CHAPTER 4:

RESEARCH RESULT

4.0 Introduction

This chapter focuses on the presentation of the findings obtained through a series of statistical analysis. The presentation will first test on the normality, relevancy and reliability of the time series data that being collected. It follows with the linear regression testing by way of Stepwise Regression method. The data are then empirically tested to answer the research questions.

4.1 Preliminary Analysis

It is essential to test the normality of the data prior to answering any of the research questions. The following econometrics test will be taken into consideration:

- Unit root test
- Multicollinearity
- Stepwise Regression

4.1.1 Unit Root Test

In time series data, the stationarity or otherwise of a series can strongly influence its behaviour and properties. As mentioned earlier, if two variables are trending over time, a regression of one on the other could have a high R^2 even if the two are totally unrelated and we will obtain spurious regressions at the end. Hence, Augmented Dickey-Fuller Unit Root test has been performed for all the 5 independent variables (GDP, CPI, KLCI, UE, and HPI).

For the ADF unit-root test, the null hypothesis of unit root can not be rejected for any of the variables. This is a first sign for non-stationary of the 5 independent variables in the analyzed period.

The results for the unit root tests are summarized in the table below:

Unit-Root Test	ADF Test Stats	Test critical values: 1%	Test critical values: 5%	Test critical values: 10%	Durbin Watson Stats	Stationary (@ 5% Significant level)
GDP	-4.938799	-2.615093	-1.947975	-1.612408	1.70922	Stationary
CPI	-7.115398	-2.615093	-1.947975	-1.612408	2.015807	Stationary
KLCI	-8.338118	-2.615093	-1.947975	-1.612408	1.753	Stationary
UE	-5.62189	-3.577723	-2.925169	-2.600658	1.893806	Stationary
HPI	-2.366421	-2.615093	-1.947975	-1.612408	1.777851	Stationary

Figure 4.1: Unit Root Test result

In this research, 5% significant level is set. From Figure 4.1, the computed absolute ADF test statistic is found smaller than the critical values of 5% significant level, hence all the independent variables have been found stationary. GDP, CPI, KLCI, HPI are to be found with stationary at 'level' whilst UE to be found significant when the model is added with intercept. Refer appendix 1 which shows the full testing from EViews application. With this result, the data analysis proceeds with multicollinearity test.

4.1.2 Autocorrelation

Autocorrelation of the samples have been tested using EView. At 5% significant level and with 5 independent variables together with 48 data observations, the lower critical value (d_L) is 1.34 and upper critical value (d_U) is 1.77 based on Durbin-Watson table.

Based on appendix 2, which shows the test result from EView, the Durbin-Watson statistic is 1.44 which falls between d_L and d_U and the result may consider as inconclusive and it may to be considered to proceed with further analysis.

4.1.3 Multicollinearity

As mentioned in Chapter 3, the stronger the variables dependency, the larger the standard errors for estimators of this variable. This problem will lead to estimators become unstable, confidence intervals larger and test on parameters for this variables are more likely not significant. To avoid the problem, one of the approaches is to measure directly the correlation between one variable and all other variables. Hence, Variance Inflation Factor is used to show directly how much the standard error of the estimation is inflated by the multicollinearity.

As in the subsequent stepwise testing, independent variables will be lagged by 1 and 2 quarters in order to find the best model of the equation. This is because we believe that when each observation consists of values measured at one point in time, sometimes the dependent variable relates more to independent variables at previous points in time, than at the same point. Thus, 4 independent variables have been lagged by subsequent 1 and 2 quarters to test on the existence of the multicollinearity issue.

The steps started with examining the correlations (continuous and ordinal variables) and associations (nominal variables) between independent variables. However, it may not be sufficient in some situation when no pair of variables is highly correlated, but several variables are involved in interdependencies. Hence, multicollinearity diagnostic statistics produced by linear regression analysis i.e. PROC REG with

options VIF TOL in SAS has been used. Tolerance and VIF for each variable has been examined. Low values indicate high multivariate correlation, since for each independent variable, Tolerance = $1 - R^2$, where R^2 is the coefficient of determination for the regression of that variable on all remaining independent variables. And, the Variance Inflation Factor (VIF) is 1/Tolerance which it shows the number of times the variance of the corresponding parameter estimate is increased due to multicollinearity as compared to as it would be if there was no multicollinearity.

