Does bank regulation matter on the relationship between competition and financial stability? Evidence from Southeast Asian countries

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\textbf{ABSTRACT}

This study examines the role of bank regulation on the relationship between competition and financial stability. The considered regulations are capital requirements, activity restrictions, deposit insurance, and official supervision based on prior literature. We used data from the banking sector of Southeast Asian countries over the period of 1990–2014. Using system Generalized Method of Moments (GMM) and considering financial freedom and property right as instrumental variables, this study found that competition promotes financial stability, and reduces credit risk. Further, capital requirements and official supervision are the most effective and straightforward bank regulations promoting financial stability irrespective of the level of competition. Activity restrictions are effective in shaping financial stability only in a highly competitive environment, while deposit insurance promotes financial stability in a less competitive environment. This study provides a framework to determine the bank regulation best suited to promote financial stability through the channel of competition.

1. Introduction

Bank regulation, competition, and financial stability are three interconnected terms in the banking sector that have gained increasing attention among the policy makers and academics, especially after the 2008–2009 Global Financial Crisis (GFC), wherein regulatory oversight rather than unfeathered competition is recognized as a pivotal cause of that crisis (Beck, 2008; OECD, 2010; World Bank, 2013; Schaeck and Cihák, 2014). The nexus of bank regulation, competition, and financial stability is first studied by Keeley (1990) who argued that deregulation in the U.S. banking market during the 1970s and 1980s increases competition which erodes the franchise value and profit margin of banks, and exacerbates their risk-taking behavior. On the other hand, Boyd and Nicolo (2005) argued that competition in the banking market reduces the risk-taking behavior of banks by driving them to lower the interest rate on loans. Yet, Martinez-Miera and Repullo (2010) claimed that the relationship between competition and financial stability is non-linear, because competition not only exacerbates risk-taking, but also increases the profit margin to build a capital buffer. To date, empirical studies have yet to reach a consensus on the effect of competition on financial stability in the banking sector. Rather, this issue has been intensified with conflicting theoretical predictions and mixed empirical results, especially after the GFC.\textsuperscript{1} This has piqued the

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\textsuperscript{1}Excellent reviews of both theoretical and empirical literatures on regulation, competition and stability nexus are reported in Beck (2008), Jiménez et al. (2013), Fu et al. (2014).

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interest of policy makers in the roles played by bank regulation in shaping the level of competition and its effects on financial stability.

Bank regulation is designed to mitigate the risk-taking behavior of the banks and sim to bolster a sound and stable banking system (Repullo and Suarez, 2013), because it's instability contaminates the entire financial system by shrinking credit facilities and distorting both interbank loan market and payment system (Khan et al., 2016). Indeed, bank regulation influences the level of competition which, in turn, shapes financial stability. One such regulation is activity restrictions, where less restrictions erode a bank's market power and increase competition, and exacerbate the bank’s risk-taking behavior due to the ‘franchise value effect’ (Keeley, 1990). On the other hand, more restrictions also increase competition by reducing scope of operations and risk diversification, and may also motivate the bank to limit risk-taking behavior at certain level of competition due to the ‘risk-shifting effect’ (Boyd and Nicolo, 2005). Similarly, deposit insurance may increase competition by increasing the level of intermediation and building public trust in the banking system, and that changed competition may alter the influence of deposit insurance on financial stability. In a similar vein, the capital requirements may influence competition by preventing new entrants and protecting the market power of existing banks (Northcott, 2004), which may also shape financial stability. This means that the efficiency of bank regulations to limit a bank's risk-taking behavior or to enhance its financial stability is channelled through the level of competition. Therefore, the selection of bank regulation without considering the level of competition may result in regulatory failure which may destabilize the banking sector, and cause financial crisis as witnessed by both emerging and matured countries in recent decades.

The academic literature has yet to examine, empirically, how bank regulations, particularly capital requirements, activity restrictions, deposit insurance and official supervision, shape financial stability through the channel of competition. We believe that such an analysis offers significant regulatory policy implications for the banking sector as we stipulate the relationship between bank regulations and financial stability is complicated by the highly-concentrated market. This motivates us to study the nexus between bank regulation, competition, and financial stability of the banking sector.

In examining the nexus between bank regulation, competition, and financial stability, we are looking at a unique market for bank restructuring and regulatory changes which are more prominent in the banking sector of the old members of Association of Southeast Asian Nations or ASEAN-5, especially Indonesia, Malaysia, the Philippines, Singapore and Thailand based on the experience of the early 1990s deregulation, 1997–1998 Asian Financial Crisis (AFC), and 2008–2009 GFC. The banking sector in this region has gone through tremendous restructuring process including regulatory reform in the forms of capital requirements, activity restrictions, market discipline and official supervision in the aftermath of the 1997–1998 AFC and 2008–2009 GFC (Teo et al., 2000; Lee and Park, 2009). The post-crisis restructuring, deregulations and supervisory drives resulted in strengthening the capital base, risk management capability and earning capability (from Appendix A) which might enhance the financial stability in the region despite its highly-concentrated banking industry. Also, the Governors of ASEAN central banks have agreed to harmonize bank regulations as a prerequisite of ABIF2 in 2011 (Yamanaka, 2014). Thus, given the regulatory changes in the last two decades, ASEAN-5 provides an excellent case for examining the relationship of bank regulation, competition, and financial stability.

The study provides new empirical evidence for the regulation, competition, and financial stability nexus in the ASEAN-5 countries, in the context of emerging markets. This study covers the period from 1990 to 2014, which captures both deregulation and restructuring efforts in ASEAN-5 countries. To capture the regulatory framework, we have constructed indices for capital requirements, activity restrictions and official supervision, and a dummy variable based on the survey results of Barth et al. (2001, 2006, 2008, 2013a). We have measured competition using a new empirical industrial approach based on the methodology of Panzar and Rosse (1987), and financial stability using Z-score and non-performing loans (NPL) ratio. The study contributes to the existing banking literature by comprehensively identifying the set of capital regulations which work well in enhancing the financial stability in the banking industry, especially in emerging markets. Second, we believe that studying the moderating role of the bank regulation on competition and financial stability provides significant policy implications on the regulations that work best in achieving the economic objective of a more stable financial system given the highly-concentrated market setup that often leads to bank fragility due to excessive risk-taking and moral hazard behavior.

We have used the dynamic panel instrumental variable technique with the system GMM estimators using financial freedom and property rights as instrumental variables to control for endogeneity, heteroscedasticity, and serial correlation in our study. The results show that competition is associated with greater financial stability, and lower credit risk. Capital requirements and official supervision work well in enhancing financial stability and reducing credit risk exposure with and without interacting the level of competition. Deposit insurance is effective in promoting financial stability and reducing risk taking behavior of the banks in general, but for those banks facing a less competitive pressure. On the other hand, activity restrictions are found weakening financial stability, and increasing risk-taking behavior of the banks facing a less competitive pressure. However, the destabilization effect of activity restrictions is found changed for the banks facing higher a level of competition.

The remainder of the paper is organized as follows. Section 2 reviews the literature on bank regulation, competition and financial stability. Section 3 discusses the methodology and the data used in this study. Results and discussion are provided in Section 4, while Section 5 concludes the study.

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2 ABIF stands for ASEAN Banking Integration Framework as a part of the ASEAN Economic Community which will be implemented in 2020 initially among the ASEAN-5, allowing the regional banks to expand cross border operations in other member countries with the status of local banks and enable them to enjoy home field advantage in the host counties.
2. Literature review on bank regulation, competition, and financial stability

In this section, we review the literature pertaining to the regulations that influence bank competition and financial stability. The literature on regulatory framework that interacts with competition and shapes financial stability started with Keeley (1990) who demonstrated how deregulation efforts in the U.S. banking market increased competition and eroded banks' market power, and induced them to assume excessive risk in order to compensate for their loss in profit margin. The importance of the interaction of banking regulation with competition is also evident from Beck et al. (2006) and OECD (2010) who blamed regulatory failure as a cause of unfettered competition and banks' excessive risk-taking which render the banking institutions fragile towards financial crisis. In reviewing the relevant literature, the attention is given to four bank regulations comprising capital requirements, activity restrictions, supervisory power and deposit insurance which are the main concerns of regulators and supervisors for policy implications designed to promote competition and financial stability in the banking market. It is important to note that the literature covering regulatory policies that interact with competition and influence financial stability are mostly theoretical in nature with limited empirical evidence.

2.1. Capital requirements

Capital requirements refer to the minimum capital requirements that banks needs to hold against its risk weighted assets (Laeven and Levine, 2009). Since the inception of the BASEL II accords of the Bank for International Settlement, the regulators and international institutions like the World Bank and the International Monetary Fund consider capital requirements as a regulatory tool for building a capital buffer and improving financial stability (Cubillas and González, 2014; Deli and Hasan, 2017).

