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Systemic Risk Cycle: Evidence from ASEAN-5

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Abstract
This study is one among the firsts to explain the behavior of systemic risk. We examine the cyclicality of systemic risk through the business cycle dynamics by using data from 84 listed banks in ASEAN-5 from 2001Q1 to 2017Q2. We employ SRISK as a measure of systemic risk, which represents the capital shortfall of a firm in the time of a crisis. The result shows that the relationships between SRISK cyclicality and the business cycle dynamics to vary across countries. We also show that the leverage ratio has explanatory power in explaining the dynamics of SRISK.

JEL Classification: E32; G21; E58; G28

Keywords
Business Cycle — Banks Leverage — Macroprudential Policy

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1. Introduction

The important role of systemic risk in the financial system has attracted so much attention since the financial crisis of 2008. In the sphere of the macro-finance strand of literature, the crisis has stimulated tons of attempts to explain the new center of attention in the banking risk, that is the systemic risk. By definition, systemic risk can be inferred as a potential of a financial institution to be undercapitalized once the financial system is in the crisis (Engle et al., 2014).

Series of studies proposed to formulate measurement to quantify the systemic risk due to its prominent role in the latest crisis. The most noticed, among others, are (i) Marginal Expected Shortfall (MES) from Acharya et al. (2016), which is based on Acharya et al. (2012); (ii) Systemic Risk Index (SRISK) measure by Brownlees and Engle (2016), which is based on MES; and (iii) CoVaR or Conditional Value at Risk developed by Adrian and Brunnermeier (2016). These studies, however, only focus on how to define and measure systemic risk. Meanwhile, the world financial system is hardly to be free from the imminent threat of the systemic risk. Thus, along the process of refining ways to define and measure systemic risk, it is also important to put effort to explain – and then control – the behavior of systemic risk.

The business cycle is defined as the fluctuation of real aggregate economic activity (Burns and Mitchell (1946) in Jacobs, 1998). On practical level, the business cycle is represented in many literatures as the fluctuation of the gross domestic product (GDP). However, as the GDP is measured quarterly, many studies also implemented the Industrial Production Index (IPI) as an alternative representation of the business cycle. Departing from the definition of the business cycle and systemic risk, we define cyclicality of systemic risk as the behaviour of systemic risk along the business cycle fluctuation. This definition has specific concern on how systemic risk may build-up as compounded by the dynamics of the business cycle.

This study attempts to examine cyclicality of systemic risk measurement toward business cycle fluctuation. Several works have been done so far to address this problem. Liu (2017) examine the dynamics of CoVaR of US Bank-Holding-Company (BHCs) using regime switching approach. The result shows that CoVaR to be pro-cyclical toward macroeconomic variables. In line with that, Lenoci (2017) also find that SRISK to be pro-cyclical by examining US BHC data. Tasca and Battiston (2016) also explore procyclicality phenomenon by simulation the cyclicality of Value-at-Risk in hypothetical setting. On the other hand, several studies documented reverse relationship of how systemic risk may predict future macroeconomic condition. Allen et al. (2012) find the aggregate systemic risk index, CATFIN, to be able to forecast six-months ahead economic downturns with the observation of US, European and Asian bank data. Meanwhile, Giglio et al. (2016) observe the ability of 19 different measures of systemic risk in predicting macroeconomic shocks. From these works, it could be inferred at least two points. Firstly, many literatures only focus on the dynamics in developed economy. This may imply some bias as the market characteristic in the developed countries differ significantly with developing countries – for instance in term of market depth and maturity. Secondly, although some literatures have explained systemic risk cyclicality in cross-countries setting, it is hard to see them provide explanation of cyclicality variation among countries in their samples. Therefore, we choose to address these gaps in our study.

Our study offers three significances. *First*, as the base measurement employed in this study is based on market information – the bank stock price – this study might explain the nature of the volatility of the stock market through the different economic cycle. *Second*, in the context of macroprudential management, this study addresses one of the most important problems, that is how to make the financial system more resilient. By examining the cyclicality of systemic risk, we can understand its dynamics over-time and one step beyond that, find out the determinant of its cyclicality. Thus, by having knowledge of factors affecting systemic risk cyclicality, we might be able to control it. *Third*, this study explores the built-up logic of systemic risk as the economy evolves along its business cycle. The results show contrasting cyclicality behavior of systemic risk across the country in the observations, in which the systemic risk is shown to be pro-cyclical for some countries, and on the opposite for the other countries.

Further, this study is also one of the very few to address systemic risk issue in developing countries, especially in South-East Asia. Most studies observe systemic risk development in the developed countries, which are mostly characterized by relatively deep and mature financial market. The South-East Asian financial market is, on the other hand, with some exception for Singapore, are characterized by developing and shallow financial market.

On the choice of the systemic risk measure, this study chooses to use SRISK, which is based on LRMES, as the proxy for systemic risk. SRISK is defined as capital shortfall (in monetary value) that a firm (financial or non-financial) will be expected to lose on the condition of the market is in crisis.

This paper is organized as follows. Section 1 provides introduction explaining the contextual ground of the study. Section 2 provide brief of the literature ground related to the study. Section 3 explain our basis theoretical framework of how macroeconomic uncertainty (business cycle) may influence risk in the banks. This section also explains the calculation step of our choice of measure of systemic risk (SRISK index), and our empirical estimation setting. Section 4 articulate the result of our study and discussion of some impact toward the literature development and practical context in the macro-prudential management. Section 5 provide conclusion and recommendation.

2. Literature Review

The systemic risk indexes employed here – LRMES and SRISK – are based on market information, especially the fluctuation of the company price in term of its market value. The spirit comes from the essential fact that recent financial crises are mostly caused by the sudden fall of asset price in short period. The deterioration of asset price, as standard business cycle theory mentioned, are a strong symptom the economy is in the downturn phase.

The work of Schwert (1989) is one of initial attempts to relate macroeconomic fundamentals with asset price. In his work, he modeled the stock price as the discounted present value of expected future cash flow to stockholders. On the aggregate level, the value of corporate equity depends on the health of the economy. Thus, the uncertainty of future macroeconomic conditions would cause a proportional change in stock return volatility. This framework is still in place until recently, as supported by Engle et al. (2014) and Subrahmanyam and Titman (2013), and were also followed by Hamilton and Lin (1996), David (1997), and Veronesi (1999).

In the same spirit, yet based on different fundamental, Bansal and Yaron (2004) developed Dynamic Capital Asset Pricing Model (DCAPM), which is a type of consumption-based CAPM, to relate macroeconomic condition with asset price volatility. The fundamental base of the relationship is uncertainty. Bansal and Yaron (2004) approach is based on the dynamic consumption preference model developed by Epstein and Zin (1989). The model incorporates changes in the conditional volatility of future growth rates to allow time-varying risk premia. The business cycle, or economic fluctuation is represented by the conditional volatility of consumption and then directly affects the price-dividend ratio. Thus, a rise in economic uncertainty (bad condition) leads to a fall in asset prices. The big story offered by this model is that the financial market dislike economic uncertainty and better long-run growth prospects raise current equity prices. In line with this model are the studies from Ozogus (2009) and Bansal et al. (2014).

