financial development and economic growth in underdeveloped countries. *Econ Dev Cult Change* 14: 174–189.

Pesaran HH, Shin Y (1998) Generalized impulse response analysis in linear multivariate models. *Econ Lett* 58: 17–29.

Pesaran MH, Shin Y, Smith RJ (2001) Bounds testing approaches to the analysis of level relationships. *J Appl Econ* 16: 289–326.

Petkovski M, Kjosevski J (2014) Does banking sector development promote economic growth? An empirical analysis for selected countries in Central and South Eastern Europe. *Ekon Istraž* 27: 55–66.

Phillips PCB, Perron P (1988) Testing for a unit root in time series regression. *Biometrika* 75: 335–346.

Plosser C (2009) Financial Econometrics, Financial Innovation, and Financial Stability. *J Financ Econom* 7: 3–11.

Pradhan RP, Arvin BM, Norman NR, et al. (2014a) Does banking sector development affect economic growth and inflation? A panel cointegration and causality approach. *Appl Financ Econ* 24: 465–480.

Pradhan RP, Arvin MB, Hall JH, et al. (2014b) Causal nexus between economic growth, banking sector development, stock market development, and other macroeconomic variables: The case of ASEAN countries. *Rev Financ Econ* 23: 155–173.

Pradhan RP, Tripathy S, Chatterjee D, et al. (2014c) Development of banking sector and economic growth: the ARF experience. *Decis* 41: 245–259.

Pradhan RP, Tripathy S, Pandey S, et al. (2014d) Banking sector development and economic growth in ARF countries: the role of stock markets. *Macroecon Financ Emerging Market Econ* 7: 208–229.

Qamruzzaman M, Jianguo W (2017) Financial innovation and economic growth in Bangladesh. *Finanl Innovation* 3: 19.

Rana RH, Barua S (2015) Financial Development and Economic Growth: Evidence from a Panel Study on South Asian Countries. *Asian Econ Financ Rev* 5: 1159–1173.

Saad W (2014) Financial Development and Economic Growth: Evidence from Lebanon. *Int J Econ Financ* 6.

Sami J (2013) Remittances, Banking Sector Development and Economic Growth in Fiji. *Int J Econ Financ Issues* 3: 503–511.

Saqib N (2015) Review Of Literature On Finance-Growth Nexus. *J Appl Financ Bank* 5: 175–195.

Schumpeter J (1911) *The Theory of Economic Development,* Cambridge: Harvard University Press.

Shahbaz M, Rehman IU, Muzaffar AT (2015) Re-Visiting Financial Development and Economic Growth Nexus: The Role of Capitalization in Bangladesh. *South Afr J Econ* 83: 452–471.

Shan J, Morris A (2002) Does Financial Development 'Lead' Economic Growth? *Int Rev Appl Econ* 16: 153–168.

Shin Y, Yu B, Greenwood-Nimmo M (2014) Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework, *Festschrift in Honor of Peter Schmidt*, Springer, New York, NY, 281–314.

Sibindi AB, Bimha A (2014) Banking Sector Development and Economic Growth: Evidence from Zimbabwe. *Banks Bank Systems* 9: 51–58.

Singh T (2008) Financial development and economic growth nexus: a time-series evidence from India. *Appl Econ* 40: 1615–1627.

Smith A (1937) The wealth of nations [1776].

Solow R (1956) A Contribution to the Theory of Economic Growth. *Q J Econ* 70: 65–94.

Sood V, Ranjan P (2015) Financial Innovation in India: An Empirical Study. *J Econ Bus Rev* 10: 1–20.

Suleiman MS (2013) Microfinance Banks and their Impact on Small and Medium Scale Industries for Economic Growth. 48–52.

Valverde SC, Paso RL, Fernández FR (2016) Financial innovation in Banking: Impact on Regional Growth. *J Dev Econ* 10: 1–40.

Verheyen F (2013) Interest rate pass-through in the EMU–new evidence using the nonlinear ARDL framework. *Econ Bull* 33: 729–739.

Wachtel P (2003) How much do we really know about growth and finance. *Federal Res Bank Atlanta Econ Rev* 33–47.

Wait C, Ruzive T, le Roux P (2017) The Influence of Financial Market Development on Economic Growth in BRICS Countries. *Int J Management Econ* 53.

World Bank (2017) World Development Indicators. Available from: http://data.worldbank.org/data-catalog/world-development-indicators.

World Economic Outlook (2017) World Economic Outlook (WEO) data, IMF.

Zaman K, Izhar Z, Khan MM, et al. (2012) RETRACTED: The relationship between financial indicators and human development in Pakistan. *Econ Model* 29: 1515–1523.

Zang H, Kim YC (2007) Does financial development precede growth? Robinson and Lucas might be right. *Appl Econ Lett* 14: 15–19.

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