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Unit Roots and Co-Integration Tests: the Effects of Consumer Price Index (CPI) on Non-Performing Loans (NPL) in the Banking Sector in Malaysia

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Abstract. The purpose of this study is to examine whether there is any genuine long run relationship between Consumer Price Index (CPI) and Non-Performing Loans (NPL). Using the logarithmic values of Consumer Price Index (CPI) inflation and Non-Performing Loans (NPL), different methodologies are employed in the analysis so that the robustness of unit roots and co-integration results is guaranteed. Based on the results, we consistently do not observe any genuine long run relationship between the two variables.

Keywords: Unit root tests, co-integration tests, non-performing loans, consumer price index (CPI)

1 Introduction

The Malaysian Law Journal interprets “Non-Performing Loan (NPL)”, as a loan, given to a person by a licensed institution, which has been in arrears for a period of times as may be determined by the licensed institution. According to Amirhossein and Soon-Yau (2013) banks in Malaysia classify non-performing loans into four classes: bad loan, doubtful loan, substandard loan and special-mentioned. Further, the classification is based on the bank’s re-scheduled loan repayment timetable and its perceived probability of loan repayment, the authors add. The authors carried out a number of investigations into the effects of Audit Expectation Gap (AEG) on bank officer’s loan quality decision. The authors point out non-performing loans may be reduced if bank officers enhance their understanding of the auditor’s responsibilities. The findings might have been far more convincing if they had included all banks in Malaysia in their sample. In a study on non-performing loan of Vietnamese banks by Delpachitra and Dai Van (2015), the authors use non-performing loan rate as a proxy for a default probability rate. By comparison in a study on loan loss provisioning practices of Malaysian banks Mohd Isa, Yap and Yong (2013) indicate the expected loss approach capture the amount of expected loss of non-performing loans more timely. Central to the entire discipline of non-performing loan is that it is a factor in the loan loss provisioning process, the authors conclude. In a recent study on the influence of institutional investors on bank loans, Huajing and Yili (2016) discovered shareholder controls are negatively related to loan costs. The authors measure the cost of bank loans through loan spreads, the number of collateral requirements and prepayment covenants. The authors find institutional holdings are negatively related to the cost of bank loans. The findings would have been far more useful if the authors had included the cost of non-performing loans.

The Consumer Price Index (CPI) measures the average change in the price paid by consumers for consumer goods and services. The index provides information about average price changes reflecting value of the Ringgit to find its purchasing power. In this regards, the purchasing power of the consumer’s Ringgit measures the change in the value to the consumers of goods and services that a Ringgit will buy at different times. As prices increase, the purchasing power of the consumer’s Ringgit declines. With changing financial obligations of households these days, it is becoming increasingly difficult to ignore the importance of proper debt management. According to Bank Negara Malaysia’s Annual Report, the inflation rate as measured by the average change in the CPI is an approximation of the rate of increase in the cost of living (Bank Negara Malaysia 2016, pp. 64).

In a recent study by Yao and Oppewap (2016) on consumers response to unit pricing (the display of an item's price per unit) the authors report that it shifts consumer choices towards the lower unit priced options. Interestingly, the study also finds the moderating role of time pressure. It results in greater responsiveness, the authors conclude.

More recently, a study based on a sample of 22 banks in Ghana, Laryea, Gyamfi and Alu (2016) find that inflation is positively associated to non-performing loans (NPL). The authors further discover that the level of non-performing loans affects profitability of the banks. It is becoming increasingly difficult to ignore the risks pose to the banks because of loans default. As economic conditions do contribute to the likelihood of being delinquent on debt, in a study by Jing Jian and Rui (2014) on patterns of loan delinquency of bank consumers, the findings suggest that family should adjust their spending downward in uncertain economic conditions. This is to reduce the likelihood of being delinquent in debt payment. Not only profitability but also bank's success are negatively affected by non-performing loans, the authors argue. McCloud and Dwyer (2011), as cited in Jing Jian and Rui (2014) attribute the likelihood of a household's debt default to income disruption. In contrast in the case of Vietnamese banks, Sarath and Pham (2015) reveal that bank's non-performing loans level does not significantly affect loan supply. The authors subscribed to the belief it is because of the divergence in lending practice between private and public banks.