Acharya et al. (2012) summarized some of the most noticeable development on systemic risk measures, especially the measurements that based on market information, the return of the firm's stock. They underlined, among others are (i) Marginal Expected Shortfall (MES) from Acharya et al. (2016), which was based on Acharya et al. (2012); (ii) SRISK measure by Brownlees and Engle (2016), which is based on MES; and (iii) CoVaR or Conditional Value at Risk developed by Adrian and Brunnermeier (2016).

Those three prominent measures of systemic risk are based on two standard firm-level risk measure, Value-at-Risk (VaR) and Expected Shortfall (ES). Value-at-risk is described as the most value a bank will lose with the confidence level of $1-\alpha$, or formally $(R < VaR_\alpha) = \alpha$. Based on this measure of risk, Adrian and Brunnermeier (2016) developed CoVaR, or Conditional Value-at-Risk, which is the increased of system VaR caused by an extreme condition of a firm/bank. Meanwhile Expected Shortfall (ES) is the average of the worst α -percent return of the left-tail of the firm return distribution. Since α is usually similar both for VaR and ES, then ES can also be interpreted as the expected loss conditional on the loss being greater than the VaR, or $ES_\alpha = -E[R|R \leq VaR_\alpha]$.

Marginal Expected Shortfall (MES), as formally documented on Acharya et al. (2016) measures the ES contribution of one firm to total system ES. This clarifies the term "marginal" on its name. Formally, MES defined as the contribution of individual firm toward the system when the system is on its worst α-percent. It is defined as $MES_\alpha = \frac{\partial ES_\alpha}{\partial y_i} = -E[r_i|R \leq VaR_\alpha]$. The term ES_α stands for overall Expected Shortfall with the default probability of α. Meanwhile, y_i stands for weigh of the group.

At the operational level, VaR, ES and MES are computed based on the daily return of a certain window period. For example, from the return distribution of a firm in one year, we can calculate VaR, ES, and MES. It means there is only one value of VaR, ES, and MES on that one-year period. Then, Brownlees and Engle (2016) developed a time-varying version of MES, called as Long-Run Marginal Expected Shortfall (LRMES). The base period of calculation of LRMES changes over time period window causing the value of MES vary over time. Practically it may use recursive or rolling-window style estimation. LRMES is then used to predict, SRISK, or Systemic Risk Index which measures the total capital shortfall a firm will experience when the market is on a crisis. The step-by-step process of LRMES and SRISK calculation will be presented in section 3.

3. Model

3.1 Conceptual Framework

We borrow conceptual framework developed by Adrian and Shin (2013). They developed a framework to measure default probability on certain confidence level α, based on the Extreme Value Theorem (EVT). The ultimate result of their model showing that default probability is determined by two variables, the leverage level and the business cycle condition.

The probability of default in α, by Adrian and Shin (2013) is defined to be determined by fundamentals of the contracting problem. The basic of contracting problem developed on their paper departs from the range of expected pay-off of high-return investment $F_H(z) = exp\left\{\frac{z-\theta}{\sigma} - 1\right\}$ and pay-off of low-return investment $F_L(z) = exp\{\frac{z-(\theta-c)}{\sigma} - 1\}$. Term z refers to the certain time the pay-off will occur. Meanwhile, θ refer to the business cycle, which is high if the business cycle is in good condition (expansion phase). Term σ refers to standard deviation and c in this model is a constant. The relationship of both returns is $F_L(z;\theta)/F_H(z;\theta) = e^{k/\sigma} > 1$. The term k is a constant. Meanwhile, z stands for the random variable that follows Second Order Stochastic Dominance (SOSD).

By summing up the $F_H(z)$ and $F_L(z)$, it might be obtained the temptation payoff of the investment as

$$\begin{aligned}\Delta\pi(z;\theta) &= \int_{-\infty}^{z} (F_L(s;\theta) - F_H(s;\theta))ds \\ &= \left(e^{\frac{k}{\sigma}} - 1\right) \int_{-\infty}^{z} F_H(s;\theta)ds \\ &= \left(e^{\frac{k}{\sigma}} - 1\right) \times \sigma F_H(s;\theta)\end{aligned} \tag{1}$$

where s stands for the second order derivative of the option price with respect to the strike price evaluated at z. Restating the equation into Indifference Curve constraint form will result in

$$\left(e^{\frac{k}{\sigma}} - 1\right) \times \sigma F_H\left(\bar{d}^*;\theta\right) = r_H - r_L \tag{2}$$

and modification from payoff equation before will result in:

$$\begin{aligned}\alpha(\theta) &= F_H\left(\bar{d}^*;\theta\right) \\ &= \frac{r_H - r_L}{\sigma\left(e^{\frac{k}{\sigma}} - 1\right)}\end{aligned} \tag{3}$$

substituting this equation into the probability of default $\alpha(\theta)$ definition yield the following equation:

$$\begin{aligned}\alpha(\theta) &= F_H\left(\bar{d}^*;\theta\right) \\ &= \exp\left\{\frac{\bar{d}^* - \theta}{\sigma} - 1\right\} \\ &= \frac{r_H - r_L}{\sigma\left(e^{\frac{k}{\sigma}} - 1\right)}\end{aligned} \tag{4}$$

where $\bar{d}^*$ is the debt ratio, which in this study is proxied by Log-Liability. In the closed form function, the probability of default is then function of

$$\alpha(\theta) = f(\bar{d}^*, \theta) \tag{5}$$

this equation is the basic for empirical estimation in this study. For the complete derivation of the framework is in Adrian and Shin (2013). From equation (5), it could be inferred that the probability of default $\alpha(\theta)$ is determined by the debt ratio $\bar{d}^*$ and the business cycle θ.

3.2 Systemic Risk Measures: LRMES and SRISK

As in Acharya et al. (2012) and Brownlees and Engle (2016), Systemic Risk Index (SRISK) is defined as capital shortfall that a firm expected to experience in crisis. Formally it is defined as:

$$SRISK_{i,t} = E_{t-1}(Capital\ Shortfall_i|Crisis) \tag{6}$$

The term $SRISK_{i,t}$ represent the level Systemic Risk Index of the institution i at the period of t. SRISK is computed and updated regularly on the Volatility Lab of New York University (NYU) website for approximately 100 US financial firm and for 1,200 global financial firms[1]. On the operational level, there are several technical developments to compute SRISK. This study chooses to adopt the global dynamic version, as this version is very suitable for cross-country SRISK analysis, which makes the result of SRISK of the different firm in different countries comparable to each other. The global version of SRISK calculation is based on the Global Dynamic MES, based on Dynamic Conditional Beta as documented in Engle (2016). This study employs the Global Dynamic MES as documented in Engle (2016). It is called dynamic as it varies over-time.

