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The influences of Interest rate volatility on banking sector development: Evidence from cross countries in the MENA region

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This study investigates the dynamic relationship between a set of banking sector development indicators and interest rate volatility for 12 emerging market countries during the period of 1980-2019. For this purpose, the bounds testing within autoregressive distributed lag (ARDL) methodology is employed. The empirical results reveal that the interest rate volatility has negative impacts on the majority of the banking sector development indicators which also play a significant role in dampening the banking sector development path in the long-run. These findings suggest that the banking sectors of emerging countries are vulnerable to interest rate risks. Thus, the results have important implications for policymakers to improve the banking system and to promote economic growth of emerging economies.

1. Introduction

There is no doubt about the leading role of the banking sector in the economy. A sound banking sector is an essential and inextricable part of economic development. The financial development literature has emphasized that the countries with well-developed banking institutions tend to enjoy superior economic growth (see King & Levine 1993; Levine & Zervos 1998; Beck, Levine, & Loayza 2000; Levine, Loayza, & Beck 2000; Levine 2005, among others). The interest rate is one of the key macroeconomic factors that is strongly associated with banking sector development as well as with economic growth. The interest rates can affect the banking sector in several contradictory manners. In fact, an increase in the deposit interest rates leads investors to switch their money from other investment instruments towards bank deposits that augment the ability of the banking sector in financing economic activities. In contrast, increasing the deposit interest rates raises the cost of banks' excess reserves which lead to hike lending interest rates and slow down the investment activity in the economy and vice versa (Alam & Uddin 2009). Therefore, interest rate movements affect the volume of banking transactions, and thus, the level of the banking sector development. Mankiw (1986) illustrated that the quality of the banks' credit portfolio can also be affected by the interest rate volatility; increase in the lending interest rate leads to reductions in the demand for credit from high-quality creditors while at the same time will mount the requested credit from the low-quality creditors. This could initiate an adverse selection for the banks with undesirable impacts on their market value. Therefore, theoretically, interest rate volatility could limit the vital role of the banking sector in promoting economic growth.

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The influences of the level of interest rates and their volatilities on the banking industry have been widely investigated in the financial literature from various perspectives. For instance, the banking sector can be affected by the sensitivity of their assets and liabilities to interest rate fluctuations. Indeed, such effects could be exacerbated because of the duration mismatch of the banking assets and liabilities (Joseph and Vezos 2006; Papadamou and Siriopoulos 2014). Moreover, the costs and revenues of financial institutions significantly rely on interest rates. As a result, fluctuations of interest rate could affect the banking sector through the channels of costs and revenues (Sounders & Yourougou, 1990; Tripathi & Ghosh, 2012). Also, frictions in the credit markets may cause interest rate volatility which in turn affects the performance of the banking sector adversely (Huybens & Smith 1999).

In recent decades, the fluctuations of interest rates have been observed reflecting the updates of the financial environment such as the shifts in the regimes of the monetary policies, financial innovations and integration of financial markets (Elyasiani & Mansur, 1998). Therefore, this study aims to investigate the impacts of interest rate volatility on the banking sector development (BSD) indicators in emerging countries. There are several reasons behind selecting emerging economies: in the past few decades, the majority of emerging countries embarked on implementing financial liberalization programs as a step to reform their financial sectors. Deregulation of interest rates was one of the requirements of these programs which led to interest rate fluctuations. However, revitalization of the financial sectors accelerated the banking industry development which contributed to economic growth. Moreover, the financial systems of these countries are bank-based, which means that the banking sectors play a vital role in their economies (see Demirgü-Kunt and Levine 2001, 81-140). Therefore, investigating the impacts of interest rate fluctuations on the BSD is a serious matter for the monetary policy designers, especially in emerging economies where this topic is under-researched.

The rest of this article is organized as follows: the literature review is presented in section 2. This is followed by data description and analytical framework in section 3. The econometric methodology is presented in section 4. The empirical findings of the study were reported in Section 5. Finally, the study's conclusions and implications for policy makers are presented in section 6.

2. Literature review

The impacts of interest rate volatility on thebanking institutions have been investigated in a massive number of studies fromvarious perspectives. The majority of those studies have been designed toexamine the relationship between interest rate volatility and bank stockreturns. The empirical results of this strand of literature provide an evidenceof a negative association between market stock returns and the interest ratefluctuations (see Campbell 1987; Yourougou 1990; Zhou 1996; Elyasiani &Mansur 1998; Harasty & Rouet 2000; Joseph & Vezos 2006; Alam &Uddin 2009; Kasman, Vardar, & Tunç 2011; Tripathi & Ghosh2012; Papadamou & Siriopulos 2014; Al-Gasaymeh, et al., 2020; Al-Gasaymeh,et al., 2022a; Al-Gasaymeh, et al., 2022b). For instance, Elyasiani and Mansur(1998) investigated the sensitivity of the US banking stock returns to changesin the interest rate and its volatility for the period of 1970-1992 byemploying an autoregressive conditional heteroscedasticity in mean (GARCH-M)model. Their empirical findings showed that the long-term interest rate has asignificant reverse effect on stock market returns. In addition, volatility ofthe interest rate was found to be the primary source of the banking stock returnsvariations. Hsing (2004) found a negative relationship among interest rate and stockprices in Brazil by using the structural vector autoregressive (SVAR)model. Alam and Uddin (2009) examinedthe relationship between interest rate volatility and banks' stock returns in15 developed and developing countries. They employed both time seriestechniques and panel data analysis of monthly data for the period of 1998-2003.Their findings revealed a negative and significant association between marketstock returns and interest rate volatility. Kasman, Vardar, and Tunç (2011)analyzed the dual impact of interest and exchange rate fluctuations on thestock market returns of the Turkish banks during 1999-2009. The authors usedboth GARCH models and ordinary least squares (OLS) estimation methods. Theiroutcomes provided evidence for the sensitivity of the Turkish banking stockreturns to the interest rate volatility. Their findings indicated that theinterest rate volatility was the key determinant of the stock market volatilitywhich were compatible with those of Elyasiani and Mansur (1998). On the otherhand, Simpson and Evans (2003) employed the cointegration technique to testfor the long-run association between interest rate, a set of macroeconomicvariables and the stock returns of the Australian banks. They reported noevidence for the presence of a co-integration relationship between both short-and long-term interest rates and the banks' stock returns.

