Is the relationship between non-performing loans of banks and economic growth asymmetric ? Malaysia's evidence based on linear and nonlinear ARDL approaches

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Is the relationship between non-performing loans of banks and economic growth asymmetric ? Malaysia's evidence based on linear and nonlinear ARDL approaches

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Abstract

Banks play an important role as intermediaries between the savers and the borrowers in an economy. One issue, however, that the banks face during the development process is the increase in the non-performing loans (NPL) in the developing economies. In particular, during the financial crisis, many loans become non-performing loans (NPL) and the banks face liquidity crises. It is the focus of this paper to investigate whether (a) the relationship between the non-performing loans of banks and economic growth (GDP) is cointegrated or not i.e., whether they are theoretically related or not in the long term and (b) if they are, whether the relationship is symmetric or asymmetric in the short and long term. We use ARDL and nonlinear ARDL for the analysis. Malaysia is used as a case study. The findings tend to indicate that the NPL and GDP are indeed cointegrated as evidenced in both ARDL and Nonlinear ARDL. As to whether the relationship between the NPL and GDP is symmetric or not, the findings tend to indicate that the relationship is asymmetric in the long run but symmetric in the short run. These findings have important policy implications for the developing countries like Malaysia.

Keywords: Non-performing loans of banks, GDP, Linear ARDL, Nonlinear ARDL, Malaysia

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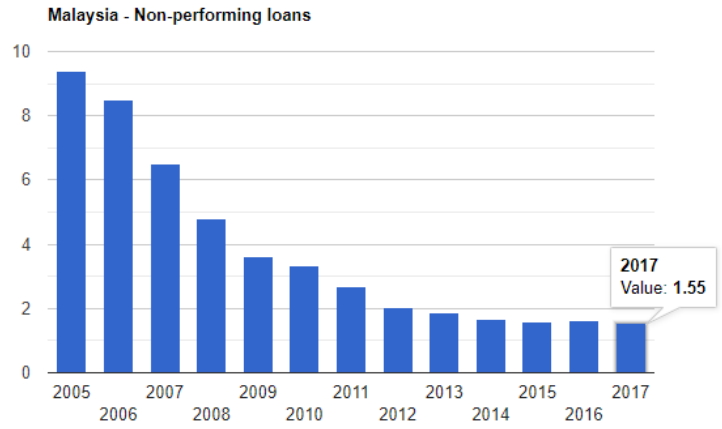
1. Introduction

In 2005, Malaysia recorded Non-performing loan (NPL) of 9.39%, while in 2017, the percentage has decreased to 1.55%. Average of NPL for Malaysia for past 13 years is 3.78%. This percentage has implications for the banking industry's health. Higher percentage of NPL, indicates that banks may be facing difficulty to collect principal and interest from their borrowers. NPL may have negative relationship with bank's earnings. Higher NPL may impact bank's profitability badly and worsened scenario may lead to banks' closure.



(https://www.theglobaleconomy.com/Malaysia/Nonperforming_loans/)

Banks play important role in the financial system and economy. Bank's role is to take deposit from depositors and lend to borrowers. Bank is known as intermediaries between savers and borrowers. Borrower (retail/ corporation) will borrow money and make activities that will lead to economic expansion. Therefore, banks' services help make the overall economy more efficient.

From the previous studies, many researchers found that GDP influenced the NPL percentage. When the economy is in a hostile environment, borrowers are likely to keep their money from making repayment. Thus this will increase the NPL percentage. There are also many researchers who found that, NPL influenced the economic growth. When people stop paying their obligation to banks, banks' profitability may decrease and it may retard the economic growth. In this paper, we would like to analyze, which variable has greater impact on another. By understanding the relationship, we hope that the result will help government and policy-makers make decision.

Our research has the following sections: 2. Theory framework, 3. Empirical Study, 4. Data and variable construction, 5. Methodology and result analysis, and 6. Conclusion and Policy Implications.

1. Theoretical Framework

GDP is one of the measurement used to determine the health of the country. According to IMF publication, the monetary value of final good and services that are bought by final user, in a period of time are called GDP. GDP consists of 4 component which are consumption, investment, government spending and net export. In equation, GDP(Y) is $Y = C + I + G + (X - M)$.

i. C = Consumption is a final good and services consumed by household. This includes food, car, jewelry, rental house, diesel and petrol. However, sub-sale of final good doesn't count as it has already counted before.
ii. I = Investment, normally by businesses and firm. Investment is counted in GDP when the production of final goods and services transferred to others.
iii. G = Government expenditures on final goods and services. This includes salaries of public servants, purchases of weapons for the military and any investment expenditure by a government. However, it doesn't include the any transfer payment like security service and unemployment benefit as the transfer are made without exchange of goods and services.
iv. (X-M) = This is net export, when X is export minus with M, the import. Import has to be deducted in this equation to elude from counting in foreign goods and services as domestic.