The results for the multicollinearity tests are summarized in the table below:

VIF	NPL	GDP0	GDP1	GDP2	CPI0	CPI1	CPI2	KLCI0	KLCI1	KLCI2	UE0	UE1	UE2	HPI0	HPI1	HPI2
NPL	-	1.029	1.092	1.034	1.008	1.002	1.013	1.339	1.003	1.042	1.044	1.008	1.015	1.085	1.260	1.039
GDP0	1.029	-	1.023	1.298	1.016	1.002	1.069	1.002	1.017	1.364	1.072	1.307	1.122	1.051	1.011	1.006
GDP1	1.092	1.023	-	1.022	1.001	1.017	1.002	1.000	1.000	1.007	1.290	1.099	1.171	1.041	1.056	1.013
GDP2	1.034	1.298	1.022	-	1.005	1.001	1.017	1.020	1.003	1.002	1.000	1.324	1.128	1.034	1.046	1.062
CPI0	1.008	1.016	1.001	1.005	-	1.001	1.001	1.009	1.022	1.009	1.029	1.018	1.005	1.026	1.005	1.006
CPI1	1.002	1.002	1.017	1.001	1.001	-	1.001	1.008	1.011	1.025	1.002	1.020	1.011	1.066	1.026	1.005
CPI2	1.013	1.069	1.002	1.017	1.001	1.001	-	1.001	1.007	1.012	1.000	1.001	1.015	1.056	1.065	1.025
KLCI0	1.339	1.002	1.000	1.020	1.009	1.008	1.001	-	1.067	1.031	1.005	1.052	1.002	1.033	1.015	1.131
KLCI1	1.003	1.017	1.000	1.003	1.022	1.011	1.007	1.067	-	1.036	1.055	1.000	1.092	1.021	1.031	1.014
KLCI2	1.042	1.364	1.007	1.002	1.009	1.025	1.012	1.031	1.036	-	1.027	1.084	1.008	1.035	1.022	1.028
UE0	1.044	1.072	1.290	1.000	1.029	1.002	1.000	1.005	1.055	1.027	-	1.073	1.009	1.002	1.005	1.000
UE1	1.008	1.307	1.099	1.324	1.018	1.020	1.001	1.052	1.000	1.084	1.073	-	1.138	1.015	1.002	1.005
UE2	1.015	1.122	1.171	1.128	1.005	1.011	1.015	1.002	1.092	1.008	1.009	1.138	-	1.049	1.013	1.002
HPI0	1.085	1.051	1.041	1.034	1.026	1.066	1.056	1.033	1.021	1.035	1.002	1.015	1.049	-	2.831	1.529
HPI1	1.260	1.011	1.056	1.046	1.005	1.026	1.065	1.015	1.031	1.022	1.005	1.002	1.013	2.831	-	2.821
HPI2	1.039	1.006	1.013	1.062	1.006	1.005	1.025	1.131	1.014	1.028	1.000	1.005	1.002	1.529	2.821	-

Figure 4.2: Multicollinearity Test Result

From figure 4.2 above, results show all the standard errors for the parameter of variables are less than 2 times higher (inflated). Values of VIF exceeding 10 are often regarded as indicating multicollinearity as mentioned in Chapter 3. With all these results, we may conclude that the multicollinerity issue does not exist in any combination of the variables.

4.1.4 Stepwise Regression

After taken all the preliminary testing, in order to meet the objective of this research which to find out the linear model that best predicts the dependent variable from the independent variables (macroeconomic variables), stepwise regression statistical technique has been used. This stepwise regression technique allows the program to automatically make the model choices of entry and elimination.

SAS application is the tools to run this stepwise regression. As mentioned in Chapter 3, combination of forward entry and backward elimination approach has been performed which the option SLENTRY = 0.95 and option SLSTAY = 0.95 to be included in the SAS program. The earlier represent the forward entry which specifies that a variable has to be significant at the 0.95 level before it can be entered into the model while the latter represent the backward elimination which specifies that a variable in the model has to be significant at the 0.95 level for it to remain in the model.

The results end up giving 29 models which consist from 3 independent variables and up to 5 independents variables in the model. The summary of the results show as below:

