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Economic Growths of ASEAN-5 Countries Impacted by Global and Domestic Credit Risks

Jin-Chuan Duan[1]†, Yanqi Zhu[2]

[1]National University of Singapore (Department of Finance, Risk Management Institute, and Department of Economics),

[2]National University of Singapore (Risk Management Institute)

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Abstract

The five founding members of ASEAN – Indonesia, Malaysia, the Philippines, Singapore, and Thailand (a.k.a. ASEAN-5) have maintained moderate economic growths over the past decades. The role of the credit risk cycle in predicting the economic growths of the ASEAN-5 countries is the focus of this paper. Our analysis suggests that the aggregate credit risks of Malaysia and Singapore co-move strongly with the global credit risk cycle while those of Indonesia, Malaysia and the Philippines are more sensitive to regional/domestic credit risk shocks. By comparing to a benchmark growth forecasting model with typical macroeconomic indicators, we find that information on credit risk environments improves the model's explanatory power considerably. The economic growths of all except for Indonesia respond significantly to either global or domestic credit risk movements, or both. Not surprisingly, inclusion of more updated and readily available credit risk assessments arriving intra-quarter can, in a spirit similar to nowcasting, further boost the model's forecasting performance on economic growths.

†Corresponding author: E-mail address: bizdjc@nus.edu.sg.

1 INTRODUCTION

Understanding and forecasting economic growth has always been one of the most important tasks of macroeconomists and economic policy makers. Early studies have established strong links between economic growth and a wide range of real and monetary variables such as unemployment rate, inflation and interest rate. These are the three series generally used in the New Keynesian framework in studying the dynamic interaction between output growth and other macroeconomic variables. To name a few in the literature, [15], [7], and [22], are recent examples among many others. These three series also form the traditional set of GDP growth predictors and are commonly present in the growth forecasting literature.[a]

In the wake of Asian and global financial crises, economists have increasingly recognized the role of financial sector, in particular the credit market, in driving real business cycle. The seminal work of [14] demonstrates how dynamic interaction between credit limit and asset prices can be a powerful transmission mechanism by which the effects of shocks persist, amplify, and spill over to other real sectors. In a similar spirit, [4] features a financial accelerator model to clarify the role of credit market frictions in business fluctuations. Subsequently, there emerge a vast literature quantifying the co-movement and interaction between the credit cycle and business cycle, with [16], [18] and [3] being a few examples.[b]

The credit cycle studied in the above literature are mainly the quantity cycle measured by credit growth or credit-to-GDP ratio. However, the role of credit risk in accounting for economic growth and its fluctuations is much less explored. [11] and [17] are among the very few that link credit spread or credit-market sentiment to economic growths/fluctuations. As shown by [9], a credit risk cycle fundamentally differs from a credit quantity cycle, evoking our curiosity in the role of credit risk cycles in explaining and predicting economic growths. In this paper, we strive to answer this question using the sample on the five founding countries of ASEAN – Indonesia, Malaysia, the Philippines, Singapore, and Thailand (a.k.a. ASEAN-5).

Even after the ASEAN-5 economies being severely hit by the Asian and global financial crises as evidenced in [23], studies on the impact of credit risk environment on their economic growths remain scarce. In this paper, we characterize the credit risk cycles of the ASEAN-5 economies and examine how they can help in understanding and forecasting their economic growths. The country-specific credit risk cycles are measured using the novel indices proposed by [9] which is in essence the median probability of default (PD) across all exchange-listed firms in a country, leveraging the PD database maintained under the Credit Risk Initiative (CRI) of National University of Singapore in

[a] See [5] for a comprehensive survey of the literature.

[b] For some other examples showing how financial shocks drive fluctuations in output, see [13] and [10].

which PDs are based on the forward intensity corporate default prediction model of [8].[c] Similarly, the global credit risk cycle is the median PD across all exchange-listed firms under the CRI's global coverage of 133 economies. Interestingly, we find that in general, more advanced economies (Singapore followed by Malaysia) have lower and relatively stable aggregate credit risks as compared to the other three emerging economies. Moreover, the credit risk cycles of Malaysia and Singapore co-move strongly with the global credit risk cycle, whereas those of Indonesia, Malaysia and the Philippines are more regional/domestic in nature.

ASEAN, being a regional association mainly consisting of emerging countries in Southeast Asia, has demonstrated its relevancy and high growth potential. According to the IMF, ASEAN nations have achieved and maintained an average growth rate of more than 4% per annum over the past few decades. "Few regions present more opportunity to the 21st century than the Asia Pacific," president Barack Obama said at the opening session of the first US-ASEAN Summit hosted by the United States in early 2016. The expanding economic and geopolitical importance of ASEAN nations have attracted greater amount of efforts from researchers to understand and forecast their economic growths. This is particularly so for its five founding members who are relatively well-developed and arguably of greater importance in terms of regional and global impacts.

