7. THRESHOLD EFFECTS OF INFLATION ON THE BANKING SECTOR PERFORMANCE IN THE ASEAN-6 COUNTRIES

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Abstract

This study examines the influence of inflation on the banking sector performance in the ASEAN-6 countries, with a focus on the threshold effect of inflation. The empirical study is based on the threshold regression models estimated using the panel data of the ASEAN-6 countries including Cambodia, Indonesia, Malaysia, Philippines, Thailand, and Vietnam over the 1996-2016 period. Using various indicators for the banking sector performance, the results provide strong evidence of the inflation-threshold effect in the relationship between inflation and the banking performance. We find that inflation has a negative effect on each of the size indicators of the banking performance when inflation is below their individual threshold rates, around 4-7%, while this negative effect vanishes as inflation rises above these thresholds. However, the asset-quality indicator worsens only when inflation exceeds 3%. Therefore, the findings would be useful for the policy makers in the ASEAN-6 countries to identify a target-inflation regime that is compatible with their banking systems development.

Keywords: inflation; banking performance; threshold effect; panel data; ASEAN-6.

JEL Classification: E31; G21; C33.

1. Introduction

Inflation is a common macroeconomic phenomenon for every country in the evolution of economic development. Over the past decades, the world economy has experienced substantial variations; in particular, the global economic crises depressed the economic growth and led to high inflation in many countries. It is well recognized that high inflation and hyperinflation are harmful to many domains of economy. While low-to-moderate inflation is sometimes beneficial, it also causes mild detriment to the economy. Although the consensus of a negative relationship between inflation and real economic activity has been reached,

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some researchers still question whether such a relationship exists prevalently at all rates of inflation (Boyd *et al*., 2001; Bruno and Easterly, 1995; Bullard and Keating, 1995, Huybens and Smith, 1999).

This study aims to examine the threshold effect of inflation on the banking sector performance in the ASEAN-6 countries. The reasons why we focus on the ASEAN-6 countries are twofold. Firstly, the ASEAN-6 countries are middle-income developing countries. As compared to the developed ones, the threshold level of inflation which switches the impact direction of inflation on the banking activities in the ASEAN-6 countries should be different. The production capacity of the developed countries is close to the potential level and generally grows at a moderate rate, while in many developing countries the growth rate of production often maintains in a high level, as the production factors such as labor and natural resources have been untapped yet. By examining the threshold effects in the relationship between inflation and the output growth, Khan and Senhadji (2001) estimate a threshold range of 11-12% for the developing countries and one of 1-3% for the industrialized countries. However, there is no theoretical prediction or empirical evidence suggesting the threshold level of inflation that is implied for the banking system of the developed or the developing economies.

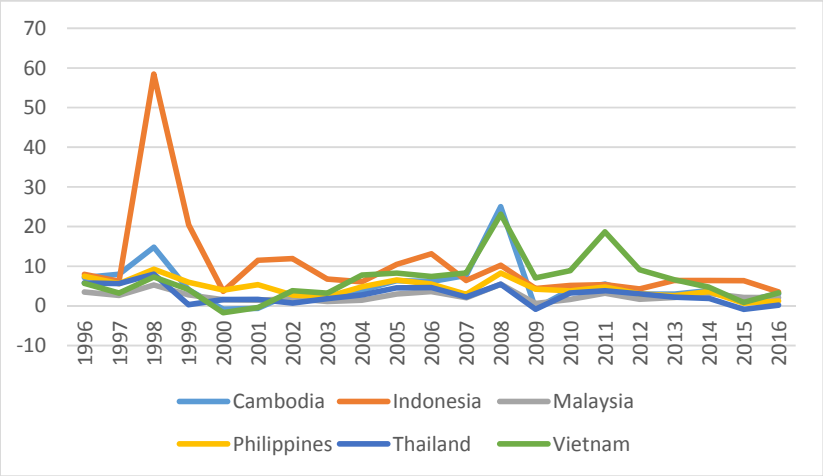
Secondly, the ASEAN countries share many economic similarities for their similar geographical locations and social development. With the tight economic cooperation in the ASEAN community, the ASEAN countries have achieved a comprehensive, stable and sustained economic integration. As argued by Fleming (1971), similarities in the national employment targets, growth rates of productivity, and the degree of trade union aggressiveness lead to similarity in inflation behavior. Besides, many developing economies such as the ASEAN-6 countries adopt the indexation systems to adjust the income payments, which partially denies the negative impact of inflation. The inflation dynamics among these countries are thus expected to behave similarly, so that the policy suggestions implied by this study are applicable uniformly to all the ASEAN-6 countries.

In previous years, the ASEAN countries have experienced significant changes in the annual rates of inflation. As presented in Figure 1, the inflation rates in the ASEAN-6 countries[3] range from Vietnam's -1.710% to Indonesia's 58.451% over the 1996–2016 period. High inflation may occur due to world economic crises or country-specific events. For example, Figure 1 shows that the peaks of inflation rates occurred in 1998 during the Asian financial crisis, in 2008 during the subprime crisis, as well as in 2011 due to the problem in Vietnam's foreign exchange market (Hang, N. T. T. and Thanh, N. D., 2010). This demonstrates that inflation management in these countries is not only a challenge, but also an urgent priority for the policymakers in the ASEAN-6 countries.