With respect to the theories of capital requirements, Hellmann et al. (2000) and Repullo (2004) identified that capital requirements are influenced by the ‘equity-at-risk’ effect and ‘franchise value’ effect. Where ‘equity-at-risk’ effect may provide an incentive to the bank owners to focus on prudent investment decisions along with an increase in monitoring and controlling of the investment process to avoid potential cost of financial distress. Thus, the more stringent capital requirements may reduce risk-taking intensity of banks due to the ‘equity-at-risk’ effect of capital requirements, which may promote financial stability of banks. Conversely, the ‘franchise value’ effect may provide an incentive for the banks to assume higher risk and involve them in the riskier lending process to increase profitability to compensate for the cost of equity, and the loss in franchise value. Although Hellmann et al. (2000) found positive ‘equity-at-risk’ effect on bank risk-taking ambiguous in the presence of negative ‘franchise value’ effect, Repullo (2004) rejected the claim of Hellmann et al. (2000) and did not find the presence of ‘franchise value’ effect, because, if the cost of capital exceeds the return on prudent investment, in order to maintain the profit margins, banks will offer lower deposit interest rates, meaning that the franchise value will be preserved. Northcott (2004) argued that the capital requirements may influence financial stability through the channel of competition. Because, as a regulatory tool it deters new entrants and controls the level of competition which helps existing banks to build market power, and to behave prudently which may enhance their financial stability.

Furthermore, Bolt and Tieman (2004) showed in a dynamic model that imposed capital requirements allow the bank to set loan approving criteria for the borrowers that eventually resulted in prudent risk-taking behavior. In a similar vein, Behr et al. (2010) showed, both theoretically and empirically, that the capital requirements in 61 countries have different effects on risk-taking incentive due to the level of concentration. It can effectively reduce the risk-taking incentive for the banks in the low concentrated market. Further, Berger and Bouwman (2013) considered capital stringency requirements as banks' incentive to enhance the relationship with borrowers which reduces moral hazard and default probability. Most recently Holod et al. (2017) also found an evidence that market risk based capital requirements reduce moral hazard and adverse selection problem associated with opaque trading activities.

2.2. Activity restrictions

Activity restrictions indicate regulatory restrictions on a bank's operations, such as, securities, insurance, real estate or owning non-financial firms. These are the key determinants of the scope of a bank's operations which may influence both competition and risk-taking (Barth et al., 2013b). The theoretical model of Keeley (1990) found that liberalization of restrictions increases competition by eroding bank's franchise value, which then motivates the bank to take more risk. Similarly, Boyd et al. (1998) found that a broad range of activities intensify the moral hazard of a bank and provide more incentive to take more risk. On the other hand, Barth et al. (2004) identified five theoretical reasons to restrict the commercial banks from certain activities to reduce conflict of interests, excessive risk exposure, monitoring difficulties, discipline difficulties, and promote competition. Barth et al. (2004) also identified alternative reasons to allow banks to engage in a broad range of activities, because they allow banks to attain economies of scale and scope in information gathering, promote diversification in its operations, and provide better services to the customers. It also increases the franchise value of earning high-profit margins which not only allows earning a continuous income flow, but also motivates a bank to take less risk exposure.

The empirical evidence on the effect of activity restrictions on financial stability is also mixed. Barth et al. (2001, 2004, 2008) showed a negative effect of activity restrictions on banking market development and financial stability. Similarly, Claessens and Laeven (2004) showed low restrictions reduce competition due to the increase of financial conglomerates, and high restrictions increases competition in the banking market. The high competition resulting from high restrictions affects the profitability and banks' franchise value negatively, which incentivises banks to take more risk. Similarly, Beck et al. (2006, 2013) found that tight activity restrictions reduces a bank's profitability and increase risk of failure in their cross-country studies. In addition, Liu et al. (2012) found...
a positive relationship between activity restrictions and bank risk-taking in Southeast Asian countries. However, Mohsni and Otchere (2017) found that restrictions lead to higher risk-taking by Canadian banks, while lower risk taking by US banks. Fernández and González (2005) showed that greater activity restrictions are effective in restricting banks from excessive risk-taking. However, they argued that activity restrictions are effective in reducing risk only if the auditing requirements and information disclosures are developed and reported poorly.

2.3. Deposit insurance

Deposit insurance is another regulatory measure that constructively builds financial safety nets for the depositors and promotes financial intermediation and stability by promising the depositors that their deposits are safe and protected. The deposit insurance system is mainly implemented in a banking system in order to prevent bank runs that could spillover to other banks (Diamond and Dybvig, 1983), prevent banking crisis, and promote financial stability (Demirgüç-Kunt and Detragiache, 2002), and reduces the social cost of a banking crisis (Gropp et al., 2011). Deposit insurance allows banks to deal with maturity mismatches in the assets transformation process and allows banks to offer higher return opportunities for the rational depositors who are likely to share the risk with the banks (Lowe, 2015). It also builds depositors' confidence in the banking system which helps to protect banks from the risk of early withdrawal of funds due to panic in the financial market. Thus, theoretically, the government-backed deposit insurance promotes financial stability by eliminating the risk of bank runs. Even during the crisis, the deposit insurance system works as a risk minimizer by protecting the deposits of major depositors.

The theoretical evidence of Merton (1977), Keeley (1990), Matutes and Vives (2000), and Salas and Saurina (2003) showed that alike other insurance systems, deposit insurance could also result in moral hazard problem in the form of excessive risk taken by the banks. In the presence of deposit insurance, depositors are protected against the banks’ losses or failure under the public safety net. Hence, they do not find motivation to monitor or control the risk-taking incentive of the banks and bring the market in the discipline. Under this circumstance, if the depositors' relaxed attitude to monitoring the bank's activities is known to the banks, the riskiness of the contract is altered as the bank may disclose riskier activities than it would in the presence of close monitoring. As a result, the moral hazard of the bank is created by taking extra risk or gambling to reap higher returns by investing in riskier borrowers or riskier projects. Thus, due to the exacerbation of moral hazard effect, the benefits of deposit insurance may be offset. However, empirical evidence suggests that a credibly designed deposit insurance could minimize the moral hazard effect (Barth et al., 2004; Demirgüç-Kunt and Huizinga, 2004), and increases financial intermediation (Chernykh and Cole, 2011).

The literature also empirically found that moral hazard minimization effect of deposit insurance. Martínez-Miera and Repullo (2010) showed that deposit insurance enhances the profitability and financial stability of the banking sector. In the absence of deposit insurance, banks need to offer a high deposit rate to the depositors which would increase the loan interest rate and the probability of failure. Additionally, the empirical evidence of Chernykh and Cole (2011) found that banks enjoy higher financial intermediation that operated under the explicit deposit insurance system. Furthermore, estimating the probability of banking failure during the 2008–09 GFC, Anginer et al. (2014) provided evidence that the countries that implemented explicit deposit insurance had lower bank risk, and were systematically stable. In addition, Assa and Okhrati (2018) also found that deposit insurance does not give rise to moral hazard of banks.

2.4. Official supervisory power

Powerful official supervision is related to Pillar II of the Basel Accords which promote governance in the banking system by restricting banks from excessive risk-taking, and enhancing financial stability (Basel Committee on Bank Supervision, 2011). Barth et al. (2004) demonstrated that the power of official supervisors may increase monitoring in banks’ operations, protect them from contagious run and reduce the moral hazard of excessive risk-taking in the presence of deposit insurance, despite that it may result in sub-standard bank operations if supervisors have private interest and/or are politically connected. In another study, Laeven and Levine (2009) argued that official supervision improves governance in banking and increases competitiveness. In this connection, Beck et al. (2006) proposed the alternative ‘Public Interest View’ and ‘Private Interest View’ of powerful official supervisors which may affect the incentive and risk-taking of banks. The ‘Public Interest View’ argues that powerful supervisors have skills and incentives to protect the banks from market failure resulting from information asymmetry, transaction costs and enforcement impediment. From this viewpoint, powerful supervision is negatively related to risk-taking behavior, and positively related to financial stability. The powerful supervisors which directly monitor banks and bring discipline can promote the banks' corporate governance. Conversely, the ‘Private Interest View’ suggests that powerful supervisors are not interested in protecting banks from market failure. Rather, they are interested in increasing their private interest or political agenda. As pointed out by Beck et al. (2006), if the powerful supervisors have power to discipline the non-compliant banks, the supervisors may misuse that power to force or induce those banks to allocate credit in order to serve private or political interests. This is because, politicians may have a connection with the powerful supervisors, and they may use the supervisors to force banks to lend to particular borrowers on easier terms. Politicians are not necessarily interested in ameliorating information, transaction cost and enforcement, rather they may create obstacles in lending forcing banks to be corrupted in order to exploit their political intention (Andrei and Vishny, 1998). From this viewpoint, powerful government-backed supervision may be associated with high risk-taking and negatively influence financial stability, if the supervisors are politically connected.

