DETERMINANTS OF NON-PERFORMING LOANS (NPLS) OF THE COMMERCIAL BANKS IN BANGLADESH: AN APPLICATION OF CAMEL MODEL

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Abstract

The loan portfolio represents a significant portion of a bank's total assets. This asset generates interest income, which is a measurement of bank's financial performance and stability. Non-performing loans (NPLs) are those loans that default on paying interest or principal. Hence, NPL ratio is one of the important indicators of a bank's performance. In order to ensure good performance, a thorough understanding of NPL ratios and factors that affect NPL are necessary. This research evaluates NPL ratio in the Banking sector of Bangladesh and the relationship among the variables of CAMEL (capital, asset, management, earnings and liquidity) model of performance. Last 24 years (1997-2020) time series data of banking sector have been used in this study. Upon analysis of the time series data VECM model is developed to demonstrate the relationship among the variables. The developed model shows high goodness of fit and reasonable explanatory power. Results of the study will help practitioners and regulators to pin-point policies and operational interventions to manage (reduce) NPL.

Keywords: Non-performing loan (NPL), CAMEL model, VECM model.

Introduction

Economic efficiency of any country depends on the sound and safe financial system. Financial intermediaries are one of the key players of financial system. The main responsibility of financial intermediaries is to channel economic resources into

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profitable investment ventures; in return they earn interest income. The financial system of Bangladesh is gradually growing and becoming robust. Especially, the banking sector has experienced rapid growth over last few decades. As of June 2019, the total number of bank branches in Bangladesh is 10,286. But the growing trend of NPL has become a major cause of concern. According to data published in Bangladesh Bank annual report (2019-2020) the total NPL amount is BDT 961 billion. As shown in Figure 1, the growth rate of NPL was steady till 2012 but the rate showed rapid increase thereafter till 2017. After 2017 the growth of NPL although became steady, the level of NPL too high for a well-functioning banking system.

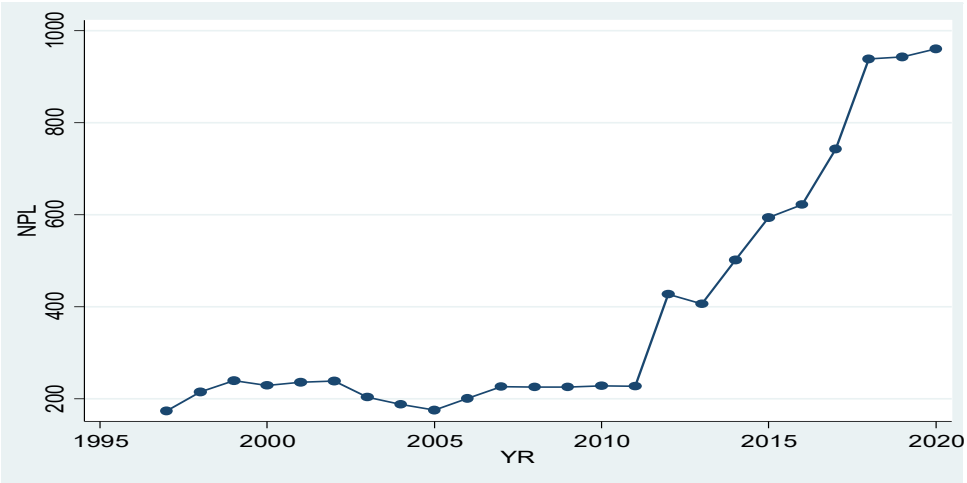

Figure 1: Trend of NPL in Bangladesh

In spite of wide-ranging reform measures initiated in the banking sector, NPL remains to be a constant headache for bankers, regulators and policy makers as well (Adhikari, 2007 and Lata 2015). Using time series data, Lata (2015) found that NPLs negatively affect profitability and interest income of the banks in Bangladesh. Rahman, Asaduzzaman & Hossain (2017) asserts that high NPL ratio in banking system or its rising tendency leads to increased bad debt loss which in turn results in decreased profitability and capital adequacy ratio of the banks. In order to address the problem of growing NPL, practitioners and policy makers must have a clear understanding of why NPLs are rising or what determines the rising NPL in the banking sector. This research thrives to answer these questions by using the CAMEL (capital, asset, management, earnings and liquidity) model of bank performance. The objective of this study thus is to identify the relationship of NPL with other variables of CAMEL model.