GDP has to exclude intermediate goods, non-production transaction and non-market activity in the equation. Intermediate goods will only calculated when if finished and there is exchange with final consumers. As for non-production transaction, such as free consultation or free final goods from company to close families, which has not exchange with Ringgit Malaysia (RM), should be excluded because this free services has not increased in Malaysia's growth. Non market activity such as illegal goods selling, i.e. drugs will also be excluded.

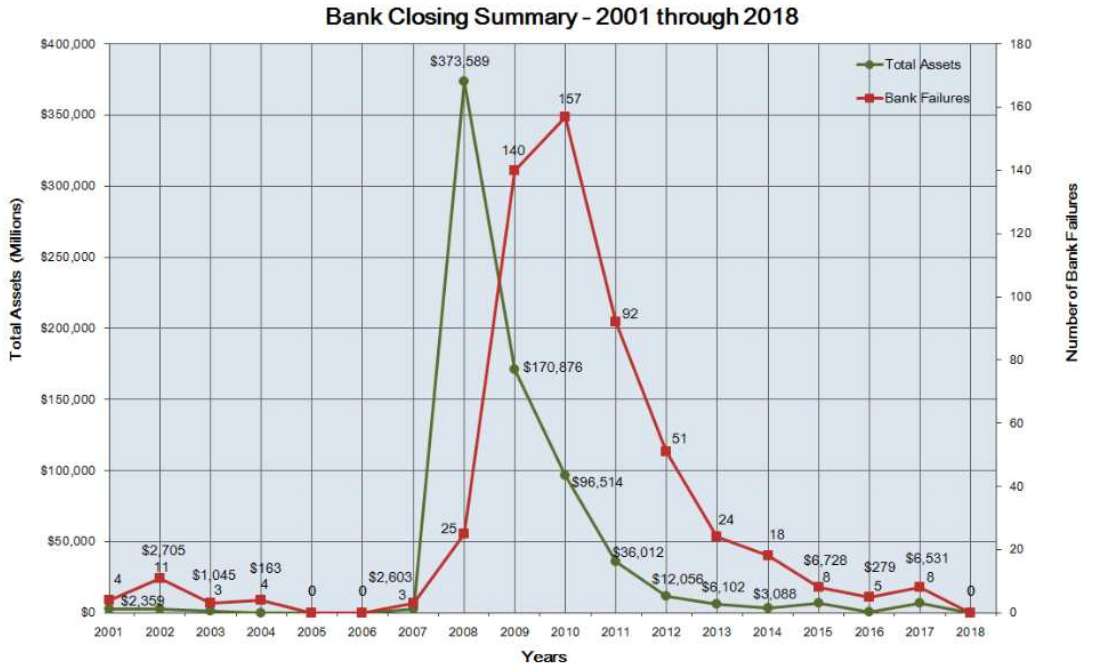
Banking system helps economic growth

Although banks are not included in GDP's equation, as the bank does not fall directly under C, I, G or (X-M) categories, banks have important roles to ensure smoothness and health of the economy. Banks have been supporting all 4 categories (C, I, G and (X-M) in improving such as provide saving and financing facilities to households, firms and government and facilitate export and import.

Imagine a world without banking system, it will be very disorganized and chaotic for a country to maintain their economy environment. Banks help match depositors and borrowers with very least information reveal (PDPA is a compliance that banks have to comply), a student can apply education loan, a developer can get bridging loan to continue their construction, an exporter felt safe to do transactions with buyers from across the countries by using banks as their middle man, and Central Bank (CB) can use its monetary policy tools to control inflation and unemployment through commercial banks. The role of banks is more than this.

Banks has many responsibilities to country and to the public such as to control their liquidity ratio by using Capital Adequacy Ratio (CAR), monitor risks that they might has to face such as credit risk, market risk, operational risk and other risks, be the eyes to the CB for any possibility money laundering/illegal market activities, and complying with all the BNM regulations. An implementation of good risk management framework and processes help to reduce the risks mentioned above. This is to avoid banks failure.

Banks' failure can impact the whole economy. According to Federal Deposit Insurance Corporation (FDIC), from 2001 until 2017, there is 553 banks in US itself that have been failed. Failure in banking system will create loss confidence in public and hostile economic condition.



Closing Summary	2001	2002	2003	2004	2005	2006	2007	2008	2009
	2010	2011	2012	2013	2014	2015	2016	2017	2018

Summary by Year

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Bank Failures	4	11	3	4	0	0	3	25	140	157	92	51	24	18	8	5	8	0
Total Assets (Millions)	2,358.6	2,705.4	1045.2	163.1	0	0	2,602.5	373,588.78	170,867.0	96,514.0	36,012.2	12,055.8	6,101.7	3,088.4	6,727.5	278.8	6,530.7	0

Source : https://www.fdic.gov/bank/historical/bank/

From the graph above, it is reported that Non Performing Loans (NPL) are the major contribution to the statistic. NPL is one of credit risk that faced by banks. Maintaining NPL to the certain level is crucial to ensure that circulation of fund from depositors to borrowers is happening.

However, when NPL is increased, banks are unable to pay depositors rate and has to reduce the lending activities which can shrink consumption of the households, productions of the firms, expenditures of the government, and performance guarantee for exporters and importers, thus distort the GDP of the countries.

