



Research article

Liquidity risk and bank performance in Southeast Asian countries: a dynamic panel approach

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Abstract: This study uses unbalanced panel data from Bankscope from 171 banks in 9 countries in Southeast Asia over the period 2004–2016 and the Generalized Method of Moments (SGMM) to analyze the impact of liquidity risk on bank performance in Southeast Asian countries. The results show that liquidity risk has a positive effect on the performance of banks or that most banks with good performance have a high liquidity risk under normal conditions. However, if there is a financial crisis, the effect of liquidity risk on bank performance is negative. This means that during the crisis, banks will seek to increase liquidity assets, to improve profitability, which will increase financial costs and reduce bank efficiency. Besides, bank performance in Southeast Asian countries is also influenced by the following factors: impact of the lag variable of bank performance, quality of liquid assets, bank size, bank capital, loan loss provision, GDP growth, money supply and inflation. The results of this study are intended to supplement the experimental results and suggest some critical guidelines for bank management in this area.

Keywords: liquidity risk; bank performance; financial crisis; Southeast Asia; SGMM

JEL Codes: G01, G20, G21

1. Introduction

The relationship between liquidity risk and performance has long been known through the approach of many hypotheses, such as the market power and efficient structure hypotheses, which are becoming increasingly interested. Liquidity risk is the bank's most dangerous risk. Not only does it endanger the safety of every commercial bank itself, but it also affects the security of the entire banking system (Eichberger & Summer, 2005).

Diamond and Dybvig (1983) have suggested that the link between liquidity risk and bank performance is still unclear. Some studies have shown a positive correlation between liquidity risk and bank performance in Africa (Aburime, 2009; Ajibike & Aremu, 2015; Alshatti, 2015), in Asia (Arif & Anees, 2012; Shen et al., 2009; Wasiuzzaman & Tarmizi, 2010), in Europe (Bourke, 1989; Goddard et al., 2004; Kosmidou et al., 2005; Poposka & Trpkoski, 2013). Some other studies have shown a negative correlation between liquidity risk and bank performance in Asia (Lee & Kim, 2013) and Africa (Bassegy & Moses, 2015). Besides, there are also several studies (Almumani, 2013; Anbar & Alper, 2011; Ayaydin & Karakaya, 2014; Roman & Camelia Şargu, 2013; Sufian & Chong, 2008) which have not yet found a link between liquidity risk, and bank performance or the dependence between these two variables depends on the economic characteristics and the research models used (Ferrouhi, 2014a; Naceur & Kandil, 2009).

Most studies examine the impact of liquidity risk on the bank performance (Aburime, 2009; Alshatti, 2015; Arif & Anees, 2012; Athanasoglou et al., 2008; Bassegy & Moses, 2015; Bourke, 1989; Ferrouhi, 2014a; Lartey et al., 2013; Naceur & Kandil, 2009; Oluwasegun & Samuel, 2015; Sayedi, 2014; Sufian & Chong, 2008; Tabari et al., 2013). Other research has analyzed the effect of bank performance on liquidity risk in different countries (Abdullah & Khan, 2012; Roman & Camelia Şargu, 2013; Vodova, 2011).

Overall, few studies combine separate analyses of the impact of liquidity risk on bank performance in many countries, except for some studies in Europe (Roman & Camelia Şargu, 2013), in America (Bordeleau & Graham, 2010), in Europe and America (Chen et al., 2018). However, these have not fully exploited the variables affecting bank performance and the liquidity risk measurement indicator. They have not resolved yet endogenous problems caused by the lagged effects of dependent variables, which can lead to distortions in the research results of the regression model. In Southeast Asian markets, there is not any study examining the effect of liquidity risk on bank performance nor investigating the influence of the financial crisis on this relationship in many countries. Therefore, research on the impact of liquidity risk on bank performance in Southeast Asian countries in the period 2004–2016 also contributes to verifying the impact of liquidity risk on bank performance in Southeast Asian countries. Studies at different locations and at different times will provide inconsistent results on the impact of liquidity risk on bank performance. In the context of theory and practice, to fill the research gaps, the combination of the approach to investigating the impact of liquidity risk on bank performance in the case of Southeast Asian countries is vital and valuable.

This study follows the research model of Rahman et al. (2020) to analyze the impact of liquidity risk on bank performance in Southeast Asian countries. This paper will contribute to empirical

evidence and provide useful information on the factors that affect bank efficiency, especially the influence of liquidity risk on bank performance in the Southeast Asia region.

2. Literature review

2.1. *Liquidity risk*

The Basel Committee on Banking Supervision (BCBS) (2003) considers that liquidity risk is a risk that the bank is unable to increase its funds in assets or liabilities with the lowest cost. Duttweiler (2011) state that liquidity represents the ability to meet all overdue payment obligations. Due to the implementation of cash, liquidity only involves cash flow. Failure to comply with payment obligations will result in a lack of liquidity. From a banking perspective, liquidity is the ability of a bank to respond quickly and comprehensively to financial obligations arising in the course of business operations such as payment of deposits, loans, payments and other financial transactions. A prolonged lack of liquidity will lead to liquidity risk. Barros et al. (2014) argue that the complexity of the bank's financial intermediary role gives rise to liquidity risk. Banks use limited resources to grant loans to businesses and consumers. Most of the resources used by banks are often tied to liabilities in the form of deposits. For-profit purposes, banks convert debt (short-term deposits) to medium and long-term loans. Term mismatches have led to liquidity risk for banks (Diamond & Dybvig, 1983). To reduce the difference in terms between assets and liabilities to control liquidity, banks can hold liquid assets. However, the opportunity costs of holding these cash and cash equivalents are a profit factor. The more liquid funds the bank has to maintain liquidity, the more the profit will decrease and vice versa. Therefore, although banks have incentives to maintain liquidity reserves (cash, short-term assets and government bonds), it is challenging to guarantee liquidity in their performance management (Barros et al., 2014). Brunnermeier and Pedersen (2009) point out that if banks do not adequately manage the liquidity risk, they are sure to be exposed to a liquidity shock, they must sell their liquidity assets and reduce loans to the economy. These actions will increase the possibility of market disruption, and the bank will be confronted with liquidity shocks, which will lead to a prolonged decline in market liquidity. This scenario will have a significant impact on real economic growth. It can be observed that the liquidity risk of each commercial bank, as well as the liquidity risk of the entire banking system were hardly taken into account by political decision-makers and bank administrators until the global financial crisis in 2007–2009. Therefore, the assessment of the impact of liquidity risk on bank performance is necessary and has a practical value.