Many studies have attributed the economic growth of ASEAN-5 to their trade openness and financial development/liberalization over the past decades. [2] documents the importance of trade openness while [6] and [19] find strong relationships between the financial development and economic progression of the ASEAN countries. [21] and [20] provide more comprehensive explorations on the nexus between economic growth, banking sector and stock market development, trade openness, and foreign direct investment of the ASEAN countries. In term of forecasting their economic growths, [1] identifies domestic money supply and exchange rate as powerful predictors that are positively correlated with the economic growths of ASEAN-5, and [12] examines the role of CPI, interest rate and exchange rate.

To distinguish and examine the impacts of global and domestic credit risks on the economic growth of ASEAN-5, we employ a two-stage approach. In the first stage, we decompose the credit risk for each country into a component resonating with the global cycle and a residual component reflecting credit risks uniquely domestic. In the second stage, we estimate a benchmark growth forecasting model and evaluate the value-added arising from complementing the benchmark model with the measures on credit risk environment. We find that the economic growths of all countries respond negatively to heightened global or domestic credit risks, or both, and the responses are all significant except for

[c]For the technical details on how the PDs are computed, readers are referred to [24]. The CRI-PD database (https://www.rmicri.org) makes available daily updated PD term structure ranging from one month to five years on over 70,000 exchange-listed firms globally.

Indonesia. And the inclusion of credit risk measures improves the explanatory power of the model considerably.

There is a recent growing literature on nowcasting GDP growth using more timely indicators that are available at a higher frequency to improve the forecast of quarterly output growth. In line with the credit cycle construction of [9], we can construct credit risk indices of monthly frequency or even higher if needed to reflect revised/updated assessment on the credit outlooks for the remaining months of a quarter for which we are forecasting the economic growth. These monthly indices are immediately available after the last day of the predicting month, making nowcasting GDP growth operationally feasible and deserving an investigation. Unsurprisingly, the output growths of all ASEAN-5 economies are significantly correlated with these intra-quarter credit risk updates, and the model's performance improves tremendously in predicting observed output fluctuations.

2 CREDIT RISK CYCLES OF THE ASEAN-5 COUNTRIES

The credit risk cycle of a country can be well captured by the novel credit cycle index proposed by [9]. The new index, denoted by CCI, reflects the aggregate credit risk movement of a country, a sector or a group of countries/sectors by leveraging the probability of default (PD) database generated by the Credit Research Initiative(CRI) of National University of Singapore (https://www.rmicri.org). The CRI-PDs assess individual firm's credit risk and covers virtually all exchange-listed firms around the world. Following that paper, we construct CCI for each of the ASEAN-5 economies by taking the median PDs across all firms domiciled in the respective countries. Similarly, we construct a global index, denoted by CCI_{global} by taking the median across all firms under the CRI's coverage. The CRI-PDs are updated on a daily bases, therefore in principle, we can have daily CCI measures. However, CCI of monthly frequency is granular enough to demonstrate their cyclical features. Hence we construct monthly CCI using the PDs on the last trading day of a month and spanning the sample period from 1994m4 to 2019m12.

The CRI-PDs are forward prediction measures reflecting the probabilities that a firm defaults over different horizons onward from the prediction time. Hence our CCI is also forward-looking and its magnitude is prediction-horizon specific. Given that CRI-PDs assess individual firm's credit risk with prediction horizons ranging from 1 month to 5 years with a one-month increment, we could in principle tailor-make a series of CCI targeting an economy and for a horizon of interest. Since a quarterly measure of GDP growth reflects the incremental production generated in a typical reporting period of three months, we focus our discussion on the CCI of a 3-month horizon to demonstrate the characteristics of the credit risk cycles of the ASEAN-5 countries.

Figure plots the credit risk cycle for the five major ASEAN countries: Indonesia, Malaysia, the Philippines, Singapore, and Thailand, together with the

global cycle over the period from 1994m4 to 2019m12. During this period, two episodes of financial crisis hit ASEAN with far-reaching consequences – the 1997 Asian Financial Crisis (AFC) and the 2008 Global Financial Crisis (GFC). The two vertical reference lines in Figure correspond to 1997m6 and 2008m9. The 3-month CCI at these two time points reflect the credit risk outlooks for 1997Q3 and 2008Q4 which were the starting quarters for these crises. Interestingly, the responsiveness of aggregate credit risk to these shocks exhibits divergent patterns among the five ASEAN economies despite their geographic proximity and political closeness. In general, the credit profile for firms in Malaysia and Singapore were more robust with their aggregate risk levels maintained well under 30 bps (basis points) per quarter over the past 25 years whereas for Indonesia, the Philippines and Thailand, their credit risks exceeded 60 bps per quarter during the AFC. In addition, Indonesia, the Philippines and Thailand seemed to be more vulnerable to regional credit shocks whereas Malaysia and Singapore were more sensitive to global shocks and exhibited stronger comovements with the global CCI.