However, from the same graph above, we can see that many banks failed in 2009, 2010 and 2011 which is post financial crisis. This has created one big question which is, “Is NPL affecting the GDP or the other way around?” Empirical studies has been done in next chapter on this issues.

2. Empirical Studies

This empirical studies is divided into 3 groups. First group of empirical studies has agreed that banks have affected economic growth of countries. In this category also, author has included the studies of previous researchers on NPL which is a major contributor to the banks' profit. Second group had contrary opinions that GDP is actually impacting banks profitability by raising the NPL. Last group has found that there is no relationship between growth and NPL.

Bank Profitability influenced growth

Keeton and Morris 1987 in their investigation of more than 2000 failed commercial banks in the United States contributed the failures to the weakening macroeconomic environment. Studies undertaken by Brownbridge (1998), Salas and Suarina (2002), Rajan and Dahal (2003), in different countries and mostly as panel studies, found an inverse relationship among growth in real GDP (RGDP) and NPL. In a study by Dash and Kabra (2010) of Indian commercial banks, using correlation analysis, it was revealed among other findings, that there is a strong negative relationship between NPLs and growth in real GDP.

The credit risk is one of the main variables that affect the bank performance, as it exhibits the loss probability because of the failure of the debtor to fulfill its obligations to the bank. The literature usually expresses it by the ratio of loan loss reserves to gross or net loans granted by banks. We expect a negative effect on performance of the potential losses from bad quality loans (Mansur et al., 1993). Majority authors like Ali et al (2011), Bogdan Căpraru et al (2014), Chaudhry et al (1995), Panayiotis P. Athanasoglou et al (2008), Petria et al (2015) and Tan et al (2012) received the same result that credit risk has a negative impact on banks' profitability. Non-performing loans (NPL) is a percentage of total loans which controls for the deficiency in credit risk management and the resultant quality of assets on profitability. Inclusion of this variable is essential because loans are the major type of earning assets. Many authors such as Albulesuu et al (2014), Alicia Alicia García-Herrero et al (2009), Claudiu Tiberiu Albulescu et al (2015), Park et al (2006), and Onder Ozgur et al (2016) found that this factor is one of the determinants of bank losses and failure.

Growth influenced Bank Profitability

Previous studies also include external determinants of bank profitability such as central bank interest rate, inflation, the GDP development, taxation, or variables representing market characteristics (e.g. market concentration). Most studies have shown a positive relationship between inflation, central bank interest rates, GDP growth, and bank profitability (e.g. (Bourke, 1989); Ćurak et al (2012); Park et al (2006); Petria et al (2015); Sakarya Iktisa; Ali et al (2011); Ayanda et al (2013); Tan et al (2012); Williams et al (2002); Acacarvai et al (2013); Alicia García-Herrero et al (2009); Panayiotis P. Athanasoglou et al (2008); Albulesuu et al (2014) ; Claudio Borio et al (2015); Claudiu Tiberiu Albulescu et al (2015) and Onder Ozgur et al (2016). Many researcher agreed that GDP is one of the factor that influenced banks profitability.

No Relationship between GDP and Bank Performance

Meanwhile, 3 studies from Athanasoglou et al (2008), Khurshid Djalilov et al (2016) and Petria et al (2015) said that there are no relationship between banks profitability and GDP as and external determinants of profit.

The direction of which variable affecting which variable is ambiguous. Some researchers above found that GDP affected NPL, and others had found the inverted relationship. There are also studies that confirm no relationship between those variables. Given these mixed results, the relationship between inflation and NPL is unclear and hence, it is subject to this study.

3. Data and Variables

Following the existing empirical literature in this area, this research uses five variables. Two main variables are Gross Domestic Product (GDP) and Non-Performing Loan (NPL) while three control variables are Loan Rate (LR), Loan Disbursed amount (LD) and Overnight Policy Rate (OPR). The research applies quarterly data from the January 2007 to December 2017. Data is collected from Department of Statistic Malaysia. The long-run equilibrium relationship between the NPL and the GDP, augmented with loan rate, loan disbursed and OPR take the following form.

$$NPL_t - \alpha_0 - GDP_t - \alpha_2 LD_t - \alpha_3 LR_t - \alpha_3 OPR\alpha_3 LR_t = \epsilon_t$$

NPL_t is a loan that defaulted, normally in 90 days.

GDP_t is calculated by adding private consumption, gross investment, (export-import) and government spending. GDP = C+I+G+ (X-M)

LD_t is a approval of loan amount that bank has offered and borrower has accepted, and bank paid out the amount to relevant parties.

LR_t is the amount charged , expressed as a percentage of principal, by lender to borrower for used of loan. Loan rate, or interest rate are typically noted on an annual basis, known as annual percentage rate.

OPR_t is an overnight interest rate set by Central Bank (BNM). This is a rate that borrower bank has to pay to leading bank for the fund borrowed.