Naveed (2015) examined the impact of monetary policy shocks, measured by interest rate, on the Pakistani banking system for the period of 2009-2013 using the VAR approach as well as other econometric methods. He reported the significant impact of monetary policy shocks on the conventional banks while observing the reverse for the case of non-conventional banks. Borio, Gambacorta, and Hofmann (2015) investigated the influence of monetary policy, represented by short-term interest rate, on the banking profitability in 14 developed economies during 1995-2012. Their results indicated a positive relationship between interest rate changes and banking performance. They argued that the shape of the relationship between short-term interest rate and banks interest income (bank's profitability) is concavely implying that the changes in interest rate have a stronger effect when it is approaching zero. Moreover, Mushtaq and Siddiqui (2017) examined the relationship between the bank deposits and real interest rate during 1999-2014. They employed annual time series data for 23 Islamic and 23 non-Islamic countries. The results of the panel ARDL approach provided evidence for insensitivity of banking sector deposits to interest rate changes especially in Islamic countries. In contrast, the impacts of interest rates become positive and significant on the banking sector in case of non-Islamic countries. However, earlier studies showed no strong support for such a relationship. For example, Flannery (1981) examined the influences of interest rate fluctuations on profitability of the US banks using linear regression analysis. He found no significant relationship between interest rate fluctuations and banking performance. He attributed this result to good risk management practices of the banks based on maturity analysis of their assets and liabilities. Another study for Flannery (1983) (you forgot to add this study in the reference list) concluded that the costs and revenues of the large size banks were insensitive to the market interest rate changes. Also, Mitchell (1989) (this study has not been added to the reference list) developed models to analyze banks' exposure to interest rate risk during the period of 1976-1983. His conclusions indicated negligible effects of interest rate volatility on the banking sector attributing this finding to active risk management strategies adopted by banks.

Regarding the relationship between interest rate volatility and banking sector development (BSD), Hajilee, Al Nasser, and Perez (2015) argued that their study is the first to investigate this nexus. Their results indicated a negative association between interest rate volatility and BSD in most of the developing countries. However, the relationship is observed to be insignificant in Malaysia and Indonesia. The study employed liquid liabilities to GDP as an indicator of BSD. This indicator is defined as "a measure of financial depth and the overall size of the financial sector without distinguishing among the financial sectors or the use of liabilities" (Beck, Demirgüç-Kunt, and Levine 2001, 22). Moreover, Pradhan et al. (2014b) have defined the BSD as "a process of improvements in the quantity, quality, and efficiency of banking services". In addition, they explained that the BSD process contains many mutual-action activities that in turn cannot be captured by a single indicator. This point of view has been supported by many financial development economists (see for instance, Levine 1997; Levien, Loayza, and Beck 2000; Demirgüç-Kunt, and Levine 2001; Beck and Levine 2004; Pradhan et al. 2014a; Akinboade and Kinfack 2015). In line with this view, there is a need for further research to investigate the relationship between interest rate behavior and BSD, measured by comprehensive indicators. Thus, the current study attempts to fill this gap in the empirical literature in three-ways: first, we employ a set of BSD indicators and an index created by the principal component analysis (PCA) that would capture the potential impacts of all these measures. Therefore, it will extend the literature to capture the linkage between interest rates behavior and various dimensions of the banking sector development process; second, since research is scarce for emerging market economies, we cover a set of 12 emerging market countries from various regions, Middle East, Asia and South America for relatively a long time span from 1980 until 2014, including recent financial liberalization era; third, the study utilized a sophisticated econometric methodology, the bounds testing with the autoregressive distributed lag (ARDL) framework to capture both the long- and short-term impacts.

3. Data description and analytical framework

Parallel with the financial development literature, the current study adopts five various measures as BSD indicators. One of these indicators was created by the PCA to construct a comprehensive measure of BSD. The PCA is a statistical technique that converts a sequence of correlated variables to be uncorrelated variables by spectral decomposition of a covariance matrix or a correlation matrix; called principal components (see Nardo et al., 2005). This indicator is labeled "*Index*", henceforth, will be referred to as one of the BSD indicators. The composite index will be a reliable measure reflecting the different dimensions of the banking sector development. Also, we adopt four of the widely-used measures of banking sector development, namely, banks credit provided to the private sector (*PC*), liquid liabilities (*LL*), broad money (*BM*) and bank deposits (*BD*) all of which are defined as a percent of GDP. Detailed definitions of these indicators are presented in Table 1. The sample consists of twelve emerging market countries which include Algeria, Brazil, Chile, Egypt, Indonesia, Korea, Malaysia, Mexico, Philippines, South Africa, Thailand, and Turkey[1]. The functional relationship between interest rate volatility and the banking sector development of the sampled countries is formulated as:

$$LnY_t = \alpha_0 + \beta_1 R_t + \beta_2 VR_t + \beta_3 LnGDP_t + \varepsilon_t \tag{1}$$

where, LnY_t is a measure of banking sector development in natural logarithmic form represented by (*Index*, *PC*, *LL*, *BM*, and *BD*). These measures are used alternatively. The first explanatory variable R_t is the real interest rate, which is equal to the time deposits interest rate minus the inflation rate measured by the consumer price index (CPI, base year 2010). The second variable, VR_t is a proxy for interest rate volatility which is calculated by the standard deviation (SD) of real interest rate. Finally, $LnGDP_t$ is the natural logarithm of GDP per capita (in constant 2010 dollars). This variable has been used to capture the banking-growth nexus since the development of banking sector is highly correlated with subsequent GDP per capita growth rate (Levine, 1997). The parameter, α_0 is the constant term. Other parameters to be estimated are β_1, β_2, and β_3 which are expected to be negative, either positive or negative, and positive, respectively. Equation (1) is estimated separately for each country.

The time series data is at annual frequency for the period of 1980–2019 producing 40 observations. It is worth noting that, using high-frequency data such as quarterly or monthly to increase the number of observations does not affect the robustness of the results in the co-integration analysis, whereas the time span of the sample data is ultimately the most important for the presence of a potential long-run relationship (Hakkio and Rush 1991). The data were gathered from the World Bank databank *World Development Indicators* and *Global Financial Development* Databases.