The next step is to compute the Long Run Marginal Expected Shortfall (LRMES), or the time-varying version of MES. We follow the standard calculation for Global Dynamic MES to compute LRMES. The LRMES is computed as:

$$LRMES_{i,t} = 1 - e^{\log(1-d)*\beta_{i,t}} \tag{7}$$

The term $LRMES_{i,t}$ stands for the LRMES of institution i at the time t. Meanwhile, term d is the six-month crisis threshold for a market decline. It is set to be 40% as follow the standard version and can be modified easily if we assume another threshold level. Meanwhile $\beta_{i,t}$ is the DCB.

Finally, after obtaining the LRMES, we can compute SRISK, which is measured as expected capital shortfall that will be experienced by a firm when the market is on a crisis. The SRISK value is normally in a negative value, although sometime it might be positive. It is in nominal so that in the context of macroprudential, SRISK is simply the expected capital the government need to inject to a company if the company is about to default. If we sum up all the individual SRISK in the system, then we will get the total expected capital shortfall of the financial system, which means the total capital injection needed to be provided by the government to bail-out the system. SRISK can be obtained by:

$$\begin{aligned}SRISK = k.DEBT - (1-k). \\ EQUITY.(1 - LRMES)\end{aligned} \tag{8}$$

where k stands for the capital requirement. In this study, we use $k = 8\%$, following the standard capital requirement level

[1] https://vlab.stern.nyu.edu/en/

as in Basel requirement and applied by all countries in the observation. LRMES is the Long-Run Marginal Expected Shortfall, EQUITY is the current market capitalization of the firm at t. Meanwhile, DEBT is the total liability of the firm.

4. Data and Methodology

4.1 Data

This study aims to examine cyclicality of systemic risk toward business cycle fluctuation. In order to do so, it needs to compute the systemic risk measurement at first, and then do estimation to measure its cyclicality.

Table 1. List of Observations

No	Country	Number of Banks	Start Period	End Period
1	Indonesia	37	2001:Q1	2017:Q2
2	Malaysia	10	2001:Q1	2017:Q2
3	Philippine	16	2001:Q1	2017:Q2
4	Singapore	11	2001:Q1	2017:Q2
5	Thailand	10	2001:Q1	2017:Q2

Empirically, this study computes SRISK listed banks in five ASEAN countries, as specifically presented in Table 1. The total database consists of data span from 2001:Q1 to 2017:Q2. We choose this span of time to make our analysis focus on the period after the Asian financial crisis, which hampered the economy of countries in our sample. To obtain the Dynamic Conditional Beta for SRISK calculation, this study calculates recursively starting on the first window of 60 observation.

All Return, SRISK and any other value variable in this study are based on local currency. Although it makes the cross-country bank SRISK becomes hard to compare, however, the use of local currency denomination will exclude the currency factor, which will deviate the time-series analysis as the exchange rate fluctuate differently for each country in the observation.

The SRISK index applied in this research is a market-based index, in which the applicability of the index depends on the market depth. As this research comprise data from developing countries, which are characterized by shallow financial market, there may be some caveat of the application of a market-based measurement. If the turnover of the stocks of bank in the dataset is substantially high, then the index might reveal its suitability to explain the dynamics. One of an example is to examine the turnover – as revealed by volume – of the stocks traded compared to the total outstanding stock.

Figure 1 provide overview of the turnover ratio for each stock quarterly. The turnover ratio is counted as the total number of volume transaction compared to the total stock available. The turnover ratio on average is 7.63% along the sample period. This number is considered as relatively high.

Figure 2 represents the volatility index (VIX) for the sample period. The shaded area shows the period of high volatility, which span from 2008q1 to 2011q4. This period is marked the definition of crisis period in this study. The period is employed as the basis of the crisis dummy variable. This period covers the 2008 financial crisis up until the burst of commodity boom and Eurozone bond crisis in the early 2012.

4.2 Empirical Model

The empirical model design applied in this study follows the conceptual framework from by Adrian and Shin (2013) as in the equation (5). The framework outlines the role of business cycle and debt ratio (leverage) in affecting default probability. Therefore, the dependent variable for our empirical model would be the default probability risk, of which we implement the Systemic Risk Index (SRISK) in this context. Meanwhile, the independent variables as a focus analysis in this study are the business cycle, represented by the GDP growth of each country where the bank operates. The other important independent variable is the liability level of the bank, which represent the debt ratio as in equation (5).

This study implements two style of estimation. The first one is Feasible Generalized Least Square (FGLS). This model is selected due to the data characteristic, especially related to heteroscedasticity and autocorrelation (Table 3). As a comparison, this study also provide analysis with fixed-effect panel combined with robust error specification.

By using empirical estimation style of Feasible Generalized Least Square (FGLS), this study designs the empirical model to examine cyclicality of systemic risk in the economy. The fundamental reason of application of FGLS method comes from the consideration of heteroskedasticity and autocorrelation. The dataset in this study are comprised of multiple banks across five countries. Furthermore, the nominal value of variables employed in the analysis are denominated in local currencies. Thus, the dataset employed in this study is by nature very prone toward heteroskedasticity problem. The FGLS estimation, as outlined by Cameron and Trivedi (2009), will provide efficient and consistent estimation. Moreover, Baltagi (2005) and Hsiao (2003) outlined the ability of FGLS style estimation to handle the autocorrelation problem observed in the dataset.

The result of heteroscedasticity and autocorrelation for the equation (9), (10), and (11) are provided in Table 3. We implement standard Breusch-Pagan test for heteroscedasticity and standard LM test for stationarity. For autocorrelation panel test, We implement autocorrelation panel test from Drucker (2003). We exhibit autocorrelation and stationarity in equation (9), (10), and (11). We also exhibit heteroscedasticity in the equation (9) and (11). Therefore, standard Pooled Least Square (PLS) panel estimation might not be the best model for our analysis. This result is the ground of our preference toward FGLS estimation. Because of this result, we also implement log-transformation for the variables.