4. Methodology and result analysis

A prerequisite for testing cointegration (Engle-Granger and Johansen) is that all variables are non-stationary. Thus, we investigate the time series properties of the individual variables. First, all variables are taken in log forms to make the variance stationary. Then first difference is taken to test whether variables are stationary in difference form. The common practice is to use the augmented Dicky-Fuller (ADF) test. Thus, we perform augmented Dicky fuller test to examine the stationarity of variables in their log forms and first difference.

From Table 1, ADF shows that the null hypothesis of a unit root cannot be rejected for some variables at log-form, indicating that they are nonstationary. However, with the first-differences, each variable indicates rejection of the null hypothesis of a unit root at 5% level, thus they are stationary in the first-difference forms.

Unit Root Test: ADF, PP and KPSS

Table 1: ADF test for log-form and first-differenced form

	VARIABLE	ADF	VALUE	C.V.	RESULT
LOG FORM	NPL	ADF(2)=AIC	301.8192	3.4697	Non Stationary
		ADF(5)=SBC	288.3643	3.5193	Non Stationary
	LD	ADF(1)=AIC	61.6072	3.4611	Stationary
		ADF(5)=SBC	48.8333	3.5193	Non Stationary
	GDP	ADF(3)=AIC	292.0428	3.4788	Stationary
		ADF(2)=SBC	277.1229	3.4611	Non Stationary
	LR	ADF(1)=AIC	360.1985	3.4611	Non Stationary
		ADF(5)=SBC	345.5716	3.5193	Non Stationary
	OPR	ADF(2)=AIC	241.4623	3.4697	Non Stationary
		ADF(5)=SBC	227.3143	3.5193	Non Stationary

	VARIABLE	ADF	VALUE	C.V.	RESULT
1ST DIFF. FORM	NPL	ADF(3)=AIC	294.6144	2.8935	Stationary
		ADF(5)=SBC	284.6778	2.8732	Stationary
	LD	ADF(3)=AIC	57.4512	2.8935	Stationary
		ADF(5)=SBC	46.0764	2.8732	Stationary
	GDP	ADF(5)=AIC	289.6293	2.8732	Stationary
		ADF(4)=SBC	273.763	2.921	Stationary
	LR	ADF(1)=AIC	355.4508	2.9404	Stationary
		ADF(5)=SBC	342.0091	2.8732	Stationary
	OPR	ADF(1)=AIC	237.4926	2.9404	Stationary
		ADF(5)=SBC	223.7042	2.8732	Stationary

Table 2 is a PP test is conducted and found similar result as ADF. From Table 2, 4 variables are non-stationary in their level form as null hypothesis of unit root cannot be rejected. They become stationary when first differences are taken as null hypothesis are rejected.

Table 2: PP test for log-form and first differenced form

	VARIABLE	T-STAT.	C.V.	RESULT
LOG FORM	NPL	1.2793	3.526	Non Stationary
	LD	7.6696	3.526	Stationary
	GDP	2.5936	3.526	Non Stationary
	LR	1.3311	3.526	Non Stationary
	OPR	2.0272	3.526	Non Stationary

	VARIABLE	T-STAT.	C.V.	RESULT
1ST DIFF. FORM	NPL	11.5859	2.8931	Stationary
	LD	24.3323	2.8931	Stationary
	GDP	13.7184	2.8931	Stationary
	LR	10.0718	2.8931	Stationary
	OPR	7.99	2.8931	Stationary

Then KPSS test is implemented. The null hypothesis of KPSS is different from ADF and PP as the null hypothesis of KPSS is stationary of variable. From Table 3, 3 variables are non-stationary in their level form as the null hypothesis of stationary is rejected for these variables. Two of them become stationary when first difference is taken, while 1 variable remain non-stationary at first different.

Table 3: KPSS test for log-form and first differenced form

	VARIABLE	T-STAT	CV	RESULT
LOG FORM	NPL	0.18526	0.13946	Non Stationary
	LD	0.11852	0.13946	Stationary
	GDP	0.076262	0.13946	Stationary
	LR	0.16743	0.13946	Non Stationary
	OPR	0.92137	0.13946	Non Stationary

	VARIABLE	T-STAT	CV	RESULT
1ST DIFF. FORM	NPL	0.067118	0.13946	Stationary
	LD	0.94317	0.13946	Non Stationary
	GDP	0.081403	0.13946	Stationary
	LR	0.072504	0.13946	Stationary
	OPR	0.084788	0.13946	Stationary

Next stage, we find the order of vector Auto-regression. From Table 4**,** adjusted LR test gives 4 lags.