Literatuer Review

Nonperforming loans (NPLs) refers to those financial assets from which banks no longer receive interest and/or instalment payments as scheduled (Adhikeri, 2007). NPLs are considered to be zero yield assets. In other words, NPLs are assets which cease to generate income for banks. According to Bangladesh Bank, all loans are usually divided into four categories which are continuous loan, demand loan, term loan and short-term agricultural credit or micro credit. As banks observe periods of elapsed repayments of any of these loans, they are categorized as unclassified (UC), special mention account (SMA), substandard (SS), doubtful (DF), and bad/loss (BL) loans depending on the degree of elapsed repayments. The rate of provision on these loans follows norms of 1%, 5%, 20%, 50% and 100% against UC, SMA, SS, DF and BL loans respectively. The loans except UC are categorized as Non-Performing Loan (NPL).

As NPLs are proven to be a significant problem that affect banking sector performance, let alone financial health of any economy (Anjom & Karim, 2015; Adhikari, 2007 and Wheelock & Wilson, 2000); the issue has been widely researched across the world, especially in economies whose financial systems are plagued with NPL. For example, Zeng S (2012) studied non-performing Loans in China and argues that NPL is dependent on micro-economic factors like a bank's internal management and macroeconomic factors like the degree of open-ness to the outside world and government policy. Messai & Jouini (2013) investigated data of 85 banks from three European countries namely Italy, Greece and Spain over the five-year period ranging 2004-2008. They assert that GDP growth; real interest rate and unemployment rates are macro determinants of NPL. Profitability of bank assets and loan loss reserve to total loans ratio are found to be micro-determinants of NPL. Haneef, Riaz, Ramzan et al. (2012) investigated the impact of risk management on non- performing loan and profitability of banking sector of Pakistan. They concluded that imprudent risk management contributes to increasing NPL, which threatens the profitability of banks. Jameel (2014) argued that besides macro factors such as GDP growth rate and average interest rate, bank specific factors namely capital adequacy ratio, credit to deposit ratio, maturity of loans influence NPL ratio (NPL to total advance ratio). Rajan & Dhal (2003) analysed a decade's data (1993-2003) of Indian banking sector and concluded that NPL amount is determined by three factors e.g., terms of credit, bank size induced risk preferences and macroeconomic shocks. Bardhan & Mukherjee (2016) examined 16-year's data since 1995 and revealed that past NPLs significantly affect current NPLs of Indian banks. Referring to this time persistence structure of NPLs despite several regulatory measures taken to curb NPLs, they concluded that bad management adversely affect the NPL. They also found that

NPLs or bad loans regress with bank size, capital adequacy, profitability, GDP growth, inflation and nominal exchange rate. Waqas, Fatima, Khan & Arif (2017) examined panel data of banks in Pakistan and India over the period 2000-2015 and revealed that inefficiency, profitability, capital to total asset ratio and macroeconomic variables like GDP growth and real interest rate are the significant determinants of NPL. Upon analysing data of Spanish commercial banks over the period 1985-1997, Salas & Saurina (2002) attested that credit growth, real GDP growth, capital ratio, bank size, and market power are the determinants of NPL. By doing a trend analysis of data from Federal Reserve Bulletin during 1967-1983 & 1990-98 period, Keeton (1999) argued that faster loan growth leads to higher loan losses or problem loans. The study also found the relationship between loans and delinquency rate for the period of 1982-96 using lagged earnings, lagged loans and lagged delinquency rate as the independent variables. Through value at risk analysis Keeton (1999) found that increases in the delinquency rate leads to a decrease in loan amount, suggesting that repayment problems either discourage businesses from taking on additional debt or discourage banks from making new loans. Berger & DeYoung (1997) studied problem loans and cost efficiency in commercial banks using Granger-causality techniques on annual observations of U.S. commercial banks from 1985 through 1994 to test which of the four hypotheses like bad luck (external events like a local plant closing), bad management, skimping (amount of resources allocated to underwriting and monitoring loans and moral hazard better explain NPL trend. Results of their analysis suggest that bad management hypothesis dominates the skimping hypothesis. Hence, relatively risky loan portfolio-mix yields relatively high level of NPL.