This paper contributes to the existing literature on the study on delinquent loans in two ways. Firstly, it provides a new channel through which loans delinquent due to CPI. Against the rise in household debt in Malaysia where its ratio to gross domestic product (GDP) increased to 89.1% in 2015 from 86.8% the previous year, to examine on the relationship between non-performing loans (NPL) and consumer price index (CPI) is timely indeed. Will higher indebtedness effects on the level of non-performing loans? As previously argued, CPI is different from GDP, and this study attempts to fill in the gap in the research on CPI on delinquent loans. As the CPI reflects the value of the Ringgit, its depreciating trends against most major and regional currencies reflect the declining purchasing power. In Malaysia, the Ringgit has depreciated by 3% against the US dollar in the third quarter 2016 (Bank Negara Malaysia (BNM) Economic and Financial Developments in Malaysia in the third quarter of 2016). Esther, Mathew and Angela (2016) in a study on the effect of non-performing loan on bank profitability use the Consumer Price Index (CPI) as an indicator of annual inflation. In recent years, there have been increasing trends in national average inflation rate. In 2017, increase in pump prices and several price adjustments - constituting about 8% of CPI index components - have been identified as major contributing factors for possible increase in inflation rate by between 2.5% and 2.8%. ("Inflation in 2017 will be manageable", 2016).

The remainder of the paper is organized as follows. Section 2 discusses the model specifications. Section 3 describes the data statistics. Section 4 reports the empirical results and section 5 provides concluding remarks.

2 Model Specification

In order to examine the long run relationship between Consumer Price Index (CPI) and Non-Performing Loans (NPL) we consider the following model where the Non-Performing Loans (NPL) is regressed on the Consumer Price Index (CPI).

$\text{Log NPL} = f(\text{log CPI}_t) + \text{Error term}$, where

Log NPL is Non Performing Loans (in natural log), LnNPL_t

Log CPI is Consumer Price Index (CPI) (in natural log), LnCPI_t

So, we have $\text{LnNPL}_t = B_0 + B_1\text{LnCPI}_t + \varepsilon_t$

In compliance with the assumptions of the classical linear regression model (CLRM);

- ✓ the regression model is linear in coefficients
- ✓ is correctly specified
- ✓ has an error term (disturbance term), ε_t
- ✓ explanatory variable (NPL) is uncorrelated with the error term (ε_t)
- ✓ no multi-collinearity (however in this study there is only one independent variable, NPL)
- ✓ "n" (sample size = 45 observations i.e. monthly from January 2013 to September 2016 is > "k" (number of parameters =3), to ensure degree of freedom is "+").

Table 1. Model specifications: LnCPI level data

Model LnCPI level data	To include in equation
$\Delta(\text{LnCPI}_t) = B_0 + B_1\text{LnCPI}_{t-1} + \varepsilon_t$	Intercept
$\Delta(\text{LnCPI}_t) = B_0 + B_1 \text{Trend} + B_2\text{LnCPI}_{t-1} + \varepsilon_t$	Trend and Intercept
$\Delta(\text{LnCPI}_t) = B_1\text{LnCPI}_{t-1} + \varepsilon_t$	No trend, no intercept

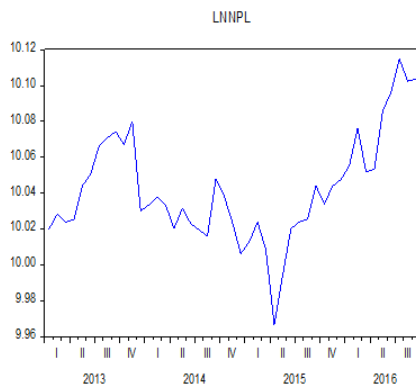
3 Data Statistics

The monthly data for this study on Consumer Price Index (CPI) and Non-Performing Loans (NPL) are obtained from the Bank Negara Malaysia (BNM) database. The data starts from January 2013 until September 2016 totalling 45 observations. Therefore, our study is more current in terms of time scopes making it more pertinent. The data on non-performing loan rates are reported as the average of the whole banking industry rather than as the rates of individual banks. Given that the banking industry in Malaysia is not monopolistic in which banks report about the same NPL rates, specifying an empirical model based on 45 observations seems acceptable for a robust time series analysis.