The empirical evidence on the effect of powerful supervision on risk-taking is also mixed. Barth et al. (2001) found that powerful official supervision has a negative influence on bank performances and increases nonperforming loans in the banking system. Barth
et al. (2003) found that powerful government-linked official supervision is especially detrimental in developing countries. However, Fernández and González (2005) found that supervision with more disciplinary power reduces the risk-taking of the banks controlling the auditing and accounting requirements. In addition, Tabak et al. (2016) found a positive relationship between strong banking supervision and financial stability. In a similar view, Barth et al. (2013b) found that where supervisors are independent and free from the political connection, it enhances efficiency which is positively related to the level of competition. In supporting this, Lee and Hsieh (2014) found that weak supervision and private monitoring make the banking system more fragile. In other words, strong supervision effectively reduces the risk-taking tendency of banks in developing countries which otherwise worsened due to high competition (Cubillas and González, 2014).

In sum, the theoretical studies showed that bank regulation might influence the level of competition and financial stability. For example, capital stringency requirements require banks to hold a minimum level of capital at risk which not only protects existing banks from new entrants, but also induces them to invest prudently, and monitor borrowers due to the ‘equity-at-risk’ effect which may reduce moral hazard by leaving scope for offsetting potential capital losses. Similarly, activity restrictions reduce banks’ scope of operations and risk diversification which increase their risk exposures due to the ‘franchise value’ effect by increasing the level of competition in a traditional loan/banking market. Likewise, deposit insurance promotes financial stability by reducing the moral hazard of depositors and promoting financial intermediation. Similarly, powerful supervision with public interest promotes governance of the banks and increases monitoring of bank operations which may restrict them from high-risk exposures and protect market failure. However, it has yet to be examined empirically how the regulations influence financial stability in a competitive environment in a disaggregated manner especially in emerging economies.

3. Methodology

To examine the relationship between bank regulation, competition, and financial stability the study uses the following general dynamic regression model:

\[
STAB_{ijt} = \alpha_0 + \alpha_1 STAB_{ijt-1} + \alpha_2 COM_{jt} + \alpha_3 (COM_{jt})^2 + \alpha_4 REG_{jt-1} + \beta BANK_{ijt} + \delta MACRO_{jt} + \gamma (YEAR)_t + \lambda_i + \epsilon_{ijt}
\]  

(1)

In the Eq. (1), \(i = 1-N, j = 1-J\) and \(t = 1-T\), \(N\) refers to the number of individual banks; \(J\) refers to the number of countries; \(T\) refers to time; and \(\alpha, \beta, \theta \text{ and } \gamma\) are estimated parameters. \(STAB_{ijt}\) denotes financial stability for bank \(i\) in country \(j\) at time \(t\). \(COM_{jt}\) denotes level of competition for country \(j\) at time \(t\). In order to capture the non-linearity between competition and financial stability, the study includes a quadratic term of competition \((COM_{jt})^2\) based on the theoretical and empirical consideration of Berger et al. (2009), Martinez-Miera and Repullo (2010), and Fu et al. (2014). \(REG_{jt-1}\) indicates regulatory variables for country \(j\) at time \(t\), that may affect financial stability in a competitive environment. A new regulation does not affect financial stability immediately, especially through the channel of competition. We take first lag of regulation on the expectation that there is a time gap between when a regulation is formed and when that regulation is enacted in banking practice and influenced on financial stability. \(BANK_{ijt}\) indicates bank level control variable for bank \(i\) in country \(j\) at time \(t\), and \(MACRO_{jt}\) is macroeconomic control variables for country \(j\) at time \(t\). Following the works of Berger et al. (2009) and Fu et al. (2014), this study included lag depended variable, \(STAB_{ijt-1}\), to capture persistence of financial stability. A positive and significant value of \(\alpha_1\) implies that the financial stability of one year is to be carried forward to the following year, implying banks’ persistent risk-taking behavior. A year dummy is included to capture the year effect due to changes in the business cycle and technological progression. \(\lambda_i\) represents unobserved individual effects, and \(\epsilon_{ijt}\) is the error term. A summary of the variables, along with their expected sign and sources is presented in Table 1.

As bank regulation may also affect financial stability in a highly competitive environment (Matutes and Vives, 2000), we extend our basic model incorporating an interaction term of competition and regulation using Eq. 2. This allows us to study the role of bank regulation in shaping financial stability in a highly competitive environment pertaining to ASEAN-5 setup.

\[
STAB_{ijt} = \alpha_0 + \alpha_1 STAB_{ijt-1} + \alpha_2 COM_{jt} + \alpha_3 (COM_{jt})^2 + \alpha_4 REG_{jt-1} + \alpha_5 (REG_{jt-1} \times COM_{jt}) + \beta BANK_{ijt} + \delta MACRO_{jt} + \gamma (YEAR)_t + \lambda_i + \epsilon_{ijt}
\]  

(2)

Here, in Eq. 2 the study uses the same dependent and independent variables as used for Eq. 1 except the interaction term of competition and regulation \((REG_{jt-1} \times COM_{jt})\) in order to capture the role of regulation on bank stability in a highly competitive market.

In the above equations, the value of the coefficient \(\alpha_2, \alpha_3, \alpha_4\) and \(\alpha_5\) are examined, such as, if financial stability is captured by natural logarithm of Z-score, the positive and significant value of both \(\alpha_2\) and \(\alpha_3\) for Eqs. 1 and 2, provide evidence to support the competition-financial stability paradigm. If \(\alpha_4\) is positive and significant in Eqs. 1 and 2, it indicates that the regulation promotes financial stability in a less competitive market. Again, if \(\alpha_5\) is also positive and significant in Eq. 2, it suggests that the regulation also promotes financial stability in a highly competitive environment. However, if \(\alpha_5\) is turned to negative and significant in Eq. 2, it implies that the stabilization effect of regulation is changed in a highly competitive environment.

We use the dynamic panel model to estimate Eqs. 1 and 2. The dynamic panel model is used to capture the dynamic nature of financial stability and potential endogeneity problem of financial stability with competition and regulation. It also offers better outcomes compared with the static model which uses random effect and/or fixed-effect models.\(^3\) Where, the random and/or fixed-

\(^3\) For example, Kasman and Kasman (2015) uses dynamic model in investigating the effect of banking competition and concentration on financial stability of Turkey over 2002–2012
effect model provides serious econometric bias and inconsistent results due to the presence of correlation between error term and lagged dependent variables (Hadad et al., 2011). To deal with such correlation between error term and the lagged dependent variable, instrumental variable techniques are used.

We chose to apply the GMM estimators proposed by Arellano and Bond (1991) to better estimate the dynamic relationship between competition and financial stability. In particular, we apply the system GMM of Arellano and Bover (1995) and Blundell and Bond (1998) to attain more accurate estimators. The system GMM is ideal for such conditions as this case where the number of period (T) is small and cross sections (N) is large; dependent variable is persistent (dynamic); explanatory variables are not exogenous (they may correlate with error term), there are heteroscedasticity, time-invariant individual fixed-effect and autocorrelation within individuals, which are more common in bank level data.

Arellano and Bond (1991) originated the standard GMM estimator, also known as first-differenced GMM where all variables are
transformed by differencing and introduced instrument variables from the lagged levels of the regressors. However, the lagged levels of the regressors could be a poor instrument if there is a serial correlation in the errors. In this case, first-difference GMM might result in imprecise or even biased estimators. To overcome these shortcomings Arellano and Bover (1995) and Blundell and Bond (1998) developed the system GMM which comprises two simultaneous equations. One equation is in lagged difference of the dependent variable as instruments for the equation in levels, and other is in lagged levels of dependent variables as instruments for the equation in first-difference. Blundell and Bond (1998) demonstrated that the system GMM has smaller variances and is more efficient, thereby improving the precision in the estimator. In investigating the competition-financial stability relationship, we consider financial freedom and property right as external instruments for controlling the potential endogeneity problem of competition with financial stability based on economic arguments following the work of Berger et al. (2009) and Fu et al. (2014). Where, financial freedom measures the efficiency as well as the freedom of the banking system from government intervention and control in the forms of banking regulations, credit allocation, deposit accumulation, types of financial services offering, dealing with foreign currencies, and foreign ownership in the banking system. Financial freedom is expected to change the market power of the banking system, and thus influences on the financial stability. Likewise, property right determines the level to which private property right is protected by the laws and its enforceability by the government. The property right is also expected to affect both competition and financial stability of a banking system, because it encourages banks to innovate new products and services which help them to capture the market share, and drives out the less efficient banks from the market.

Before running system GMM, the presence of autocorrelation, heteroscedasticity, and endogeneity of the data set has been tested applying Wooldridge test, Breush-Pagan/Cook-Weisberg test, and the Wu-Hausman test, respectively. After running the System GMM some post-diagnostic tests were also performed, such as AR(1) and AR(2) to test presence of autocorrelation at first and second difference respectively, Hanen’s J-test to test the validity of instruments of endogenous variables, such as competition and regulation. Wald test was also used to ensure the goodness of fit for all our regression models.