In the context of Bangladesh, Zheng, Bhowmik & Sarker (2020) conducted a comprehensive study on the entire banking system of Bangladesh. They have run autoregressive distributed lag (ARDL) model and vector error correction model (VEC) using data from 1979 to 2018. They concluded that GDP growth, unemployment, domestic credit and exchange rate are the significant macroeconomic determinants of NPL. Total loan growth, deposit rate, net operating profit, liquidity and lending rates are the microeconomic or bank specific determinants of NPL. Adhikari (2007) deduced that imprudent monitoring and supervision on the part of banks, inadequacy of trained human resources, insufficient debt recovery appraises, inappropriate legal infrastructure, lack of effective loan recovery policies, and poor enforcement of laws are the major reasons behind persistent NPL in the economy.

The literature presented above marks that different authors have identified different macro and micro level determinants of NPL. Table 1 presents a list of the determinants. It is evident from Table 1 that GDP growth rate, interest rate; inflation, unemployment rate, domestic credit growth and exchange rate are the

common macroeconomic determinants of NPL. Among the microeconomic or bank specific determinants management efficiency, bank profitability, imprudent risk management, capital adequacy ratio, loan to reserve ratio, terms of credit, bank size, lending and deposit rate, liquidity and total loan amount are prevalent in literature. A close scrutiny of the microeconomic determinants reveals that they actually represent the variables in the CAMEL model. This is a widely used model for analysing performance of banks and nonbank financial institutions (Matthew and Laryea, 2012; Ifeacho and Ngalawa, 2014; Sangmi and Nazir, 2010; Salim, Arjomand and Seufert, 2016; Kumbirai and Web, 2010; Naceur and Omran, 2011). Bangladesh Bank judges the banking sector performance through CAMEL model and furnishes banking sector performance data in annual report (chapter 5 of every year annual report) using this model.

Table 1: Determinants of NPL identified from literature

Author(s)	Context	Macro determinants	Micro determinants
Zeng (2012)	China	Openness of economy, regulatory framework	Management efficiency
Messai & Jouini (2013)	Italy, Greece and Spain	GDP growth, real interest rate, unemployment rate	Bank profitability and loan loss reserve ratio
Haneef, Riaz, Ramzan et al. (2012)	Pakistan	-	Imprudent risk management
Jameel (2014)	Pakistan	GDP growth, average interest rate	Capital adequacy ratio, credit to deposit ratio, and maturity of loans
Ranjan & Dhar (2003)	India	Macroeconomic shocks	Terms of credit and bank size
Bardhan & Mukharjee (2016)	India	GDP growth, inflation and nominal exchange rate	Bad management, bank size, capital adequacy, profitability
Waqas, Fatima, Khan & Arif (2017)	India and Pakistan	GDP growth, and real interest rate	Management efficiency, profitability and capital adequacy
Salas & Saurina (2002)	Spain	GDP growth, credit growth and market power	Bank size and capital adequacy
Keeton (1999)	US		Total new loan
Berger & De Young (1997)	US		Bad management and skimping.
Zheng, Bhowmik & Sarker (2020)	Banglaesh	GDP growth, unemployment, domestic credit and exchange rate	Total loan growth, net operating profit, deposit rate, lending rate and liquidity.
Adhikari (2007)	Banglaesh	Inappropriate legal infrastructure, lack of effective loan recovery policies, and poor enforcement of laws	Imprudent monitoring and supervision on the part of banks, inadequacy of trained human resources and insufficient debt recovery appraises.