[3] *The ASEAN-6 in this study includes Cambodia, Indonesia, Malaysia, Philippines, Thailand and Vietnam. This study does not include Brunei and Singapore because they are high-income (developed) countries where the banking sector and financial markets are highly developed relatively to those of the ASEAN-6. We also do not include Lao and Myanmar due to the difficulty in obtaining the data.*

Figure 1

Inflation Rates in the ASEAN-6 Countries from 1996 to 2016



Inflation impacts many dimensions of people's life. Numerous studies document the inflation-economic growth nexus, but the researches relating to the mechanism through which inflation impacts the economic growth remain sparse. The change in monetary policies is considered to impact the long-run rate of inflation. It first influences the banking system and then spreads towards the real sectors. In this study, the banking system is assumed to be one of the most crucial channels through which inflation impacts the economy. Previous studies' results are mixed regarding the effect of inflation on the performance of the banking sector. Most studies find that inflation has a significantly negative impact on the banking system performance (Boyd *et al*., 2001; Sharma and Gounder, 2012), while others also provide evidence of a positive effect (Athanasoglou *et al*., 2006; Stepanyan and Guo, 2011).

Another important strand of research revealed that the effect of inflation on the banking sector performance is non-linear, with an inflation threshold that switches the impact direction of inflation on the banking activity (Azariadas and Smith, 1996; Choi *et al*., 1996). In the context of the ASEAN countries, the empirical evidence on this issue still attracts little attention. This research fills this literature gap by providing a comprehensive evidence of a threshold effect of inflation on the banking sector performance using the panel data of the ASEAN-6 countries covering the 1996-2016 period.

The findings of this study would serve as a useful basis for the inflation targeting policy (ITP)[4] implemented by the ASEAN-6 countries. Part of the ASEAN countries[5] are currently pursuing ITP, where defining and targeting an inflation rate that is compatible with the banking development is helpful for this policy. With the inflation target, investors, lenders, and managers are capable of effectively allocating resources. The inflation thresholds implied for

[4] *Central banks estimate and announce a target inflation rate, and then attempt to steer the actual inflation rate towards that target.*

[5] *Among the 10 ASEAN countries, Indonesia, Philippines, and Thailand implement ITP (Poon and Lee, 2014).*

the banking system would be an essential reference for policymakers to determine an appropriate inflation targeting regime.

The remainder of this study is organized as follows. Section 2 reviews the literature on the relationship between inflation and the banking performance. Section 3 outlines the methodologies. Section 4 describes the data and summary statistics. Section 5 reports the empirical results and Section 6 concludes the paper.

2. Literature Review

Existing studies found two divergent views regarding the relationship between inflation and banking sector performance. Firstly, Inflation might have an adverse effect on the banking sector performance and this adverse effect could spill over the entire economy. Inflation impacts the purchasing power, exchange rate regime, and the opportunity cost of holding currency in the future. It also influences banks' loan policy and the real return of their equity holdings. Inflation also disrupts business plans, distorts the price system, and leads to inefficiency in the allocation of resources. Antonios (2010) found that inflation had a negative effect on the long-run development of the credit market of Ireland. On the other hand, the adverse effect is possibly caused by the uncertainty about the future rate of inflation. Friedman (1977) argues that inflation uncertainty is costly and may lead to an adverse output effect, since it distorts the relative prices and increases the risk of business management. Empirical studies have discovered that inflation uncertainty influences the performance of the banking industry. For example, Loayza *et al*. (2000) used an extensive cross-country database to study the determinants of saving rates and concluded that an increase in the macroeconomic uncertainty, measured by the variance of inflation, raises the private saving rates. Rizvi and Khan (2015) also reported that higher inflation volatility usually contributes to a high ratio of non-performing loans.

By contrast, other studies argue that inflation may have a positive effect on the banking performance, as long as the banking system is able to anticipate future changes in inflation and adjusts the interest rates soon to increase income more than the costs. Stepanyan and Guo (2011) found that high inflation leads to a higher growth of nominal bank credit in the emerging markets. Using an unbalanced panel data set from the South Eastern European countries, Athanasohlou *et al*. (2006) indicate that inflation positively impacts banks' profitability.

Recent studies have demonstrated that the relationship between inflation and banking performance is non-linear. Previous studies also emphasized that informational frictions played a substantial role only when inflation passed some critical rates. For instance, the studies by Choi *et al*. (1996) and Azariadas and Smith (1996) indicate that for the economies at very low inflation rates, inflation does not distort the information flow or interfere with resource allocation because the credit market frictions may be nonbinding. On the contrary, when inflation exceeds certain threshold levels, credit market frictions emerges, causing a negative impact on the financial sector performance. In addition, the studies by Huybens and Smith (1999) also suggested the existence of inflation thresholds when discussing the relationship between inflation and the real activity or financial market.

Boyd *et al*. (2001) find that for countries with the annual rate of inflation below 15%, inflation has a negative impact on the financial sector performance, but this relationship disappears for countries where the annual rate of inflation exceeding 15%. Boyd *et al*. (2001) employed cross-sectional regressions using data covering 100 countries over 36 years (from 1960 to 1995). As such, their study focuses on the long-run effect of inflation. As indicated in their

paper, the cross-sectional analyses also have various shortcomings. For example, they do not consider the time-series information of the sample data or do not control for the country-specific effect. The present study rather concerns the short-run effect of inflation and considers both the time-series and country-specific information into the regression models.