3.1. Measures of financial stability

Following Jeon and Lim (2013) this study uses Z-score as the primary measure of financial stability. The theoretical underpinning of Z-score is based on the novel work by Roy (1952), which measures a bank’s distance from insolvency, where insolvency is a condition in which loss exceeds equity, such as (−π > E), where π stands for profit and E stands for equity. The probability of insolvency can be represented as Probability(E/A < −ROA), where E/A is the equity asset ratio and ROA is the return on assets. The inverse of the probability of insolvency is (ROA + E/A)/δ(ROA), where δ(ROA) is the standard deviation of ROA. Thus, the Z-score is defined as the inverse of the probability of insolvency, and indicates an individual bank’s soundness. The Z-score is calculated in the following manner:

\[ Z_{ijt} = \frac{\text{ROA}_{ijt} + E_{ijt}/TA_{ijt}}{\delta \text{ROA}_{ijt}} \]  

(3)

where, \( Z_{ijt} \) is a measure of financial stability of \( i \) bank, in \( j \) country, at \( t \) time. \( \text{ROA}_{ijt} \) stands for the return on assets of \( i \) bank, in \( j \) country, at \( t \) time; \( E_{ijt}/TA_{ijt} \) is a ratio of equity to total assets of \( i \) bank, in \( j \) country, at \( t \) time; \( \delta \text{ROA}_{ijt} \) is a standard deviation of \( \text{ROA}_{ijt} \). Following the work of Soedarmono et al. (2013), we calculate \( \delta \text{ROA}_{ijt} \) on the basis of the observation of \( \delta \text{ROA}_{ijt} \) from time \( t \) to \( t-2 \) (a three-year rolling window period, instead of the full sample period) to calculate the standard deviation of ROA. A higher Z-score value indicates the low probability of a bank’s financial distress, and its higher financial stability or solvency. Here, we use natural logarithm of Z-score in order to normalize the distribution.

In addition, we also use NPL ratio (a ratio of non-performing loans to gross loans) to gauge financial stability. The NPL ratio measures credit risk or loan portfolio risk of the bank. Previous studies that used the NPL ratio include Jiménez et al. (2010), Amidu and Wolfe (2013) and Goetz (2017). Credit risk is the primary banking risk, and its increase results in non-performing loans in the bank’s loan portfolio. A higher ratio indicates a bank’s higher tendency to keep a riskier loan portfolio, which undermines the bank’s financial soundness.

3.2. Measure of competition

To measure competition, we opt to use H-statistic, based on the methodology of Panzar and Rosse (1987). Because, it is widely used competition measure which based on new empirical industrial organisation literature and calculated based on easily available bank level data indicating bank’s competitive behavior. Further, it provides a quantitative appraisal of the competition condition of the market under market equilibrium (Apergis et al., 2016). Also, the interpretation of H-statistic is also very straightforward which takes a value from -∞ to +1, where greater the value of H-statistic indicates higher competition in the market, and vice versa. The methodology of Moch (2013) is followed in determining H-statistic for each calendar year separately for each ASEAN-5 country, using the following reduced-form revenue as stated in Eq. 4.

\[ \ln P_i = \alpha + \beta_1 \ln W_1 + \beta_2 \ln W_2 + \beta_3 \ln W_3 + \gamma_1 \ln X_1 + \gamma_2 \ln X_2 + \gamma_3 \ln X_3 + \epsilon_i \]  

(4)

where, the subscript ln indicates the natural logarithm; \( i \) indicates bank, \( P_i \) is the measure of output price of the loans, which is calculated by dividing interest income to total assets following an intermediation approach, and \( \epsilon_i \) is the error term. \( W_1 \) is the ratio of interest expenses to total assets as a ratio of price the of borrowed funds, \( W_2 \) is the ratio of personnel expenses to total assets as a
measure of the price of labor, and $W_3$ is the ratio of administrative and other operating expense to total assets as a measure of the price of fixed capital. Three bank-specific control variables, $Y_1$, $Y_2$, and $Y_3$, were added as the ratio of customer loans to total assets, ratio of equity to total assets, and total assets in millions of USD, respectively, as these are expected to influence the bank's revenue function.

The H-statistic model is based on the reduced-form revenue equation, using easily available bank-level variables to investigate the bank's market power for product price setting. H-statistic is calculated as a sum of the elasticities of bank's total revenue, with respect to the above input prices, calculated as $H = \beta_1 + \beta_2 + \beta_3$. A larger H-value indicates the change in input prices' greater influence on total revenue and more market competition. The value of H-statistic in perfect competition is equal to one, or that the proportion of increase in input prices and total revenue is the same. This is because the firm exits the market if it does not cover input prices. H-statistic under a monopoly takes either a zero or negative value, which means that an increase in input prices reduces the bank's total revenue. Under monopolistic competition, it takes a value between zero and one.

The following regression specification (Eq. 5) is used to test whether the H-statistic satisfies the long run equilibrium condition, as the existence of a disequilibrium condition may invalidate the value of the H-statistic (Moch, 2013):

$$\ln(1 + \text{ROA}_i) = \alpha + \beta_1 \ln W_1 + \beta_2 \ln W_2 + \beta_3 \ln W_3 + \gamma_1 \ln X_1 + \gamma_2 \ln X_2 + \gamma_3 \ln X_3 + \epsilon_i$$

where, $\text{ROA}_i$ is the bank's return on assets. In a long run equilibrium condition, $\beta_1 + \beta_2 + \beta_3 = 0$, indicating that input prices do not affect the bank's return on assets.

3.3. Measures of bank regulation

As mentioned earlier, the study is interested in investigating whether and how banking regulations such as capital requirements, activity restrictions, deposit insurance, and supervisory power affect financial stability. To capture the regulatory aspects, we construct indices for capital requirements, activity restrictions and powerful supervision and a dummy variable for deposit insurance based primarily on the survey results of Barth et al. (2001, 2006, 2008, 2013a).

3.3.1. Capital requirements index

The study constructs capital requirements index showing stringency of capital regulation following the work of Laeven and Levine (2009), where, initial capital stringency indicates whether certain source funds (such as assets other than cash and government securities and borrowed funds) may be considered as regulatory capital, and whether these funds are officially verified by the regulatory or supervisory authority. The overall capital stringency shows whether a certain type of banking risk and certain type of market value losses are adjusted in determining the regulatory capital. The details of the construction of capital requirements index is provided in Appendix B. The capital requirements index takes the value from 1 to 8, where a lower value indicates less stringency of the capital requirements, and a higher value indicates greater stringency of the capital requirements which may be used as buffer for reducing risk exposures of the bank.

Due to the ‘equity-at-risk’ effect as proposed by Hellmann et al. (2000), capital stringency motivates banks to function more prudently and also increase monitoring and controlling process in the investment, and not to engage in any risky investment that could push them to potential bankruptcy. This is because, when capital requirements are imposed on the banks, the bank's equity is at risk, as the cost of defaults is adjusted with shareholders' equity. As a result, we may expect high capital requirements may decrease banks' risk-taking intensity, and promote financial stability.

3.3.2. Activity restrictions index

The study also constructs an index to capture activity restrictions of the banks following Beck et al. (2006, 2013). The details of the construction of activity restriction index are provided in Appendix B. The index determines whether the banks are unrestricted, permitted, restricted or prohibited to involve in insurance, securities, real estates, and owning non-bank firms. The index may take maximum variation between the values from 4 to 16, where a higher value indicates more restrictions on banking activities, and owning and controlling non-bank firms.

As argued by Keeley (1990), greater activity restrictions increase competition in the traditional banking market and increase fragility in the banking market due to ‘franchise value effect’. The activity restrictions reduce banks' scope of operations, information gathering, risk diversification and scope of increasing franchise value (Barth et al., 2004). Therefore, we may expect that activity restrictions may increase banks' risk intensity and make them fragile due to the franchise value effect.

3.3.3. Deposit insurance

This study also considers the deposit insurance coverage, because it is also expected to influence on banks' market power and financial stability by building a financial safety net and depositors' confidence (Demirgüç-Kunt and Detragiache, 2002). In order to capture the deposit insurance coverage, the study considers a dummy variable for indicating the presence of deposit insurance in a country with the value zero and one; where, one refers to the existence of explicate deposit insurance scheme and otherwise, zero following the works of Fu et al. (2014), and Anginer et al. (2014).