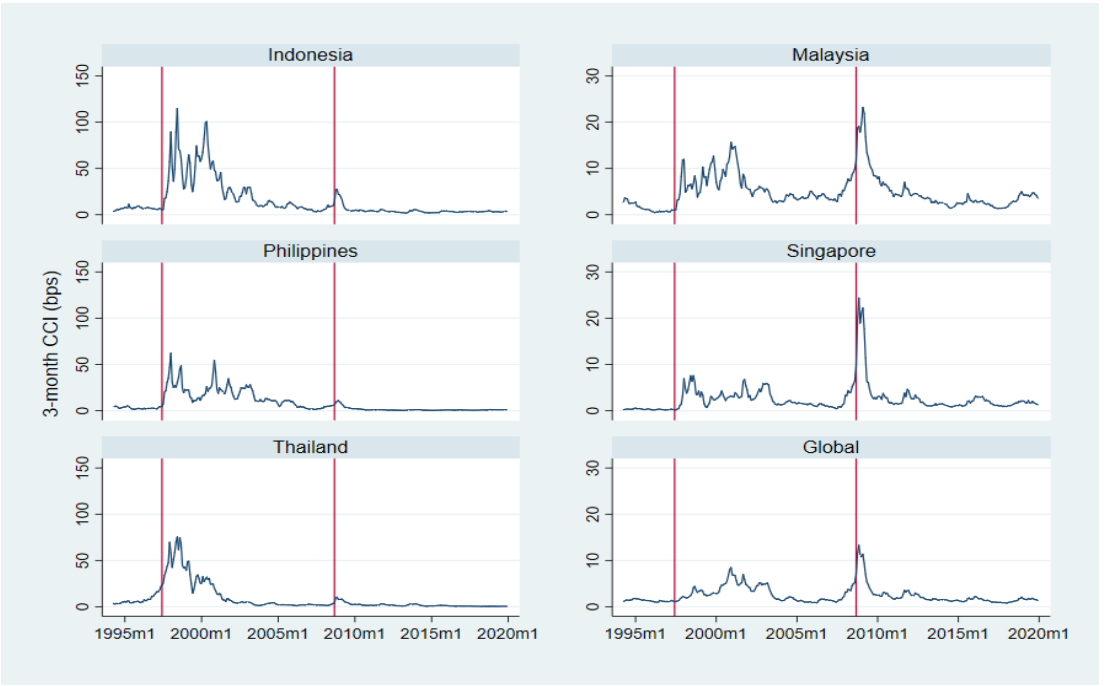

Fig. 1. Global and ASEAN credit risk cycles with the left red vertical line for the Asian Financial Crisis and the right for the Global Financial Crisis

The AFC started in Thailand on July 2nd, 1997, with the collapse of the Thai baht after the Thai government was forced to float the baht due to a lack of foreign currency reserve to support its currency peg to the US dollar. The CCI of Thailand indicates that the aggregate credit risk of Thai firms started an unusual rising trend a few quarters leading to the onset of the crisis, a sort of early warning for the upcoming financial tsunami. The aggregate credit risk of Indonesia and the Philippines responded sharply with a surge in their CCIs to a level more than ten times higher than their pre-crisis level within one year. The heightened credit risk in these two countries lasted for an extended period of time and peaked again around 2001 caused by the burst of the dot-com bubble in the US. The subsequent GFC also resulted in a hump in their CCIs, but to a lesser extent with the magnitude of impact smaller than one-third of those experienced in the AFC.

In contrast, firms domiciled in Malaysia and Singapore were more severely hit by the GFC than they were in the AFC. The aggregate credit risk reached a level much higher than the peak level experienced during the AFC, and ten times higher than the pre-crisis level. Overall, firms around the globe experienced a prolonged period of heightened credit risk from 1998 to 2003 with AFC followed by the burst of the dot-com bubble. The GFC resulted in a sharp surge in the global aggregate credit risk and pushed it to an unprecedentedly high level. However, its impact quickly subsided as governments around the world introducing massive fiscal stimulating plans and central banks adopting quantitative easing to inject liquidity into the financial system.

Table 1 provides the summary statistics for the 3-month CCI of the ASEAN-5 economies and of the globe. The average credit risk for the ASEAN countries over the past 25 years are all above the global mean and with much higher volatilities. Interestingly, the rank of their aggregate credit risk level and volatility is closely related to their economic development. Singapore followed by Malaysia, being the more advanced countries, have much lower average risk and smaller volatility as compared to the other three emerging economies. Table 2 shows the correlations among the five country cycles and the global cycle. It provides statistical evidence conforming our visual observations in Figure that the credit risk cycles of Indonesia, the Philippines and Thailand have strong correlations among themselves whereas those of Malaysia and Singapore align more closely with the global aggregate credit risk.