In fact, studies on the threshold levels of inflation mostly concentrate on the relationship between inflation and economic growth. For example, Sarel (1996) find a threshold of 8%, above which the inflation rate negatively impacts economic growth. Using a larger sample than Sarel's (1996), Ghosh and Phillips (1998) find a threshold effect at a lower annual rate of inflation, 2.5%. Most of those studies conclude that the threshold effect exists, but do not reach a consensus on the threshold level. Most importantly, the threshold level frequently depends on the econometric models, data frequencies, as well as data types; for instance, cross-country data or panel data. To the best of our knowledge, there existare no studies on the threshold level above which the impact of inflation on the banking performance changes.

3. Methodologies

To examine the impact of inflation on the banking system performance, this study employs regression models estimated using panel data of the ASEAN-6 countries. We consider both linear and threshold regression models for each banking performance indicator. Pooled estimation is applied to all regression models. The regression models are illustrated below.

3.1. Linear Regressions

We regress each banking performance indicator on inflation (INF), controlling for other factors that either capture country development or influence the development of banking. The control variables include the level of economic activities (INC), exchange rate distortion (DIS), fiscal policy (GOV). Specifically, the linear regression model can be written as follows:

$$\textit{Banking Performance Indicator} = a + b\,INC + c\,DIS + d\,GOV + e\,INF + u \quad (1)$$

where: u is a disturbance term. Many previous studies applied explanatory variables similar to Eq. (2) to examine the economic growth-inflation relationship. Related studies include Boyd *et al*. (2001) and Sargsyan (2005).

For the control variables, the variable ***INC*** is calculated as the logarithm of initial real GDP per capita. Greenwood and Jovanovic (1990) indicated that a high level of economic output is beneficial for financial market development, because prosperous economic activities may generate a higher rate of return to be earned on capital through financial intermediation. Khan and Senhadji (2001) also used initial GDP per capita in their economic growth-inflation regression model. In fact, a high level of Initial GDP per capita just provides a rich source for deposits and credit of the banking system. In this study, the banking sector is assumed to be a channel through which inflation impacts economic growth.

The variable ***DIS*** in our model represents the exchange rate distortions. To measure the distortion index, a black-market exchange rate premium is employed by Boyd *et al.* (2001). However, data on the black-market exchange rate are not available for most of the countries covered by this study. Hence, we follow another approach proposed by Odedokun (1992), where a dummy variable takes a value of unit if an inappropriate exchange rate policy is adopted and a value of zero otherwise. The inappropriate exchange rate policy is characterized as a real appreciation of the domestic currency in the current year (as

compared to its value in the previous year) following a current account deficit recorded in the balance of payments, or as a real depreciation following a current account surplus.

The variable ***GOV*** is the ratio of the central government expenditure to GDP. Cooray (2011) investigated the role of government in financial sector development and concluded that a high level of government expenditure has a negative effect on the financial system. The government expenditure can be financed by issuing money, which causes high inflation. A high inflation combined with various restrictions on the financial system help fund expenditures. The economy thus has both high inflation and a poorly functioning financial system (Boyd *et al*., 2001, pp 224). In this situation, the fiscal policy may have a negative influence on the banking sector performance. To control for this effect, we include GOV as a control variable in our model.

3.2. Threshold Regressions

The relationship between inflation and the banking performance might be non-linear. That is, there is a threshold effect. When the rate of inflation is above a threshold rate, the impact of inflation on the banking activities will change. We follow the models proposed by Sarel (1996) and Boyd *et al*. (2001) to test this threshold effect.

3.2.1. Sarel's (*1996*) Version

Sarel (1996) proposes a regression model with inflation-threshold effects. Let *INF** be a threshold rate of inflation. Sarel's threshold model is widely applied in many previous studies, such as Salami and Kelikume (2010) and Mohanty *et al.* (2011). The threshold model based on Sarel's (1996) version may be written as:

$$\textit{Banking Performance Indicator} = a + b\,INC + c\,DIS + d\,GOV + e\,INF + f\,HINF^{*}.(INF - INF^{*}) + u \quad (2)$$

where: *HINF** equals to 1 if inflation INF is higher than the threshold level *INF** and zero otherwise. The optimal threshold level *INF** is determined by running a series of regressions with different threshold levels. The threshold level with maximal adjusted R-square is chosen as *INF**. The term of *HINF*.(INF-INF*)* can be interpreted as extra inflation. Inflation impacts the banking performance through both *INF* and the extra inflation terms. That is, the effect of inflation depends on the threshold. When inflation is lower than *INF**, the effect of inflation on the banking performance is measured by ***e***, while measured by ***e+f*** when inflation is above *INF**. To test the significance of the threshold effect, we report t-statistic for the coefficient of the extra inflation term, *f*. Wald F-statistics are also applied to test whether the influence of inflation on the banking performance is significant when the rate of inflation is above *INF**; that is, we test for the null hypothesis of $e+f = 0$.