2.2. *Liquidity risk and bank performance*

Its profitability often measures bank performance. Studies on bank performance or profitability are based on two hypotheses: Market-Power and Efficient-Structure hypotheses.

2.2.1. Market-Power hypothesis (MP)

MP has two main approaches: Structure-Conduct-Performance hypothesis (SCP) and Relative Market Power hypothesis (RMP). SCP hypothesis states that the structure of a market determines the behavior of the company, and this behavior determines the market results, such as profitability, technical progress and growth. According to the SCP hypothesis, the more concentrated the banking market is, the higher interest rates and the lower deposit rates because of lower competition. Meanwhile, the RMP hypothesis suggests that companies with large market shares and differentiated products can exercise market power and gain non-competitive profits (Berger, 1995). The hypothesis implies that due to the benefits of market power, the more concentrated the market, the greater the profitability of the market. Therefore, there is a positive correlation between profit and scale (De Guevara & Maudos, 2007). The hypothesis implies that increasing scale increases the profits of the banks.

2.2.2. Efficient-Structure hypothesis (ES)

ES proposed by Demsetz (1973) argues that the most efficient banks achieve both higher profits and market share. An increase in the bank's profitability is an indirect result of improving the bank's efficiency governance rather than the power of market interests. Anyanwaokoro (1996) has confirmed that profits play an essential role in persuading depositors to deposit money in banks. Consequently, banks with higher profits are due to their more efficient operations (Olweny & Shiphoh, 2011). ES hypothesis is often proposed in two different approaches, depending on the type of efficiency that is being considered. With the X-Efficiency approach, more efficient companies often gain more market share and higher profits, because they can reduce production costs at any output (Al-Muharrami & Matthews, 2009). With the scale-efficiency approach, the relationship described above is explained by the scale. Larger firms can obtain lower unit cost and higher profits through economies of scale (Olweny & Shiphoh, 2011).

Thus, the Market-Power hypothesis states that a bank's profitability is a function of market factors, while the Efficient-Structure hypothesis implies that the bank performance is influenced by internal efficiency and administrative decisions (internal factors). Accordingly, many researchers have relied on these hypotheses to introduce many useful variables into the bank performance model and widely recognize that the profitability of the bank is a function that is influenced by both internal and external factors (Olweny & Shiphoh, 2011).

2.2.3. The risk-return trade-off hypothesis

Several background theories have tried to analyze how liquidity risk affects the performance of banks. According to the hypothesis of corporate finance (Miller & Bromiley, 1990), a bank in equilibrium would prefer to maintain an optimal level of liquidity solely to offset its costs and benefits at the marginal level. However, the capital requirements of monetary managers are forcing banks to keep liquidity above their optimal level and, therefore, force banks to exceed optimal internal liquidity. Moreover, because the optimal liquidity level of a bank can change during the economic cycle, often

increasing as the costs are expected to be higher, the relationship between liquidity and the profitability of banks tends to be much cyclical. During the period of crisis, the performance of banks is positively correlated with their liquidity, or banks try to increase liquidity to improve profits (Osborne et al., 2012) therefore the relationship between liquidity and bank performance in short-term (positive or negative) depends on whether the bank is above or below the optimal liquidity. Flannery and Rangan (2008) claim that indeed if banks succeed in maintaining optimal liquidity, there will be no such short-term relationship. However, in the long term, the regulatory liquidity requirements are binding. High liquidity reduces profitability if banks exceed their optimal levels of liquidity, e.g. due to regulatory requirements or unexpected shocks (Flannery & Rangan, 2008).

Osborne et al. (2012) suggested that the optimal liquidity of banks increased during the crisis of the banking industry because, under such conditions, bankruptcy costs will increase. Therefore, it is expected that the relationship between liquidity and profitability between banks will be cyclical. This is because, in extreme environments, banks tend to reserve a lower level of liquidity than the optimal level. However, under normal conditions, banks may or may not reach their optimal level of liquidity. In that case, the relationship would be close to zero or vice versa. This implies that bank performance can be improved by reducing liquidity (Osborne et al., 2012). The reduction in the structure of liquidity assets increases the liquidity risk. The hypothesis states that as risk increases, profitability increases accordingly, and there is a positive correlation between risk and profit.

2.2.4. Banking specificities hypothesis

Banking specificities hypothesis was developed by Pruteanu-Podpiera et al. (2007). The theory argued that the banking sector has some more special characteristics compared to other markets due to the existence of unbalanced information in an imperfectly competitive market. Therefore, banks must solve the problem of adverse selection and moral hazard. To minimize this problem, banks must maintain long-term relationships with borrowers. However, when competition increases, it is possible to increase supervisory costs due to economies of scale and a reduction in long-term customer relationships. To maintain sustainable and stable development of the economic environment, it is necessary to assess the financial situation of banks through the management and regulatory policies. This derives from the role of necessary financial intermediation of commercial banks, intending to guarantee bank performance (Halling & Hayden, 2006). Prudent management of a bank's operations to maximize profits is the primary goal of any bank. This is a prerequisite in the competitive environment of banks to provide cheap capital. This means that there is a negative correlation between costs and profits, or in other words, the higher the costs, the lower the profits.