Deposit insurance is expected to promote financial stability and reduce risk exposures of banks based on ‘stabilization effect’ of Diamond and Dybvig (1983). The theoretical argument infers that well-structured deposit insurance scheme promotes financial intermediation, and reduces spillover effect of bank runs by providing a safety net to the depositors, and developing their confidence on the banking system, and also reducing banks' risk exposures by removing the ‘moral hazard’ of the insured banks.
3.3.4. Supervisory power index

The study constructs a supervisory power index to capture the supervisory power of the regulators over the commercial bank following the work of Barth et al. (2013b). Details of the construction of the index are provided in Appendix B. The index shows the supervisory authorities’ power over bank director, management, shareholder and auditors in order to take preventive or corrective actions against high-risk exposure which may influence financial stability. The index varies from 1 to 14 with higher value indicates more powerful supervision of the bank regulators. Beck et al. (2006) argued powerful official supervisors may not be politically biased; rather they may concern about the market failure due to their ‘public interest view’. As a result, they may directly monitor and correct banks’ risk-taking operations and bring them in discipline which may promote corporate governance and increase financial stability in the banking system. Thus, this study expects powerful official supervision in ASEAN-5 promotes financial stability, as the ASEAN governments desire to make the financial sector to be more protected, and official supervisors are also more concerned about market failure based on the experience of 1997–98 AFC (Zamorski and Lee, 2015).

3.4. Control variable

In examining the interaction of the bank regulation, competition and financial stability, the study opts to control a number of bank level and macroeconomic control variables. Bank level control variables include bank size, loan composition, loan quality, operational efficiency, and foreign ownership based on economic justification. Bank size is the natural logarithm of total assets. This is controlled as Tabak et al. (2012) suggested that large banks are more benefited from the competition; this may be due to the fact that large banks enjoy more market power in a competitive market, and they also enjoy more opportunity to diversify their assets' portfolio risk than small banks. The loan composition, which is the ratio net loans to total assets, is also included as this measures banks' lending behavior, as Kasman and Kasman (2015) found that a high lending rate increases banks' both credit risk and overall risk. The cost to income ratio is also included to account for the banks’ operational efficiency, as Schaeck and Cihák (2014) found that efficiency is the channel through which competition affects financial stability. Further, Boyd and Nicolo (2005) and Fiordelisi and Mare (2014) argued that less efficient banks expose their operations to a higher risk to improve performance and generate higher returns. A foreign bank ownership dummy is also included, following the work of Berger et al. (2009), as foreign banks may have higher efficiency and capitalization which help them to improve their risk management capability. Loan quality is also captured with the ratio of loan loss reserve to gross loans following the work of Laeven and Levine (2009), as it measures the extent of gross loans which is provided for but not charged off. A higher value of this ratio indicates poor loan quality which is expected to increase default risk or the probability of nonperforming loans, and undermine financial stability.

We also control macroeconomic variables, such as annual GDP growth and inflation rate. An annual real GDP growth rate is considered, following the work of Fu et al. (2014), and Lee and Hsieh (2014), as this implies fluctuations of economic activities, or a movement in the business cycle, which is likely to affect the country’s financial institutions’ performance. Inflation, or the consumer price index's annual growth rate, is also used following the work of Cubillas and González (2014) as a proxy of macroeconomic instability due to its inverse effect on the real economy.

3.5. Data and sample

We have collected data from a number of sources. Where, bank-level data are retrieved from the BankScope database, by Bureau Van Dijk, to construct a sample of an annual, unbalanced panel from 1990 to 2014, which covers both the 1997–1998 AFC and the 2008–2009 GFC. Banks are eliminated from the initial sample with less than three consecutive years’ observations, as we used three years rolling period in calculating the standard deviation of return on assets in calculating excluding other types of banks (such as, investment banks, saving banks and cooperative banks) and non-bank et al. (2013). To ascertain the compatibility of regulatory requirements, the study focuses on only commercial banks of ASEAN-5. GMM estimations are collected from the World Bank Development Indicator (WB-DI) and Heritage Foundation respectively.

We present summary statistics of the variables in Table 2 which contains bank level, regulatory and country specific data to understand bank characteristics, bank regulation and macroeconomic condition of the region. The lowest price of the fund (0.026) and price of output (0.036), and highest total assets (37,623.6) demonstrate that most developed banks in ASEAN-5 come from large banks concentration ratio in total assets is 0.97, 0.83 and 0.71 in Singapore, Malaysia and Thailand against 0.70 in Philippines and 0.68 in Indonesia during 1999–2014 (Khan et al., 2016), and average technical efficiency score of Singaporean, Malaysian and Thai commercial banks are 0.86, 0.73 and 0.71 respectively against that of 0.50 and 0.49 of Indonesian and Philippines banks respectively during 2004 to 2013 (Banna et al., 2014). Consolidation improves the...
performance of the ASEAN banks due to gain in economies of scale and scope, and synergistic effect (Rao-Nicholson et al., 2016). The table further shows that Singaporean banks are the most financially stable banks with the highest Z-score of 113.621 and Thai banks are least financially stable with the lowest average Z-score of 63.341. The highest financial stability of Singaporean banks in the region could be the results of lowest NPL ratio (3.437%) in the region. Berger et al. (2009) argued that high capitalization may be used as a risk management strategy to reduce credit risk and insolvency risk. In addition, more stringent regulations and supervision over the Singaporean commercial banks could also be a reason for greater financial stability in that country, where commercial banks are obliged to maintain minimum 12.5% risk-weighted capital which is 2% more than the Basel III accord of 10.5% (Monetary Authority of Singapore, 2011). With respect to the level of competition as captured by H-statistic, the average value ranges from 0.696 to 0.321 explaining monopolistic competition in the ASEAN banking market, where banks have limited market power to set loan price. The maximum level of competition is observed among Indonesian banks which may be attributed to the minimum level of concentration resulting from the less consolidation with only five deals accompanying 9% of all deals in the region during 2001–2012 period (Rao-Nicholson et al., 2016).

The table further demonstrates regulatory environment among ASEAN-5 is divergent where Singaporean banks face greater capital stringency (5.632) against lowest in Malaysian banks (4.557) which may lead to less competition and more financial stability in the Singaporean banks. In term of activity restrictions, banks from Malaysia face greater restrictions (13.327) to involve insurance and other non-bank activities, and banks from Indonesia (8.891) face less restrictions on those activities. In addition, highest value of deposit insurance in Indonesia (1.0) against lowest in Thailand (0.196) may cause Indonesian banks to increase government safety
net and depositors’ confidence in the banking system which is reflected in the level of intermediation as measured by highest loan ratio (56.01%) and most competitive banking market in the region captured by H-statistic (0.696). In terms of official supervision, the most powerful supervisors to monitor and control bank risk come from Malaysia (12.038) and least from Thailand (10), the reason why Malaysian banks enjoy less NPL and higher market power despite having lower capital stringency and greater activity restrictions.

4. Results and discussion

Table 3 reports the system GMM estimates of Eq. 2, along with pre- and post-diagnostic test statistics of GMM specifications, using lnZ-score and NPL ratio as proxy of financial stability in models 1–4 and models 5–8 respectively. Before running any system GMM model, the Variance Inflation Factor (VIF) is calculated and reported at the bottom of Table 3 showing a value of less than ten in all models, implying that the models are free from multicollinearity problem. A significant value at 1% level in all models of pre-diagnostic tests-Woolridge test, Breush-Pagan/Cook-Weisberg test and Wu-Hausman test demonstrate that the regression specifications suffer from serial correlation, heteroscedasticity, and endogeneity between the dependent variable and explanatory variables mainly bank regulation and competition. Therefore, the application of system GMM to examine the association of financial stability with regulation and competition is justified, as Roodman (2006) argued that the system GMM is designed especially for handling serial correlation, heteroscedasticity and endogeneity problems.

In addition, the insignificant value of the post-diagnostic test, Hansen’s J test ensures the validity of overidentification restrictions indicating that instrumental variables particularly financial freedom and property right used for handling endogeneity problem are valid. Thus, heteroscedasticity problem is also handled, because, in the presence of heteroscedasticity, overidentification restrictions would not be validated (Baum et al., 2003). Similarly, the significant value of AR(1) and insignificant value of AR(2) indicate that serial correlation is present at first order, but it is absent in the second order. Moreover, the significant value of Wald test implies that all models are correctly specified.

Table 3 exhibits that the coefficient of H-statistic on lnZ-score is positive and significant in models 3 and 4, and it is negative and significant on NPL ratio in models 5, 7 and 8. In addition, the coefficient of the quadratic term of H-statistic on lnZ-score is negative and significant in models 3 and 4, and it is positive on NPL ratio in models 7 and 8. Moreover, in order to assess the type of the relationship between competition and financial stability, the inflation point for each model are calculated and compared with the data distribution. The inflection points of H-statistic in all models are > 0.730 which correspondence to 90th percentile, indicating that > 90% of the data distribution of H-statistic lying under the inflection point. These results suggest that increased competition is supportive for financial stability in the region, which is consistent with the competition-stability view of Boyd and Nicolo (2005).