Table 4: Order of Vector Auto-regression

Order	LL	AIC	SBC	LR test	Adjusted LR test
				------	------
6	1424.7	1269.7	1050.5		
5	1398.4	1268.4	1084.5	CHSQ(25)= 52.6768[.001]	39.6129[.032]
4	1383.3	1278.3	1129.9	CHSQ(50)= 82.7149[.002]	62.2016[.115]
3	1348.5	1268.5	1155.4	CHSQ(75)= 152.3665[.000]	114.5796[.002]
2	1316.3	1261.3	1183.5	CHSQ(100)= 216.8536[.000]	163.0739[.000]
1	1280.4	1250.4	1208.0	CHSQ(125)= 288.6183[.000]	217.0410[.000]
0	1234.1	1229.1	1222.0	CHSQ(150)= 381.2930[.000]	286.7323[.000]

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AIC=Akaike Information Criterion SBC=Schwarz Bayesian Criterion

Cointegration test: Autoregressive distributed lags (ARDL)

Since at the log level forms some variables are I(1) (non-stationary) and some are I(0) (stationary), we proceed to ARDL. ARDL test is conducted to check whether there is a cointegrating relationship between the variables. In ARDL, H_0 assumes that is no cointegrating relationship between the variables, while H_1 assume the existence of relationship between variables.

$$H_0 = \text{No Cointegration (Insignificant)}$$

$$H_1 = \text{Have Cointegration (Significant)}$$

The ARDL technique does not require pre-tests for unit roots. Consequently, ARDL cointegration technique is preferable when dealing with variables that are integrated of different order I(0) and I(1), like in this study. The long-run relationship of the variables are detected through the F-statistic (Wald test). Long-run relationship of the series is said to be established when the F-statistic exceeds the critical value bound.

From Table 7, we test for long-run relationship and found that F-statistics in Loan Rate (LR) and OPR are higher than upper critical bound in 90% significant level. Thus, we reject the null hypothesis of "no long-run relationship". There is a cointegration among variables, therefore we accept H_1.

Table 7: Test for ARDL

Model	F-stat	Critical Bound at (90%)		Result
NPL (NPL, LD,GDP, LR, OPR)	3.4003[0.007]	2.782	3.827	Inconclusive
LD (NPL, LD,GDP, LR, OPR)	2.7661[0.022]			Reject
GDP (NPL, LD,GDP, LR, OPR)	1.8194[0.116]			Reject
LR (NPL, LD,GDP, LR, OPR)	4.0047[0.002]			Accept
OPR (NPL, LD,GDP, LR, OPR)	4.0047[0.002]			Accept

Cointegration tells us that there is a long-run relationship between variables. We will proceed to error-correction model to examine the short-run adjustment to long-run equilibrium.

Error Correction Model (ECM)

The short-run dynamics shows how quickly the speed of adjustment is represented by the value of the error-correction term. Result of ECM will tell us which variables are exogenous and endogenous. H_0 for this test is exogenous. Thus, H_1 is endogenous.

The coefficient of error-correction model shows feedback effect of the deviation from equilibrium on the dependent variable. When the coefficient is significant, that dependent variable bears the burden to bring about equilibrium. Thus, it is endogenous. If it is not significant, the dependent variable is exogenous.

Table 8: Coefficients of error correction models

Dependent Variable	ECM(-1) Coefficient	P-value	Variable
GDP	-0.03608	0.020	Endogenous
LD	-0.45217	0.000	Endogenous
LR	-0.19299	0.000	Endogenous
NPL	-0.036527	0.267*	Exogenous
OPR	-0.019067	0.551*	Exogenous

From Table 8, as error-correction term are significant for GDP, LR and LD as these variables are below than 5% level, they are endogenous. The significant of error-correction coefficient confirms our finding of a significant long-run cointegrating relationship between variables. The error-correction term is not significant for Non-Performing Loan (NPL) and Overnight Policy Rate (OPR), thus they are exogenous.

Intuitively, NPL is an exogenous variable because NPL cannot be controlled by government, it is depends on the borrowers. However, policy maker must understand what influenced borrowers to NPL and defaulted. One of the reasons is the OPR increased, and it has increased the lending rate. As for loan rate and LR, both of them are influenced by BNM's regulation. BNM can increase the BLR to affect LR, and put restriction to LD to FI. GDP can be affected by many factors such as productivity, inflation, interest rate, expenditure and so on.

All the sign of ECM(-1) is negative sign. This is good because it shows that the model is significant. From the ECM(-1) also, we can analyze the speed of convergence to equilibrium. All variables have ECM(-1) between (-1) to 0, which is again good because there is a steady-state equilibrium in the long-run between the variables. Error correction coefficient is at -0.01 which is highly significant and has a correct sign. The size indicates the moderate adjustment to equilibrium. Approximately, 1.9% departure from equilibrium in the previous quarter is corrected in this quarter to bring long-run equilibrium.

However, ARDL model has limitation as it assumes symmetric change of GDP when NPL depreciates and appreciates. However, NPL has asymmetric relationship with GDP. Therefore, we will apply NARDL model.

Non-linear autoregressive distributed lags (NARDL)

Shin, Yu and Greenwood-Nimmo (2014) has developed the most recent model called NARDL. NARDL is allowing user to test positive and negative partial sum decompositions allowing detecting the asymmetric effects in the long and the short-term. We like to check is there is existence of asymmetric relationship in NPL that is attributed to GDP. We would like to check the changes in NPL whether its positive changes/negative changes will impact on appreciation or depreciation of GDP.

Our intuition said that, the negative change in NPL will appreciate GDP growth. We assume that when more borrowers pay their debts to the bank, bank can recover from loan given out, and give new loan to other borrowers. Therefore, negative changes in NPL will motivate GDP growth. However, when borrowers are reluctant to service their loan, banks are unable to collect the repayment, thus new loan disbursed will be cut to the 4 categories of GDP (households, firms, government and exporters/importers), and it will distort the GDP.