2.2.5. The impact of liquidity risk on bank performance

The studies focus on the analysis of factors that influence the bank's performance, including the liquidity risk factor. The relationship between liquidity risk and bank performance is quite complicated. Some studies suggest that high liquidity risk increases the bank's performance through high-interest profits, while others point out that it reduces the bank's efficiency due to the high cost of capital

involved in financing. Some authors find a positive relationship, others find a negative one, while some authors find both positive and negative relationships, and some find no relationship at all. There are two conflicting views on the relationship between liquidity risk and bank performance:

Liquidity risk increases bank performance: Most studies in Africa (Ajibike & Aremu, 2015; Alshatti, 2015; Sayedi, 2014; Siaw, 2013) and Europe (Bourke, 1989; Goddard et al., 2004; Kosmidou et al., 2005; Poposka & Trpkoski, 2013) all approach the scope of research in a single country and use ROA, ROE variables to reflect the bank performance, the results show that the greater the bank's liquidity risk, the higher the bank performance. Another point of view from Siaw (2013), compared to other studies, is the use of the financing gap as a measure of liquidity risk. In particular, there are two studies in Asia (Arif & Anees, 2012; Shen et al., 2009) on the impact of liquidity risk on bank performance. Meanwhile, Shen et al. (2009) studied the impact of liquidity risk on bank performance in developed economies (Australia, Canada, France, Germany, Italy, Japan, Luxembourg, Netherlands, Switzerland, Taiwan, United Kingdom and the United States) from 1994 to 2006, Arif and Anees (2012) used financing gap as a measure of liquidity risk and analyze this relationship only in Malaysia during the 2006-2008 period. In both studies, three variables were used to represent bank performance: return on assets (ROA), return on equity (ROE), net interest margins (NIM).

Liquidity risk reduces bank performance: Studies in Asia (Lee & Kim, 2013), in Europe (Ndoka et al., 2017) and Africa (Bassey & Moses, 2015; Kutsienyo, 2011) only approach the scope of research in a separate country and all use ROA and ROE variables to represent bank performance. The results of their research show that liquidity risk is one of the factors that influences bank performance with an opposite effect.

Furthermore, some studies show no link between liquidity risk and bank performance or a relationship depending on the research model used, such as some cases in Asia (Sufian & Chong, 2008). In Europe, Roman and Camelia Şargu (2013) analyze the determinants of liquidity risk to achieve financial stability in Europe. This study uses data from banks operating in Central and Eastern European countries (CEE: Bulgaria, Czech Republic, Hungary, Latvia, Lithuania, Poland, Romania). Researchers looked at banking factors in the 2004–2011 period using the OLS regression analysis method. The results show that the relationship between liquidity risk and profit is not significant. Similar research results have been found in Europe, such as studies by Almunani (2013), Ayaydin and Karakaya (2014). Research for the Americas region (Anbar & Alper, 2011; Bordeleau & Graham, 2010; De Young & Jang, 2016; Ferrouhi, 2014a) show that the impact of liquidity risk and bank performance is not significant. There is only the study of (Bordeleau & Graham, 2010) which approaches the scope of research in many countries with a database table of 65 commercial banks in the United States and Canada over the period 1997–2009. This study suggests that banks' liquidity and performance depend on the bank's business model and the state of the economy. If the bank maintains low liquidity, the profit will be increased by the impact on the low financial costs. If the bank increases its liquidity, the opportunity cost will decrease, and the profit will be reduced. The study shows the relationship between liquidity and profit in a parabolic form. Profits improve when banks hold liquid assets, but at some point, holding liquid assets will reduce bank performance. Unlike previous studies, De Young and Jang (2016) use two variables for liquidity risk measurement variables (LTCD, NSFR) based on Basel 3 standards. The results show that small and medium-sized banks that traditionally

handle liquidity are riskier. In the meantime, the results of the study show that the impact of liquidity risk on bank performance is not statistically significant.

In general, studies related to liquidity risk and bank performance are conducted mainly within a country except for those in Europe (Roman & Camelia Şargu, 2013), in America (Bordeleau & Graham, 2010), in Europe and America (Chen et al., 2018). As noted by the author, these are three reasonably methodical empirical studies on liquidity risk and bank performance in many countries and published in high-reliability journals. In the case of Southeast Asian countries, there has not been any study that analyses the impact of liquidity risk on bank performance in many countries. Studies in various research areas and study periods will provide inconsistent results on the relationship between liquidity risk and bank performance. The studies combines the approach of using liquidity gap measurement using the financing gap method (FGAP) and using the SGMM method to manage the endogenous phenomena caused by lagged effects in the model.

3. Methods

The study was conducted with unbalanced panel dataset from 171 banks during the 2004–2016 period of 9 countries in Southeast Asia, including Brunei, Cambodia, Indonesia, Laos, Myanmar, Malaysia, Philippines, Thailand and Vietnam. The data comes from two sources: (i) bank-level data from the Bankscope database, (ii) macro information data from the Asian Development Bank (ADB) database. The impact of liquidity risk on bank performance has lagged effects and not complete over time and industry. Therefore, the verification of the impact of liquidity risk on bank performance requires specialized models for panel data.

Due to the limitations of the OLS pool model in estimating panel data with bias due to variance, autocorrelation or endogeneity (Kiviet, 1995), FEM and REM estimates are used to control individual effects. However, since FEM and REM fail to manage endogeneity (Ahn & Schmidt, 1995), the system GMM method (SGMM) is used to solve the above problems (Arellano & Bond, 1991; Hansen, 1982; Hansen et al., 1996).

Anderson and Hsiao (1981) suggest using lags of explained variables as an instrument where these lags are uncorrelated with the residuals. In our framework, we can also use the alternative measures of profitability as an instrument variable in the instrumental variable estimation. Furthermore, some exogenous variables work well as an instrument in this dynamic panel data estimation. We applied dynamic panel data in the Arellano and Bond (Arellano & Bond, 1991; Hansen, 1982; Hansen et al., 1996) framework. The SGMM method produces robust, standard and efficient distribution coefficients. Stata software version 12 was used to determine these research results.