In examining the role of regulation on competition-financial stability nexus, firstly, the results of Table 3 show that the coefficient of capital requirements index on lnZ-score is positive and significant in models 1 and negative and significant on NPL ratio in model 5. These results suggest that capital requirements appear to be an effective regulatory tool for promoting financial stability and reducing credit risk in the ASEAN banking system, supporting the work of Laeven and Levine (2009), Allen et al. (2011), Barth et al. (2013b) and Holod et al. (2017). This finding is also consistent with our expectation which supports the ‘equity-at-risk’ effect of Hellmann et al. (2000) and Repullo (2004). This is because, according to the ‘equity-at-risk’ effect, when the capital requirements are imposed, equity holders need to keep more equity which becomes risky, as a loss on bankruptcy is adjusted from shareholders’ equity. Therefore, banks do not have the incentive to engage in excessive risk that could potentially push them towards bankruptcy. As a result, ‘equity-at-risk’ effect makes banks more prudent and careful in investment process in order to reduce probability of insolvency, which not only attributed to set stricter loan granting criteria, but also increase monitoring and control the relationship with the borrowers with too-big-to-fail problem based on which bank may grant lower amount of loan to them. This finding is also consistent with the supervisory power hypothesis, where the supervisor requires a bank to maintain a minimum level of regulatory capital which not only strengthens their capital buffer in order to face unexpected financial shocks and risk-taking capacity but also limits them from excessive risk-taking and possibility of spillover effect (Jackson et al., 1999). In respect to risk limiting effect of capital requirements, Berger et al. (2009) argued that high capital adequacy provide franchise value which a bank may enjoy only if it remains active in the market and takes the lower lending risk.

To investigate whether the positive relationship between capital requirements and financial stability is changed in highly competitive environment, an interaction term of H-statistic and capital stringency index is included in Eq. 2, and also reported in models 1 and 5. The results demonstrate that the interaction term of H-statistic and capital requirements index remains positive and significant on lnZ-score in model 1 suggesting that capital requirements increase financial solvency and reduces fragility also for the banks facing higher level of competition. This may due to fact that high capital requirements in competitive market appear as a regulatory instrument which not only build market power by increasing capital buffer and risk-taking capacity of the existing banks, but also induce them to behave prudently due to ‘equity-at-risk’ effect in a competitive market. Because, despite competition erodes franchise value of banks and reduces the profit margin, banks do not go for excessive risky project in the competitive market, even though excessive risky projects promise higher returns. This is attributed to the fact that the probability of risky project to be successful is lower and probability of the project to be failed is higher (Niinimäki, 2004). The finding is consistent with the theoretical model of Repullo (2004) who proved that risk-based capital requirements enhance banks’ market power, and is an effective tool to restrain banks from risk-taking in a perfectly competitive deposit market. The finding is also consistent with the theoretical model of Behr

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6 A VIF value of > 10 indicates multicollinearity problem (Gujarati, 2009).
Table 3
Bank regulation, competition and financial stability in ASEAN-5 banking system from 1990 to 2014.

<table>
<thead>
<tr>
<th>Dependent variables</th>
<th>lnZ-score</th>
<th>NPL ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Lag of lnZ-score</td>
<td>0.635</td>
<td>0.660</td>
</tr>
<tr>
<td>H-statistic (H)</td>
<td>0.489</td>
<td>0.75</td>
</tr>
<tr>
<td>H2</td>
<td>-0.292</td>
<td>-0.426</td>
</tr>
<tr>
<td>Inflection point</td>
<td>0.836</td>
<td>0.880</td>
</tr>
<tr>
<td>A. H. Md. Noman et al.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The table exhibits system GMM results showing the exogenous loan, in model 5 between competition and bank regulation, competition and financial stability. The dependent variables are natural logarithm of Z-score in models 1-4 and NPL ratio, ratio of non-performing loan to gross loan, in model 5-8. Regressors are H, Panzar Rosse H-statistic; CAR, capital requirements; ACR, activity restrictions; DI, deposit insurance; SUR, official supervision. Control variables are loan composition, ratio of net loan to total assets; loan quality, ratio of loan loss reserve to gross loan; bank size, natural logarithm of total assets; operational efficiency, cost to income ratio; foreign ownership, a dummy variable considering if > 50% of ownership belongs to foreigners, otherwise 0; GDP, GDP growth rate; and inflation, inflation rate. Small value of VIF indicates the models are free from multicollinearity problem. Insufficient value of Hansen J test indicates that instrumental variables are valid. Significant value of Wooldridge test, Breush-Pagan/Cook-Weisberg test and Wu-Hausman test show there involves serial correlation, Heteroscedasticity and endogeneity and justify the use of GMM specification. Besides, significant value of Wald test implies that all models are correctly specified. The robust standard errors are reported in the parenthesis. ***, ** and * indicates the coefficient are significant at 1%, 5% and 10% respectively.
et al. (2010) who argued that capital requirements can effectively reduce risk-taking tendency of the banks in a less concentrated market.

Secondly, the coefficient of activity restrictions index on \( \ln Z \)-score is negative and significant in model 2, and positive and significant on NPL ratio in model 6, suggesting that tighter activity restrictions are associated with greater fragility in ASEAN banking system as it increases insolvency risk and credit risk, supporting the empirical work of Barth et al. (2004, 2008, 2013b) and Laeven and Levine (2009). This result is consistent with the expectation of this study as activity restrictions reduce the scope of operations and risk diversification, and exacerbate banks to take more insolvency risk. Regarding this issue, Claessens (2003) argued that financial services integration in emerging countries is a hotly debated issue. Theoretically, activity restrictions condense the scope of risk diversification opportunity. It also reduces the opportunity of risk shifting to other lines of businesses providing fees or profit in order to compensate potential loss from traditional banking. Rather, it forces banks to remain in the traditional banking activities to earn only interest and reduces opportunity to earn fees and franchise value.

However, the coefficient of the interaction term of activity restrictions index and H-statistic turns positive and significant on \( \ln Z \)-score in models 2 suggesting that with an increase in the level of competition the negative ‘franchise value’ effect of activity restrictions in the ASEAN banking system neutralizes and motivates banks to invest prudently reducing risk-taking efforts, which is consistent with ‘risk-shifting’ effect of Boyd and Nicolo (2005). This may the due to fact that, activity restrictions not only increases risk-taking incentive to the bank due to loss in scope of risk diversification, it also increases competition on the traditional banking market, which induces banks to take less risk due to ‘risk-shifting’ effect, where the ‘risk-shifting’ effect argues that banks assume less risk in the competitive loan market, because greater risk-taking by a bank increases the default risk of its borrowers which ultimately shifted to the bank due to high positive correlation between the bank’s insolvency and borrowers’ default risk (Boyd and Nicolo, 2005). This finding is also consistent with the theoretical consideration of Bellmann et al. (2000) who suggested that restrictions on certain assets classes reduce moral hazard problem of the banks, especially if they accelerate gambling opportunity which may cause of moral hazard. Beck (2008) also reported that many industrialized countries imposed restrictions on branching and other banking activities after financing crisis of the 1930s to promote competition and financial stability.

The effect of activity restrictions on financial stability is particularly an interesting issue for policy implication where a negative coefficient turns to positive, and vice versa, if the index interacts with H-statistic. To calculate the threshold level of H-statistic at which the risk-taking appetite of bank changes, we take the first derivate of the absolute value of Eq. 2 with respect to activity restrictions index and makes it equal to zero following Wooldridge (2015). This provides \( \frac{\Delta STAB_{it}}{\Delta ACT_{it}} = c_4 + c_5 H = 0 \) or \( | -0.115 + 0.178 + H | = 0.6446 \) model 2, and \( 0.701 - 0.995 + H = 0 \) or \( H = 0.705 \) in model 6. These results explain that, for the level of competition beyond the threshold level, more restrictions increase financial stability and reduce appetite for risk-taking. The results suggest that activity restrictions exacerbate risk appetite of banks with high market power in a less competitive market. However, the risk-taking behavior of the banks is changed with decreasing the level of market power and increasing the level of competition. This finding is in accordance with the theoretical consideration of Hellmann et al. (2000), Repullo et al. (2004) and Barth et al. (2004).

Thirdly, with respect to the effect of deposit insurance on financial stability, Table 3 further shows that the coefficient of deposit insurance on \( \ln Z \)-score is positive and significant in model 3, and negative and significant on NPL ration in model 7. These results suggest that deposit insurance has a stabilization effect in the absence of high competition in the ASEAN banking market. This finding is consistent with our expectation, and the theory of Diamond and Dybvig (1983), and the empirical findings of Chernykh and Cole (2011), Anginer et al. (2014) and Assa and Okhrati (2018). This may be due to the fact that deposit insurance promotes the level of intermediation in the banking market and reduces the moral hazard of the bank for taking the excessive risk as argued by Demirgüç-Kunt and Detragiache (2002). In the absence of deposit insurance, banks need to offer higher interest rate to the depositors which would increase loan interest rate, and also the moral hazard of the banks for earning more return. However, in the presence of deposit insurance depositors are protected by a public safety net which builds their confidence in the banking system and motivates them to deposit their savings in the banking system. This not only increases the banks’ market power for creating more loan and earn franchise value, but also it increases the financial stability of the banking system.