Research Method

The CAMEL model and the variables

CAMEL model is composed of five parameters -Capital Adequacy, Assets Quality, Management Efficiency, Earnings Ability and Liquidity Management. The model was first introduced in the US in 1979 as an internal supervisory tool to evaluate the performance of financial institutions on a uniform basis (Rahman & Islam, 2018). This is a quantitative rating system that is currently widely used even beyond the US. Bangladesh Bank has introduced CAMEL rating system in 1993 as performance analysis tool to identify financial institutions requiring special supervisory attention. Table 2 tallies the microeconomic determinants identified from literature with the five parameters of CAMEL model and presents the variables to be used in this study.

In CAMEL model, NPL is a sub-parameter of asset quality. In this research, we have used NPL as the dependent variable and other parameters and sub-parameters of the model as independent variables. Other relevant measures of asset quality like gross NPL ratio (GNPL), net NPL ratio (NNPL), required provision, and maintained provision are directly related to NPL. For example, the GNPL, NNPL, required provision, and maintained provision will increase when the NPL increases. Therefore, Only NPL has been used in this model. This is widely used in the BB disclosure statistics.

Table 2: Microeconomic determinants, CAMEL model and variables to be used

CAMEL Parameters	Corresponding microeconomic determinants	Reference	Variable used to measure the parameter in current research	Acronym
Capital Adequacy	Capital adequacy ratio	Jameel (2014); Bardhan & Mukharjee (2016); Waqas, Fatima, Khan & Arif (2017) and Salas & Saurina (2002)	Capital adequacy ratio = Tier 1 and Tier 2 Capital / risk weighted assets	RWA
Asset Quality	Loan loss reserve ratio	Messai & Jouini (2013)	Non-Performing Loan	NPL
	Credit to deposit ratio	Jameel (2014)		
Management Efficiency	Management efficiency	Zeng (2012); Waqas, Fatima, Khan & Arif (2017)	Expenditure income ratio = Total operating expenses/Total operating income	EIR
	Bad management	Bardhan & Mukharjee (2016); Berger & De Young (1997)		
	Imprudent risk managemetn	Haneef, Riaz, Ramzan et al. (2012), Adhikary (2007)		
Earnings	Profitability	Messai & Jouini (2013); Bardhan & Mukharjee (2016); Waqas, Fatima, Khan & Arif (2017)	Return on Asset = Net Income /Total Asset; Return on Equtiy = Net Income/ Total equity	ROA; ROE
	Net operating profit	Zheng, Bhowmik & Sarker (2020)		
Liquidity	Liquidity ratio	Zheng, Bhowmik & Sarker (2020)	Liquidityratio = short-term asset/ short-term liability	LR

The hypotheses

Based on the findings of past studies referred in the literature review section, following six hypotheses are formulated-

H_{o1}: RWA has no impact on NPL

H_{a1}: RWA has negative impact on NPL (Jameel, 2014; Bardhan & Mukharjee, 2016; Waqas, Fatima, Khan & Arif, 2017 and Salas & Saurina, 2002)

H_{o2}: EIR has no impact on NPL

H_{a2}: EIR has positive impact on NPL (Zeng, 2012; Waqas, Fatima, Khan & Arif, 2017; Bardhan & Mukharjee, 2016 and Haneef, Riaz, Ramzan et al., 2012)

H_{o3}: ROA has no impact on NPL

H_{a3}: ROA has negative impact on NPL (Messai & Jouini, 2013; Bardhan & Mukharjee, 2016; and Waqas, Fatima, Khan & Arif, 2017)

H_{o4}: ROE has no impact on NPL

H_{a4}: ROE has negative impact on NPL, (Messai & Jouini, 2013; Bardhan & Mukharjee, 2016; and Waqas, Fatima, Khan & Arif, 2017)

H_{o5}: LR has no impact on NPL

H_{a5}: LR has negative impact on NPL (Zheng, Bhowmik & Sarker, 2020)

Sources of data and analysis technique

Bangladesh Bank publishes annual report focusing on the macroeconomics where in chapter-5; the banking sector data is furnished. To accumulate data, the annual reports from 1997-1998 to 2019-2020 have been collected. In the report of 2019-2020, the data for 2020 has been furnished up to June 2020. From these reports we accumulated relevant data for the period of 1997-2020. These aggregate data over the 24-years period have been collected in descriptive fitting with CAMEL model. Stata-14 package has been used for data analysis.