In the estimation process, all banks in one country are brought in as one-panel estimation. Thus, there are in total five panels in the model, following the total of five countries.

$$LRMES_{ij,t} = \alpha + \beta GDP\_Growth_{j,t} + \gamma Liabilities_{i,j,t} + \varepsilon_{ij,t} \quad (9)$$

$$SRISK_{ij,t} = \alpha + \beta GDP\_Growth_{j,t} + \gamma Liabilities_{i,j,t} + \varepsilon_{ij,t} \quad (10)$$

Table 2. List of Variables

No	Variables	Frequency	Observation Unit	Sumber
1	Individual Stock Return	Daily; to construct quarterly LRMES and SRISK	Individual Bank	Bloomberg
2	Asset	Quarterly	Individual Bank	Bloomberg
3	Liability	Quarterly	Individual Bank	Bloomberg
4	Equity	Quarterly	Individual Bank	Bloomberg
5	Market Capitalization	Quarterly	Individual Bank	Bloomberg
6	Market Return	Daily; to construct quarterly MES/SRISK	Country	Bloomberg
7	Real GDP Growth	Quarterly	Country	World Bank

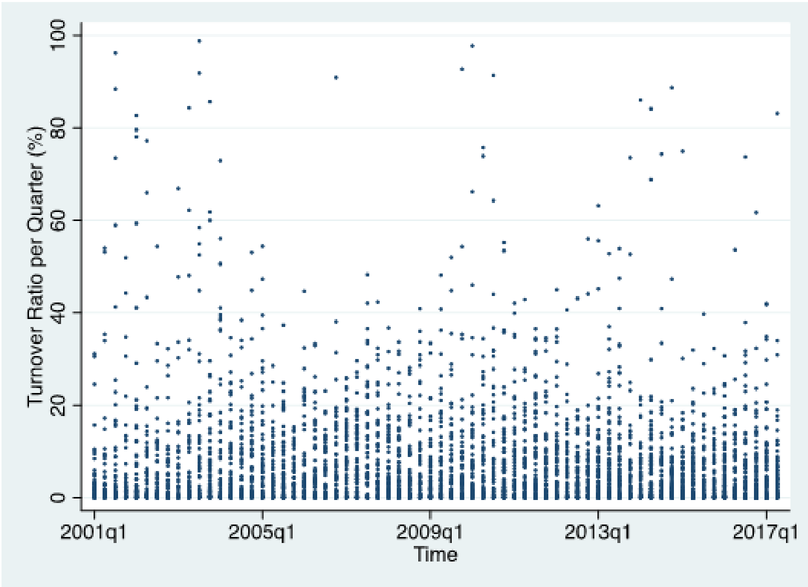

Figure 1. Turnover Ratio per Quarter
Source: Bloomberg

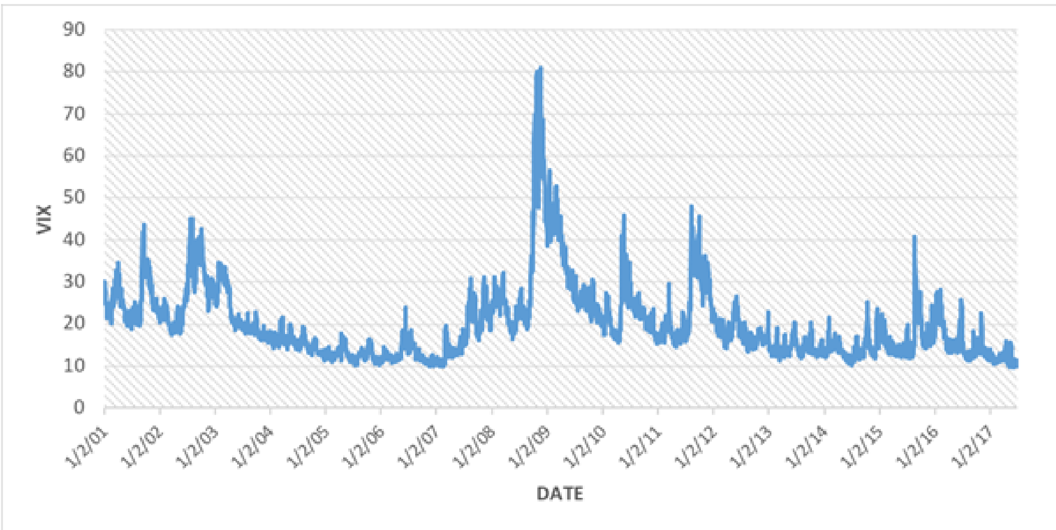

Figure 2. VIX Index
Source: Bloomberg

Table 3. Heteroscedasticity and Autocorrelation Test for Equation (9), (10), and (11)

Equation	Heteroscedasticity	Autocorrelation	Stationarity
Equation (9)	Yes	Yes	No
Equation (10)	No	Yes	No
Equation (11)	Yes	Yes	No

$$SRISK/Equity_{ij,t} = \alpha + \beta GDP\_Growth_{j,t} + \gamma Liabilities_{i,j,t} + \varepsilon_{ij,t} \quad (11)$$

For each country, there are three estimations conducted. The first estimation put LRMES ($LRMES_{ij,t}$) of bank i, in country j, at the time t, as the dependent variable (equation 9). This equation specifically observes the cyclical behavior of LRMES. Second estimation put Systemic Risk Index ($SRISK_{ij,t}$) in log-transform as the dependent variable (equation 10). This equation observes the cyclicality nature of SRISK toward dynamics of business cycle and liabilities. This equation then becomes our center of observation. The last estimation put the ratio of SRISK/Book Equity

$\left(\frac{SRISK}{Equity_{ij,t}}\right)$ as the dependent variable (equation 11). This part is an extended focus of this study. In this part, rather than simply focus on the SRISK as it is, we try to compare it with the bank book equity. This ratio might tell us the size of SRISK in a more stylized way so that it can be compared from one bank to another. Furthermore, the ratio will also give us an impact of how far SRISK could deviate from the book value of equity shareholder.

The term $GDP\_Growth_{ij,t}$ is the GDP growth of country j, which represents the business cycle in the estimation, with parameter β. The term $Liabilities_{i,j,t}$ stands for the total liability of each bank i in country j at time t in log-transform, with parameter γ. The term α stands for the intercept, and the term $\varepsilon_{ij,t}$ stands for standard error.

5. Result

5.1 LRMES and SRISK

Table 4 presents summary statistics of LRMES and SRISK calculation. The results are classified by country. The first panel presents LRMES results. LRMES shows fractional loss contribution of each institution – in this case, bank – toward the system expected shortfall. LRMES is a bit hard to be interpreted directly. Nevertheless, it is still worth to compare the variation of LRMES across the country. It might tell us the different behavior of the stock market fluctuation in each country. Indonesia, with the biggest number of banks in the sample, has the highest number of observation with LRMES ranging from -31.08 to 0.55. Compared to other countries, the interval of Indonesia LRMES is the widest, with the standard deviation of 0.82. In the second position is Philippine, with standard deviation of 0.13. The rest are Malaysia, Singapore, and Thailand.

SRISK, as the main concern of this study, is represented by the amount of capital shortfall an institution bears if an extreme event occurs. In this study, the SRISK amount is in local currency in order to avoid currency bias in the analysis. However, it made the SRISK value of each institution across the country cannot be compared. As in Engle (2016), the SRISK value is represented in a positive value, and any capital surplus is regarded as zero SRISK value. The convention made the lowest SRISK value in all observation becomes zero. For Indonesia, the average SRISK value is 1.15 trillion Rupiah, with the standard deviation of 3.89 and the maximum value of 42. For Malaysia, the average SRISK value is 196 million Ringgit, with standard deviation of 531 and the maximum value of 3.7 billion Ringgit. For Philippine, the average of SRISK value is 4.84 billion Peso, with the standard deviation of 7.05 and the maximum value of 49. Meanwhile, for Singapore, the average of SRISK value is 388 million SGD, with the standard deviation of 547, and the maximum value of 3.6 trillion SGD. Lastly, Thailand has an average SRISK value of 3.94 billion Baht, with the standard deviation of 10.1, and the maximum value of 64 (Table 4).