Table 1

Detailed description of the banking sector development indicators (BSDIs)

Symbol	Definitions
PC	The financial resources provided to the private sector by domestic money banks (commercial banks and other financial institutions that accept transferable deposits) as a share of GDP. The *PC* indicator can be employed to measure the growth of the banking system. Also, it is one of the most comprehensive measures of financial intermediary development and significantly superior to the other used indicators. It may indicate the degree to which the formal banking sector plays a role in the economy (Beck, Levine, & Loayza 2000; Akinboade and Kinfack 2015).
LL	The share of liquid liabilities of the financial sector to GDP. Also known as a share of M3 to GDP. This measure equals the sum of currency and demand liabilities of the financial intermediaries as a share of GDP. *LL* is a common measure of the relative size of financial intermediaries to the size of the economy, usually used as an indicator of the financial development or financial depth (King & Levine 1993; Beck, Demirgüç-Kunt, & Levine 2001).
BM	The ratio of broad money to GDP. *BM* is the sum of currency outside banks; the time, savings, and foreign currency deposits; bank and travelers checks; and other securities such as certificates of deposit and commercial paper. *BM* is one of the commonly-used indicators of the banking sector development (Pradhan et al., 2014a, 2014b).
BD	The ratio of bank deposits to GDP. Bank deposits equal the sum of demand, time, and saving deposits at domestic deposit money banks. Deposit money banks comprise commercial banks and other financial institutions that accept transferable deposits, such as demand deposits. *BD* is the relative size indicator which measures the importance of the banking sector (Beck, Demirgüç-Kunt, & Levine 2001).

Source: *World Development Indicators* and *Global Financial Development* Databases. 2020.

4. Econometric methodology

The bounds test within ARDL for co-integration approach of Pesaran, Shin, and Smith (2001) (hasn't been added to the reference list) is employed to investigate the existence of a long-term level relationship between each pair of the BSD indicators (*Index*, *PC*, *LL*, *BM*, and *BD*) and the explanatory variables (*R*, *VR*, and *LnGDP*). One of the main features of the ARDL framework is the possibility to apply it regardless of the integration order of the regressors which can be integrated at their levels, $I(0)$, integrated at their first differences, $I(1)$, or mutually co-integrated. As the first step, we estimate the following unrestricted conditional error correction model (UCECM) by the OLS method:

$$\Delta Ln\, Y_t = \phi_0 + \theta_1 Ln\, Y_{t-1} + \theta_2 R_{t-1} + \theta_3 VR_{t-1} + \theta_4 Ln\, GDP_{t-1} + \sum_{i=1}^{p} \delta_i\, \Delta Ln\, Y_{t-i} + \sum_{i=0}^{q} \eta_i\, \Delta R_{t-i} + \sum_{i=0}^{q} \omega_i\, \Delta VR_{t-i} + \sum_{i=0}^{q} \pi_i\, \Delta Ln\, GDP_{t-i} + e_t \quad (2)$$

where, Δ is the first difference operator, ϕ_0 is the constant term, θ_1, θ_2, θ_3, and θ_4 are the coefficients of one period lagged regressors at their levels, and e_t is the random error term with a zero mean and a finite covariance matrix. After estimating the UCECM of Eq. (2) *F*-tests are used to verify the possible existence of a long-term level relationship between the BSD indicators (*Index*, *PC*, *LL*, *BM*, and *BD*) and the determinants (*R*, *VR*, and *LnGDP*) for each country, separately. As presented by Pesaran, Shin, and Smith (2001) the calculated *F*-statistics should be compared with two sets of critical values. The first set of the critical values assumes that the integration order of the regressors is *I*(1), called upper bound, while the next set of critical values assumes that the regressors are *I*(0), called lower bound. The null hypothesis of no co-integration relationship is $H_0\colon \theta_1 = \theta_2 = \theta_3 = \theta_4 = 0$. The joint significance of lagged level variables provides evidence of the existence of a long-run relationship among the variables based on the following decision criteria: if the calculated value of the *F*-statistic lies above the upper bound at conventional significance levels of 0.01, 0.05, or 0.10, the H_0 will be rejected confirming the existence of a co-integration relationship. On the other hand, if the calculated value of the test statistics lies below the lower bound, the H_0 cannot be rejected; this indicates no levels relationship among the variables. In the case when the test statistics falls within the upper and the lower bounds, the test result is inconclusive and knowing the order of integration is needed. Once the bounds test of Eq. (2) affirms the existence of a long-run relationship between the underlying variables, the next step is to estimate the long-term and short-term models by employing the ARDL approach of Pesaran and Shin (1999) (it hasn't been added to the reference list). Hence, the dynamic long-term model of Eq. (1) will be estimated under the ARDL approach as presented in Eq. (3) below:

$$\Delta Ln\, Y_t = c_0 + \sum_{i=1}^{p} \psi_1 Ln\, Y_{t-i} + \sum_{i=0}^{q} \gamma_1\, R_{t-i} + \sum_{i=0}^{q} \gamma_2\, VR_{t-i} + \sum_{i=0}^{q} \gamma_3\, Ln\, GDP_{t-i} + u_t \quad (3)$$

where all the variables are as defined previously. The short-run dynamic model, under the ARDL methodology involves estimating the conditional error correction model (CECM) as presented here:

$$\Delta Ln\, Y_t = \mu_0 + \sum_{i=1}^{p} \lambda_1 \Delta Ln\, Y_{t-i} + \sum_{i=0}^{q} \vartheta_1\, \Delta R_{t-i} + \sum_{i=0}^{q} \vartheta_2\, \Delta VR_{t-i} + \sum_{i=0}^{q} \vartheta_3\, \Delta Ln\, GDP_{t-i} \; + \vartheta_4 u_{t-1} + \nu_t \tag{4}$$

where, μ_0 is a constant term. λ_1, ϑ_1, ϑ_2, and ϑ_3 are the short-term coefficients to be estimated, u_{t-1} is the one period lagged error correction term (ECT), which was estimated from equation (3) and ϑ_4 is the estimated coefficient of the ECT with an expected sign to be negative and statistically significant. Our expectation about the sign of ϑ_2 is to be negative reflecting the adverse relationship between interest rate volatility and BSD indicators in the short-term. Since the ARDL methodology is highly sensitive to the number of lags (p, q, q, and q), we employed the Schwartz-Bayesian criteria (SBC) through the estimation procedures of equations (2, 3, and 4) to select the optimum lag length.