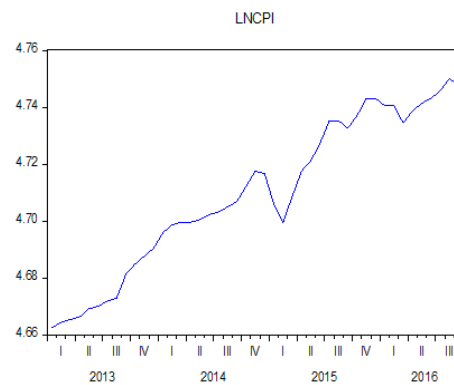
For CPI, since the cross-sectional data with delinquency across multiple CPI categories are limited or unavailable, this study also uses time series data on CPI to depict an overall aggregate picture of non-performing loans due to changes in Consumer Price Index (CPI).

4 Tests Results

Graphically, we noticed the pattern of time series in the line graphs of LnNPL and LnCPI as follows. The graphs 1 and 2 below exhibit plots of stochastic trends non-stationary models.



Graph 1. LNNPL



Graph 2. LNCPI

In order to deal with the stochastic non-stationary series, we induced stationarity by “differencing” as in Table 2 below. This is required before analysis the data has to be stationary for shocks to have permanent effects rather than transitory (effects).

Table 2. Model specifications: LnNPL first difference

Model LnNPL first difference	To include in equation
$\Delta(\text{LnNPL}_{t,2}) = B_0 + \Delta B_1\text{LnNPL}_{t-1} + \varepsilon_t$	Intercept
$\Delta(\text{LnNPL}_{t,2}) = B_0 + B_1\text{Trend} + \Delta B_2\text{LnNPL}_{t-1} + \varepsilon_t$	Trend and Intercept
$\Delta(\text{LnNPL}_{t,2}) = \Delta B_1\text{LnNPL}_{t-1} + \varepsilon_t$	No trend, no intercept

4.1 Tests for Unit Roots

As a pre-test prior to estimation and inference of the long term relationship between the two variables, we tested the existence of unit-root and whether the data is stationary. For this purpose, the following tests are conducted as in table 3 below:

Table 3. Tests available

Unit root tests	Stationary test
Augmented Dickey-Fuller (ADF)	Kwiatkowski, Phillips, Schmidt and Skin (KPSS)
Phillips-Perron (PP)	

(i) Augmented Dickey-Fuller (ADF) test

We conducted unit root tests for both variables (LnCPI and LnNPL) firstly using the Augmented Dickey-Fuller (ADF) method. The null hypothesis for the ADV model is the data has unit root (i.e. the data is non-stationary).

The results in levels indicate that the data contains unit root (i.e. the data is non-stationary). So we proceed to first difference as in table 4 below.

Table 4. ADF unit root test results of logs of CPI and NPL in levels and differences.

.Test	ADF			
	In level, LnCPI		In level, LnNPL	
	t-Statistic	p-value	t-Statistic	p-value
Intercept	-1.256(9)	0.641	-1.398(9)	0.575
Trend & Intercept	-3.358(9)	0.071	-1.619(9)	0.769
None	2.880(9)	0.999	0.740(9)	0.871

	In difference LnCPI		In difference LnNPL	
	t-statistics	p-value	t-Statistic	p-value
	Intercept	-5.605(9)	0.000 ^b	-7.021(9)
Trend & Intercept	-5.642(9)	0.000 ^b	-4.496(9)	0.001 ^b
None	-4.417(9)	0.000 ^b	-7.023(9)	0.000 ^b

Source: Own elaboration

^aNull hypothesis rejected at 5%.

^bNull hypothesis rejected at 1%.

Figure in parenthesis represents optimum lag length selected based on Akaike Info Criterion

The interpretation is that in level data, the p-values are higher than specified significance levels 0.05 (5%) and 0.01 (1%). So we failed to reject the null hypothesis in both cases, at 5% level critical value and at 1% level critical value. Even at 10% (0.1) level critical value we failed to reject the null hypothesis. Besides, the t-Statistic is 1.256 (in absolute value) which is less than 2.604 (in absolute value) at the 10% level critical value, the weak significance. Therefore, the level data has a unit root or the series is not-stationary in level.

The data becomes stationary in first difference. In the first difference, we rejected the null hypothesis at 1% level critical values as the p-values (0.000) are less than 0.01 (1%) level critical values.

(ii) Kwiatkowski, Phillips, Schmidt and Skin (KPSS) test

Another complementing test to the ADF test is the Kwiatkowski, Phillips, Schmidt and Skin (KPSS) in which case the null hypothesis is trend-stationary. This is against the alternative hypothesis, the presence of a unit root. It is important to note however in the case of KPSS test, the absence of a unit root is not a proof of data stationary, but of trend-stationary. It is possible the data is non-stationary, have no unit root but is trend-stationary.