The study is based on the approach of Rahman et al. (2020) to build a model to assess the impact of liquidity risk on bank performance in South East Asia.

$$Y_{i,t} = \alpha Y_{i,t-1} + \beta_1 \text{LIQUIDITY RISK}_{i,t} + \beta_2 X_{i,t} + u_{it} \quad (1)$$

The dependent variable is Y_{it} (NIM, ROA, ROE).

Independent variables include: LIQUIDITY RISK: FGAP (financing gap), NLTA (Net Loans/Total Assets), NLST (Net loans/Total deposits Short-term).

X is the matrix of control variables include: SIZE (bank size); $SIZE_{it}^2$ (square of bank size); Quality of liquid assets including LIA_{it} (Liquid Assets/Total Assets), LLR_{it} (Liquid Assets/total loans) and $LADS_{it}$ (Liquid assets/Short-term customer deposits); ETA_{it} (Equity/total assets); LLP_{it} (loan loss provision/loans); GDP_{it} (GDP growth); INF_{it} (inflation); $M2_{it}$ (money supply); A moderator variable is **LIQUIDITYRISK*DCRIS_t**, presenting impacts of liquidity risk on bank performance when there is a financial crisis ($fgapcris_{it}$; $nlstcris_{it}$, $nltacris_{it}$).

With α (intercept), i (bank), t (year), u (error).

The relationship between the dependent and independent variables in the model investigating the impact of liquidity risk on bank performance is shown in Table 1.

To assess the impact of liquidity risk on bank performance, the study uses three-scale estimation models: ROA, ROE and NIM, in which each model is estimated with the SGMM method. Before regressing dependent variables with independent variables, the author examines whether the OLS hypotheses have been violated. Based on the arguments of the research methodology mentioned above, the SGMM method is the most appropriate method due to the occurrence of lagged effects in model with panel data, which causes endogenous phenomena and destroys the effectiveness and efficiency of regression coefficients in the model.

The SGMM method eliminates the problems of variance variation, autocorrelation or endogenous. Therefore the results of the estimate will be significant and firm. The results show that the estimates are statistically significant with tiny ($Prob > F$) ($Prob > F = 0.0000$). Then, we use the Sargan test to test the over-identifying property of the instrument variables. Besides, the quadratic autocorrelation test showed that the p-value results were more significant than 0.05, which concluded that the remainder of the SGMM model did not exist the quadratic autocorrelation phenomenon. The instrument variables used in the model satisfy both of the two tests set forth. Therefore, the use of the SGMM model with the lag variable of dependencies as a tool variable has solved the phenomenon of endogeneity in the model. The results found in the model are robust and can be analyzed effectively (Tables 2, 3, 4, and 5).

Table 1. Variables description (Impacts of liquidity risk on bank performance in Southeast Asian countries).

Category	Variables	Measurement	Previous studies	Expectation	Data sources
Bank performance	ROA	Net income/Total assets	(Anbar & Alper, 2011; Arif & Anees, 2012; Bassey & Moses, 2015; Chen et al., 2018; Ferrouhi, 2014b; Marozva, 2015; Lee et al., 2015)		BankScope
	ROE	Net income/Total equity	(Ajibike & Aremu, 2015; Anbar & Alper, 2011; Arif & Anees, 2012; Bassey & Moses, 2015; Chen et al., 2018; Ferrouhi, 2014b; Marozva, 2015; Lee et al., 2015)		BankScope
	NIM	(Interest income-Interest expense)/Average assets	(Arif & Anees, 2012; Chen et al., 2018; Ferrouhi, 2014b; Lee et al., 2015; Naceur & Kandil, 2009)		BankScope
Explanatory variables					
Category	Variables	Measurement	Previous studies	Expectation	Data sources
Liquidity risk	FGAP	(Bank loan –Customer deposit)/Total assets	(Bunda & Desquilbet, 2008; Chen et al., 2018; Ferrouhi, 2014b; Marozva, 2015; Lucchetta, 2007; Tehranian et al., 2006)	(+)	BankScope
	NLTA	Net loans/Total assets	(Anbar & Alper, 2011; Ayaydin & Karakaya, 2014; Chen et al., 2018; Ferrouhi, 2014b; Marozva, 2015; Lee et al., 2015)	(+)	BankScope
	NLST	Net loans/(Customers funding + Short-term funding)	(Anbar & Alper, 2011; Ayaydin & Karakaya, 2014; Ferrouhi, 2014b; Marozva, 2015; Lee et al., 2015; Munteanu, 2012)	(+)	BankScope
Control variables (Bank-specific)					
Variables	Definition	Measurement	Previous studies	Expectation	Data sources
Lag of bank performance	Bank performance has an effect on each other over time.	lag (P _{t-1})	(Ayaydin & Karakaya, 2014; Lee & Hsieh, 2013; Lee et al., 2015; Perera et al., 2014)	(+)	BankScope

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Control variables _(Bank-specific)

Variables	Definition	Measurement	Previous studies	Expectation	Data sources
SIZE	The large scale increases the power in the market and improves technology efficiency at low cost	Log (total assets)	(Anbar & Alper, 2011; Ferrouhi, 2014b; Godfey Marozva, 2015; Lee & Hsieh, 2013; Munteanu, 2012)	(+)	BankScope
SIZE^2	An increase in size increases profits until a threshold, an increase in size decreases profits	Log (total assets)^2	(Ayaydin & Karakaya, 2014; Chen et al., 2018; Lee et al., 2015; Lee & Kim, 2013)	(-/+)	BankScope
LIA	(Liquid assets/Total assets)	(Cash, CDs, deposits with banks, Short-term investments in the interbank market)/Total assets	(Anbar & Alper, 2011; Ayaydin & Karakaya, 2014; Chen et al., 2018; Ferrouhi, 2014b; Marozva, 2015; Kosmidou et al., 2005; Lee et al., 2015; Poposka & Trpkoski, 2013)	(+)	BankScope
LLR	Liquid assets/ Total loans	(Cash, CDs, deposits with banks, Short-term investments in the interbank market)/Total loans	(Anbar & Alper, 2011; Ayaydin & Karakaya, 2014; Chen et al., 2018; Ferrouhi, 2014b; Marozva, 2015; Lee et al., 2015; Shen et al., 2009)	(-)	BankScope
LADS	Liquid assets/Short-term customer deposits	(Cash, CDs, deposits with banks, Short-term investments in the interbank market)/Short-term customer deposit	(Almumani, 2013; Anbar & Alper, 2011; Ayaydin & Karakaya, 2014; Ferrouhi, 2014b; Marozva, 2015)	(-)	BankScope
Capital structure (ETA)	If the capital level is high, leverage and risks are lower	Equity/Total assets	(Anbar & Alper, 2011; Ayaydin & Karakaya, 2014; Chen et al., 2018; Ferrouhi, 2014b; Marozva, 2015; Lee et al., 2015)	(+)	BankScope
Credit risk (LLPT)	Problematic asset quality often reduces bank profits.	Loan loss provision/Loans	(Ayaydin & Karakaya, 2014; Chen et al., 2018; Lee et al., 2015; Trujillo-Ponce, 2013)	(-)	BankScope