5. Empirical findings

Although, the ARDL approach does not require any of pretesting procedures to recognize the integration order of the variables, we employed the Zivot-Andrews (Z-A) unit root test of Zivot and Andrews (1992) to ascertain that none of the variables were integrated of order two $I(2)$ and that the regressand was integrated of order one $I(1)$. The findings shows that, "*Index*", *LnPC*, *LnLL*, *LnBM*, *LnBD*, and *LnGDP* are nonstationary at their levels but become stationary at their first differences. However, *R* and *VR* are found to be stationary at their levels[2].

The bounds test of Eq. (2) was estimated under three different scenarios for the specification of the deterministic components. These include (i) unrestricted intercept and no trends (F_{III}); (ii) unrestricted intercept and restricted trends (F_{IV}); and (iii) unrestricted intercept and unrestricted trends (F_V). In other words, the intercept values were unrestricted in all of the scenarios ($a_0 \neq 0$), (refer to Pesaran, Shin, and Smith 2001, 295-296). Compatible with the original paper of Pesaran, Shin, and Smith (2001) the calculated F-statistics are presented in panel A of Table 2. In panel A three lower letters (a, b, and c) were printed beside each one of calculated F-statistics to indicate the test results. Every letter indicates the possibility of rejecting the null hypothesis of no level relationship among the variables based on the decision criteria presented in the econometric methodology part. The first letter, (a) indicates that the test statistic lies below the corresponding critical value of lower bound, which means that there is not enough evidence for the existance of a level relationship among the variables since one cannot reject the H_0 and thus there is no need to estimate an ARDL level relationship model. The second letter, (b) indicates that the test statistic lies within upper and lower bounds indicating that inference is inconclusive and knowing the integration order of the variables is needed. The last letter, (c) shows that the test statistic lies above the upper bound critical values for at least one of the scenarios ($F_{III,}$ F_{IV} and F_V) of the bounds test. This case provides strong evidence for an existing level relationship among the variables since the null hypothesis of no level relationship is rejected and thus proceeding to estimate the ARDL level relationship is possible. The corresponding upper and lower bound critical values originally derived by Narayan (2005) for small samples of 30 – 80 observations are reported in panel B of Table 2. The results presented in Table 2 revealed that, for each country there is at least one or more of the BSD indicators (*Index*, *PC*, *LL*, *BM*, and *BD*) that has a level relationship with the explanatory variables (*R*, *VR*, and *LnGDP*). For example, all of the BSD indicators of Indonesia have a level relationship with the explanatory variables since the H_0 of no level relationship is rejected for at least one of the bounds test scenarios. In contrast, for Korea there was only one of the BSD indicators that had a level relationship with the explanatory variables which is "*Index*" since the null hypothesis of no level relationship is rejected at all scenarios of the bounds tests. The results are considered as permission to estimate the level relationship model of Eq. (3) for each variable that affirm the existence of a level relationship with the determinants. It is worth noting here that the banking sector development index which is created by PCA has a level relationship with the explanatory variables for all the sampled countries except Egypt. Thus, we can conclude that the created "*index"* is able to be a superior measure of the banking sector development compared to the individual measures.

Based on the bounds test results, we proceed to estimate the long-term level relationship model under the ARDL approach of Pesaran and Shin (1999) presented in Eq. (3) for each one of the BSD indicators that has a level relationship with the regressors and for each country, separately. The outcomes of the level relationship were presented in Table 3. The estimated $\hat{\gamma}_1$, the coefficient of *R* in Eq. (3) reflects the relationship between real time deposit interest rate and BSD indicators. The nature of this relationship strongly depends on the used BSD measure, which shows varying results in the direction of the impact. When "*Index*" is used as a measure of BSD, only three negative and significant relationships are observed between real time deposit interest rate and banking sector development in cases of Brazil, Chile, and Philippines. However, the estimated coefficient of Brazil is negligibly small. On the other hand, banking deposit to GDP as an indicator of BSD yields positive and significant estimates in cases of Indonesia, Malaysia, Mexico, South Africa, and Turkey. This result implies that higher real deposit interest rates attract more deposits to the banking system which improves the ability of banks to lend more money to businesses, thus growing the level of BSD. For instance, the highest value for this parameter is estimated to be 0.0786 in Malaysia meaning that 1% change in *R* will lead to 7.86% change in *BD* in the same direction. The lowest impact of this indicator is 0.0128 for Mexico. Some other BSD indicators have also significant and positive impacts such as *PC* in case of Brazil, Chile, Egypt, and Indonesia.

Table 2

The bounds test *F*-statistics and its corresponding critical values

Panel A: The *F*-statistics for testing the existing of a level relationship.