Table 5. Kwiatkowski, Phillips, Schmidt and Skin (KPSS) unit root test results of logs of CPI and NPL in levels and differences

Test	KPSS			
	In level, LnCPI		In level, LnNPL	
	LM-Stat	CV 5%	LM-Stat	CV 5%
Intercept	0.839	0.463	0.236	0.463
Trend & Intercept	0.094	0.146	0.171	0.146

	In difference LnCPI		In difference LnNPL	
	LM-Stat	CV 5%	LM-Stat	CV 5%
	Intercept	0.137	0.463 ^a	0.181
Trend & Intercept	0.088	0.146	0.138	0.146

Source: Own elaboration

^a Null hypothesis rejected at 5%.

^b Null hypothesis rejected at 1%.

Figure in parenthesis represents optimum lag length selected based on Akaike Info Criterion

For the data in first-difference since the estimated test-statistic 0.137 is less than 0.463 the critical value at 5%, we cannot reject the null hypothesis the data is trend-stationary. There is no evidence that the data in first-difference is not trend-stationary.

(iii) Phillips-Perron (PP) test

Besides ADF and KPSS tests, another complementing test is the Phillips-Perron (PP) test. In the case of the Philips-Perron (PP) test, it is a unit root test to test the null hypothesis that the series integrated of order 1. The PP test tests the generating data might have a higher order of autocorrelation than is admitted in the equation resulting Y_{t-1} endogeneous and therefore invalidating the ADF t-test as in table 6 below.

Table 6. Phillips-Perron (PP) unit root test results of logs of CPI and NPL in levels and differences

Test	Phillips-Perron (PP)			
	In level, LnCPI		In level, LnNPL	
	Adj. T-Statistic	p-value	Adj. T-Statistic	p-value
Intercept	-1.161	0.683	-1.296	0.623
Trend & Intercept	-2.365	0.392	-1.518	0.808
None	4.151	1.000	0.920	0.902

	In difference LnCPI		In difference LnNPL	
	Adj. T-statistics	p-value	Adj. T-Statistic	p-value
	Intercept	-0.474	0.000	-7.124
Trend & Intercept	-5.589	0.000	-7.520	0.000
None	-3.922	0.000	-7.095	0.000

Source: Own elaboration

^a Null hypothesis rejected at 5%.

^b Null hypothesis rejected at 1%.

Figure in parenthesis represents optimum lag length selected based on Akaike Info Criterion. The results of unit root and stationary tests using the ADF, KPSS and PP tests taken in logs for the two variables CPI and NPL in Tables 2, 3 and 4 above show the variables are integrated of first order (which technically means difference of once or integrated of order one series $I(1)$).

Returning to estimate stationary test equations for the three tests, we find the following results as in table 7.

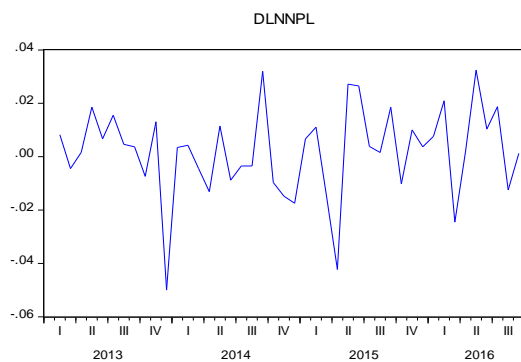
Table 7. Test equations

No.	Variable	ADF, KPSS and PP test equations ^a
1.0	lnCPI	Constant is significant, so need to include the constant term. Trend is not significant so does not need to include the trend term.
2.0	lnNPL	Constant is not significant, so does not need to include the constant term. Trend is not significant, so does not need to include the trend term

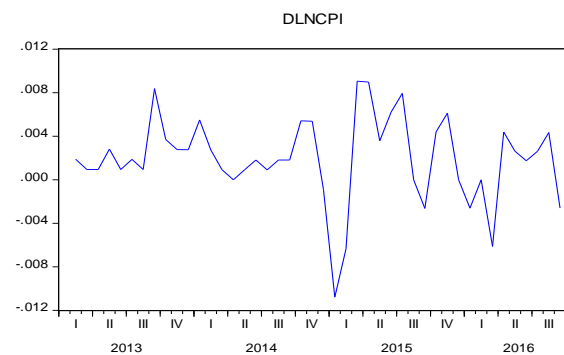
^a Model is stationary

As all the above tests (unit root, stationary and test equation) yield similar results implying the data is stationary in first differences our confidence in their estimates increases, and robustness of the estimates is guaranteed.