Further, to be able to compare SRISK across country and institution, we construct new simple measurement. That is SRISK-to-Equity ratio. This ratio simply divides the value of SRISK with book equity value of the institution. SRISK is based solely on market information, in which the market value of equity is one of main information to calculate it. The aim of this ratio is then to observe the distance or difference of how far is SRISK compared to the book value of equity of the institution. This ratio than can give us a description of how bad a crisis – and systemic risk – can deteriorate a single institution and market capitalization.

The SRISK-to-Equity ratio can be a good step to initiate the discourse of bail-in as a complementary foreseeable solution to mitigate the future crisis. The book value of equity represents the real value of the stock owner's capital, as it is based on the item line on the company balance sheet. To some extent, it describes the institution capital resources better than the market value. As we can see, the number of observations of the SRISK-to-Equity ratio are lower than SRISK, since many of the SRISK values are zero. For Indonesia, the SRISK-to-Equity average is 0.27, with the standard deviation of 0.2, and the ratio ranging from 0.0004 to 1. In the case for Malaysia, the SRISK-to-Equity average is 0.27, with the standard deviation of 0.24, and the ratio ranging from 0.0026 to 0.84. For Philippine, the SRISK-to-Equity average is 0.29, with the standard deviation of 0.2, and the ratio ranging from 0.0009 to 1.7. Meanwhile for Singapore, the SRISK-to-Equity average is 0.5, with the standard deviation of 0.26, and the ratio ranging from almost zero to 0.38 (Table 4).

Figure 3 represents the scatter plot of LRMES overtime by country. The distribution of LRMES tends to be concentrated on a certain number. It is quite normal as LRMES value is solely based on market information. It simply represents fractional loss contribution toward market Expected Shortfall. The pattern for each country seems to be stable and similar.

Meanwhile Figure 4 represents the scatter plot of SRISK over-time by country. SRISK is presented in a positive value, as capital surpluses are represented as zero SRISK. One main component of SRISK calculation is LRMES. Further, it also involves market capitalization and the total liability of the institution. As we can see, SRISK in every country tends to be sprawling as the time goes on. This development might indicate the process of risk build-up as the economy is booming. This description fits very well with Indonesia, Philippine, and Thailand. In the beginning of the observation period of this study, the SRISK value were considerably low for these three countries. The growth of SRISK were also stable until lately. However, Thailand observed different behavior. Starting from about 2010, the SRISK distribution started to sprawl, a bit earlier compared to Indonesia and Philippine.

For the case of Malaysia and Singapore, the pattern seems to be different. SRISK distributions for these two countries tend to be unstable at the beginning and end of the observation window. For the case of Singapore, SRISK were also sprawl after the crisis period, especially in 2009 and 2010.

The diverse pattern of systemic risk development for each country might be caused by numerous reasons. *First*, the stock market condition. As a market-based measure, LRMES and SRISK are highly related to the dynamics of the stock market in each country. So that the stock market condition becomes a prominent determinant in the SRISK development. Singapore, which plays role as the financial

Table 4. Summary Statistics of SRISK

Country	Unit	Obs	Mean	Stdev	Min	Max
LRMES						
Indonesia		1,738	0.0935	0.8222	-310.797	0.5501
Malaysia		660	0.2163	0.0628	-0.0179	0.5418
Philippine		824	0.1138	0.1366	-23.636	0.921
Singapore		726	0.1407	0.0589	-0.2066	0.572
Thailand		627	0.2474	0.0488	0.0612	0.7285
SRISK						
Indonesia	Trillion Rupiah	2,442	1.15	3.89	0	42
Malaysia	Million Ringgit	660	196	531	0	3,700
Philippine	Billion Peso	1,056	4.84	7.05	0	49
Singapore	Million SGD	726	388	547	0	3,600
Thailand	Billion Baht	660	3.94	10.1	0	64
SRISK-to-Equity						
Indonesia	Ratio	1,027	0.2742	0.2011	0.0004	10.000
Malaysia	Ratio	166	0.2787	0.2411	0.0026	0.8475
Philippine	Ratio	680	0.2895	0.1991	0.0009	16.957
Singapore	Ratio	479	0.4993	0.2622	0.0001	0.8276
Thailand	Ratio	200	0.1313	0.1073	0	0.3875