NARDL model enables the investigation of the short-run and long-run relationship when these linkages are non-linear and asymmetric. NARDL model will decompose NPL rate into its positive Δnpl_{t-i}^{+} and negative Δnpl_{t-i}^{-} partial sums for increases and decreases. Introducing

the short-run and long-run asymmetries in the standard ARDL model leads to the following general form of NARDL model.

$$\Delta gdp_t = \beta_0 + \beta_1 gdp_{t-1} + \beta_2 npl^+_{t-1} + \beta_3 npl^-_{t-1} + \sum_{i=1}^{p} \varphi_i \Delta gdp_{t-i} + \sum_{i=0}^{q} (\theta_i^+ \Delta npl^+_{t-i} + \theta_i^- \Delta npl^-_{t-i}) + u_t$$

Table 9 shows the result of asymmetry in the long run and short run between GDP and NPL. From the table, there is asymmetric relationship between these variables in the long run. However, there is short run, there is no sign of asymmetric between the variable.

Table 9 : NARDL long-run and short-run asymmetry test

Test	F-Stat	P>F	Result
Long Run	143	0.0000	Asymmetric
Short Run	0.1145	0.7360	Symmetric

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Cointegration test statistics:    t_BDM =     -4.3451
                                  F_PSS =      7.4891
```

F_PSS = 7.4891, which is larger than the upper bound critical value at 1% (i.e. 6.36). Accordingly, there is evidence for cointegration. Figure 3 is the Critical values from Pesaran et al. (2001).

Figure 3: Critical values from Pesaran et al. (2001)

Table CI(iii) Case III: Unrestricted intercept and no trend

	0.100		0.050		0.025		0.010		Mean		Variance	
k	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
0	6.58	6.58	8.21	8.21	9.80	9.80	11.79	11.79	3.05	3.05	7.07	7.07
1	4.04	4.78	4.94	5.73	5.77	6.68	6.84	7.84	2.03	2.52	2.28	2.89
2	3.17	4.14	3.79	4.85	4.41	5.52	5.15	6.36	1.69	2.35	1.23	1.77
3	2.72	3.77	3.23	4.35	3.69	4.89	4.29	5.61	1.51	2.26	0.82	1.27
4	2.45	3.52	2.86	4.01	3.25	4.49	3.74	5.06	1.41	2.21	0.60	0.98
5	2.26	3.35	2.62	3.79	2.96	4.18	3.41	4.68	1.34	2.17	0.48	0.79
6	2.12	3.23	2.45	3.61	2.75	3.99	3.15	4.43	1.29	2.14	0.39	0.66
7	2.03	3.13	2.32	3.50	2.60	3.84	2.96	4.26	1.26	2.13	0.33	0.58
8	1.95	3.06	2.22	3.39	2.48	3.70	2.79	4.10	1.23	2.12	0.29	0.51
9	1.88	2.99	2.14	3.30	2.37	3.60	2.65	3.97	1.21	2.10	0.25	0.45
10	1.83	2.94	2.06	3.24	2.28	3.50	2.54	3.86	1.19	2.09	0.23	0.41

Table 10: NARDL model

Asymmetry statistics:

Exog. var.	Long-run effect [+] coef.	F-stat	P>F	Long-run effect [-] coef.	F-stat	P>F
npl	0.958	34.56	0.000	0.142	2.858	0.094
	Long-run asymmetry F-stat		P>F	Short-run asymmetry F-stat		P>F
npl	143		0.000	.1145		0.736

Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

Cointegration test statistics: t_BDM = -4.3451
F_PSS = 7.4891

Result of NARDL is reported in Table 10. Long-run positive coefficient of NPL (L^{+}_{npl}) is positive and significant at 0.958, showing that appreciation of NPL by 1% will appreciate GDP by 0.95% in the long-run. Long-run negative coefficient(L^{-}_{npl}) is also positive and significant but at lower coefficient of 0.142, showing that decrease in NPL by 1% leads to appreciation of GDP by 0.14.

We are not expecting the result to be like this. It means that, the more borrowers fail to pay their debt obligation (NPL increased), the more healthy growth of the economy. While, least borrowers fail to pay their debt (NPL decreased), growth of the economy are still positive but at minimal level.