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Macro-variables					
Variables	Definition	Measurement	Previous studies	Expectation	Data sources
GDP growth (GDP)	Banks lower interest rates during the growth period. Due to the high demand for loans allows banks to charge more from their services.	The real change in the gross domestic product (GDP) by year for each country. Log ((GDP _t -GDP _{t-1})/GDP _{t-1})	(Anbar & Alper, 2011; Ayaydin & Karakaya, 2014; Chen et al., 2018; Ferrouhi, 2014b; Marozva, 2015; John Y Lee et al., 2015)	(+)	ADB
M2	Money supply	Log (Money supply)	(Dietrich & Wanzenried, 2014)	(+)	ADB
Inflation rate (INF)	With unpredictable inflation, costs can grow faster than revenue and profits can decline	CPI change rate for each country of each year	(Anbar & Alper, 2011; Ayaydin & Karakaya, 2014; Chen et al., 2018; Ferrouhi, 2014b; Marozva, 2015; Lee et al., 2015; Sufian & Chong, 2008)	(-)	ADB
Interaction					
LIQUIDITY_CRIS	Assess the impact of liquidity risk on bank performance when there is a crisis factor	1: crisis period (2008–2010) 0: before the crisis period (2005–2007)	(Bunda & Desquilbet, 2008; Delécha et al., 2012; Lucchetta, 2007; Munteanu, 2012; Shen et al., 2009; Skully & Perera, 2012; Vodova, 2011).		

Note: (-) negative correlation, (+) positive correlation, (-/+) nonlinearity. Source: Summarized by authors.

Table 2. Descriptive statistics of fundamental variables, studying the impact of liquidity risk on bank performance in Southeast Asian countries.

Variable	Obs	Mean	Std. Dev.	Min	Max
NIM	1584	3.9	2.6	-4.7	22.3
ROA	1584	1.5	2.1	-26.0	19.2
ROE	1584	10.5	29.3	-604.4	232.4
FGAP	1584	-0.3	0.2	-1.0	0.7
NLTA	1584	56.8	18.6	0.4	102.1
NLST	1584	82.0	65.7	0.7	718.2
SIZE	1584	2.4	2.3	0.0	10.9
SIZE2	1584	10.8	17.1	0.0	118.6
LIA	1584	4.7	6.3	-20.4	46.4
LLR	1584	282.2	2146.5	0.3	5730.1
LADS	1584	21.2	29.5	-0.3	469.6
ETA	1584	9.7	8.7	-1.9	67.9
LLP	1584	26.1	71.9	0.0	1380.3
M2	1584	552.6	1197.0	1.0	7125.8
D_CRIS	1584	0.7	0.5	0.0	1.0

Source: Summary and calculations from ADB and Bankscope.

Table 3. Correlation between independent variables in the research model investigating the impact of liquidity risk to bank performance in Southeast Asian countries.

	FGAP	NLT	NLST	SIZE	SIZE2	LIA	LLR	LADS	ETA	LLP	GDP	INFL
FGAP	1											
NLTA	0.887	1										
NLST	0.611	0.513	1									
SIZE	0.204	0.156	0.161	1								
SIZE2	0.201	0.154	0.121	0.900	1							
LIA	-0.14	-0.18	-0.16	-0.70	-0.45	1						
LLR	-0.26	-0.30	-0.12	-0.07	-0.05	0.155	1					
LADS	-0.15	-0.32	0.099	0.326	0.139	-0.44	0.038	1				
ETA	0.248	-0.06	0.314	0.377	0.240	-0.44	-0.03	0.521	1			
LLP	-0.38	-0.42	-0.19	-0.29	-0.20	0.432	0.798	-0.18	-0.19	1		
GDP	0.050	0.039	0.034	0.098	0.025	-0.13	-0.01	0.067	0.087	-0.05	1	
INFL	0.013	-0.00	0.032	-0.09	-0.16	-0.03	-0.05	0.048	0.016	0.004	-0.00	1
M2	-0.13	-0.07	-0.07	-0.16	-0.10	0.136	-0.01	-0.10	-0.27	0.064	-0.06	0.074
D_CR	0.127	0.134	0.048	0.099	0.143	-0.01	0.045	-0.11	-0.04	0.015	0.088	-0.27
IS		4	1	7	3	65	5	94	78	2	8	78

Source: Summary and calculations from ADB and Bankscope.

Table 4. Results Tables: impact of liquidity risk on bank performance in Southeast Asian countries.