3.2.2. Boyd et al.'s (2001) Version

Boyd *et al*. (2001) proposed a model with threshold effects to evaluate the impact of inflation on the performance of the financial sector. This study also applies Boyd *et al*.'s (2001) approach to introduce an inflation threshold into the regression model. The model is formulated as follows:

$$\textit{Banking Performance Indicator} = a + b\,INC + c\,DIS + d\,GOV + e\,INF + f\,HINF^{*} + g\,HINF^{*}.\,INF + u \quad (3)$$

where the regressors are defined as before. Without searching for an optimal threshold level, Boyd *et al*. (2001) directly identify a threshold rate of 15%. For comparison, we use the optimal threshold levels derived from Sarel's version in Eq. (2). Equation (3) shows that both the intercept term and the slope of inflation depend on the threshold level. When inflation is lower than the threshold, the intercept is *a*, while *a+f* if inflation is above the threshold. Similarly, if the rate of inflation is below the threshold, the slope on inflation is *e*, while *e+g* if inflation is above the threshold.

4. Data and Summary Statistics

This study uses the panel data of the ASEAN-6 countries over the 1996–2016 period. The panel data is collected from the World Bank. The regressors used in this study, including inflation and control variables, were detailed in Section 3. The regressand, *i.e.*, the banking performance indicators, and summary statistics for all variables are described in this section.

4.1. Data regarding the Banking Performance

We focus on five measures for the development of banking, including the ratio of liquid liabilities (*LIA)*, the total assets held by deposit money banks (*ASS),* the total value of demand, time, and saving deposits at domestic deposit money banks *(DEP)*, the total value of banks' credit distributed to the private sector *(PRE)*, and nonperforming loans (*NPE)*. Among these five measures, *LIA*, *ASS*, *DEP*, and *PRI* measure the size of the banking sector, and *NPE* gauges the asset quality of the banking system.

LIA **(**also known as M3) is calculated by summing the following items, expressed as a percent of GDP: (i) currency and deposits in the central bank (M0); (ii) transferable deposits and electronic currency (M1); (iii) time and savings deposits, foreign currency transferable deposits, certificates of deposit, and securities repurchase agreements (M2); (iv) traveler checks, foreign currency time deposits, commercial paper, and shares of mutual funds or market funds held by residents. *LIA* measures the size of formal financial intermediaries. ***ASS*** represents the total assets held by deposit money banks, as a share of GDP. The deposit money banks comprise commercial banks and other financial institutions that accept transferable deposits such as demand deposits. Here, *ASS* includes claims on domestic nonfinancial sector such as central, state, and local governments, nonfinancial public enterprises, and private sector. An alternative measure for the size of banking is ***DEP*** which is the total value of demand, time, and saving deposits at domestic deposit money banks, expressed as a percent of GDP. *LIA, ASS,* and *DEP* are the size measures and issued to both private and public sectors. In contrast, ***PRI*** measures bank credit distributed only to the private sector, as a percent of GDP. Finally, our preferred asset-quality measure is ***NPE*** – the ratio of banks' non-performing loans to total gross loans. Non-performing loans are payments of interest and principal past due by 90 days or more, and total gross loans is the total value of loan portfolios (including non-performing loans, before the deduction of specific loan-loss provisions).

A number of these banking performance indicators have been utilized to investigate their relationships with economic growth. King and Levine (1993) and Estrada *et al*. (2010) found a strong correlation between *LIA* and economic growth. Levine *et al*. (2000) and Olowofeso *et al*. (2015) found that *NPE* impacts the economic growth. Using the Bahamas data, Jordan and Tecker (2013) also found a feedback effect from non-performing loans to real GDP. We summarize in Table 1 the notations of all variables used to estimate the regression models.

Table 1

Description of the Variables

Symbol	Content
Regressand–Banking performance indicators	
LIA	Liquid liabilities/GDP
ASS	Total assets of deposit money banks/GDP
DEP	Total value of deposits at domestic deposit money banks/GDP
PRI	Banks' credit distributed to the private sector/GDP
NPE	Non-performing loans/total gross loans
Regressor	
INC	Logarithm of initial real GDP per capita
DIS	Dummy for exchange rate distortions (1 for an inappropriate exchange rate policy and 0 otherwise)
GOV	Central government expenditure/GDP
INF	Inflation rate
INF*	Inflation threshold
HINF*	Dummy variable (1 for inflation above INF* and 0 otherwise)

4.2. Summary Statistics

Table 2 shows the mean, standard deviation, median, minimum, and maximum for all variables used to estimate the regression models. These statistics indicate that a number of variables, *e.g., LIA*, *ASS*, *DEP*, *PRI*, and *INF*, have extremely high values during the sample period. This partly justifies why this study considers a threshold into the regression model, since extreme values may produce spurious estimated results for the linear regression models. During our sample period, the maximal annual rate of inflation is Indonesia's 58.451%, occurred in 1998. [6] Except for the *NPE*, the number of observations for each variable is 126. Table 3 presents the correlations matrix for variables of *INF* and the five banking performance variables, *LIA*, *ASS*, *DEP PRI*, and *NPE*, over the 1996-2016 period. Clearly, the size indicators including *LIA*, *ASS*, *DEP,* and *PRI* are negatively correlated with inflation, but the asset-quality indicator of *NPE* is positively associated with inflation, showing that asset quality deteriorates with the rising inflation. All size indicators are positively correlated with each other, while they are less correlated with the asset-quality indicator, with absolute values of correlation coefficients lower than 0.09. Table 4 shows the mean and median values for four quartile groups sorted by inflation. When inflation increases across quartiles, the three banking indicators, *ASS, DEP,* and *PRI*, tend to decrease, but *LIA* and *NPE* have no clear patterns. In order to investigate more rigorously the nature of the relationship between inflation and the banking system performance, in the next section we conduct the regression analysis by considering the threshold effect of inflation to capture possible nonlinearity and controlling for other factors that may impact the banking performance.