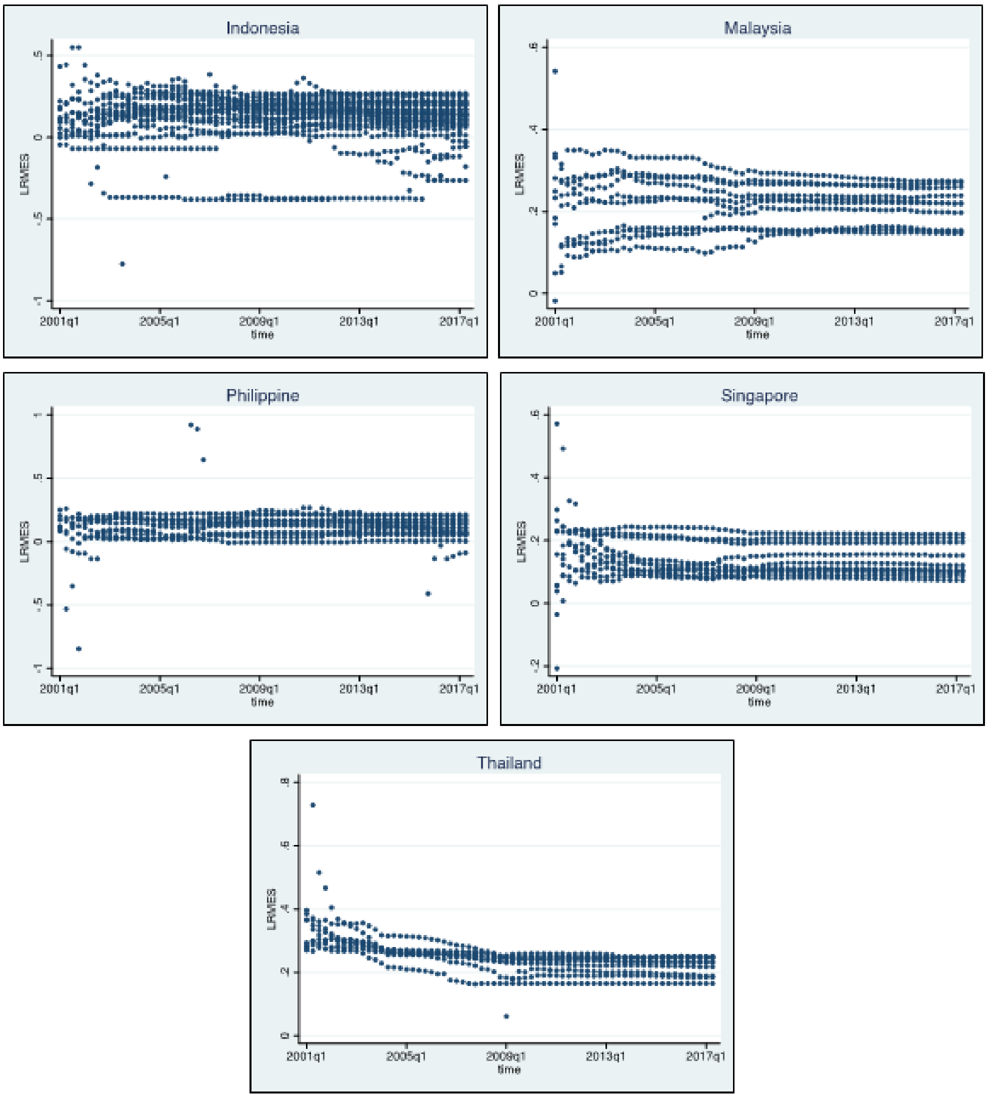

Figure 3. LRMES Dynamics over Time by Country

hub in the region, is well-known for its relatively free and deep financial market. It is no wonder to find SRISK of the banking system in Singapore to be more dynamics compared to other countries in the observation (Figure). *Second*, the banking regulatory stance. Aside from the market information, SRISK also has a substantial weight of the institution-specific information, such as liabilities and market capitalization. Market capitalization is closely related to

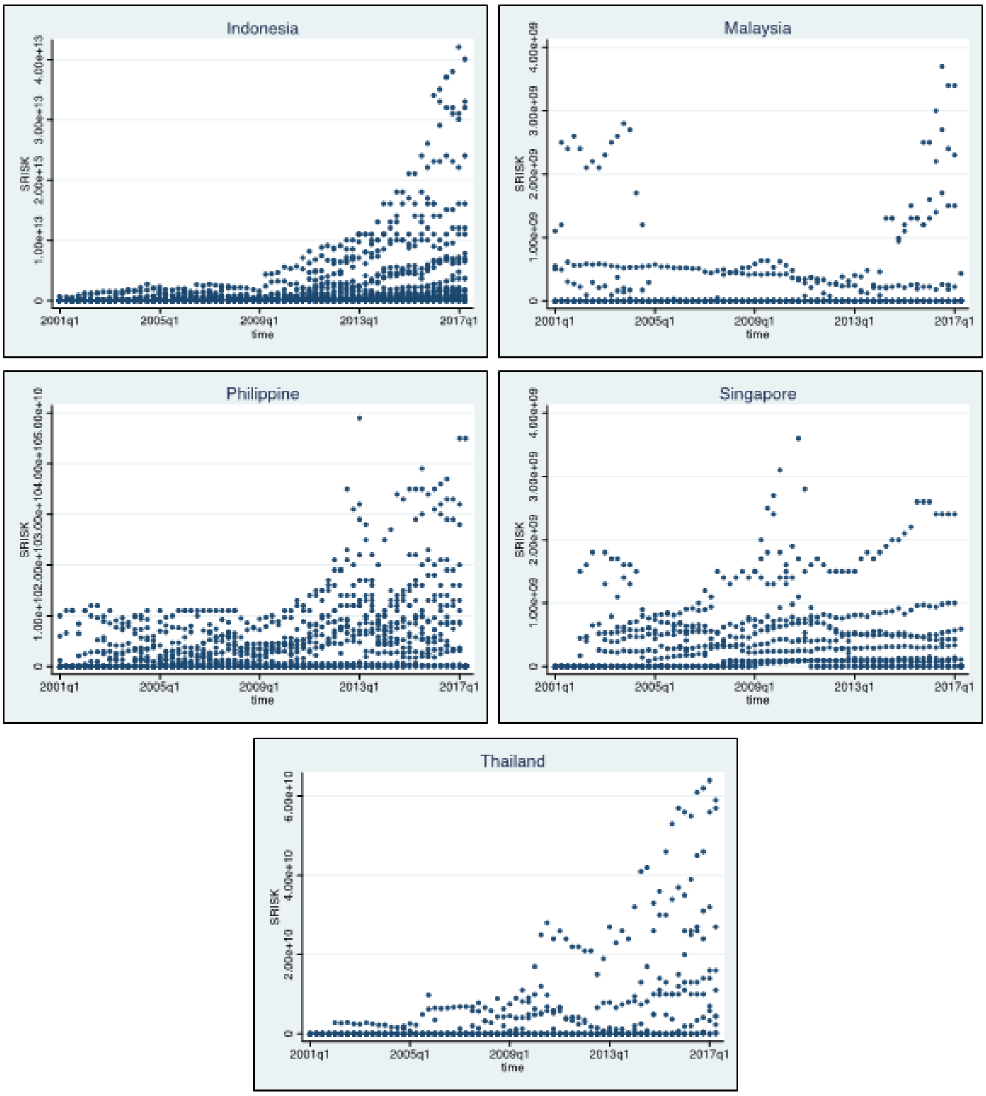

Figure 4. SRISK Dynamics over Time by Country

the development and dynamics of the stock market. On the other hand, liabilities, especially for banks, is a subject of close supervision by the financial service authority in each country. The threshold or tolerance of leverage level, and stance of the regulator will affect this variable very much.

5.2 Systemic Risk Cycle

The estimation results are presented in Table 5, 6, and 7. Each table employs exactly similar estimation specification, that is (1) FGLS estimation with heteroscedasticity option; (2) Fixed-Effect with robust error option (FE-VCE Robust); and (3) Fixed-Effect with robust error option and dummy crisis variable. The estimations are conducted for six panels, covering regressions at ASEAN level and each country panel.

Estimation with FGLS reveal the cyclicality to vary across the country, though it is shown to be highly significant, except for Malaysia (Table 5, Panel (1)). For the ASEAN panel, LRMES tend to be counter-cyclical toward business cycle. The business cycle is represented by country GDP growth. Meanwhile, the liabilities is represented by log-transformed liabilities of the institution (bank). The results for Indonesia, Singapore and Thailand, show LRMES to be pro-cyclical. Meanwhile for Malaysia and Philippine, LRMES are shown to be counter-cyclical. The main purpose of these estimations is to observe the similarity (or difference) of LRMES cyclicality across the country, since it is a bit hard to literally interpret the meaning of the LRMES in the cyclical context. For the case of liabilities, LRMES are shown to be positively correlated for each country and ASEAN panel, except Thailand, which is not significant statistically.