Variable	ROA			ROE			NIM		
L.ROA	0.121***	0.117***	0.114***						
	[16.63]	[15.33]	[14.58]						
L.ROE				0.0396***	0.0395***	0.0393**			
				[50.81]	[43.36]	[50.73]			
L.NIM							0.708***	0.645***	0.645***
							[33.40]	[31.28]	[32.84]
FGAP	1.207***			-12.21***			1.483***		
	[7.62]			[-6.97]			[5.63]		
fgapcris	-0.0774			-0.247			-0.406***		
	[-0.79]			[-0.28]			[3.32]		
NLST		-0.0001			-0.0312**			0.00329**	
		49			*			*	
		[-0.37]			[-4.32]			[5.45]	
nlstcris		0.000122			-0.00291			-0.00277*	
		[0.31]			[-0.67]			**	
								[-5.16]	
NLTA			0.0125***			-0.205**			0.0337**
						*			*
			[5.53]			[-11.24]			[14.20]
nltacris			-0.00104			0.00359			-0.00553

			[-1.56]			[0.60]			[-7.92]
SIZE	-0.109	-0.162	-0.102	4.751***	4.988***	5.310***	0.347***	0.361***	0.331***
	[-1.17]	[-1.85]	[-1.16]	[6.85]	[8.56]	[8.16]	[2.89]	[3.28]	[3.22]
SIZE2	0.00181	0.00694	0.00228	-0.425***	-0.459***	-0.481**	-0.0208**	-0.0205**	-0.0180*
						*			*
	[0.25]	[1.03]	[0.33]	[-7.65]	[-9.97]	[-9.50]	[-2.25]	[-2.44]	[-2.27]
LIA	0.102***	0.107***	0.107***	-0.503***	-0.640***	-0.601**	-0.0194	0.00968	-0.00716
						*			
	[9.10]	[9.43]	[9.61]	[-8.81]	[-12.42]	[-13.04]	[-1.72]	[0.93]	[-0.66]
LLR	-0.000135	-0.0001	-0.000134	-0.000399	-0.000542	-0.00024	0.0000259	0.0000472	0.000008
	***	17***	***	***	***	4**	***	***	74
	[-8.98]	[-9.16]	[-8.78]	[-3.04]	[-4.30]	[-1.99]	[3.12]	[4.70]	[1.18]
LADS	0.00686**	0.00554*	0.00659**	0.0142	0.0269**	0.00119	-0.00373*	-0.00589*	-0.00127
	*	**	*				**	**	
	[12.91]	[10.92]	[11.21]	[1.18]	[2.30]	[0.10]	[-4.51]	[-6.66]	[-1.56]

Continued on next page

Variable	ROA			ROE			NIM		
ETA	-0.00397	0.00376	0.00594	1.035***	1.034***	0.974***	0.0511**	0.0655**	0.0591**
							*	*	*
	[-0.59]	[0.58]	[0.90]	[20.75]	[20.25]	[22.31]	[7.37]	[10.28]	[10.07]
LLP	0.00635*	0.00503*	0.00627*	0.00376	0.0142**	-0.00885	-0.00106	-0.00283	0.000146
	**	**	**				*	***	
	[9.48]	[8.95]	[9.20]	[0.53]	[2.13]	[-1.40]	[-1.71]	[-4.07]	[0.26]
GDP	0.00191*	0.00180*	0.00187*	0.00180*	0.00322*	0.00164*	0.00164*	0.00132*	0.00207*
	**	**	**	*	**	*	**	**	**
	[12.72]	[12.08]	[12.75]	[2.27]	[4.19]	[2.06]	[5.26]	[3.97]	[6.87]
INFL	0.0107**	0.0105**	0.0101**	0.216***	0.177***	0.158***	0.0166**	0.0170**	0.0177**
							*	*	*
	[2.53]	[2.46]	[2.37]	[7.54]	[5.87]	[5.77]	[4.23]	[4.30]	[4.81]
M2	-0.00000	-0.00000	-0.00000	-0.00041	-0.00043	-0.00046	-0.00006	-0.00005	-0.00004
	825	172	0355	2**	4**	1***	43***	37***	65***
	[-0.01]	[-0.14]	[-0.03]	[-2.42]	[-2.46]	[-2.88]	[-4.17]	[-3.63]	[-3.09]
_cons	0.949***	0.642***	-0.196	-8.196**	-1.02	8.172***	0.633**	-0.0459	-1.578**
				*					*
	[4.12]	[3.30]	[-1.03]	[-5.83]	[-0.67]	[4.36]	[2.56]	[-0.24]	[-7.77]
N	1194	1194	1194	1194	1194	1194	1194	1194	1194
Sargan test	H0: overidentifying restrictions are valid			H0: overidentifying restrictions are valid			H0: overidentifying restrictions are valid		
	chi2(65)	chi2(65)	chi2(65)	chi2(65)	chi2(65)	chi2(65)	chi2(65)	chi2(65)	chi2(65)
	=	=	=	=	=	=	=	=	=
	77.75555	73.97577	76.35681	104.08	107.0254	107.1224	87.50523	80.78564	91.67758
	Prob >	Prob >	Prob >	Prob >	Prob >	Prob >	Prob >	Prob >	Prob >
	chi2 =	chi2 =	chi2 =	chi2 =	chi2 =	chi2 =	chi2 =	chi2 =	chi2 =
	0.1334	0.2085	0.1584	0.0015	0.0008	0.0008	0.0329	0.0896	0.0163
Arellano-Bond test	H0: no autocorrelation	H0: no autocorrelation	H0: no autocorrelation	H0: no autocorrelation	H0: no autocorrelation	H0: no autocorrelation	H0: no autocorrelation	H0: no autocorrelation	H0: no autocorrelation
	Prob > z = 0.0154	Prob > z = 0.0166	Prob > z = 0.0164	Prob > z = 0.1315	Prob > z = 0.1299	Prob > z = 0.1335	Prob > z = 0.0001	Prob > z = 0.0001	Prob > z = 0.0001
Turning Point	7.1427774			253.4159			11640.84658		
Size (%)									

Note: The symbols (***), (**), (*) indicate the level of statistical significance respectively 1%, 5%, 10%. Turning points is calculated with formula $\exp\left(\frac{-y_1}{2y_2}\right)$, same as Ouyang and Rajan (2010).