[6] *This study does not remove outliers from data. Previous studies related to the threshold effect of inflation tend to not eliminate outliers from the data set. For example, Boyd* et al. *(2001) only excluded countries with very high inflation rates of over 100% from the sample. Sarel (1996) did not eliminate outliers from data.*

Table 2

Descriptive Statistics

	Regressands–Banking performance indicators					Regressors			
	LIA	ASS	DEP	PRI	NPE	INC	DIS	GOV	INF
Mean	68.956	68.988	54.219	60.263	8.572	3.335	0.389	9.517	5.295
Standard Deviation	36.678	43.819	38.193	41.770	9.812	0.393	0.487	3.413	6.407
Median	59.375	50.583	44.423	43.453	3.757	3.344	0.000	9.404	3.951
Minimum	8.442	3.992	3.155	3.933	1.593	2.534	0.000	3.460	-1.710
Maximum	139.472	170.656	126.365	163.210	48.600	4.038	1.000	17.121	58.451
Obs.	126	126	126	126	94	126	126	126	126

Notes: LIA = liquid liabilities/GDP, ASS = total assets of deposit money banks/GDP, DEP = total value of deposits at domestic deposit money banks/GDP, PRI = banks' credit distributed to the private sector/GDP, NPE = non-performing loans/total gross loans, INC = the logarithm of initial real GDP per capita, DIS = exchange rate distortion, GOV = central government expenditure/GDP, INF = inflation rate.

Table 3

Correlation Matrix

	INF	LIA	ASS	DEP	PRI	NPE
INF	1	-0.301	-0.261	-0.386	-0.242	0.415
LIA		1	0.951	0.694	0.934	-0.049
ASS			1	0.708	0.992	0.075
DEP				1	0.696	0.083
PRI					1	0.048
NPE						1

Notes: INF = inflation rate, LIA = liquid liabilities/GDP, ASS = total assets of deposit money banks/GDP, DEP = total value of deposits at domestic deposit money banks/GDP, PRI = banks' credit distributed to the private sector/GDP, NPE = non-performing loans/total gross loans.

Table 4

Quartile Averages Sorted by Inflation Means of the Banking System Performance Indicators

	INF	LIA	ASS	DEP	PRI	NPE
All	5.295	68.956	68.988	54.219	60.263	8.572
	(3.951)	(59.375)	(50.583)	(44.423)	(43.453)	(3.757)
1	0.907	94.285	95.467	83.672	85.590	8.311
	(1.237)	(108.612)	(115.300)	(101.543)	(102.239)	(3.490)
2	3.200	72.908	70.967	60.650	61.791	7.311
	(3.192)	(60.782)	(49.311)	(51.538)	(43.461)	(3.157)
3	5.290	53.599	55.124	44.637	47.560	6.605
	(5.441)	(41.399)	(38.540)	(35.434)	(28.650)	(3.999)
4	11.991	54.089	53.476	26.759	45.245	13.033
	(8.281)	(46.136)	(42.627)	(24.724)	(29.776)	(5.893)
Obs.	126	126	126	126	126	94

Notes: Values in parentheses are medians. INF = inflation rate, LIA = liquid liabilities/GDP, ASS = total assets of deposit money banks/GDP, DEP = total value of deposits at domestic deposit

money banks/GDP, PRI = banks' credit distributed to the private sector/GDP, NPE = Non-performing loans/total gross loans.

5. Empirical Results

This study applies pooled estimation for both the linear and the threshold regression models using panel data of the ASEAN-6 countries from 1996 to 2016. The empirical results are reported for each banking performance indicator.

5.1. Linear Regressions

Table 5 presents the regression results of linear regression models for five banking performance indicators. As shown in Table 5, the size measures for banking system performance, *i.e.*, *LIA*, *ASS, DEP,* and *PRI*, are negatively related with inflation, but only the relationship with *LIA* is significant. By contrast, *NPE* is significantly positively correlated with inflation, implying that banks' non-performing loans are increasing with inflation. A possible reason for the insignificant relationship between some indicators and inflation is that the relationship might be nonlinear. As such, a linear regression model cannot detect an effective relationship between *INF* and the banking performance indicator. Therefore, we further include an inflation threshold into the regression model to capture possible nonlinear relationship.