Table 1: Summary Statistics – 3-month CCI (bps)

Countries	(1) sample size	(2) mean	(3) sd	(4) min	(5) max
Indonesia	309	14.41	19.61	1.705	115.0
Malaysia	309	4.859	3.703	0.484	23.22
Philippines	309	7.930	10.59	0.304	62.49
Singapore	309	2.497	3.069	0.130	24.37
Thailand	309	8.122	14.08	0.294	75.49
Global	309	2.460	1.913	0.777	13.30

Table 2: Credit Risk Cycle Correlations

	Indonesia	Malaysia	Philippines	Singapore	Thailand	Global
Indonesia	1	0	0	0	0	0
Malaysia	0.48	1	0	0	0	0
Philippines	0.78	0.45	1	0	0	0
Singapore	0.31	0.78	0.31	1	0	0
Thailand	0.82	0.30	0.72	0.20	1	0
Global	0.41	0.87	0.48	0.86	0.19	1

3 DISENTANGLE GLOBAL AND DOMESTIC CREDIT RISKS

As mentioned in [9], increased globalization and capital mobility have led to synchronization of credit cycles across countries. The correlations in Table 2 also confirms that there are substantial co-movements between the credit cycles of ASEAN-5 economies and the global cycle. Hence fluctuations in the country-specific credit risks, captured by our 3-month CCI index, are driven by a common global component and affected by regional/domestic shocks. In order to understand how economic growths of ASEAN-5 countries are impacted differently by the global and domestic credit risk environments, our first task is to disentangle these two by projecting the country-specific credit risks on the contemporaneous global cycle. Mathematically, it is decomposed as follows:

$$CCI_{i,t} = \alpha + \beta \times CCI_{global,t} + e_{i,t} \quad (1)$$

where $CCI_{i,t}$ is the 3-month CCI for country i in month t and $CCI_{global,t}$ denotes the global CCI of the same period. The residual series $e_{i,t}$ captures any remaining credit risks unexplained by the global cyclical movements and adjusted for a constant shift, α. Hence it can be interpreted as a measure reflecting the regional/domestic credit risk envi-

ronment.

Table 3 summarizes the estimation results of Equation (1) for each of the ASEAN-5 economies. Unsurprisingly, their credit risks are all positively correlated with the global credit risk cycle and these correlations are of strong significance at 99% confidence level. However, the explanatory power of the global cycle varies across countries in terms of accounting for the fluctuations of country-specific credit risks. On the one hand, the global cycle alone accounts for over 70% of the variations observed in the credit risks of Malaysia and Singapore. But that number drops to only around 20% for Indonesia and the Philippines and to even less than 4% for Thailand.

Table 3: CCI Projection

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Indonesia	Malaysia	Philippines	Singapore	Thailand
CCI_global	4.15***	1.68***	2.64***	1.37***	1.43***
	(0.535)	(0.055)	(0.278)	(0.047)	(0.412)
Constant	0.04**	0.01***	0.01*	-0.01***	0.05***
	(0.017)	(0.002)	(0.009)	(0.001)	(0.013)
Observations	309	309	309	309	309
R-squared	0.164	0.749	0.228	0.732	0.038

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Even after removing the impact of global credit risk cycle, we can expect considerable correlations to remain among the domestic credit risks of some ASEAN countries due to their common exposure to regional shocks and close nexus among their economic activities and financial markets. This is confirmed in Table 4 which documents the correlations among the residual series from Equation (1) for individual countries. The correlations among Indonesia, the Philippines, and Thailand remain largely unchanged indicating that the synchronization of their credit cycles is more likely to be attributable to regional/domestic factors instead of their co-movements with the global cycle. In contrast, the correlations between the credit cycle of Singapore and that of other countries, especially Malaysia, are substantially reduced after removing the global component.

Table 4: Domestic Credit Risk Correlations

	Indonesia	Malaysia	Philippines	Singapore	Thailand
Indonesia	1	0	0	0	0
Malaysia	0.28	1	0	0	0
Philippines	0.73	0.09	1	0	0
Singapore	-0.09	0.16	-0.23	1	0
Thailand	0.83	0.28	0.72	0.07	1

4 ECONOMIC GROWTH OF ASEAN-5 IMPACTED BY CREDIT RISKS

The ASEAN-5 economies have experienced strong growths over the past quarter century. Substantial research efforts have been devoted to understanding the determinants of their economic growths and to improve the quality of their growth forecasts. Early studies have focused on exploring the roles of trade, price stability, and financial development. Motivated by the works of [4] and [14] that feature credit channel/frictions into business cycle models and show how they amplify and propagate shocks to the real economy, empirical studies have established strong links between credit availability and economic growth. However, study on the explicit impact of credit risk on output growth has always been scarce. This paper is motivated by the recent work of [9], showing evidence that heightened credit risk has adverse impact on credit growth/accessibility. A natural conjecture is that credit risk has significant impact on real economic growth. Thus, we revisit the economic growth of the ASEAN-5 countries and examine how credit risk measures can add explanatory power and hence improve predictions on their economic growths.