BSDIs	Country	F_{IV}	F_V	F_{III}	Country	F_{IV}	F_V	F_{III}
Index	Algeria	3.967[b]	4.254[b]	5.130[c]	Malaysia	5.447[c]	6.775[c]	7.149[c]
PC		5.070[c]	6.254[c]	3.057[b]		3.123[a]	3.453[a]	2.565[a]
LL		3.000[a]	3.716[a]	1.314[a]		4.872[c]	6.086[c]	5.990[c]
BM		3.388[b]	4.177[b]	2.186[a]		2.509[a]	3.101[a]	3.255[b]
BD		3.413[b]	4.240[b]	1.561[a]		4.541[c]	5.669[c]	5.377[c]
Index	Brazil	6.519[c]	7.045[c]	7.473[c]	Mexico	4.605[c]	5.579[c]	5.775[c]
PC		5.065[c]	6.218[c]	5.319[c]		0.75[a]	0.874[a]	0.764[a]
LL		1.590[a]	0.569[a]	2.079[a]		4.299[c]	5.342[c]	5.478[c]
BM		4.205[c]	5.119[c]	5.429[c]		5.344[c]	6.399[c]	6.474[c]
BD		8.306[c]	10.365[c]	4.478[c]		4.295[c]	5.251[c]	5.595[c]
Index	Chile	8.952[c]	10.697[c]	11.403[c]	Philippines	3.305[b]	3.621[a]	4.175[c]
PC		6.518[c]	8.075[c]	8.191[c]		3.642[b]	4.156[b]	4.149[c]
LL		2.147[a]	2.664[a]	2.426[a]		1.469[a]	1.652[a]	1.641[a]
BM		0.989[a]	1.228[a]	1.235[a]		3.000[a]	3.121[a]	3.731[b]
BD		3.174[a]	3.790[a]	3.494[b]		2.262[a]	2.606[a]	2.467[a]
Index	Egypt	2.293[a]	2.603[a]	3.009[b]	South	3.708[b]	4.133[b]	4.329[c]
PC		9.644[c]	11.91[c]	11.796[c]	Africa	4.051[b]	4.614[b]	5.226[c]
LL		1.800[a]	1.798[a]	2.362[a]		2.600[a]	2.810[a]	2.173[a]
BM		3.564[b]	3.308[a]	4.597[c]		1.119[a]	1.303[a]	1.442[a]
BD		1.652[a]	1.120[a]	2.152[a]		3.407[b]	3.091[a]	4.434[c]
Index	Indonesia	7.205[c]	8.745[c]	8.793[c]	Thailand	13.754[c]	10.192[c]	2.234[a]
PC		14.063[c]	14.608[c]	5.098[c]		2.031[a]	2.532[a]	0.798[a]
LL		7.1823[c]	3.203[a]	6.212[c]		11.408[c]	5.795[c]	14.650[c]
BM		6.143[c]	3.667[a]	6.194[c]		5.317[c]	3.542[a]	6.562[c]
BD		9.305[c]	5.808[c]	4.390[c]		10.804[c]	5.515[c]	13.654[c]
Index	Korea	11.082[c]	13.657[c]	14.325[c]	Turkey	3.221[a]	3.946[b]	4.139[c]
PC		0.733[a]	0.688[a]	0.841[a]		1.295[a]	0.204[a]	1.675[a]
LL		1.477[a]	1.767[a]	1.123[a]		4.482[c]	5.504[c]	5.809[c]
BM		1.614[a]	1.703[a]	1.828[a]		2.583[a]	3.218[a]	3.358[c]
BD		2.030[a]	2.529[a]	0.817[a]		3.692[b]	4.588[b]	4.784[c]

Panel B: Critical values for bounds testing approach as taken from Narayan (2005).

	0.10		0.05		0.01	
K = 3	*I* (0)	*I* (1)	*I* (0)	*I* (1)	*I* (0)	*I* (1)
F_{III}	2.958	4.100	3.615	4.913	5.198	6.845
F_{IV}	3.290	4.176	3.936	4.918	5.654	6.926
F_V	3.800	4.888	4.568	5.795	6.380	7.730

Notes: F_{IV}, F_V and F_{III} represent the *F*-statistics of the model with unrestricted intercepts and restricted trends, unrestricted intercepts and trends, and unrestricted intercepts and no trends, respectively. a, b, and c indicate that the test statistics lie below the lower bound, within the upper and lower bounds, and above the upper bound, respectively.

Regarding the relationship between interest rate volatility and BSD indicators as presented in the same Table 3, the estimated coefficients of *VR*, $\hat{\gamma}_2$, provide evidence for a negative significant relationship between at least one measure of BSD indicators and interest rate volatility for Algeria, Brazil, Indonesia, Mexico, Philippines, South Africa, Thailand, and Turkey. In the case of Algeria, Indonesia, and South Africa, this significant negative relationship was observed for "*Index*" as the dependent variable, while for other countries some other indicators have also entered the equation estimates as important dependent variables. For instance, in Mexico 1% increase in interest rate volatility led to 2.93% fall in the ratio of bank deposits to GDP as a measure of BSD. Also, it should be noted that the impact of interest rate volatility is the highest for Indonesia and Philippines. On the other hand, the BSD of Chile, Korea, and Malaysia are evidenced to be insensitive to interest rate fluctuations. Moreover, the values of $\hat{\gamma}_3$, the estimated coefficient of *LnGDP*, was positive and statistically significant for the majority of the sampled countries, Brazil, Chile, Egypt, Indonesia, Malaysia, Mexico, Philippines, South Africa, and Thailand. This result reflects the positive relationship between banking sector development and economic growth in these economies. The comprehensive measurement of the banking sector development, "Index", observed to be positive and highly significant in all of these countries except in Egypt, Mexico, and Philippines. The magnitude of the estimated values of $\hat{\gamma}_3$ observed to be relatively high when the "Index" used as a measure of BSD, the highest value is recorded to be 12.25 in case of South Africa, while the lowest value is 1.90 in case of Chile. Significant large positive values for $\hat{\gamma}_3$ indicate high sensitivity of the banking sector development to the GDP growth rate. This implies that degree of the banking sector development is elastic and very responsive to the changes in the level of economic growth in the emerging economies. Some other used BSD indicators have also positive and significant association with the economic growth as in Egypt, Mexico, and Philippines. However, there is not enough evidence for the direction of the relationship between the BSD indicators and economic growth when the indicator "Index" is used as the dependent variable in cases of Algeria, Korea, and Turkey.

The variations in our results may be partially attributed to the association between used indicators and the characteristic of the respective countries. These characteristic include differences in the banking sector structure and/or the banking regulations. Beck, Levine, and Loayza (2010) have illustrated that "the cross-country studies are subject to biases and variations in findings. These variations might be because of the differences in the accounting standards, as well as the differences in the degrees of measurement quality among the countries"

The estimates for the short-term dynamic relationship between the BSD indicators and *VR* are reported in Table 4. Here we focus on the estimated value of $\hat{\vartheta}_3$, the coefficient of *VR* in the CECM of Eq. (4). The outcomes confirmed the negative association between BSD indicators and the interest rate volatility in the short-run for all sampled countries. Each country, at least has one negative and significant short-term coefficient of *VR*. These results are strongly compatible with the long-term estimates presented in Table 3. Moreover, the one period lag of the ECT (u_{-1}) was negative and statistically highly significant in all the estimated models. The negative and statistically significant ECT coefficient provided a further evidence of a long-term feedback amongst the variables that were presented in Eq. (1). In addition, the estimated values of $\hat{\vartheta}_4$, the coefficient of the ECT (u_{t-1}) in equation (4) is recorded to be between -1 and -2 in four cases. These are in Brazil when "*Index*" and *BM* are the BSD indicators, in Korea when "*Index*" is the BSD indicator, and in Indonesia when *BM* was the dependent variable. It is interesting to provide an interpretation for those values which means the ECT produces dampened movements in the equilibrium path of the banking development.