Meanwhile, regression with Fixed-Effect show only regression at ASEAN level and Malaysia to be weakly significant (Table 5, Panel (2)) for GDP growth cyclicality toward LRMES. After dummy for crisis is included, the fixed-effect model show GDP growth cyclicality toward LRMES at ASEAN level and Malaysia remain weakly significant, and Indonesia is highly significant and pro-cyclical (Table 5, Panel (3)).

Table 6 presents estimations result of the main focus of this study, that is the cyclicality of SRISK toward business cycle fluctuations. The dependent variable in the estimations is SRISK, which is log-transformed. Meanwhile, the dependent variables are GDP growth (represents business cycle) and log-transformed liabilities.

In general, regression with FGLS shows that business cycle tends to be statistically significant toward SRISK (Ta-

Table 5. Estimation of LRMES Cyclicality

Dependent Variable: LRMES

	Variable	ASEAN	Indonesia	Malaysia	Philippine	Singapore	Thailand
(1)	**FGLS**						
	GDP Growth	-0.0007***	0.0054***	-0.0003	-0.0029***	0.0005***	0.0014***
	Liabilities	0.0041***	0.0315***	0.0093***	0.0270***	0.0161***	-0.0014
	C	0.0530***	-0.8673***	-0.0082	-0.5559***	-0.2213***	0.2904***
	Observation	4,014	1,521	642	711	571	569
	Total Bank	84	37	10	16	11	10
(2)	**FE-VCE(Robust)**						
	GDP Growth	0.0006*	0.0011	-0.0010*	-0.0002	0	0.0016
	Liabilities	-0.0005	0	0.0118	0.0044	-0.0011	-0.0260**
	C	0.1721	0.1253	-0.0734	0.0104	0.1674	0.9502***
	Observation	4,014	1,521	642	711	571	569
	Total Bank	84	37	10	16	11	10
(3)	**FE-VCE(Robust) with Dummy Crisis**						
	GDP Growth	0.00061*	0.0047***	-0.0010*	0.0011	0.0001	0.0006
	Liabilities	-0.001	-0.0019	0.0117	0.0034	-0.0012	-0.0304***
	Crisis	-0.0061	-0.0179**	0.0006	0.0114	-0.0013	-0.0223***
	C	0.1879	0.1691	-0.0727	0.0264	0.1709	1.0784***
	Observation	4014	1521	642	711	571	569
	Total Bank	84	37	10	16	11	10

Note: *** Significant at 1%; ** Significant at 5%; * Significant at 10%

Table 6. Estimation of SRISK Cyclicality

Dependent Variable: SRISK

	Variable	ASEAN	Indonesia	Malaysia	Philippine	Singapore	Thailand
(1)	**FGLS**						
	GDP Growth	0.0197***	-0.2429***	-0.0680***	0.0771***	0.0101**	0.0097
	Liabilities	0.7946***	0.7726***	0.0594*	0.4799***	0.1697***	0.3066***
	C	2.2328***	4.9338***	18.7600***	9.5854***	16.1728***	14.4153***
	Observation	2,552	1,027	166	680	479	200
	Total Bank	78	35	6	16	11	10
(2)	**FE-VCE(Robust)**						
	GDP Growth	0.0053	-0.2036***	-0.0022	0.0790***	0.0107	0.0444
	Liabilities	0.7077***	1.0061***	-0.2506	0.5488***	0.0976	0.8897***
	C	45.544	-25.952	25.8040***	77.206	17.5186***	-16.658
	Observation	2,552	1,027	166	680	479	200
	Total Bank	78	35	6	16	11	10
(3)	**FE-VCE(Robust) with Dummy Crisis**						
	GDP Growth	0.0056	-0.1488**	-0.0021	0.0609**	0.0096	0.0397
	Liabilities	0.6786***	0.9716***	-0.2495	0.5624***	0.1058	0.8384***
	Crisis	-0.2744***	-0.2785	-0.0218	-0.1529	0.1373	-0.1993
	C	54.094	-17.629	25.7812***	75.112	17.3013***	-0.2053
	Observation	2552	1027	166	680	479	200
	Total Bank	78	35	6	16	11	10

Note: *** Significant at 1%; ** Significant at 5%; * Significant at 10%

ble 6, Panel (1)). For the overall pattern, the ASEAN panel estimation result shows SRISK to be pro-cyclical toward business cycle. Meanwhile, for each country panel, the results are shown to be varied. The result for Indonesia and Malaysia show SRISK to be counter-cyclical toward business cycle. The results for Philippine, Singapore and Thailand show the opposite. Especially for Thailand, we found the coefficient to be statistically insignificant. For the case of liabilities, the results from all panels show it to be positively correlated with SRISK. This means that as the liabilities of an institution grows, so does its capital shortfall, as represented by SRISK value.

Meanwhile, regression with Fixed-Effect show regression at Indonesia and Philippine to be highly significant (Table 6, Panel (2)) for GDP growth cyclicality toward SRISK. After dummy for crisis is included, the fixed-effect model show GDP growth cyclicality toward Indonesia and Philippine remain significant.

The fixed-effect models reveal liabilities to be highly significant in affecting the SRISK cyclicality. The results show significant relationship between liabilities toward SRISK at ASEN level, Indonesia, Philippine, and Thailand. The results then strengthen the role of liabilities in controlling the magnitude of systemic risk. Leverage level plays significant role in determining systemic risk cyclicality at bank level. The results remain consistent when dummy crisis is included in the estimation.

Table 7 presents estimations result of SRISK-to-Equity ratio estimation toward business cycle and liabilities. The dependent variable in the estimations is SRISK-to-Equity ratio. The dependent variables are GDP growth (represents business cycle) and log-transformed liabilities. In general, regression with FGLS show the business cycle tends to be statistically significant toward SRISK-to-Equity, except for Singapore and Thailand panel (Table 7, panel (1)). The overall cyclicality result of the estimation resembles the result from SRISK estimation (Table 6). The estimation results are shown to be significant for liabilities, with all coefficient sign to be similar. However, the liabilities coefficients are all negative, which are in contrast with the all-positive result from SRISK estimation.

Meanwhile, regression with Fixed-Effect show regression at Indonesia and Philippine to be highly significant (Table 7, Panel (2)) for GDP growth cyclicality toward SRISK-to-Equity ratio. After dummy for crisis is included, the fixed-effect model show GDP growth cyclicality toward Indonesia and Philippine remain significant.

The fixed-effect models reveal liabilities to be highly significant in affecting the SRISK cyclicality. The results show significant relationship between liabilities toward SRISK-to-Equity ratio at ASEN level, Indonesia, Philippine, and Singapore. The results then strengthen the role of liabilities in controlling the magnitude of systemic risk. Leverage level plays significant role in determining systemic risk cyclicality at bank level. The results remain consistent when dummy crisis is included in the estimation.