Table 5

Linear Regression Results

Dependent variables	LIA	ASS	DEP	PRI	NPE
constant	-162.245***	-184.181***	-169.567***	-172.293***	2.788
	(-23.589)	(-14.431)	(-19.269)	(-14.083)	(0.415)
INC	70.675***	71.816***	56.337***	67.316***	-1.371
	(25.984)	(15.707)	(17.770)	(15.473)	(-0.813)
DIS	9.084*	7.553	1.181	5.513	-0.566
	(1.796)	(1.273)	(0.491)	(0.909)	(-0.275)
GOV	-0.453	1.352**	3.991***	0.855	0.676***
	(-0.683)	(2.165)	(13.734)	(1.424)	(2.772)
INF	-0.699**	-0.400	-0.476	-0.416	0.713***
	(-2.523)	(-1.417)	(-1.620)	(-1.374)	(4.491)
Adj. R^2	0.575	0.553	0.828	0.489	0.168
N	126	126	126	126	94

Notes: **, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively. Values in parentheses are t-statistics. N represents the number of observations. LIA = liquid liabilities/GDP, ASS = total assets of deposit money banks/GDP, DEP = total value of deposits at domestic deposit money banks/GDP, PRI = banks' credit distributed to the private sector/GDP, NPE = Non-performing loans/total gross loans, INC = logarithm of initial real GDP per capita, DIS = exchange rate distortion, GOV = central government expenditure/GDP, INF = inflation rate.*

5.2. Threshold Regressions

We first report the estimated results of the threshold regressions based on Sarel's (1996) approach in panel A of Table 6, then followed by the results based on Boyd *et al*.'s (2001) approach in panel B.

Table 6

Threshold Regression Results

Dependent variables	LIA	ASS	DEP	PRI	NPE
Panel A: Sarel's (1996) version					
Constant	-149.058***	-175.035***	-152.917***	-161.550***	9.762
	(-15.680)	(-11.427)	(-15.266)	(-11.108)	(0.895)
INC	70.561***	72.475***	55.740***	68.090***	-1.750
	(29.499)	(17.867)	(22.918)	(18.461)	(-1.022)
DIS	7.133	6.164	-1.156	3.882	-1.033
	(1.472)	(1.026)	(-0.467)	(0.628)	(-0.462)
GOV	-0.776	1.098	3.596***	0.556	0.526**
	(-1.007)	(1.532)	(17.648)	(0.789)	(2.237)
INF	-3.262***	-3.420**	-3.156***	-3.963**	-0.902
	(-3.261)	(-2.094)	(-5.317)	(-2.558)	(-0.590)
INF*	6	4	7	4	3
HINF*.(INF-INF*)	3.087**	3.329*	3.377***	3.911***	1.662
	(2.596)	(1.823)	(5.022)	(2.288)	(1.080)
Adj. R^2	0.591	0.557	0.853	0.498	0.176
Obs.	126	126	126	126	94
Wald F-statistic	0.188	0.056	3.298	0.022	27.682
[P-value]	[0.666]	[0.813]	[0.072]	[0.882]	[0.000]
Panel B: Boyd *et al.*'s (2001) version					
Constant	-149.100***	-173.200***	-154.446***	-159.603***	11.001
	(-15.426)	(-10.569)	(-14.732)	(-10.070)	(0.997)
INC	70.567***	71.611***	56.514***	67.173***	-2.431
	(29.535)	(16.377)	(21.776)	(16.546)	(-1.280)
DIS	7.152	6.230	-1.233	3.952	-1.034
	(1.476)	(1.058)	(-0.520)	(0.653)	(-0.460)
GOV	-0.762	1.110	3.566***	0.570	0.562
	(-0.935)	(1.610)	(16.773)	(0.843)	(2.327)
INF	-3.340***	-2.486*	-3.515***	-2.972**	-0.081
	(-3.135)	(-1.862)	(-5.046)	(-2.463)	(-0.049)
INF*	6	4	7	4	3
HINF*	-18.288**	-14.223*	-21.732***	-16.604**	-4.845**
	(-2.135)	(-1.717)	(-4.621)	(-2.087)	(-1.060)
HINF*.INF	3.153***	2.475*	3.652***	3.004**	0.869
	(2.697)	(1.769)	(5.153)	(2.367)	(0.524)
Adj. R^2	0.588	0.555	0.852	0.495	0.172
Obs.	126	126	126	126	94
Wald F-statistic	0.187	0.001	1.267	0.005	33.098
[P-value]	[0.666]	[0.982]	[0.263]	[0.941]	[0.000]

Notes: W*ald F-statistics in panel A test for the null hypothesis that the sum of coefficients on INF and HINF*.(INF-INF*) is equal to zero, while those in panel B test for the null hypothesis that the sum of coefficients on INF and HINF*.INF is equal to zero. Values in parentheses are t-statistics and in brackets are P-values. Obs. represents the number of observations. INF* represents the Inflation thresholds and HINF* is a dummy variable with value of one for inflation above INF* and*

*zero otherwise. See Table 5 for more details about the definition of variables. *,**, and *** represent significance at the 10%, 5%, and 1% levels, respectively.*

5.2.1. Sarel's (1996) Version

To determine the optimal threshold for each performance indicator, we estimate Eq. (2) and calculate adjusted R-squares for a number of thresholds, ranging from 1% to 58%. We use an increment of 1% according to Hansen (1999), who suggests an integer increment when setting the threshold values over an interval. By choosing the threshold level that produces the maximal value of adjusted R-squares, we obtain optimal threshold levels, INF*, for each banking performance indicators. These are 6% for *LIA*, 4% for *ASS*, 7% for *DEP*, 4% for *PRI*, and 3% for *NPE*.