Table 3
Level relationship estimations under the ARDL approach

Country	BSDIs	$\hat{c}_0$		$\hat{\gamma}_1$		$\hat{\gamma}_2$		$\hat{\gamma}_3$	
Algeria	*Index*	8.5311**	(2.0548)	0.0063	(0.9951)	-0.0765**	(2.3935)	-1.0047***	(2.0252)
	PC	-134.9038	(0.3040)	15.1454	(0.3016)	-0.2146	(0.0129)	169.4616	(0.3046)
Brazil	*Index*	-22.9857*	(5.7576)	-0.0001*	(6.0697)	-0.0002*	(7.8140)	2.6289*	(5.8177)
	PC	-26.8824	(1.5189)	0.0006*	(2.7572)	-0.0004***	(1.7643)	3.4198***	(0.0972)
	BM	10.1374	(1.6783)	-0.0003***	(1.7686)	0.0008*	(3.4424)	-0.8844	(1.2907)
	BD	25.6125**	(2.7278)	-0.0002**	(2.1469)	0.0002***	(2.0194)	-2.5889**	(2.4484)
Chile	*Index*	-18.1234*	(3.8567)	-0.1080**	(2.4943)	0.1154	(1.5656)	1.9085*	(3.9097)
	PC	-4.3476**	(2.3595)	0.0375***	(1.9319)	-0.0284	(0.8158)	0.9152*	(4.7261)
Egypt	*PC*	-28.472*	(4.4583)	0.1157*	(9.5544)	0.1597*	(5.4138)	4.5025*	(5.0126)
	BM	46.071	(0.3861)	-0.0057	(0.1741)	-0.6132	(0.3712)	-5.5834	(0.3473)
Indonesia	*Index*	-62.623***	(1.9624)	0.0159	(0.2738)	-1.1164*	(2.8162)	9.9249**	(2.0818)
	PC	-17.0605*	(4.5129)	0.0369*	(4.7489)	0.0200	(1.2178)	2.8281*	(5.1974)
	LL	-20.5043**	(2.0649)	0.0264***	(1.7575)	0.0543**	(2.5700)	3.4308**	(2.3940)
	BM	25.2097**	(2.2090)	0.0872*	(5.0203)	0.1060**	(2.6138)	-3.2505***	(1.9243)
	BD	-13.7060	(1.6337)	0.0480**	(2.2441)	0.0175	(0.6438)	2.4732**	(2.0612)
Korea	*Index*	0.8133	(1.1118)	-0.0047	(1.0109)	0.0036	(0.5936)	-0.0921	(0.2900)
Malaysia	*Index*	-36.0074*	(3.2981)	0.4330***	(1.8202)	-0.4116	(1.0534)	4.1593*	(3.5379)
	LL	1.4622	(1.0976)	0.0402	(1.4026)	-0.0402	(0.8321)	0.3766**	(2.6232)
	BD	9.2593*	(3.9030)	0.0786*	(3.0302)	-0.0196	(0.4984)	-0.6414**	(2.2244)
Mexico	*Index*	-139.3809	(1.1079)	2.1115	(1.2631)	3.4767	(1.2243)	154.3614	(1.1035)
	LL	-4.6181	(0.5390)	0.0105**	(2.4707)	-0.0235*	(3.7897)	0.9248	(0.9597)
	BM	-36.0397*	(3.7970)	0.0161*	(4.1680)	0.0160***	(1.8395)	4.3985*	(4.0958)
	BD	-1.5602	(0.1347)	0.0128**	(2.2075)	-0.0293*	(3.4241)	0.5670	(0.4357)
Philippines	*Index*	25.5026	(1.0179)	-0.3560**	(2.1712)	-0.6044**	(2.5991)	-3.1953	(0.9221)
	PC	3.9288*	(2.9289)	-0.1192*	(2.9825)	-0.4095*	(6.5717)	3.9288*	(2.9289)
South Africa	*Index*	-107.581*	(4.0255)	0.1719**	(2.5302)	-0.2612***	(1.8436)	12.2529*	(4.0626)
	BD	-11.9048*	(5.4892)	0.0353*	(5.6662)	0.0012	(0.0945)	1.8034*	(7.1084)
Thailand	*Index*	-32.6341*	(2.8958)	0.0076	(0.0787)	-0.3105**	(2.3880)	4.4694*	(2.9384)
	LL	2.7352	(0.8586)	-0.0150	(0.5467)	-0.0895**	(2.2268)	0.2891	(0.6786)
	BD	2.0155	(1.2497)	-0.0033	(0.1416)	-0.0527	(1.5853)	0.3358	(1.7734)
Turkey	*Index*	-0.9925	(0.4709)	0.0100**	(2.0447)	0.0210	(1.5253)	0.0772	(0.3363)
	LL	19.2758**	(2.2904)	0.0174*	(4.0327)	-0.0133	(1.4266)	-1.9104***	(1.9516)
	BM	58.8591*	(3.3804)	0.0014	(0.3807)	-0.0482*	(3.3093)	-6.5349*	(3.2014)
	BD	30.2410*	(2.5451)	0.0190*	(3.3888)	-0.0270***	(1.9671)	-3.2029**	(2.3205)

Notes: $\hat{c}_0$ is a constant. $\hat{\gamma}_1$, $\hat{\gamma}_2$, and $\hat{\gamma}_3$ are the coefficients of *R*, *VR*, and *LnGDP* in Eq. (3), respectively. *, ** and *** denote the significance level of 0.01, 0.05 and 0.10, respectively. Absolute *t*-statistics are presented between the parentheses.