Independent variables: P (NIM, ROA, ROE) measures bank performance; Dependent variables: Pt-1 – lag variable of bank performance; LIQUIDITYRISK⁻ – liquidity risk (FGAP, NLTA, NLST), CONTROL_ Control variables including: SIZE – bank size; SIZE² – square of bank size; LIA - Liquid assets/Total assets; LLR - Liquid assets/Total loans, LADS- Liquid assets/Short-term customer deposits; ETA – equity/total assets; LLP- loan loss provision/loans; NIM - Net Interest Margin. Macro-variables: GDP – GDP growth, M2 – money supply, INFL – inflation, Moderator variables: LIQUIDITYRISK_DCRIS: impact of liquidity risk on bank performance when there is a crisis. Research period: 2004–2016, estimation method SGMM. Research model: $P_t = f(\alpha, P_{t-1}, LIQUIDITYRISK_t, LIQUIDITYRISK_t * DCRIS_t, CONTROL_t, u_t)$.

Table 5. Impact of liquidity risk to bank performance in Southeast Asian countries.

Variables	Expectation	Southeast Asia		
		ROA	ROE	NIM
L (Pt-1)	(+)	(+)	(+)	(+)
FGAP	(+)	(+)	(-)	(+)
fgapcris	(-)			(-)
NLST	(+)		(-)	(+)
nlstcris	(-)			(-)
NLTA	(+)	(+)	(-)	(+)
nltacris	(-)			(-)
SIZE	(+)	(+)	(+)	(+)
SIZE2	(-)	(-)	(-)	(-)
LIA	(+)	(+)	(-)	
LLR	(-)	(+)	(-)	
LADS	(-)	(+)		(-)
ETA	(+)		(+)	(+)
LLP	(-/+)	(+)		(-)
GDP	(+)	(+)	(+)	(+)

Source: Summarized from research results.

4. Research result and discussion

In terms of correlation, the impact of liquidity risk on bank performance of Southeast Asian cases is consistent with the predictions based on science.

The liquidity risk measured by FGAP and NLTA has a positive statistical relationship at a significant level of 1% with bank performance, measured by ROA and NIM. This result is quite similar to previous studies (Almumani, 2013; Ayaydin & Karakaya, 2014; Sufian & Chong, 2008; Trujillo-Ponce, 2013). In the meantime, the liquidity risk, measured by FGAP, NLST and NLTA, shows a negative correlation with a statistical significance of 1% with ROE, which acts as a proxy for bank performance. This result is similar to previous studies (Lee & Hsieh, 2013; Sufian & Chong, 2008). Furthermore, the interactive variables between liquidity risk and crisis have negative values with a level of significance of 1% in the model that used the NIM to measure bank performance. The results show that for this model if there is a crisis factor, this reduces the relationship between liquidity risk (measured by FGAP, NLST and NLTA) with bank performance. In the meantime, in models that use ROA or ROE as a proxy for bank performance, there is no statistical significance, or there is insufficient evidence to prove this relationship. This is entirely consistent with the real fact. In the context of crisis, banks tend to increase liquidity, then increase financial costs to control liquidity risk and improve their performance. The research results are similar to Osborne et al. (2012)'s.

Besides, the study found that the lags of bank performance variables (ROA, ROE, NIM) were positively correlated with bank performance at a significant level of 1%. The result entirely in line with the expectations and results of previous research (Ayaydin & Karakaya, 2014; Lee & Hsieh, 2013; Trujillo-Ponce, 2013). This means that the bank performance interacts and has a positive correlation between the periods.

At the same time, the study found that bank size (SIZE) has the same impact on bank performance (ROA, ROE, NIM) at a significance level of 1%. This result is consistent with the market-power hypothesis. Banks with a larger size will provide benefits that can increase the profit of banks. This result is quite similar to the research results of (Anbar & Alper, 2011) (Sufian & Chong, 2008). However, the variables (SIZE) and (SIZE²) change direction from positive to negative and are statistically significant at a significance level of 1%. This implies that the impact of the bank size variable on liquidity risk is a non-linear and inverted U-shaped graph. Hence, increasing the size of the bank does not always increase bank performance as a theory of economies of scale. The commercial activities of the bank contain many risks and uncontrollable factors, so in the beginning, the scaling-up will improve the bank's performance, but if the bank's scale goes beyond certain thresholds, it will harm bank performance. By the technique of determining the extreme, the author found the turning points corresponding to the variables of liquidity risk (FGAP, NLTA, NLST), which are presented in Table 4. This result is consistent with the research expectations and in line with the findings of Lee and Kim (2013), Chen et al. (2018). This shows that the relationship between bank size and bank performance is non-linear. An increase in the scale can initially support bank performance, but up to a certain level, it can lead to inefficiency due to bureaucracy. On a larger scale, banks can diversify, invest in a risky manner or rely on government intervention in the event of a lack of liquidity, rising costs, which affects the bank's performance.

Research shows that bank capital (ETA) has a positive correlation with bank performance, measured by ROE and NIM at a significance level of 1%. This result is entirely similar to the results of previous research (Ayaydin & Karakaya, 2014; Chen et al., 2018; Lee & Hsieh, 2013; Ongore & Kusa, 2013; Poposka & Trpkoski, 2013; Trujillo-Ponce, 2013). This means that bank performance tends to increase when the bank raises its capital, leverage and risk are lower. This study is in line with the theory of market power. The capital increase shows the strength and position of banks in the financial market.

The loan loss provision variable (LLP) is positive and statistically significant at 1% in the model with ROA and negative in the model with NIM. The result implies that the impact of credit risk on bank performance depends on the research model. This is relatively consistent with reality and theory. If the quality of the bank's assets is problematic, often accompanied by robust lending strategies, banks tend to have a higher provision for loan losses. This provision may not show loan problems, but it has a positive meaning to limit the risk (Golin & Delhaise, 2013). The higher the rate of loan loss, the more the bank has to make provisions, resulting in insufficient profits for the business, and even in some cases, the bank may fall into insolvency. Therefore, the credit risk that leads to the loss of the loan is inevitable; the loan loss always goes hand in hand with the credit activities that derive from the relationship between profit and risk. Therefore, the greater the profit obtained from credit activities, the greater the willingness of the bank to face credit risk and the greater the risk of causing a loan loss. The research results are comparable to previous studies (Ayaydin & Karakaya, 2014; Chen et al., 2018; Trujillo-Ponce, 2013). This means that if banks aim at bank performance goals, they are often accompanied by high credit risk. Hence, credit risk control is significant. It is not only done at the macro level, but commercial banks must also specify it in processes and policies associated with the situation of the credit activities, whereby the credit risks of customers and banks are comprehensively controlled.