We collect the quarterly GDP for each of the ASEAN-5 countries and convert into growth series which covers the period from 1994Q2 to 2019Q4 to match the sample period of our credit risk variables.[d] Figure plots the quarterly GDP growths and Table documents their summary statistics. All countries except for Thailand achieved an annualized average growths of more than 4% over the past 25 years, outpacing the majority of the rest of the world.

[d]Information on original data definition and source are provided in Appendix A

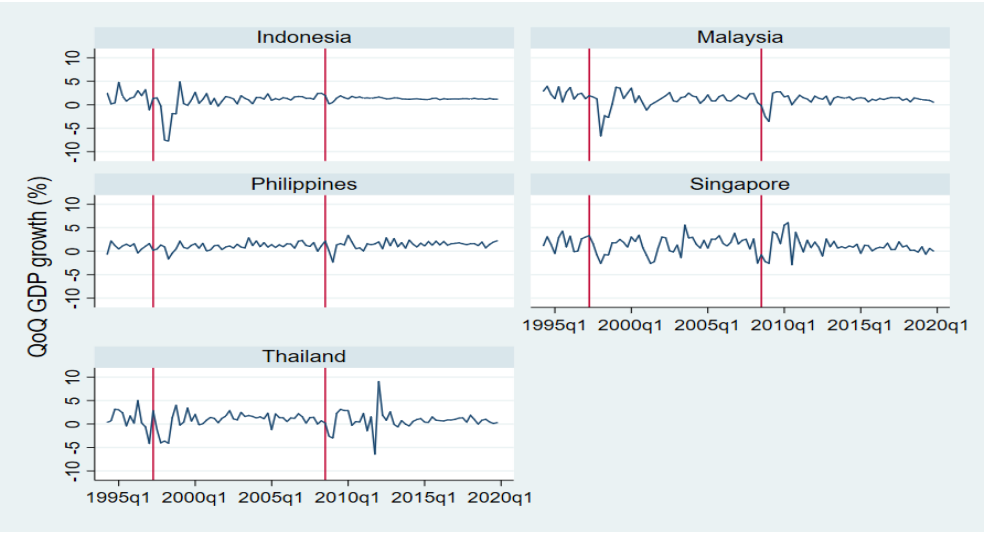

Fig. 2. GDP growth

Table 5: Summary Statistics – GDP Growth Rate (quarterly in percentage points)

	(1)	(2)	(3)	(4)	(5)
VARIABLES	sample size	mean	sd	min	max
Indonesia	103	1.120	1.549	-7.757	4.867
Malaysia	103	1.252	1.459	-6.667	3.935
Philippines	103	1.198	0.850	-2.345	3.377
Singapore	103	1.229	1.785	-2.877	6.079
Thailand	103	0.845	1.903	-6.411	9.098

Prior to examining the value-added from utilising information on credit risks, we estimate the following benchmark growth forecasting model that incorporates a number of standard real and monetary predictors:

$$\begin{aligned} GDP_{i,t} =& \beta_{i,0} \times GDP_{i,t-1} \\ &+ \beta_{i,1} \times GDP_{i,t-4} \\ &+ \boldsymbol{\gamma} \cdot \boldsymbol{controls} \\ &+ u_i + \epsilon_{i,t} \end{aligned} \tag{2}$$

where GDP denotes the quarter-on-quarter GDP growth rate. We include the first and fourth lag of GDP growth to capture the auto-correlation features in the gross production with respect to the previous quarter and the same quarter in the previous year to capture seasonality. $\beta_{i,0}$ and $\beta_{i,1}$ are the coefficients attached to the two lags and are of our primary interest. We allow them to vary across the ASEAN-5 countries to reflect the heterogeneity in the auto-correlation features of their economic growths. The set of control variables are either growth rate or change on commonly adopted macroeconomic measures, which include $UNEMP_{i,t-1}$, $CPI_{i,t-1}$, $NEER_{i,t-1}$, $INT_{i,t-1}$ with subscript $t-1$ denoting the first lag of

[e]Variable transformation, definition and data source are detailed in Appendix A.

the growth rate or change.[e] $\boldsymbol{\gamma}$ is the vector of coefficients in front of the control variables and "$\cdot$" stands for the dot product of two vectors. We include country fixed effect u_i to capture any country-specific characteristics that are invariant of time.