In other words, instead of the directly monotonically converging to the equilibrium path of the banking sector development, the error correction process fluctuates around the long-run equilibrium in a dampening way, or it suggests oscillatory convergence (see Loayza & Ranciere 2005; Narayan & Smyth 2006). In contrast, the majority of the remaining ECT estimations have small negative values, relatively. The small magnitude of the estimated ECT indicates sluggishness in the converging system; the banking sector development needs a longer period to reach steady status. Our empirical findings provide strong evidence for the role of interest rate volatility in damaging the banking sector development process of emerging countries.

Table 4

Short-run coefficient ($\hat{\vartheta}_3$) for interest rate volatility

Country	BSDIs	$\Delta\ VR_t$	$\Delta\ VR_{t-1}$	$\Delta\ VR_{t-2}$	$\Delta\ VR_{t-3}$	*ECT*
Algeria	*Index*	- 0.0184***				-0.6022*
		(1.8405)				(4.7671)
	PC	-0.0028	0.0325	0.0929*		-0.9917*
		(0.1422)	(1.4945)	(4.4578)		(8.4015)
Brazil	*Index*	-0.0002*	0.0006**			-1.6200*
		(6.7482)	(2.0950)			(7.0701)
	PC	-0.0002**				-0.5938*
		(2.4724)				(4.1003)
	BM	0.000704*				-1.5727*
		(4.7263)				(4.2396)
	BD	0.0001*				-0.4818*
		(5.1999)				(6.8531)
Chile	*Index*	-0.0306**	-0.0366**	0.0134	-0.0142**	-0.3966*
		(2.7971)	(2.2519)	(1.3541)	(2.6873)	(10.8983)
	PC	0.0110*				-0.2358*
		(4.0655)				(6.1128)
Egypt	*PC*	0.0217*	-0.0242*			-0.2867*
		(8.1080)	(6.4117)			(8.0293)
	BM	-0.0097**	0.0159*	0.0133*		-0.0593*
		(2.7819)	(3.8738)	(4.4696)		(5.9817)
Indonesia	*Index*	-0.0300*	0.1277*	0.0745*	0.0131***	-0.1002*
		(3.5226)	(5.9852)	(5.0113)	(2.1065)	(7.1053)
	PC	-0.0101***	0.0098**			-0.0877*
		(1.9094)	(2.4746)			(7.4053)
	LL	0.0065*				-0.1027*
		(3.0471)				(6.0631)
	BM	-0.0130*	-0.0593*	-0.0330*	-0.0226*	-0.5200*
		(3.2418)	(8.5032)	(8.0702)	(6.7266)	(10.479)
	BD	0.0067*	0.0031***			-0.0982*
		(3.7178)	(1.8232)			(8.3439)
Korea	*Index*	-0.0038				-1.4456*
		(0.4981)				(7.9160)
Malaysia	*Index*	-0.4083**				-0.6841*
		(2.4412)				(5.7176)
	LL	-0.0315***				-0.6391*
		(1.8390)				(5.3447)
	BD	-0.0312				-0.5539*
		(1.5832)				(4.8223)
Mexico	*Index*	0.0457	-0.5375*	-0.3267*	-0.1262*	-0.1938*
		(1.6489)	(7.3562)	(7.1302)	(5.3553)	(9.2381)
	LL	-0.0084*				-0.3078*
		(6.3638)				(4.5123)
	BM	0.0093**	-0.0132*	-0.0085*		-1.0082*
		(2.7551)	(4.9137)	(3.6881)		(8.9242)
	BD	-0.0099*				-0.2773*
		(6.1061)				(4.1052)
Philippines	*Index*	-0.1088*				-0.1784*
		(4.3105)				(4.5654)
	PC	-0.0692*	0.1154*	0.0685*	0.0336*	-0.4988*
		(6.1485)	(5.1875)	(4.3961)	(3.4966)	(6.8028)
South Africa	*Index*	-0.1420*	-0.0598	-0.0773**	0.0085	-0.5144
		(5.0177)	(1.7222)	(2.2923)	(0.2626)	(8.2504)
	BD	-0.0045***	-0.0122*	-0.0136*	-0.0043***	-0.7657*
		(1.9144)	(3.7861)	(4.2842)	(1.7688)	(10.687)
Thailand	*Index*	-0.0612*				-0.1558*
		(3.3173)				(3.4849)
	LL	-0.0107*				-0.1288*
		(2.8952)				(3.6698)
	BD	-0.0069***				-0.1295*
		(1.9187)				(3.4469)
Turkey	*Index*	-0.0116*				-0.4321*
		(2.8901)				(4.7802)
	LL	0.0060*	0.0107*			-0.4341*
		(3.1686)	(6.3337)			(6.0854)
	BM	0.0096*	-0.0048	-0.0205*	-0.0047*	-0.6216*
		(3.2133)	(1.4351)	(5.7248)	(4.2766)	(4.7188)
	BD	0.0053**	0.0128*			-0.3561*
		(2.7313)	(6.8394)			(6.5312)

Notes: *ECT* is the error correction term, (u_{t-1}), in equation (4). *, ** and *** denote the significance level of 0.01, 0.05 and 0.10, respectively. Absolute *t*-statistics are presented between the parentheses.

Finally, Table 5 presents the test statistics of the selected diagnostic tests. The test statistics indicate that the residual series of the estimated model are not serially correlated and are normally distributed. In addition, the Ramsey Regression Equation Specification Error Test (RESET) statistics indicated that the estimated models did not suffer from any misspecification.

Table 5
Diagnostics tests for the estimated ARDL models.