Data analysis techniques and tools

Correlation has been run to check relationship between the variables. In time series analysis, the non-stationarity of the data may cause problem in the model specification. In this consideration, unit root test like Augmented Dickey Fuller

(ADF) and Philip-Perron (PP) unit root test have been performed for time series analysis for I(0). Before that lag length has been checked for each variable. The similar process has been done for I(1) variables. The ARDL bound test has been run to check the appropriate model whether ARDL or VEC model. The cointegration test has also been done for choosing whether VAR or VECM is the appropriate model. The post estimation of the model has been diagonize by serial correlation test, Lagrange-multiplier test, Jarque-Bera normality test and stability test.

The Results

To get the appropriate result, the econometric analysis has been done using Stata-14 package. First, the descriptive statistics about the NPL measures are presented then other results of the analysis has been done step by step.

Descriptive Statistics

Mean NPL over this 24-year period is BDT 390.10 billion. Minimum and Maximum value of NPL was BDT 173.32 billion and BDT 961.20 billion respectively. Standard deviation of NPL was BDT 266.57 billion. Mean, standard deviation, minimum and maximum value of RWA are respectively 9.46%, 1.92%, 6.60% and 12.10%. EIR ranged between 68.60% and 99.94% with a mean 84.35% and standard deviation of 9.69%. Mean ROA over this period is 0.71%. Minimum and Maximum value of ROA was 0.01% and 1.80% respectively. Standard deviation of ROA was 0.42%. Mean, standard deviation, minimum and maximum value of ROE are respectively 10.84%, 5.15%, 0.25% and 21.70%. LR ranged between 18.20% and 32.70% with a mean 24.43% and standard deviation of 3.52%. Table 3 presents these descriptive statistics.

Table 3: Descriptive Statistics of NPL, RWA, EIR, ROA, ROE, LR

Variables	Observation	Mean	Std. Dev.	Min	Max
NPL	24	390.095	266.5738	173.32	961.2
RWA	24	9.46625	1.92114	6.65	12.1
EIR	24	84.35375	9.69323	68.6	99.94
ROA	24	0.7058533	0.42096	0.01	1.8
ROE	24	10.84208	5.15318	0.25	21.7
LR	24	24.43292	3.52272	18.2	32.7

Correlation Analysis

Table 4 presents the correlation matrix of NPL to RWA, EIR, ROA, ROE and LR. NPL has high positive correlation with RWA, which is 0.68. This indicates that higher value of RWA results higher NPLs. EIR, ROA, ROE and LR shows negative correlation with NPL (values are -0.48, -0.25, -0.41 and -0.27 respectively) implying that higher EIR, ROA, ROE and LR results lower value of NPL.

Table 4: Correlation Matrix

Variables	NPL	RWA	EIR	ROA	ROE	LR
NPL	1.0000					
RWA	0.6825	1.0000				
EIR	-0.4750	-0.8397	1.0000			
ROA	-0.2517	0.3319	-0.6123	1.0000		
ROE	-0.4109	0.0887	-0.3705	0.8952	1.0000	
LR	-0.2786	-0.0493	0.0429	-0.0200	-0.1214	1.0000

But in the correlation matrix, it seems that there is multicollinearity among the independent variables. As EIR and ROA show high correlation (-0.8397 and 0.8952) with RWA and ROE respectively, EIR and ROA have been omitted to clean the multi-collinearity issue in the data set.

Unit Root Test

Spurious results generally occur in economic and financial time series data due to non-stationery property of the data. Therefore, unit root test is essential before conducting the analysis. To convert non-stationery data to stationery, the first difference of the data is created. When the data is at level zero it is called I(0) and first differential level is called I(1). There are various ways of testing the stationerity such as (a) Graphical- Two way graphical, and Autocorrelation Function (ACF) and Correlogram; (b) Unit Root Test - Augmented Dickey-Fuller (ADF) Test, and Phillips-Perron (PP) Test. In this time series analysis unit root tests namely, Augmented Dickey-Fuller (ADF) Test and Phillips-Perron (PP) Test have been used at levels zero and one. Before unit root test the lag length has been chosen from AIC (Akaike Information Criterion), SBIC (Schewarz Information Criterion). Table 5 & 6 show summary results of the stationerity tests for variables NPL, RWA, ROE and LR.