The graphs below exhibit plots of stationary models of first differences for LnCPI and LnNPL. Interestingly Noghondari and Fong (2013) state that Non Performing Loans may be reduced through recruiting bank officers with the right accounting skills.



Graph 3. DLNPL

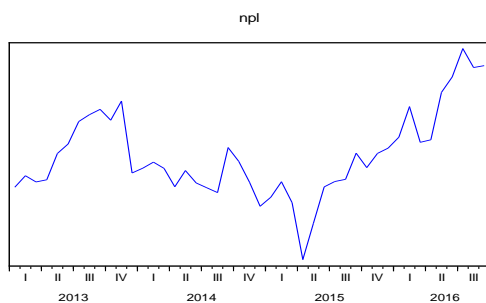


Graph 4. DLNCPI

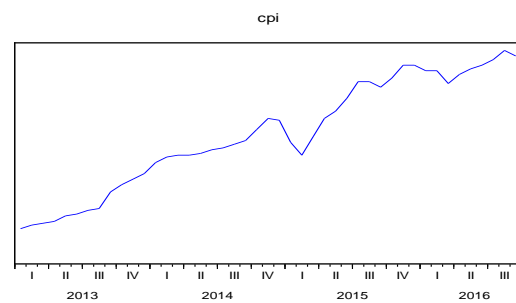
4.2 Tests for Co-integration

Next step is to test for a genuine and an equilibrium long-run relationship between CPI and NPL, i.e., to test whether co-integration or “co-movement” between the two variables exists. In other words, we are also to test for the presence of “spurious” regression problems in the regression. A spurious model is not desirable or acceptable.

The graphs below detect the regression suffers from spurious regression problem suggesting relationships between npl and cpi when there are none. Also because the series are I(1) we cannot rely on the series. It might be spurious regression. It can be observed from the graphs, the gap between npl and cpi over time becomes wider indicating there is no equilibrium relationship between npl and cpi.



Graph 5. npl s



Graph 6. cpi

The estimate of the long-run regression using Ordinary Least Squares (OLS) is as tabulated below in Table 8.

Table 8. Ordinary Least Square (OLS)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPI	66.23250	34.15472	1.939190	0.0591
C	15629.88	3794.362	4.119238	0.0002
R-squared	0.080420	Mean dependent var		22985.22
Adjusted R-squared	0.059034	S.D. dependent var		704.1189
S.E. of regression	683.0193	Akaike info criterion		15.93435
Sum squared resid	20060161	Schwarz criterion		16.01465
Log likelihood	-356.5229	Hannan-Quinn criter.		15.96428
F-statistic	3.760458	Durbin-Watson stat		0.332259
Prob(F-statistic)	0.059058			

Note: To test for co-integration, the NPL and CPI series are assumed to be I(1), that is they require a differencing at least once to become stationary; and not I(0); otherwise we cannot use this co-integration procedure. We have tested and discovered that after first difference the two series become stationary, therefore they are I(1) Also, even if both series are I(1); the regression process itself - in combination - in the long run become stationary I(0); they become stationary as the model itself adjust the “noises” or the “shocks”. So, the series become co-integrated.

There are 2 popular approaches for testing for co-integration:

- 1) The single equation method of residual-based test: the Engle-Granger co-integration test and
- 2) The system equation method: the Johansen and Juselius co-integration test
- 3) The single equation method of residual-based test: the Engle-Granger co-integration test

The Engle-Granger 2-steps residual-based test of co-integration is the unit roots test applied to residuals obtained from Ordinary Least Squares (OLS) estimation of the long-run regression (in step 1 above).

The result of step 2 is as tabulated below in Table 9.

From the above table our residuals equation = $NPL - 66.2325 \text{ CPI} - 15629.88$ (“the constant”). In this test, instead of using the standard critical values, we use the Engle-Granger test critical values at 1% of -3.89644, at 5% of -3.33613 and at 10% of -3.04445 (MacKinnon, 2010). Since the estimated t-statistic of -1.612173 is smaller than the critical value of -3.89644 at 1%; we cannot reject null hypothesis of unit root in the residual series.

The Engle-Granger tau-statistic (t-statistic) and normalized auto-correlation coefficient (z-statistic) both cannot reject the null hypothesis that there is a unit root in the residual series. We fail to reject the null hypothesis of no co-integration in the unit root of the residuals between npl and cpi at 5% level too. In addition, the tau-statistic (t-statistic) fails to reject at a 10% significance level.