Country	BSDIs	R^2	Adj. R^2	*F*-statistic	DW	JB	LM	ARCH	RESET
Algeria	*Index*	0.953	0.887	14.460	2.728	1.341	2.383	0.155	2.986
	PC	0.957	0.886	13.640	2.548	1.880	0.772	0.139	2.511
Brazil	*Index*	0.865	0.810	15.709	2.271	0.401	1.050	0.969	0.373
	PC	0.741	0.679	11.954	2.067	1.852	6.033	1.137	1.711
	BM	0.741	0.651	8.257	2.303	4.598	2.492	1.279	0.110
	BD	0.734	0.698	20.082	2.201	3.642	0.961	0.126	0.375
Chile	*Index*	0.988	0.966	44.590	1.937	0.798	2.296	1.022	1.629
	PC	0.853	0.775	11.036	1.756	0.053	1.923	0.143	0.162
Egypt	*PC*	0.931	0.903	33.415	2.298	1.331	1.671	1.559	1.435
	BM	0.706	0.580	5.612	2.289	0.128	1.256	0.232	0.620
Indonesia	*Index*	0.983	0.965	53.391	2.439	0.393	1.070	0.857	1.185
	PC	0.888	0.862	34.515	2.090	1.575	0.298	0.152	2.371
	LL	0.618	0.565	11.755	1.691	0.104	0.114	0.552	0.919
	BM	0.957	0.888	13.823	2.882	0.228	1.696	2.488	0.563
	BD	0.782	0.742	19.456	1.639	3.804	2.561	1.748	1.078
Korea	*Index*	0.686	0.642	15.853	1.994	1.245	1.040	1.143	2.702
Malaysia	*Index*	0.632	0.536	7.175	2.308	2.295	0.391	0.479	2.712
	LL	0.624	0.537	7.190	2.294	0.766	1.005	0.468	2.395
	BD	0.577	0.480	5.929	2.172	1.177	1.129	0.380	1.161
Mexico	*Index*	0.971	0.925	21.133	2.640	1.553	1.663	0.859	2.401
	LL	0.649	0.601	13.462	1.883	0.545	1.398	1.404	1.859
	BM	0.878	0.814	13.741	1.857	0.190	2.001	2.106	1.195
	BD	0.621	0.568	11.885	1.781	1.048	1.301	0.123	1.953
Philippines	*Index*	0.633	0.565	9.345	2.289	3.319	0.742	0.299	1.549
	PC	0.922	0.853	13.514	2.273	0.845	1.279	1.860	1.065
South Africa	*Index*	0.959	0.894	14.611	2.508	2.047	0.248	0.011	1.591
	BD	0.934	0.888	20.235	2.035	2.002	1.761	0.898	1.449
Thailand	*Index*	0.850	0.815	24.631	1.711	0.685	0.657	0.352	0.775
	LL	0.830	0.791	21.223	1.916	0.936	0.112	1.673	0.577
	BD	0.839	0.801	22.589	1.864	0.452	0.158	0.566	0.102
Turkey	*Index*	0.837	0.788	16.968	2.146	3.830	3.369	0.044	1.136
	LL	0.864	0.804	14.220	2.056	2.793	3.117	0.446	0.491
	BM	0.949	0.867	11.534	2.480	1.256	1.446	0.648	0.638
	BD	0.870	0.811	14.883	1.897	2.451	2.069	0.301	0.755

Notes: DW is Durbin-Watson statistic. JB is Jarque-Bera to test for the normality of the residuals. LM is Breusch-Godfrey test for serial correlation in the residual series. ARCH is a residuals heteroscedasticity test. RESET is Ramsey specification test.

6. Conclusions and policy implications

This study investigates the dynamic relationship between interest rate volatility and a set of banking sector development indicators for 12 emerging market countries located in various regions of the world for the period of 1980–2019. To this end, the bounds testing approach was employed in the analysis of level relationship among the considered variables. The outcomes of bounds tests reveal that for each country, at least one of the suggested BSD indicators has a level relationship with the regressors. Thus, the ARDL modelling approach of co-integration analysis has also been used. The estimated models provide evidence regarding the direction of the relationships among each pair of the variables. A positive and significant link was observed between at least one of the BSD indicators and interest rate (*R*) for, Egypt, Indonesia, Malaysian, Mexico, South Africa, and Turkey. In contrast, this relationship becomes negative and significant in both Chile and the Philippines. However, there is no significant relationship between any of the BSD indicators and *R* in cases of Algeria, Korea, and Thailand. This relationship was negative and significant with a negligibly small value for Brazil. Regarding the estimated relationships between banking sector development, measured by the suggested indicators, and interest rates volatility (*VR*), the empirical findings indicate the presence of negative and significant association between at least one of the BSD indicators and *VR* in the majority of sampled countries including Algeria, Brazil, Indonesia, Mexico, Philippines, South Africa, Thailand, and Turkey. While the banking sector development of Chile, Korea, and Malaysia are observed to be insensitive to the fluctuations of interest rates, only one positive relationship was observed in Egypt when the *PC* was used as an indicator of BSD.

The empirical results have shown that the development of the banking sectors in emerging economies were elastic and very responsive to changes in economic growth. This result implies that the movements of the banking sector development tend to be, usually, in the same direction of the economic growth path, which is consistent with the financial development literature. This relationship is confirmed for all of the sampled countries except in Algeria, Korea, and Turkey.

The dynamic short-run relationships between interest rate volatility (*VR*) and BSD indicators have been estimated by the CECM. The empirical results showed that there is a negative and significant association between at least one of the suggested BSD indicators and *VR* for all sampled countries. Hence, the interpretation may be that the banking sector development of these countries is affected negatively by the interest rate fluctuations in the short-term. The estimated coefficients of the ECTs were negative and significant in all cases which supported the existence of long-term feedback amongst the BSD indicators and the determinant variables. Moreover, the findings revealed the sluggishness in the converging equilibrium process of the banking system in the long-term. For the majority of the countries these results complement most of the previous empirical work that have analyzed the role of interest rates in financial development.

As a summary, the empirical results indicate that interest rate volatility has an undesirable effect on the banking sector development of all the sampled emerging market economies in the short-run and majority of the countries in the long-run except for Chile, Korea and Malaysia. This result points to the importance of the interest rate uncertainty on the banking sector development process and the growth path of these countries. In line with the views of the financial development economists, these empirical results do not rely on a single measure of BSD but are based on a set of comprehensive measures of BSD.

The authors would like to reassert that well-understanding of the sensitivity of the banking system to the interest rate policy is a serious issue for both regulators and monetary policy makers. This issue imposes an imperative responsibility on the policy makers particularly in emerging countries; they should design their plans very carefully to mitigate the undesirable effects of the interest rate uncertainty, in order to achieve an improvement in their banking system and thus economic growth.

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