No	Dependent Variable	Model	Model R-square	Model F-Value	Model Prob F-Value	F-Distribution Value
1	NPL	GDP1 KLCI0 HPI1	0.5587	18.5665	0.00000006	2.8400
2	NPL	GDP1 CPI2 KLCI0 UE1 HPI1	0.5587	18.5665	0.00000006	2.8400
3	NPL	GDP1 CPI2 KLCI0 HPI1	0.5587	18.5665	0.00000006	2.8400
4	NPL	GDP1 KLCI0 UE1 HPI1	0.5587	18.5665	0.00000006	2.8400
5	NPL	GDP1 CPI0 KLCI0 HPI1	0.5719	14.3600	0.00000016	2.6100
6	NPL	GDP2 KLCI0 UE0 HPI1	0.5656	13.9996	0.00000022	2.6100
7	NPL	GDP2 CPI0 KLCI0 UE1 HPI1	0.5624	13.8153	0.00000025	2.6100
8	NPL	GDP2 CPI0 KLCI0 HPI1	0.5624	13.8153	0.00000025	2.6100
9	NPL	GDP1 CPI1 KLCI0 HPI1	0.5613	13.7552	0.00000026	2.6100
10	NPL	GDP1 CPI2 KLCI0 UE0 HPI1	0.5608	13.7249	0.00000027	2.6100
11	NPL	GDP1 KLCI0 UE0 HPI1	0.5608	13.7249	0.00000027	2.6100
12	NPL	GDP1 CPI2 KLCI0 UE2 HPI1	0.5598	13.6691	0.00000028	2.6100
13	NPL	GDP1 KLCI0 UE2 HPI1	0.5598	13.6691	0.00000028	2.6100
14	NPL	GDP2 KLCI0 UE2 HPI1	0.5585	13.5970	0.00000030	2.6100
15	NPL	CPI0 KLCI0 UE0 HPI1	0.5567	13.4980	0.00000033	2.6100
16	NPL	GDP2 CPI0 KLCI0 UE0 HPI1	0.5867	11.9230	0.00000033	2.4500
17	NPL	GDP1 CPI0 KLCI0 UE0 HPI1	0.5761	11.4175	0.00000054	2.4500
18	NPL	GDP1 CPI0 KLCI0 UE2 HPI1	0.5739	11.3127	0.00000060	2.4500
19	NPL	GDP1 CPI0 KLCI0 UE1 HPI1	0.5722	11.2348	0.00000065	2.4500
20	NPL	GDP2 CPI0 KLCI0 UE2 HPI1	0.5720	11.2248	0.00000066	2.4500
21	NPL	GDP2 CPI2 KLCI0 UE0 HPI1	0.5668	10.9891	0.00000083	2.4500
22	NPL	GDP2 CPI1 KLCI0 UE0 HPI1	0.5658	10.9480	0.00000087	2.4500
23	NPL	GDP1 CPI1 KLCI0 UE0 HPI1	0.5628	10.8146	0.00000100	2.4500
24	NPL	GDP1 CPI1 KLCI0 UE2 HPI1	0.5622	10.7874	0.00000103	2.4500
25	NPL	GDP2 CPI2 KLCI0 UE2 HPI1	0.5614	10.7532	0.00000106	2.4500
26	NPL	GDP1 CPI1 KLCI0 UE1 HPI1	0.5614	10.7528	0.00000106	2.4500
27	NPL	GDP2 CPI1 KLCI0 UE2 HPI1	0.5596	10.6733	0.00000116	2.4500
28	NPL	GDP0 CPI0 KLCI0 UE1 HPI1	0.5582	10.6127	0.00000123	2.4500
29	NPL	GDP0 CPI0 KLCI0 UE0 HPI1	0.5582	10.6111	0.00000123	2.4500

Figure 4.3: Stepwise Regression Result

With the results shown above, all the models shown above are with acceptable F-value and the model with highest F-value is being considered as the best model for the equation. However, noted that 4 models are having the highest F-value and same R^2, but the combination of the independent variables are different for all these 4 models. Model 1 which highlighted in Figure 12 has been decided to proceed with the scenario testing at later section as this model is having the least independent variables which it will be easier for senior management to monitor the movement of the independent variables against the dependent variable. If there is too many of the variables, possibility of the combination situation might not be notice easily for the management who take care of the portfolio.

Figure 4.4 shows the actual and predicted changed in NPL% which some of the points like 2002 to 2003 found inverse direction between actual and predicted changed in NPL%. The prediction will not be as close as actual result since R^2 in this model is at 55.87%.