As to whether the relationship between the NPL and GDP is symmetric or not, the findings tend to indicate that the relationship is asymmetric in the long run but in the short run it is symmetric.

Variance Decompositions (VD)

ECM model in previous section only enabled us information about the absolute causality of endogeneity or exogeneity, however, only VDCs could provide the relative causality of endogeneity or exogeneity. The VDCs decomposes the variance of the forecast error of each variable into proportions attributable to shocks from each variable including its own.

In other word, VDCs finds out to what extent shocks to specified variables are explained by other variables in the system. If a variable explains most of its own shock, then it does not

permit variances of other variables to assist its explanation and is therefore said to relatively exogenous.

Two types of VDCs which are orthogonalized VDCs and Generalized VDCs. Generalized VDCs are more informative due to absence of orthogonalized VDCs. Firstly, orthogonalized VDCs depends on the particular ordering of the variables in the VAR, whereas generalized VDCs are invariant to the ordering of the variables. Secondly, the orthogonalized VDCs assumes that when a particular variable is shocked, all other variables in the model are switched off, but the generalized VDCs do not make such a restriction. The results from the VDCs as per display in the Table 11 for Othogonalized Variance Decompositions and Table 12 for Generalized Variance Decompositions below. The variable that is ranked higher is the leading variable, and therefore should be set as the intermediate target by policymakers.

Table 11: Othogonalized Variance Decompositions

Horizon	Variable	GDP	LD	LR	NPL	OPR
12 months	GDP	66.24%	19.40%	1.62%	4.25%	8.50%
	LD	80.19%	3.17%	0.91%	3.39%	12.34%
	LR	56.37%	8.72%	24.59%	4.03%	6.28%
	NPL	68.43%	9.86%	13.43%	3.79%	4.49%
	OPR	83.10%	3.10%	9.57%	3.16%	1.07%

Horizon	Variable	GDP	LD	LR	NPL	OPR
24 months	GDP	65.54%	19.82%	1.74%	4.34%	8.55%
	LD	79.65%	3.18%	1.02%	3.66%	12.49%
	LR	56.15%	8.70%	24.54%	4.21%	6.40%
	NPL	67.46%	10.22%	13.56%	4.20%	4.55%
	OPR	82.87%	3.17%	9.65%	3.18%	1.12%

Horizon	Variable	GDP	LD	LR	NPL	OPR
36 months	GDP	65.51%	19.82%	1.75%	4.36%	8.57%
	LD	79.64%	3.18%	1.03%	3.67%	12.49%
	LR	56.14%	8.70%	24.54%	4.22%	6.40%
	NPL	67.43%	10.23%	13.57%	4.23%	4.56%
	OPR	82.86%	3.18%	9.66%	3.18%	1.13%

Horizon	Variable	GDP	LD	LR	NPL	OPR
48 months	GDP	65.51%	19.82%	1.75%	4.36%	8.57%
	LD	79.63%	3.18%	1.03%	3.67%	12.49%
	LR	56.14%	8.70%	24.54%	4.22%	6.41%
	NPL	67.42%	10.23%	13.57%	4.23%	4.56%
	OPR	82.86%	3.18%	9.66%	3.18%	1.13%

Horizon	Variable	GDP	LD	LR	NPL	OPR
60 months	GDP	65.51%	19.82%	1.75%	4.36%	8.57%
	LD	79.63%	3.18%	1.03%	3.67%	12.49%
	LR	56.14%	8.70%	24.54%	4.22%	6.41%
	NPL	67.42%	10.23%	13.57%	4.23%	4.56%
	OPR	82.86%	3.18%	9.66%	3.18%	1.13%

Table 12: Generalized Variance Decompositions

Horizon	Variable	GDP	LD	LR	NPL	OPR
12 months	GDP	58.37%	18.68%	1.41%	4.94%	16.60%
	LD	73.80%	2.96%	4.36%	9.44%	9.44%
	LR	48.10%	8.62%	25.58%	9.52%	8.18%
	NPL	64.37%	10.85%	11.28%	7.57%	5.94%
	OPR	63.35%	8.19%	17.97%	8.16%	2.34%

Horizon	Variable	GDP	LD	LR	NPL	OPR
24 months	GDP	57.85%	19.15%	1.52%	5.03%	16.45%
	LD	73.17%	2.98%	4.47%	9.86%	9.52%
	LR	47.73%	8.55%	25.57%	9.75%	8.39%
	NPL	63.54%	11.16%	11.29%	8.12%	5.89%
	OPR	63.06%	8.24%	18.12%	8.13%	2.46%

Horizon	Variable	GDP	LD	LR	NPL	OPR
36 months	GDP	57.82%	19.15%	1.53%	5.05%	16.44%