Asset structure variables (LIA, LLR, LADS) are positive in the model with ROA at 1% significance level and harmful in the model with NIM at 1% significance level. This implies that bank performance is quite sensitive to changes in the structure of the assets, which is entirely consistent with reality. Bank performance does derive from not only its reputation and business opportunities but also a large part of its profits from the management of term risk of assets. If banks usually reserve liquid assets at an optimal level to ensure business operations, bank performance can be monitored in the event of shocks. Nevertheless, if banks reserve too many liquid assets, bank performance will decrease due to a faster increase in financial expenses than revenue. This result fully corresponds to the original expectations and the results of previous research (Chen et al., 2018; Kosmidou et al., 2005; Lee & Hsieh, 2013; Poposka & Trpkoski, 2013).

The macroeconomic variable (GDP) is positive in the model with ROA, ROE and NIM at a significance level of 1%. This result is comparable to previous studies (Chen et al., 2018; Kosmidou et al., 2005; Lee & Hsieh, 2013; Lee & Kim, 2013; Trujillo-Ponce, 2013). This can be explained by the fact that economic growth has a positive impact on bank performance through reducing interest rates, which leads to high demand for loans and allows banks to charge more for their services. Conversely, the period of economic recession often leads to a decline in the ability of the borrower to pay off its debt, which leads to an increase in credit risk that affects banks' performance.

The money supply and inflation variables (M2, INFL) are negative and statistically significant in most models with 1%. These results are similar to some previous studies (Ayaydin & Karakaya, 2014; Ongore & Kusa, 2013; Sufian & Chong, 2008). Ferrouhi (2014a) suggests that inflation has a direct and indirect impact on bank performance. With unpredictable inflation, costs can increase rapidly, and bank performance will decrease. As a term converter, banks grant loans for a more extended period than its time to raise capital, so inflation fluctuations affect bank performance (Bordeleau & Graham, 2010).

5. Conclusions and policy implication

The investigation into the impact of liquidity risk on the performance of banks in Southeast Asian countries can draw some of the following implications:

First, this study provides empirical evidence of the impact of liquidity risk on bank performance in Southeast Asian countries. The results showed that credit risk has a positive impact on bank performance measured by ROA and NIM. However, if the ROE is used as a proxy for bank performance, this impact of credit risk is negative. It means that this relationship tends to be positive or negative depending on the measurement of liquidity risk, bank performance and the economic cycle. Flannery and Rangan (2008) argue that the positive or negative relationship between liquidity and profit in the short term depends on whether the bank is above or below optimal liquidity. If the banks could remain at an optimal level of liquidity, there would be no relationship between the liquidity balance and bank performance. In the long term, however, when legal liquidity requirements are binding, which means ensuring high liquidity, lower liquidity risk will reduce banks' profitability if they exceed their optimal liquidity, due to regulatory requirements or unexpected shocks. This reinforces the results of empirical research on the impact of liquidity risk on bank performance in Southeast Asian countries.

Second, the research results show that most banks that perform well contain a high liquidity risk. This is consistent with the risk-return trade-off theory. Moreover, the evidence shows that when there is a financial crisis, the impact of liquidity risk on bank performance is negative. This means that during the crisis, banks will try to increase their liquidity to improve profitability, and this will increase their financial costs and reduce their operational efficiency. Osborne et al. (2012) stated that, under normal circumstances, banks tend to maintain low liquidity, which provides good performance to the bank intending to save financial costs. In the event of a crisis, however, these effects tend to decrease. This implies that better-performing banks contain a higher liquidity risk.

Third, the results of the investigation find other factors that affect the performance of the banks in the case of Southeast Asian countries, including:

The size of the bank has a non-linear effect on bank performance. This result is entirely consistent with the economics of scale theory. An initial increase in the scale will increase bank performance, but up to a threshold, a continuous increase in the scale reduces bank performance.

Bank capital will help improve bank performance. This is consistent with the theory of structure-behavior-efficiency and the theory of market power. A capital increase shows the strength and position of the bank in the financial market. It is suggested that changes in the market structure or the degree of concentration of banks affect bank performance. Large companies tend to have better profitability (Akhavain et al., 1997).

Credit risk, measured by the variables of the credit provider, depends on the research model, and this is entirely consistent with reality and theory. The credit risk that leads to loan loss is inevitable. The loan loss always goes hand in hand with credit activities deriving from the relationship between profit and risk. The higher the profit from credit activities, the greater the bank's willingness to take credit risk and the greater the risk of causing a loan loss. This means that banks are often exposed to high credit risk if they want to achieve their high-performance goals. That is why credit risk management is critical. Not only is it done at the macro level, but it also has to be set by the commercial banks in the processes and policies related to the situation of credit activities, so that the credit risks of customers and banks are fully controlled.

Macro variables such as inflation, economic growth and money supply all have an impact on bank performance.

The limitation of this study, however, is that the sample of data collected during the 2004–2016 period is relatively short compared to research for developed countries and measures the bank's performance only on the ratio scale such as ROA, ROE and NIM. These data are collected from financial statements, which is the moment-to-moment data and may be adjusted by banks according to their business strategy. The study provides empirical evidence of the impact of liquidity risk on bank performance but does not take into account the impact of liquidity risk on the performance of small and medium-sized banks. Nor has it evaluated the similarity of the research results concerning the economies developed inside and outside the region to increase the reliability of the research results. The author expects further studies to complement and overcome the objective limitations of this study.

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Conflict of interest

The authors declare no conflicts of interest in this paper.

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