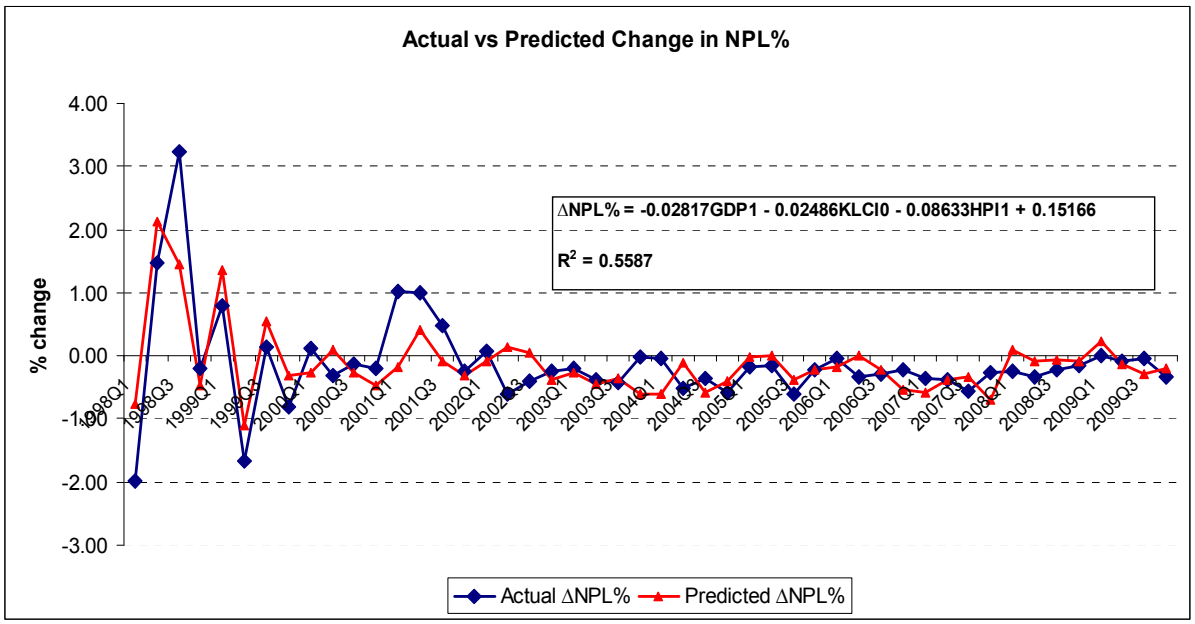

Figure 4.4: Actual vs. Predicted Change in NPL%

After determined the best model, selected variables are inputted in EViews program in order to find out the correlation between the selected independent variables (GDP lagged by 1 quarter, KLCI at current quarter, HPI lagged by 1 quarter) and dependent variable (NPL). The results of the correlation are as follow:

Variable	Expected Sign of Effect to Credit Risk	Tested Result: Sign of Effect to Credit Risk	Coefficient
GDP lagged by 1 quarter	-	-	-0.02817
KLCI at current quarter	-	-	-0.02486
HPI lagged by 1 quarter	-	-	-0.08633

Figure 4.5: Expected Correlation Result versus Actual Correlation Result

The actual results of the correlation between the independent and dependent variables which selected from the best regression model are to be said intuitive. Hence, the regression model which to be used for the scenario testing will be as follow:

$$\Delta NPL\% = - 0.0287GDP1 - 0.02486KLCI - 0.08633HPI1 + 0.15166 \quad (7)$$

4.2 Scenario Testing

With all the testing being done, the best regression model in equation 7 above is built to test the 3 scenarios that have been identified earlier where Malaysia's economy in severe stress scenario, moderate stress scenario and mild stress scenario.

Using the equation, the results of the 3 scenarios shown as follow:

Economic Stress Scenario	GDP	CPI	KLCI	UE	HPI	ΔNPL%
Severe Recession	-8.30%		21.50%		-9.50%	15.69%
Moderate Recession	-10.40%		-13.60%		2.50%	15.58%
Mild Recession	-9.60%		-4.50%		2.60%	15.32%

Figure 4.6: Stress Scenarios test result

Figure 4.6 shows instinctive results which the changes in NPL% are with accordance to the severity of the stress scenarios. This prediction explain that, for instance, in severe scenario, if NPL for the previous quarter is 1.8%, and the 3 scenarios meet the percentage changed criteria shown above at current quarter, the NPL for this quarter will increase to 1.96%, with the assumption of total loan to be held constant. If with the same quarter being analyzed and Malaysia is having mild recession, with the

equation given, the NPL% may predict to go up to 1.95%, having the total loan constant, it is 1 basis point different with severe scenario.

4.3 Summary

It is therefore confirmed that the results are supporting Hypothesis 1 to Hypothesis 4 in some extent. GDP has proven to be negatively related to credit risk (NPL) but only with lagged of 2 quarters. On the other hand, KLCI found to be negatively related with NPL at current quarter. And, same goes to House Price Index which it is expected to have positive relationship and the result reviewed so at 1 quarter lagged. It is further discovered that the multiple linear equation did not show a high Correlation of Coefficient and the scenario stress testing are to be concluded with intuitive result.