We use least square dummy variable (LSDV) estimator for all our analysis in this section. Although LSDV is known to be biased for dynamic panel models, given our small cross-sectional N and large T, the bias is negligible and less of a practical concern. Table presents the estimation results for the benchmark regression. The current quarter economic growths of Malaysia and Singapore are strongly positively correlated with their growths in the previous quarter and negatively associated with those one year ago. There's also evidence suggesting that the GDP growth of the Philippines is significantly autocorrelated with its fourth lag. However, the growths of Indonesia and Thailand do not exhibit strong links to their past values. Among the four control variables, high inflation measured by CPI seems to hurt economic growth and strong local currency is associated with more robust growth. Overall, these traditional macroeconomic indicators explain about 22% of the fluctuations in economic growths of the ASEAN-5 economies.

Table 6: Benchmark GDP Forecasting Model

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Indonesia	Malaysia	Philippines	Singapore	Thailand
Variables with country-specific coefficients					
GDP_L1	0.081	0.387***	0.012	0.207***	-0.041*
	(0.069)	(0.012)	(0.023)	(0.013)	(0.015)
GDP_L4	0.084	-0.239***	0.137***	-0.283***	0.021
	(0.088)	(0.008)	(0.025)	(0.005)	(0.011)
Control variables with shared coefficients					
UNEMP_L1	-0.256				
	(0.272)				
CPI_L1	-0.160*				
	(0.074)				
NEER_L1	0.071***				
	(0.013)				
INT_L1	-0.015				
	(0.060)				
Total Observations	491				
R-squared	0.224				

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Observing the plots of credit risk cycles (Figure) and GDP growths (Figure) of the ASEAN-5 countries, it is not hard to notice that heightened aggregate credit risks usually signify a looming financial crisis and are followed by a deep trough in economic growth. Hence having knowledge of the aggregate credit risk environment, both global and domestic, may help in understanding and predicting economic growth. This is confirmed by our augmented growth forecasting model below, which includes the global and domestic credit risk measures as additional predictors. Specifically, we estimate

$$\begin{aligned} GDP_{i,t} =& \alpha_{i,0} \times CCI_{global,t-1} \\ &+ \alpha_{i,1} \times CCI_{domestic,i,t-1} \\ &+ \beta_{i,0} \times GDP_{i,t-1} \\ &+ \beta_{i,1} \times GDP_{i,t-4} \\ &+ \boldsymbol{\gamma} \cdot \boldsymbol{controls} \\ &+ u_i + \epsilon_{i,t} \end{aligned} \tag{3}$$

where $CCI_{domestic,i,t-1}$ is the estimated residual series $\hat{e}_{i,t}$ from Equation (1) that projects individual country's CCI on the global credit risk cycle. Since Equation (1) is estimated with monthly global and country-specific CCIs, the resulting residuals are also of monthly frequency. We therefore need to convert the global and domestic CCI series into quarterly frequency before adding them to the forecasting model. This is done by keeping the CCIs of the last month of a quarter, i.e, March, June, September and December of each year. Given that the CCIs used for estimating Equation (1) are of 3-month prediction horizon and the monthly CCI is calculated based on PDs of the last trading day of the month, the quarterly CCIs that we extract provide credit outlook for the subsequent quarter immediately after the prediction month. For example, the 3-month CCI in March 2019, which correspond to 2019Q1, reflects the aggregate credit outlook for 2019Q2 and hence may provide additional information for forecasting the economic growth in 2019Q2.

The estimation results in Table indicate that for all ASEAN-5 countries except for Indonesia, the economic growths are significantly impacted by the global credit risk environment. A 1% rise in the 3-month global aggregate credit risk is associated with more than 10% reduction in the quarterly economic growths for Malaysia, the Philippines and Singapore and 4.7% for Thailand. In addition to responding to the global credit risk movement, the economic growths of Malaysia and Thailand are also adversely affected by their domestic credit risks in excess of the expected level from the global component. With credit risk outlooks available in both global and domestic dimensions at the beginning of each quarter, the overall explanatory power of our forecasting model increases by more than 3% as compared to the benchmark model.

Table 7: GDP Regression II

VARIABLES	(1) Indonesia	(2) Malaysia	(3) Philippines	(4) Singapore	(5) Thailand
Variables with country-specific coefficients					
CCI_global_L1	-0.653	-16.542***	-13.576***	-18.682***	-4.666***
	(0.747)	(0.561)	(0.878)	(0.920)	(0.135)
CCI_domestic_L1	-0.173	-9.989***	-0.171	3.241*	-2.330***
	(0.532)	(0.673)	(0.193)	(1.360)	(0.345)
GDP_L1	0.076	0.293***	-0.097**	0.152***	-0.096***
	(0.085)	(0.010)	(0.029)	(0.009)	(0.010)
GDP_L4	0.090	-0.274***	0.079*	-0.291***	-0.044***
	(0.138)	(0.010)	(0.035)	(0.004)	(0.008)
Control variables with shared coefficients					
UNEMP_L1	-0.169				
	(0.255)				
CPI_L1	-0.159				
	(0.082)				
NEER_L1	0.067**				
	(0.016)				
INT_L1	-0.023				
	(0.078)				
Total Observations	491				
R-squared	0.256				