As presented in Table-5, t-stat of ADF and PP model is greater than the critical value at 1% (-4.38). The p-values in both cases are higher than 5% which refers all of the variables are non-stationery at level zero. Therefore, first difference of all variables is generated.

Table-6 shows that t-stat of ADF and PP model is less than the critical value at 1% (-4.38) and at 5% (3.60). The p-value in both cases are less than 5% which refers all of the variables are stationery at I(1).

Table 5: Stationerity test of the variables NPL, RWA, ROE and LR at I (0)

Variables	**Lag Criteria**	**ADF Test**		**PP**		**Decision for I(0)**
Decision criteria	If t-stat> critical value or P-value>5%, the data is non-stationery					
		t-stat	**p-value**	**t-stat**	**p-value**	
NPL	1(AIC)	-1.26*	89.58%	-1.14*	92.21%	Non-stationery
RWA	1 (SBIC)	-2.76*	21.09%	-3.63*	2.74%	Non-stationery
ROE	1 (AIC)	-1.72*	73.82%	-2.25*	46.46%	Non-stationery
LR	2 (SBIC)	-1.57*	80.38%	-1.92*	64.75%	Non-stationery
* Statistical significance at 1%						

Table 6: Stationerity test of the variables NPL, RWA, ROE and LR at I (1)

Variables	**Lag Criteria**	**ADF Test**		**PP**		**Decision for I(1)**
Decision criteria	If t-stat> critical value or P-value>5%, the data is non-stationery					
		t-stat	**p-value**	**t-stat**	**p-value**	
NPL	1(AIC)	-3.56**	3.29%	-5.28*	0.001%	Stationery
RWA	1(AIC)	-3.51**	3.74%	-6.77*	0.0001%	Stationery
ROE	1(AIC)	-4.27*	3.50%	-6.77*	0.0001%	Stationery
LR	1(AIC)	-5.13*	0.001%	-7.44*	0.0001%	Stationery
* Statistical significance at 1% ** Statistical significance at 5%						

ARDL Bound Test

Autoregressive Distributed Lag (ARDL) method and ARDL Bounds test were developed by Pesaran et al. (2001). ARDL bound test procedure is the tool in estimation of level relationship irrespective of the time series being I(0) and/or I(1) but not I(2) cointegration. From the bound test, the presence of cointegration of the variables can also be decided. Actually, bound test is the extension of ARDL model using F and t-statistics to test the significance of the lagged levels of variables in an univariate equilibrium correction system which also examine short and long run association between variables. If there is short run association, ARDL regression model is used and if there is long run association ECM (Error Correction Model) is used. Table-7 shows ARDL bound test results.

Table 7: ARDL bound test results

Pesaran/Shin/Smith (2001) ARDL Bounds Test

H0= no levels relationship

F= 36.979
t=-11.009

Critical Values (0.1-0.01), **F-Statistics**, case 3

	[I_0] L_1	[I_1] L_1	[I_0] L_05	[I_1] L_05	[I_0] L_025	[I_1] L_025	[I_0] L_01	[I_1] L_01
k_3	2.72	3.77	3.23	4.35	3.69	4.89	4.29	5.69

accept if f< critical value for i(0) regressor
reject if F> critical value for I(1) regressor

Critical Values (0.1-0.01), **t-Statistics**, case 3

	[I_0] L_1	[I_1] L_1	[I_0] L_05	[I_1] L_05	[I_0] L_025	[I_1] L_025	[I_0] L_01	[I_1] L_01
k_3	-2.57	-3.46	-2.86	-3.78	-3.13	-4.05	-3.43	-4.37

accept if t>critical value for i(0) regressor
reject if t< critical value for I(1) regressor

k:# of non-deterministic regressor in long-run relationship
Critical values from Pesaran/Shin/Smith (2001)

From Table-7, it is observed that all the I_0s are less than F which refers that ECM will be the appropriate model for the given time series data. Moreover, the adjusted coefficients in the adjustment panel of the ARDL bound test are negative and statically significant which dictates the use of ECM model.