Notably, Table 3 further demonstrates that the coefficient of the interaction term of deposit insurance and H-statistic becomes negative and significant on \( \ln Z \)-score in model 3, and positive and significant on NPL ratio in model 7. The results demonstrate that deposit insurance undermines financial stability and increases risk-taking appetite for the banks facing higher level competition. The results suggest that level of competition plays a critical role on the relationship between deposit insurance and financial stability. Following Wooldridge (2015), we have calculated the threshold level of competition, by taking first derivate of absolute value of the Eq. 2 with respect to deposit insurance and making it equal to zero, \( \frac{\Delta STAB_{it}}{\Delta DI_{it}} = c_4 + c_5 H = 0 \) or \( H = 0.656 \) in model 3, and \( -1.363 + 2.153 + H | = 0.633 \) in model 7. These results explain that high deposit insurance weakens financial stability and increases appetite for risk-taking after exceeding the level of competition beyond its threshold level. This may be due to the fact that deposit insurance may increase the moral hazard of excessive risk-taking in the banking system with a rise in the level of competition, because, in the presence of deposit insurance in the banking system, depositors are protected by a public safety net, and they are lenient to monitor the risk-taking appetites of the banks. Therefore, banks can borrow funds at a lower interest rate issuing deposit insurance, which then lends to risky borrowers in a highly competitive market at the higher interest rate to compensate their lost franchise value.

Finally, with respect to the effect of powerful official supervision, the results of Table 3 also show that effect of official supervision is positive and significant on \( \ln Z \)-score in model 4, and negative and significant on NPL ratio in model 8, suggesting that powerful
official supervision has a positive effect on strengthening the financial stability and reducing credit risk. The findings indicate that banks reduce their tendency to take excess risk in the presence of powerful supervision, which promotes their financial stability. This is consistent with the ‘public interest view’ of Beck et al. (2006), and also empirical finding of Tabak et al. (2016). The reason is that powerful official supervisors are concerned about market failure. Therefore, they give their full effort to bring discipline in the banks by monitoring their risk-taking behavior and ensuring regulatory compliance which promotes corporate governance in the banking system, and incentivizes banks to maintain a close relationship with the borrowers. This not only solves the information problem of the banks, but also mitigates the moral hazard problem through a close lending relationship.

The results further demonstrate that coefficient of the interaction term of the official supervision index and H-statistic is positive and significant on lnZ-score in model 4, and negative and significant on NPL ratio in model 8. These results suggest that stringent official supervision increases financial stability even in a highly competitive environment in the ASEAN banking system. These results are also consistent with the public interest view of official supervision identified by Beck et al. (2006), suggesting powerful supervision obliges banks to comply with banking regulations and brings discipline in the banking system which is highly needed in a competitive banking market.

4.1. Robustness tests

To ensure accuracy of the system GMM estimates reported in Table 3, and validate the findings of the role of bank regulation on the relationship between competition and financial stability, this study undertook several robustness checks. We choose not to present the tables of robustness tests results for space conservation, but the results are almost identical to the Table 3, and the tables are available upon request from the authors. Firstly, we checked efficiency of the GMM estimates by comparing the lagged dependent variable of the system GMM estimate reported in Table 3 against the same lagged dependent variable calculated using dynamic Ordinary Least Square (OLS) and dynamic fixed effect. This is because, Roodman (2006) argued that lagged dependent variable of the GMM estimation must be within the lagged dependent values of dynamic OLS (suffering from upward biasness and provides maximum value) and dynamic fixed effect estimation (suffering from downward biasness and provides minimum value). Therefore, the study re-estimated Eq. 2 using both dynamic OLS and dynamic fixed effect. We found that the coefficient of lagged dependent variable of the system GMM estimates are in between the coefficients of lagged dependent variables calculated using dynamic OLS and dynamic fixed effect which ensures efficiency of the system GMM estimates. Secondly, we removed the quadratic term of H-statistic (H²) to examine the linear relationship between competition and financial stability, and re-estimated Eq. 2 using system GMM following the works of Berger et al. (2009) and Kasman and Kasman (2015). Thirdly, instead of dynamic formulation, we used static formulation of Eq. 2, and apply both OLS and Fixed-effect following the work of Lee and Hsieh (2014) who examined banking reform effect on the relationship between foreign ownership and bank’s risk-taking instead of two-step System GMM. Thirdly, instead of Panzar Rosse’s H-statistic, we considered Lerner index of Lerner (1934) that measures market power of a bank in setting loan price over the marginal cost, which is inversely related to the competition (Berger et al., 2009). The estimation method of Lerner index is provided in Appendix C. Fourthly, we made a sub-sample analysis of the role of bank regulation on competition and financial stability relationship during the 2000–2014 period. As, the banking sector of ASEAN-5 has gone through tremendous bank restructuring, and regulatory and supervisory changes during 1999–2002 period aftermath of the 1997–1998 AFC in order to strengthen financial institutions, rebuild public trust and restore financial stability in the banking system (Laevens, 2005; Williams and Nguyen, 2005; Lee and Hsieh, 2014). Here, we considered the succeeding year of 1999 when regulatory reform strategies are adopted in ASEAN countries as the starting year of sub-sample since a new regulation does not influence on financial stability immediately, particularly through the channel of competition. We found that our robustness tests are robust with our main findings. The robustness tests conform that competition is supportive for financial stability. The robustness tests also robustly indicate that capital requirements and official supervision are effective risk minimizing tools for the bank irrespective of the level of competition. In addition, deposit insurance robustly promotes financial stability in a less competitive environment, while activity restrictions promote financial stability in a highly competitive environment.

5. Conclusion and policy implications

This study examines the role of bank regulation, especially capital regulations, activity restrictions, official supervision, deposit insurance and official supervision on the relationship between competition and financial stability. Our sample consists of 180 commercial banks from ASEAN-5 over the 1990–2014 period. Applying the system GMM and using financial freedom and property right as instrumental variables this study has revealed several interesting findings. Firstly, we have found that competition promotes financial stability, and reduces credit risk in the banking system. Secondly, with respect to the regulatory effect on financial stability, the findings indicate that capital requirement, deposit insurance and official supervision have a positive effect on financial stability, if they are independent of competition. These regulatory policies promote financial stability by reducing credit risk of the banks. Further, we have found that the role of capital regulations and official supervision remain unchanged as regulatory tools in promoting financial stability even in a highly competitive environment. However, the effect of deposit insurance on financial stability is found altered in a high competitive market. On the other hand, activity restrictions are found weakening financial stability and increasing risk-taking behavior of the banks in a less competitive market. However, the negative effect of activity restrictions on financial stability found mitigated in a highly competitive market.

The above findings have important policy implications for the bank managers, regulators, and policy makers. Firstly, the policy maker should avoid anti-competitive policy as competition promotes financial stability. Secondly, the effectiveness of different bank
regulations in shaping financial stability should be investigated along with the level of competition in a disaggregated manner so that the most effective bank regulation can be identified. In the absence of high competition, activity restrictions have a risk-taking effect in the banking system, while that effect is altered in the presence of high competition due to the risk-shifting effect of competition, suggesting that bank regulators may impose activity restrictions to increase competition and restrict banks from excessive risk-taking. Also, deposit insurance may be more explicit to promote financial stability and reduce the risk exposure of the banks in a market where competition is lower. However, deposit insurance may weaken financial stability in the presence of high competition in the banking market. Finally, the findings reveal that capital requirements and official supervision are the most effective and straightforward regulatory tools for reducing credit risk and promoting financial stability irrespective of the level of competition in the banking market. Therefore, this study suggests that the adaptation of Basel III framework by ASEAN-5, to improve the risk management capacity and bring discipline to the market, would be beneficial for the region to ensure financial stability.

Acknowledgement

Special thanks are due to the academic editor (S. Ghon Rhee), and anonymous referee for their constructive comments and suggestions. We believe that the quality of the paper has substantially improved after addressing the comments and suggestions. We would like to thank Jin-Chuan DUAN, and participants of the 24th Conference on the Theories and Practices of Securities and Financial Markets at Sun Yat-Sen University, Taiwan for their valuable comments and suggestions. We also thankful to Yong-Cheol Kim, Michiel van Leuvensteijn, and Jens Hagendorff for their valuable advices in preparing the paper. All remaining errors are our own. The usual caveats apply.