5.3 Discussion

5.3.1 Cyclicality of Systemic Risk

Current strand of the literature shows us that systemic risk tends to be pro-cyclical. The ground of this argument is quite obvious. As the economy grows – booming – banks tend to excessively take risk so that the systemic risk is building up. This result is then in line with current existing literatures such as Liu (2017); Lenoci (2017); and Tasca and Battiston (2016).

On the other hand, we also documented some reverse cyclical relationship between systemic risk and the business cycle. This condition applies especially for Indonesia and Malaysia. The results suggest that for both countries, systemic risk tends to be counter-cyclical toward business cycle fluctuation. Further examination is needed to uncover the explanation of this findings, and that is beyond the scope of this study. Such condition might be related to the regulatory stances that authority in both countries holds. The counter-cyclicality behavior of the systemic risk may be a signal of the effective macro-prudential action both in the banking sector and financial market in general. Further study is needed to see the possible effects of regulatory stance of banking or financial market on SRISK.

5.3.2 Leverage and Systemic Risk

Another important finding from this study is the examination of the role of leverage (liabilities) in explaining dynamics of systemic risk. The estimation results show that level of liabilities of a financial institution is a major determinant of its systemic risk. Unlike the macroeconomic variables, leverage level is something a regulator can directly change. The financial authority certainly, as supported by the finding in this study, might use leverage level as a macroprudential tool. The ultimate goal is to tame the danger of the systemic risk.

6. Conclusion

This study examines cyclicality of systemic risk through business cycle dynamics. Understanding the nature of systemic risk is a necessary condition if the regulators want to control it. Empirical estimations are conducted using data from 84 listed banks in ASEAN-5 countries, i.e. Indonesia, Malaysia, Philippines, Singapore, and Thailand. The data span in from 2001Q1 to 2017Q2. We employ SRISK as the measure of systemic risk as it represents the capital shortfall of a firm in the time of a crisis happens.

The results show that SRISK cyclicality toward business cycle dynamics to vary across country. For some countries, SRISK tends to be pro-cyclical. As the economy grows – i.e. booming – banks tend to excessively take risk causing the systemic risk is building up. This result is in line with current existing literature such as Liu (2017); Lenoci (2017); and Tasca and Battiston (2016). On the other hand, for other countries, we found SRISK to be counter-cyclical. Further examination is needed to uncover the explanation of this findings, and that is beyond the scope of this study. Further, the results also observe the significant role of leverage level (liabilities) in explaining dynamics of SRISK. This finding, though still preliminary, is a good sign of the possibility of the macroprudential regulation to control the dynamics of systemic risk.

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Table 7. Estimation of SRISK-to-Equity Cyclicality

Dependent Variable: SRISK-to-Equity

	Variable	ASEAN	Indonesia	Malaysia	Philippine	Singapore	Thailand
(1)	**FGLS**						
	GDP Growth	0.0032***	-0.0330***	-0.0066***	0.0104***	0.0008	0
	Liabilities	-0.0316***	-0.0408***	-0.1139***	-0.1004***	-0.1028***	-0.0589***
	C	1.1415***	1.6938***	2.9529***	2.7948***	2.7204***	1.7235***
	Observation	2,552	1027	166	680	479	200
	Total Bank	78	35	6	16	11	10
(2)	**FE-VCE(Robust)**						
	GDP Growth	-0.0005	-0.0245***	0.0034	0.0098***	0.0005	0.0017
	Liabilities	-0.0378**	-0.0132	-0.1693***	-0.0510*	-0.0643***	-0.0208
	C	1.3291***	0.8156	4.2074***	1.5410**	1.8945***	0.6899
	Observation	2,552	1,027	166	680	479	200
	Total Bank	78	35	6	16	11	10
(3)	**FE-VCE(Robust) with Dummy Crisis**						
	GDP Growth	-0.0005	-0.0205***	0.0034	0.0079***	0.0005	0.001
	Liabilities	-0.0409**	-0.0157	-0.1699***	-0.0495*	-0.0642***	-0.0277
	Crisis	-0.0299**	-0.0203	0.01	-0.0164	0.0013	-0.0266
	C	1.4224***	0.8766	4.2179***	1.5185**	1.8924***	0.8854
	Observation	2552	1027	166	680	479	200
	Total Bank	78	35	6	16	11	10

Note: *** Significant at 1%; ** Significant at 5%; * Significant at 10%

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Appendix

Table A1. List of Banks in Dataset

Indonesia	Malaysia	Philippine	Singapore	Thailand
- Bank Mandiri	- Malayan Banking	- BDO Unibank	- DBS Group Holdings	- Bangkok Bank
- Bank Rakyat Indonesia	- CIMB Group Holdings	- Metropolitan Bank & Trust	- Oversea-Chinese Banking Corporation	- Krung Thai Bank
- Bank Central Asia	- Publik Bank	- Bank of The Philippine Islands	- United Overseas Bank	- Siam Commercial Bank
- Bank Negara Indonesia	- RHB Bank	- Philippine National Bank	- Hong Leong Finance	- KASIKORNBANK
- Bank Cimb Niaga	- Hong Leong Bank	- Security Bank	- UOB-Kay Hian Holdings	- Bank of Ayudhya
- Bank Danamon Indonesia	- AMMB Holdings	- China Banking	- Sing Investment and Finance	- Thanachart Bank
- Bank Pan Indonesia	- AHB Holdings	- Rizal Commercial Banking	- Singapura Finance	- TMB Bank
- Bank Permata	- Alliance Financial Group	- Union Bank of the Philippines	- GK Goh Holdings	- CIMB Thai Bank
- Bank Tabungan Negara	- BIMB Holdings	- East West Banking	- IFS Capital	- TISCO Financial Group
- Bank Maybank Indonesia	- Kenanga Investment Bank	- Philippine Saving Bank	- Tat Hong Holdings	- Kiatnakin Bank
- Bank OCBC NISP		- Asia United Bank	- GuocoLand	
- Bank Bukopin		- Philtrust Bank		
- Bank Pembangunan Daerah Jawa Barat dan Banten		- Philippine Bank of Communication		
- Bank Tabungan Pensiunan Nasional		- First Metro Investment		
- Bank Mega		- Philippine Business Bank		
- Bank Mayapada Internasional		- Citystate Savings Bank		
- Bank Sinarmas				
- Bank QNB Indonesia				
- Bank Artha Graha Internasional				
- Bank Victoria International				
- Bank Woori Saudara Indonesia 1906				
- Bank Jtrust Indonesia				
- Bank Capital Indonesia				
- Bank MNC Internasional				
- Bank China Construction Bank Indonesia				
- Bank Mestika Dharma				
- Bank Nusantara Parahyangan				
- Bank Rakyat Indonesia Agroniaga				
- Bank Bumi Arta				
- Bank of India Indonesia				
- Bank Pembangunan Daerah Banten				
- Bank Maspion Indonesia				
- Bank Agris				
- Bank Harda Internasional				
- Bank Mitraniaga				
- Bank Ganesha				
- Bank Panin Dubai Syariah				

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