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5 NOWCASTING GROWTHS WITH INTRA-QUARTER CCIs

So far we have only used the 3-month credit risk outlooks at the beginning of quarters to help forecasting economic growths. But we can actually construct monthly CCI series for other prediction horizons which in principle provide more up-to-date credit risk information within a quarter to further improve the prediction quality on economic growths. Two such CCI series are (i) the 2-month CCI for the first month of a quarter and (ii) the 1-month CCI for the second month of a quarter. They provide updated assessments on the credit risk outlooks for the remaining two months and one month of a quarter, respectively. These two intra-quarter series are of real-time availability in the sense that they become available right after the last day of the respective month, and hence can be utilised to revise and improve our nowcasting on the economic growths of a quarter.

In [9], using the global CCI and CCIs of six major countries/regions, the authors show that monthly CCI series exhibit strong auto-correlations with most

of them having lag structure beyond one period. Therefore, directly adding the 2-month and 1-month country CCI into our forecasting model may be inappropriate. Their high correlations with the 3-month global and domestic CCIs may result in distorted and misleading conclusions. Hence, we perform the following transformation to mitigate the problem of collinearity. For the CCI with 2-month prediction horizon, we first project its monthly series on the 3-month global and domestic CCIs of the previous month; that is,

$$\begin{aligned} CCI^{2m}_{i,t} =& \alpha + \beta \times CCI_{global,t-1} \\ &+ \delta \times CCI_{domestic,i,t-1} \\ &+ CCI^{2m}_{innovation,i,t} \end{aligned} \tag{4}$$

where $CCI^{2m}_{innovation}$ denotes the monthly residual series. We then sample a quarterly sub-series by taking the values for the first month of a quarter, i.e, January, April, July and October of each year. Similarly for the 1-month CCI, we project its monthly series on the 3-month global and domestic CCIs two months ago plus the $CCI^{2m}_{innovation}$ in the previous month. Specifically, we estimate

$$\begin{aligned} CCI^{1m}_{i,t} =& \alpha + \beta \times CCI_{global,t-2} \\ &+ \delta \times CCI_{domestic,i,t-2} \\ &+ \theta \times CCI^{2m}_{innovation,i,t-1} \\ &+ CCI^{1m}_{innovation,i,t} \end{aligned} \tag{5}$$

where $CCI^{1m}_{innovation}$ captures additional shocks or revised credit outlooks that are independent of previous information. Similarly, we sample a quarterly sub-series but keep the values for the second month of a quarter. These two quarterly series – $CCI^{2m}_{innovation}$ and $CCI^{1m}_{innovation}$ – can be used to augment our growth forecast model and in principle yield a better performance.

$$\begin{aligned} GDP_{i,t} =& \alpha_{i,0} \times CCI_{global,t-1} \\ &+ \alpha_{i,1} \times CCI_{domestic,i,t-1} \\ &+ \eta_i \times CCI^{2m}_{innovation,i,t} \\ &+ \kappa_i \times CCI^{1m}_{innovation,i,t} \\ &+ \beta_{i,0} \times GDP_{i,t-1} \\ &+ \beta_{i,1} \times GDP_{i,t-4} \\ &+ \boldsymbol{\gamma} \cdot \boldsymbol{controls} \\ &+ u_i + \epsilon_{i,t} \end{aligned} \tag{6}$$

As can be seen from Table , inclusion of the updated assessment on the aggregate credit risk environment during the predicted quarter increases the explanatory power of our forecasting model tremendously from 25% to 35%. As compared to our benchmark model, there is a more than 50% increase in accounting for the percentage of growth fluctuations. Negative shocks or adjustments on credit outlook at the end of the first month of a quarter are associated with lower economic growths for all countries except for the Philippines whose growth seems to respond negatively to heightened credit risks in the second month of a quarter. Such negative adjustments, however, do not result in further lower growths for the other four countries. Instead, their quarterly GDP growths are positively correlated with such adjustments which could be due to over-reacting to the shocks in the first month of a quarter.

Table 8: GDP regression III

VARIABLES	(1) Indonesia	(2) Malaysia	(3) Philippines	(4) Singapore	(5) Thailand
Variables with country-specific coefficients					
CCI_global_L1	2.019**	-18.353***	-13.989***	-18.675***	-5.091***
	(0.479)	(0.759)	(0.845)	(0.773)	(0.727)
CCI_domestic_L1	-0.481	-11.154***	-0.467	3.386*	-4.840***
	(0.363)	(0.534)	(0.324)	(1.359)	(0.309)
CCI_2m_innovation	-11.823***	-66.757***	-2.189	-61.933***	-34.163***
	(1.803)	(3.250)	(1.111)	(0.616)	(2.737)
CCI_1m_innovation	7.551**	80.540***	-5.658***	14.925***	17.688***
	(2.602)	(4.517)	(1.103)	(3.050)	(2.458)
GDP_L1	0.215	0.294***	-0.094***	0.112***	-0.094***
	(0.102)	(0.008)	(0.020)	(0.008)	(0.008)
GDP_L4	0.052	-0.237***	0.072*	-0.243***	0.061***
	(0.078)	(0.008)	(0.027)	(0.005)	(0.004)
Control variables with shared coefficients					
UNEMP_L1	-0.207				
	(0.232)				
CPI_L1	-0.142				
	(0.078)				
NEER_L1	0.049**				
	(0.014)				
INT_L1	-0.045				
	(0.046)				
Total Observations	491				
R-squared	0.353				