Appendix A. Capitalization, risk management capacity and earning capacity of each ASEAN-5 countries in 1998, 2008, and 2014

<table>
<thead>
<tr>
<th></th>
<th>Indonesia</th>
<th>Malaysia</th>
<th>Philippines</th>
<th>Singapore</th>
<th>Thailand</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capitalization</strong></td>
<td>−3.70</td>
<td>13.25</td>
<td>13.27</td>
<td>9.75</td>
<td>10.77</td>
</tr>
<tr>
<td><strong>Risk management capacity</strong></td>
<td>36.46</td>
<td>3.58</td>
<td>3.10</td>
<td>11.13</td>
<td>2.06</td>
</tr>
<tr>
<td><strong>Earning capacity</strong></td>
<td>−15.27</td>
<td>0.130</td>
<td>1.23</td>
<td>0.32</td>
<td>1.30</td>
</tr>
</tbody>
</table>

Source: Bankscope (Bureau Van Dijk). Capitalization is measured with the ratio of equity on total assets, Risk management capacity is measured with the ratio of nonperforming loans on gross loans, and earning capacity is measured with the ratio of return on average total assets.

Appendix B. Construction of bank regulation index

<table>
<thead>
<tr>
<th>Regulation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capital REQUIREMENTS index</strong></td>
<td>In constructing the index, the study considers the following 8 questions where 1 is assigned to the ‘yes’ answer to the question from 1 to 6 and ‘no’ answer to the questions 7 and 8, otherwise, 0. The questions are (1) is the minimum required capital ratio risk weighted in the line with Basel guidelines? (2) Does the minimum ratio change with market risk? (3) Are market values of loan losses not realized in accounting books deducted from capital? (4) Are unrealized losses in securities portfolios deducted? (5) Are unrealized foreign exchange losses deducted? (6) Are the sources of funds to be used as capital verified by the regulatory or supervisory authorities? (7) Can the initial disbursement or subsequent injections of capital be done with assets other than cash or government securities? (8) Can initial disbursement of capital be done with borrowed funds?</td>
</tr>
<tr>
<td><strong>Activity restrictions index</strong></td>
<td>The index uses to decide whether the commercial banks are (1) unrestricted, (2) permitted, (3) restricted or (4) prohibited in the country in involving in insurance, securities, real estate financing and ownership of non-bank financial firms. In constructing the index, the value 1 is considered for unrestricted, 2 is considered for permitted, 3 is considered for restricted and 4 is considered for prohibited in insurance, securities, real estate activities and owning non-bank financial institutions.</td>
</tr>
<tr>
<td><strong>Official supervision index</strong></td>
<td>The index is calculated by incorporating the following 14 questions of Barth et al. (2001, 2006, 2008, 2013a) following the work of Barth et al. (2013b). The question takes the value of 1, if answer is found as yes, otherwise, it takes the value of zero. The questions are: 1) Does the supervisory agency have the right to meet with external auditors to discuss their report without the approval of the bank? 2) Are auditors required by law to communicate directly to the supervisory agency any presumed involvement in the financial stability irrespective of the level of competition in the financial institutions.</td>
</tr>
</tbody>
</table>
of bank directors or senior managers in illicit activities, fraud, or insider abuse? 3) Can supervisors take legal action against external auditors for negligence? 4) Can the supervisory authority force a bank to change its internal organizational structure? 5) Are off-balance sheet items disclosed to supervisors? 6) Can the supervisory agency order the bank's directors or management to constitute provisions to cover actual or potential losses? 7) Can the supervisory agency suspend the directors' decision to distribute dividends? 8) Can the supervisory agency suspend the directors' decision to distribute bonus? 9) Can the supervisory agency suspend the directors' decision to distribute management fees? 10) Can the supervisory agency legally declare-such that this declaration supersedes the rights of bank shareholders-that a bank is insolvent? 11). Does the banking Law give authority to the supervisory agency to intervene that is, suspend some or all ownership rights-a problem bank? 12–14). Regarding bank restructuring and reorganization, can the supervisory agency or any other government agency do the following: (12) supersede shareholder rights? (13) Remove and replace management? (14) Remove and replace directors?

Appendix C. Explanation of Lerner index

Lerner Index is also used extensively in recent studies to gauge banking market competition by estimating market power of setting loan price over the marginal cost (such as, Berger et al., 2009; Amidu and Wolfe, 2013; Beck et al., 2013; Soedarmono et al., 2013; Fiordelisi and Mare, 2014; Sun et al., 2017). High market power indicates less competition, and vice versa (Lerner, 1934). In a perfectly competitive market, the Lerner index takes a value of zero, Lerner = 0, indicating that both product price and marginal cost are equal for the bank. In less a competitive market, the market price and marginal cost would be different, and the bank may enjoy high mark-up. Thus, unity of Lerner index indicates, Lerner index = 1, pure monopoly market; and a value of Lerner index between unit and zero, 0 < Lerner index < 1, indicates monopolistic market. Non-optimal behavior of the market participant in setting loan price is represented by the Lerner Index < 0, where the bank loan is priced below the marginal cost (Fu et al., 2014).

Despite Lerner index has many advantages to measure competition, including simplicity in estimation, easy interpretation, and flexibility of data requirement (Leon, 2014), it suffers from some theoretical and practical constraints. Such as, theoretically it is possible to increase price-cost margin with increasing competition which makes Lerner index misleading (Stiglitz, 1989). Similarly, due to reallocation effect from inefficient firms to efficient ones, despite individual firm’s Lerner indices decreases with the competition, the average competition level remains stable, increase or decrease (Boone, 2008). Therefore, this study has not used Lerner index as a major testing variable, and only used in the robustness test.

The Lerner index is measured in the following manner:

\[
\text{Lerner index} = \frac{P_{TAi} - MC_{TAi}}{P_{TAi}} \tag{A.1}
\]

where, \(P_{TAi}\) is the price of total assets, indicating the ratio of total revenue (sum of interest income, non-interest operating income and other operating income) to total assets for bank \(i\) at time \(t\), following the work of Berger et al. (2009). \(MC_{TAi}\) is the marginal cost of the total assets of bank \(i\) at time \(t\). The following translog cost function is estimated for each ASEAN-5 country, using the methodology of Demirguc-Kunt and Peria (2010), to estimate \(MC_{TAi}\):

\[
\ln\text{Cost}_{it} = \alpha + \beta_1 \ln(Q_{it}) + \beta_2 (\ln Q_{it})^2 + \beta_3 \ln(W_{1it}) + \beta_4 \ln(W_{2it}) + \beta_5 \ln(W_{3it}) + \beta_6 \ln(Q_{it}) \ln(W_{1it}) + \beta_7 \ln(Q_{it}) \ln(W_{2it}) + \beta_8 \ln(Q_{it}) \ln(W_{3it}) + \beta_9 \ln(W_{1it}) \ln(W_{2it}) + \beta_{10} (\ln W_{1it})^2 + \beta_{11} (\ln W_{2it})^2 + \beta_{12} (\ln W_{3it})^2 + \beta_{13} \ln(W_{2it}) \ln(W_{3it}) + \beta_{14} \ln(W_{1it}) \ln(W_{3it}) + \theta \text{Year Dummies} + \epsilon_{it} \tag{A.2}
\]

The subscript \(i\) in equation Eq. (A.2) indicates the natural logarithm, \(i\) indicates banks, and \(t\) indicates year. Cost is the sum of interest expenses, non-interest operating expense, personnel expenses, other administrative expenses, and other operating expenses, expressed in millions of USD. \(Q_{it}\) is total assets in millions of USD, representing output quality. Three input prices are then used to capture the price of borrowed funds \(W_{1it}\), the price of labor \(W_{2it}\), and fixed capital \(W_{3it}\). \(W_{1it}\) is the ratio of interest expenses to total assets, \(W_{2it}\) is the ratio of personnel expenses to total assets, and \(W_{3it}\) is the ratio of administrative and other operating expenses to total assets. The cost function is estimated separately for each country to account for potential technological differences among the countries, following the work of Berger et al. (2009). A year dummy is included to handle technological progress and changes to the business cycle’s condition. Additionally, the following five restrictions are imposed to ensure homogeneity of degree one in the input prices:

\[
\beta_1 + \beta_4 + \beta_5 = 1; \beta_6 + \beta_7 + \beta_8 = 0; \beta_9 + \beta_{12} + \beta_{13} = 0; \beta_{10} + \beta_{11} + \beta_{14} = 0; \beta_{11} + \beta_{13} + \beta_{14} = 0
\]

The coefficient of Eq. (A.2) is used to estimate the marginal cost for bank \(i\) at time \(t\), using the following equation:

\[
MC_{it} = \frac{\partial C_{it}}{\partial Q_{it}} = \frac{C_{it}}{Q_{it}} [\beta_1 + 2\beta_2 \ln Q_{it} + \beta_3 \ln W_{1it} + \beta_4 \ln W_{2it} + \beta_5 \ln W_{3it}] \tag{A.3}
\]

Here, \(MC_{it}\) is the marginal cost of bank \(i\) at time \(t\), \(\ln Q_{it}/\ln W_{it}\) indicates changes in log of cost with respect to change in log of quantity. The remaining variables are defined along with the Eq. (A.2) above.