Johansen Tests for Cointegration

Spurious correlation occurs when two or more variables are associated in the time series due to either a coincident or unknown third factor. Cointegration technique is used to find possible correlation between time series variables in the long run (Engle R & Granger C, 1987). The Johansen's test is widely used for cointegration test which has two main forms namely trace test and maximum eigenvalue test. When trace statistics is less than the critical value at rank zero, there is no cointegration. Trace statistics less than the critical value at rank more than zero signifies cointegration. In econometric analysis, the Vector Autoregression (VAR) model is used when there is no cointegration and Vector Error Correction Model (VECM) used when there is cointegration. Table-8 shows the results of Johansen's co-integration test.

Table 8: Cointegration Test Result

Maximum rank	Params	LL	Eigenvalue	Trace statistics	5% critical value
0	36	9.2287421	.	76.8796	47.21
1	43	27.183619	0.83395	40.9699	29.68
2	48	41.729183	0.76650	11.8787*	15.41
3	51	45.872049	0.33919	3.5930	3.76
4	52	47.668547	0.16444		

The trace statistics is less than the critical value only at rank 2 (Table 8). That means there is co-integration in the data set. Hence, VECM model is applicable.

Lag Selection

Appropriate lag choosing is very important for VECM model. We can use information criteria (IC) for lag selection. Table-9 shows the co-integration lag selection criteria for the VECM model.

Table 9: VECM Lag Order Selection Criteria

lag	LL	LR	df	P	FPE	AIC	HQIC	SBIC
0	-9.92689				0.000047*	1.39269	1.43156	1.59183*
1	1.88701	23.628	16	0.098	0.000075	1.8113	2.00568	2.80703
2	17.1477	30.521	16	0.015	0.000102	1.88523	2.23511	3.67755
3	47.6685	61.042*	16	0.000	0.000049	0.433145*	0.938527*	3.02205
Endogenous: dnpl, draw, droe, dlr Exogenous: _cons								

LR (Sequential modified LR test statistic), AIC (Akaike Information Criterion), HQIC (Hannan-Quinn Information Criterion) values in Table 9 suggest that appropriate length of lag should be 3 for this study.

VECM Estimates

Finally, VECM estimation is done by using time series data for the period of 1997-2020. The number of co-integration equation is 2 (from the Johansen tests for cointegration) and maximum lag used 3 for the VECM model. The results of the VECM model are shown in Table10. The R Square of NPL, RWA and LR are significant, but ROE is not significant in Table 10. Based on the p-values (less than 0.05), it is evident that RAW and LR have significant impact on NPL but ROE's influence on NPL is not significant. The lagged values of RWA and LR have significant effect on NPL. Both the lagged coefficient of the RAW is negative, which indicate negative association with NPL. Both the lagged coefficients of LR are positive. Hence LR has positive

Table 10: VECM Results

Sample: 2000-2020 Number of obs = 2

AIC = -.4887502

Log likelihood = 53.13188 HQIC = .029394

Det (Sigma_ml) = 7.46e-08 SBIC = 1.89873

Equation	Parms	RMSE	R-Sq	chi2	p>chi2
D_npl	11	.08149	0.8817	67.05859	0.0000
D_rwa	11	.79094	0.7847	32.79963	0.0006
D_roe	11	4.9158	0.5350	10.35601	0.4987
D_lr	11	.01185	0.6977	20.77569	0.0358

	Coef.	STD. Err.	z	p>z	[95% Conf.	Interval]