Panel A of Table 6 shows the estimated results using these optimal thresholds for each banking performance indicator. The significant t-statistics for the coefficients on the extra inflation terms, *HINF*.(INF-INF*)*, shows that the influence of inflation on the banking sector performance has a significant threshold effect. Compared with the insignificant relationship derived from the linear regression model, the significantly negative effect of inflation on the size measure of the banking sector performance (*i.e.*, *LIA*, *ASS*, *DEP*, *PRI*) usually occurs when inflation is below the threshold levels. This indicates that the model considering the threshold effect performs better than the linear model in capturing a valid banking performance-inflation relationship.

We are interested in whether the influence of inflation varies across high and low inflation regimes. This can be judged by the t-statistics for coefficients of *INF* and the Wald-statistics. For *LIA, ASS,* and *PRI*, when inflation rate is below their individual thresholds, the banking performance-inflation relationships are negative. However, when inflation moves beyond the thresholds, this negative effect essentially disappears, suggesting that the damage of inflation to the banking system has already been done, so that a further increase in inflation does not cause additional detriment to the banking system. In particular, the Wald F-statistics show that the sums of the coefficients on *INF* and *HINF*.(INF-INF*)* for these three indicators in panel A of Table 6 do not reject the null hypothesis of $e + f = 0$, suggesting that once inflation exceeds the threshold levels, a further increase in the inflation rate does not cause additional damage to the banking system.

For *DEP*, the relationship between inflation and *DEP* remains negative when inflation is below the threshold. However, when inflation rises above the threshold, the negative relationship not only that it disappears but also turns to be significantly positive, with the slope of inflation changing from a negative (-3.156) to a positive (-3.156+3.377=0.221) value. This indicates that the adjustment speed of salary in circumstances of a low inflation regime is slower than that in circumstances of a high inflation regime, so that the amount of deposits decreases with inflation when inflation is below 7% but increase with inflation when inflation exceeds 7%.

Finally, the relationship between *NPE* and inflation is negative but insignificant for rates of inflation below 3%; however, it becomes significantly positive when inflation exceeds 3%. This demonstrates that banks' non-performing loans increase with inflation when inflation exceeds 3%. Since *NPE* is a measure of banks' asset quality, this indicates that inflation above 3% definitely harms the asset quality, while a moderate rate of inflation (below 3%) has no influence on the asset quality. Overall, the results based on the threshold regression strongly suggest an existence of the threshold effect of inflation on the banking sector performance.

5.2.2. Boyd et al.'s (2001) Version

We next examine the threshold effect based on Boyd *et al.*'s (2001) approach as in Eq. (3) using the same optimal thresholds derived on the basis of Sarel's (1996) version (as shown in panel A of Table 6). The estimated results are reported in panel B of Table 6. A significant threshold effect is determined by the coefficient estimates of *HINF** or *HINF*.INF* or both. The significant t-statistics for the above-mentioned coefficients for each banking performance indicator confirm again the existence of the threshold effect of inflation. In particular, a significantly negative coefficient for *HINF** means that the average level for each indicator reduces if inflation rises above the threshold. The Wald F-statistics and t-statistics of *INF* suggest that the influence of inflation across high and low inflation regimes for each performance indicator is consistent with the findings obtained based on Sarel's (1996) version as presented in panel A. It is worth noticing that both Boyd *et al*. (2001) and Sarel's (1996) version imply an inflation-threshold effect for the deposit ratio *DEP*, but the effect from Sarel's (1996) version is stronger than that from Boyd *et al.*'s (2001) version. As revealed by the Wald-statistic with *DEP* in Table 6, the result with Boyd *et al*.'s (2001) version signals that the negative effect of inflation in a low-inflation regime simply disappears in a high-inflation regime; however, the result with Sarel's version shows a twist in this effect.

5.3. Discussion about the Regression Results

Of the five banking performance indicators, *LIA*, *PRI*, *ASS*, and *DEP*, measuring the size of the banking sector, are positive performance indicators, while *NPE*, measuring the asset quality, is a negative performance indicator. It may be inferred from our results that inflation impacts differently for these two types of indicators. For the size indicators, the higher the inflation rate the worse the performance of these indicators, but this effect vanishes as inflation exceeds a certain threshold for individual indicators. In contrast, for the asset-quality indicator (*NPE*), inflation has no effect on the banking system performance as inflation is below a threshold rate of 3% but turns to have a negative effect once inflation exceeds that threshold. We discuss and interpret the empirical results for each banking performance indicator below.

*The Effect of Inflation on Liquid Liabilities (*LIA*)*

For the ASEAN-6 countries, this study shows that inflation has a negative effect on liquid liabilities (M3) when inflation is below 6%. The impact of inflation on liquid liabilities can be explained in terms of quantity theory, MV=PY, where: P is the average price level, M the money supply, V the velocity of money, and Y real output. In situation of full employment, P is positively correlated with M given nearly constant V and Y. A possible explanation for our finding that liquid liabilities and inflation are negatively related is that the ASEAN-6 are generally classified as emerging and developing economies, where a constant V or Y is not expected. Thus, a high level of P accompanied by a low value of liquid liabilities could happen as a result of a low real output or a high velocity of money during the sample period, relatively to their historical record in the ASEAN-6 countries. Boyd *et al*. (2001) also found that the ratio of the liquid liabilities to GDP in the financial sector was negatively associated with inflation when inflation rates were below the inflation threshold of 15%. For economies with inflation rates exceeding the threshold, the marginal impact of additional inflation on banking development diminishes rapidly. Rousseau and Wachtel (2002) also argued that M3/GDP varies inversely with inflation at inflation rates below 10.6% and is not affected by inflation in a high-inflation environment.