	LD	73.15%	2.98%	4.48%	9.86%	9.52%
	LR	47.72%	8.55%	25.57%	9.76%	8.40%
	NPL	63.51%	11.17%	11.30%	8.14%	5.89%
	OPR	63.04%	8.25%	18.12%	8.13%	2.46%

Horizon	Variable	GDP	LD	LR	NPL	OPR
48 months	GDP	57.82%	19.15%	1.53%	5.05%	16.45%
	LD	73.15%	2.98%	4.48%	9.86%	9.52%
	LR	47.72%	8.55%	25.57%	9.76%	8.40%
	NPL	63.50%	11.17%	11.30%	8.14%	5.89%
	OPR	63.04%	8.25%	18.12%	8.13%	2.46%

Horizon	Variable	GDP	LD	LR	NPL	OPR
60 months	GDP	57.82%	19.15%	1.53%	5.05%	16.45%
	LD	73.15%	2.98%	4.48%	9.86%	9.52%
	LR	47.72%	8.55%	25.57%	9.76%	8.40%
	NPL	63.50%	11.17%	11.30%	8.15%	5.89%
	OPR	63.04%	8.25%	18.12%	8.13%	2.46%

Result from both Table 11 and Table 12 shows that GDP is the most exogenous while OPR is the most endogenous. This means that policy makers can hit GDP as a target to influence loan rate (LR), NPL, loan disbursement (LD) and OPR. This result shows that GDP can influence NPL in those horizon. However, the result does not support the ECM result where GDP is an endogenous while NPL is exogenous, as per Table 13.

Table 13: Summary of ECM and VDC result

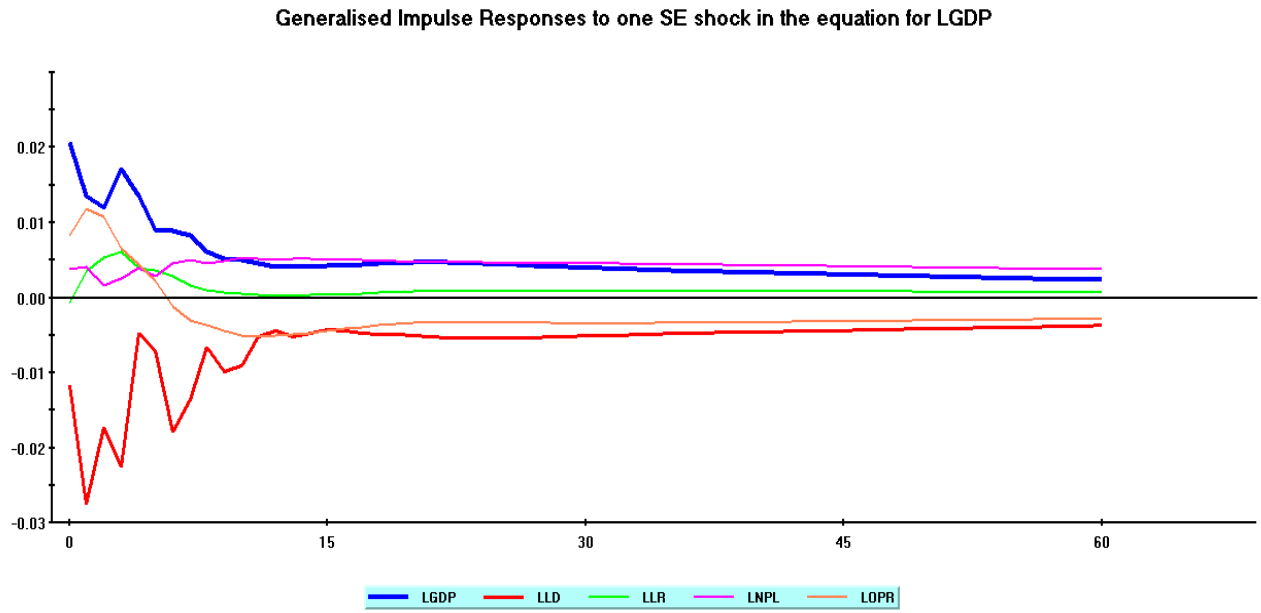
Variable	ECM	VDC
GDP	Endogenous	1
LD	Endogenous	4
LR	Endogenous	2
NPL	Exogenous	3
OPR	Exogenous	5

Our intuition is as for the data period, ECM result is more accurate. Therefore, NPL can influence GDP as the NPL is the exogenous. While in the 12, 24, 36, 48 and 60 horizons, GDP can influence NPL rate.

Impulse Response Function (IRF)

After test the VDCs test, the next test will be on the IRF. The impulse response function (IRF) displays the impact of a shock of one variable on others and validate the degree of response

and how long it would take to normalize. IRFs gives us the same information as VDC but in graphical form. Graph below shows that GDP take the longest time to get back to zero.



Policy Implications

From the above study, we found that both variables are cointegrated. We also found that they have an asymmetric result in a long run when appreciation and depreciation of the NPL. However, the result we found are not what we first expected. It turns out that an increase in NPL will increase GDP.

Due to this, we intuitively felt that when a borrowers are unable to repay their debt obligation, the money that they supposed to pay the banks, they have used it for consumptions and investment, which also will increase the GDP. Therefore, we encourage that the banks tighten the approval of the loan. Bank should do credit checking on borrowers' behaviors and pattern, check their ability to pay the instalment by doing stress test on the customers.

Other than that, loan rate is an exogenous factor to NPL. Bank can tackle NPL issue by hitting on loan rate. Restructuring and Rescheduling (R&R) is one of the tools that bank can use for post-disbursement loan. Other than increase the maturity of the loan, government can put ceiling price or subsidize on final goods such as house and car, to reduce, as it will make the instalment lesser.

Finally, the findings tend to indicate that the NPL and GDP are cointegrated as evidenced in both ARDL and Nonlinear ARDL. As to whether the relationship between the NPL and GDP is symmetric or not, the findings tend to indicate that the relationship is asymmetric in the long

run but symmetric in the short run. These findings have important policy implications for the developing countries like Malaysia.

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