The evidence clearly suggests that npl and cpi are not co-integrated. The two series do not have long run relationship or equilibrium between them. The possibly d.f. corrected coefficient standard error for npl is 0.088423 and cpi is 0.036054. The squared standard error of the regression is 146169.0 for npl and 0.470006 for cpi. Next is the Johansen and Juselius co-integration test as in table 10 below.

There are limitations of this study that should be acknowledged. Future research may need to use cross-sectional data sets to examine delinquency across multiple CPI categories. In addition, as has been suggested that theoretically indicators of inflation may include not only consumer prices proxy by CPI, but also economic growth and trade openness (Aviral, Muhammad and Faridul, 2013). This would provide more insight into future study. Future study should also be encouraged to use data from other countries to identify commonalities and differences of consumer delinquent behaviours at the international level.

Table 9. the Engle-Granger test results

Series: NPL CPI				
Sample: 2013M01 2016M09				
Included observations: 45				
Null hypothesis: Series are not cointegrated				
Cointegrating equation deterministics: C				
Automatic lags specification based on Schwarz criterion (maxlag=9)				
Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
NPL	-1.612173	0.7185	-6.272340	0.6064
CPI	-1.357781	0.8139	-2.153966	0.9247
*MacKinnon (1996) p-values.				
Intermediate Results:				
		NPL	CPI	
Rho - 1		-0.142553	-0.048954	
Rho S.E.		0.088423	0.036054	
Residual variance		146169.0	0.470006	
Long-run residual variance		146169.0	0.470006	
Number of lags		0	0	
Number of observations		44	44	
Number of stochastic trends**		2	2	
**Number of stochastic trends in asymptotic distribution				

Table 10. Johansen and Juselius co-integration test

Sample (adjusted): 2013M03 2016M09				
Included observations: 43 after adjustments				
Trend assumption: Linear deterministic trend				
Series: NPL CPI				
Lags interval (in first differences): 1 to 1				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.065366	3.884777	15.49471	0.9126
At most 1	0.022487	0.977958	3.841466	0.3227
Trace test indicates no cointegration at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.065366	2.906820	14.26460	0.9528
At most 1	0.022487	0.977958	3.841466	0.3227
Max-eigenvalue test indicates no cointegration at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

5 Conclusion

Using monthly data from January 2013 to September 2016 totalling 45 observations, the purpose of this paper is to examine whether there is a genuine long run relationship between Consumer Price Index (CPI) and Non-Performing Loans (NPL). A number of tests are carried-out for the purpose including unit roots and co-integration tests. Based on the results, we consistently do not observe any genuine long run relationship between the two variables. Our finding supports Esther, Mathew and Angela (2016) conclusion that inflation - as measured by CPI - is not significant in determining non-performing loans although it is positively related.

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Appendix

Table 1. Definition of variables

Variables	Glossary
Consumer Price Index (CPI)	A single/fixed basket of goods and services which represents the consumption basket of all households with year 2010 as a base year, and their respective weights (2010=100) are as follows: Food non-alcoholic beverages 30.2 Alcoholic beverages, tobacco 2.9 Clothing & footwear 3.3 Housing, water, gas & electricity 23.8 Furnishing & household equipments 3.8 Health 1.7 Transport 13.7 Communication 5.2 Recreation services & culture 4.9 Education 1.1 Restaurant & Hotel 2.9 Miscellaneous goods & services 6.5
Non-Performing Loans (NPL)	Commercial banks and Islamic banks Non-Performing Loans

Table 2. CPI Inflation by States and Income Groups in 2015 (Annual change, %)

		Total	
MALAYSIA		2.1	
Highly urbanised states	Kuala Lumpur	2.78	Inflation tends to be higher for more urbanised states
	Selangor & Putrajaya	2.34	
	Pulau Pinang	2.45	
	Melaka	1.92	
	Johor	2.78	
Semi-urbanised states	Negeri Sembilan	2.30	
	Perak	1.77	
	Kedah & Perlis	1.65	
	Terengganu	1.85	
Less-urbanised	Sabah & Labuan	0.88	
	Sarawak	1.45	
	Pahang	1.83	
	Kelantan	1.91	
Inflation tends to be higher for lower income groups			

Source: Source: Bank Negara Malaysia (2016), *Annual Report 2015 "Box Article: Inflation and the Cost of Living"*, pp. 67