The Effect of Inflation on the Total Credit to the Private Sector (PRI)

Similar to the influence on liquid liabilities, inflation has a negative influence on the credit to the private sector, and the impact disappears as inflation exceeds 4%. In economies with high inflation, intermediaries will lend less and allocate capital less effectively (Boyd *et al*., 2001). The banking system tends to provide less credit at a lower real lending interest rate when the system has not yet adjusted the nominal interest rate to protect it from the increase in inflation. Thus, the quantity of credits provided by the banking system was limited at higher inflation rates, which depresses activities in financial markets and narrows financial depth (Kulyk, 2002). That is in line with the finding of Rousseau and Wachtel (2002). They found a significantly negative effect of inflation on the ratio of credit to GDP at inflation rates lower than 16.1%, but inflation does not influence this ratio in a high-inflation environment. The study by Antonios (2010) also revealed that inflation in Ireland harms credit market development in the long run. By studying the relationship between inflation and the size of banking sector for 100 countries over 15 years, Boyd and Champ (2006) found that at median inflation rates, a one percentage point increase in inflation is associated with a one percentage point decline in the ratio of bank lending to GDP.

The Effect of Inflation on the Total Assets of Deposit Money Banks (ASS)

The total assets of deposit money banks are primarily loans, which are issued not only to the private sector but also to the central, state and local governments, as well as to nonfinancial public enterprises. The influence of inflation on the total assets of deposit money banks is consistent with the finding for the credit to the private sector, with the same impact direction and threshold. Our panel-data results parallel the cross-country findings by Boyd *et al*. (2001), who reported that inflation was negatively associated with banks' assets for countries with annual rates of inflation below 15%; and for countries with rates of inflation above this threshold, the partial correlation between inflation and the banking development disappears substantially.

The Effect of Inflation on Deposits of the Deposit Money Banks (DEP)

We find that the total amount of deposits decreases with inflation for the ASEAN-6 as the rate of inflation is below 7%; however, it turns to increase with inflation when inflation rises above this threshold rate. This reveals that wage does not keep up quickly with the average price level at relatively low inflation regime. In this instance, people are forced to reduce their deposits to meet the requirement for increasing expenditures. As a result, the total amount of banks' deposits decreases with the rate of inflation. When the rate of inflation exceeds the 7% threshold, wage, to a certain extent, adjust quickly to reflect the high level of average price so that the deposits in this instance even slightly increase with inflation. A higher saving rate that is adjusted to reflect the high rate of inflation can be a possible reason to explain the increase in the amount of bank's deposits in a high-inflation environment. Loayza *et al*. (2000) used a comprehensive cross-country database to study the determinants of savings. Their analysis showed that macroeconomic uncertainty measured by the variance of inflation had a positive effect on the private saving rates.

The Effect of Inflation on Non-performing Loans (NPE)

Inflation might have positive and negative effects on the non-performing loans. Rizvi and Khan (2005) indicated that lower inflation volatility can reduce the proportion of Pakistan's non-performing loans. As indicated in Beaton *et al*. (2016), high inflation depreciates the value of borrowers' debts and mitigates borrowers' burden to repay loans, thus leading to lower non-performing loans. Alternatively, a high rate of inflation is usually accompanied by

a high interest rate. If wages do not keep up soon with rising inflation, the ability to repay loans would decline, further leading to higher non-performing loans. In the ASEAN-6 countries, we find less influence of inflation on the non-performing loans when the inflation rate is below 3%; however, non-performing loans worsens when inflation rises above 3%.

6. Conclusions

This study investigates the influence of inflation on the banking sector performance for the ASEAN-6 countries. Particularly, this study applies threshold regression models estimated using panel data collected from the ASEAN-6 countries over the 1996-2016 period. By analyzing the linear and the threshold regressions, this study finds significant evidence of an inflation-threshold effect on the banking sector performance. We also analyze the impact direction of inflation across high and low inflation regimes for each performance indicator.

The threshold rates implied from all the performance indicators are around 3–7%. The evidence demonstrates that high inflation is associated with a lower level of liquid liabilities, the credit to the private sector, and the total bank assets when inflation is below the threshold rates, *i.e.*, 6%, 4%, and 4% corresponding to these three performance indicators, respectively. However, such a negative effect becomes insignificant as inflation rises above these thresholds. The relationship between banks' deposits and inflation behaves somewhat differently. When the annual rate of inflation is below 7%, the relationship between inflation and bank deposits remains negative, but it turns to be positive as inflation rises above 7%.

For our asset-quality indicator, non-performing loans, we found that inflation is harmful to non-performing loans in the ASEAN-6 only when inflation rises above the threshold rate of 3%. When inflation is lower than 3%, it has no influence on the non-performing loans. This demonstrates that banks' asset quality in the ASEAN-6 countries does not deteriorate in an environment of moderate inflation.

Therefore, our study identifies an inflation regime that is relevant for the banking development in the ASEAN-6 countries. The findings are useful for the ASEAN-6 countries to pursue the inflation targeting policy. We propose a basis for these economies to determine an appropriate inflation rate target(ing) that is compatible with their banking systems development.

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