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6 CONCLUSION

The ASEAN-5 economies have been growing rapidly for decades, yet the role of their credit risk cycles are hardly studied. To the best of our knowledge, this is the first scientific study that characterizes the credit risk cycles of the ASEAN-5 countries and examines their impacts on economic growths. This work also serves as the first attempt to explore how information on aggregate credit risk environment can help increase the explanatory power of a growth forecasting model. More empirical studies may be carried out to improve the forecasting/nowcasting usage of credit risk information on economic growth and/or to ascertain the benefit of using such information on other economies.

Appendix A.1 Macroeconomic Data and Sources

Countries	Data Descriptions	Frequency	Data Source
	Gross Domestic Product (GDP)		
Indonesia	SA, IDR, 2010 Prices	Quarterly	Oxford Economics
Singapore	SA, SGD, 2010 Prices	Quarterly	Oxford Economics
Malaysia	SA, MYR, 2010 Prices	Quarterly	Oxford Economics
Thailand	SA, Thai Baht, 2002 Chained Prices	Quarterly	Oxford Economics
Philippines	SA, PHP, 2000 Prices	Quarterly	Oxford Economics
	Unemployment Rate ($UNEMP$)		
Indonesia	Unemployed Rate	Quarterly	Oxford Economics
Singapore	Unemployed Rate, Total, SA	Quarterly	Ministry of Manpower, Singapore
Malaysia	Unemployed Rate	Quarterly	Oxford Economics
Thailand	Unemployed Rate	Quarterly	Oxford Economics
Philippines	Unemployed Rate, Standardized, SA	Quarterly	Philippine Statistics Authority/Thomson Reuters
	Consumer Price Index (CPI)		
Indonesia	Standardized, SA, Index, 2010 = 100	Monthly	Statistics Indonesia/Thomson Reuters
Singapore	Standardized, SA, Index, 2010 = 100	Monthly	Statistics Singapore/Thomson Reuters
Malaysia	Standardized, SA, Index, 2010 = 100	Monthly	Department of Statistics, Malaysia/Thomson Reuters
Thailand	Standardized, SA, Index, 2010 = 100	Monthly	Bureau of Trade & Economic Indices, Ministry of Commerce, Thailand/Thomson Reuters
Philippines	Standardized, SA, Index, 2010 = 100	Monthly	Philippine Statistics Authority/Thomson Reuters
	Nominal Effective Exchange Rate ($NEER$)		
Indonesia	Nominal Broad EER Index	Monthly	Bank for International Settlements
Singapore	Nominal Narrow EER Index	Monthly	Bank for International Settlements
Malaysia	Nominal Broad EER Index	Monthly	Bank for International Settlements
Thailand	Nominal Broad EER Index	Monthly	Bank for International Settlements
Philippines	Nominal Broad EER Index	Monthly	Bank for International Settlements
	Interest Rate (INT)		
Indonesia	Immediate Rates (<24 Hours), Call Money, Interbank Rate, IDR	Monthly	Main Economic Indicators, OECD
Singapore	Interbank 3 Months Sibor ABS de	Monthly	Thomson Reuters
Malaysia	Interbank Rate - 3 Month (EP)	Monthly	Central Bank of Malaysia
Thailand	Interbank Rates, Overnight, Average	Monthly	Bank of Thailand
Philippines	Interbank Call Loan Rate	Monthly	Bangko Sentral ng Pilipinas

*SA: Seasonally adjusted

Appendix A.2 Data Transformations

Variables	**Transformation**
GDP	Quarter-on-quarter growth rate is calculated based on the quarterly GDP data
UNEMP	Quarter-on-quarter change (first difference) is calculated based on the quarterly unemployment rate
CPI	Monthly growth rate on CPI is calculated based on the raw data. The series is then converted to quarterly frequency by summing up the 3 monthly growths in a quarter
NEER	Monthly growth rate on exchange rate is first calculated based on the raw data. The series is then converted to quarterly frequency by summing up the 3 monthly growths in a quarter
INT	Change (first difference) on interest rate is first calculated based on the monthly raw data. The series is then converted to quarterly frequency by summing up the 3 monthly changes in a quarter

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