D_npl	_ce1						
	L1.	-.9864328	.2431153	-4.06	0.000	-1.46293	-.5099355
	_ce2						
	L1.	-0.073883	0.0414203	1.78	0.074	-0.0072994	.1550654
	npl						
	LD.	.9717099	.3407689	2.85	0.004	.3038151	1.639605
	L2D	.609762	.4124839	1.48	0.139	-1.986908	1.418216
	rwa						
	LD.	-.0876988	0.0280612	-3.13	0.002	-.1426978	-.0326999
	L2D	-.1336509	0.0226139	-5.91	0.000	-.1779734	-0.0893285
	roe						
	LD.	.0082166	.0099665	.82	0.410	-.0113173	.0277506
	L2D	-.0005369	.0066528	-0.08	0.936	-.0135761	.0125023
	lr						
	LD.	16.55534	3.971173	4.17	0.000	8.771985	24.3387
	L2D	12.66204	4.293746	2.95	0.003	4.246446	21.007762
	_cons	.1265218	.0270934	4.67	0.000	.0734197	.179624

Cointegration equations

Equation	Params	chi2	p>chi2
_ce1	2	601.1008	0.0000
_ce2	2	276.2692	0.0000

association with NPL. However, the lagged values of the ROE do not show statistically significant relation with NPL. In the model, the p-value of cointegration equations is also statistically significant. The result of the model attributed that RWA and LR have long run relationship with NPL. High NPL will adversely affect RWA and LR.

As evident from Table 10 coefficient ce_1 is negative and statistically significant (p-value <0.05). Therefore, it can be concluded that there is long run causality between the dependent and independent variables. The results of short run causality test as presented in Table 11 indicate that there are short run causalities in the independent variables individually and altogether.

Table 11: Short- run causality Test

Variables	prob>chi^2	Decision Criteria
NPL	2.70%	Positive value(s) of the variable(s) signifies short run causality running from the independent variables.
RWA	23.96%	
ROE	79.31%	
LR	2.06%	
Altogether	0.00001%	

VECM Model Diagnostic

VECM model was diagnosed (details in appendix). From the Lagrange-multiplier test it is observed that the p-value is greater than 5% which imply no serial correlation in the model. From the Jarque-Bera normality test, all the p-values are found to be greater than 5%, which refers that the model is normally distributed. In the Eigenvalue stability condition, the VECM specification imposes 2-unit moduli.

ANALYSIS OF RESULTS

Form the correlation analysis it is found that EIR and ROA have multicollinearity issue, thus EIR and ROA are omitted from our model. Hence, we cannot test the null hypotheses H_{o2} and H_{o3}.

For the rest of the variables, there is long term relationship between the variables as evident from the ARDL bound test. From the results of ARDL bound test and Johansen co-integration test it has been determined that the VECM model is applicable for the data set of this study. Correlation analysis indicates a positive relationship between NPL and RWA, but the VECM model indicate that the relationship is negative. The wrong correlation result is perhaps due to prevailing co-integration between the variables. Hence, we can reject H_{01} and accept the H_{a1}. The negative and significant result has also been observed by Jameel, 2014; Bardhan & Mukharjee, 2016; Waqas, Fatima, Khan & Arif, 2017 and Salas & Saurina, 2002.

VECM results also indicate that the null hypotheses H_{04} cannot be rejected. That means there is no significance relationship between NPL and ROE. This result contradicts the result of Messai & Jouini, 2013; Bardhan & Mukharjee, 2016; and Waqas, Fatima, Khan & Arif, 2017. Such a result may be associated with the

performance measures used to reward/ punish the bankers. Bankers in Bangladesh often get bonus based on income and profitability. On the other hand, the issue of NPL is handled at policy level. Any abnormal rise in NPL triggers policy and regulatory intervention from the government (Adhikari, 2007 and Rahman, Asaduzzaman & Hossain, 2017). Few banks have gone under water to date due to rising NPL. In most of the dire situations the central bank has come up with bail-out interventions. Hence, managers focus heavily on profitability and liquidity and often side-track the problem of NPL.

However, the null hypothesis H_{o5} is rejected. Significant positive association is found between NPL and LR. This result contradicts the result of Zheng, Bhowmik& Sarker, 2020. This can be explained by the fact that any liquidity problem exerts huge strain on operations of banks, hence managers are held accountable for maintaining liquidity position. Thereby, despite high level of NPL, bankers manage to maintain high liquidity by holding higher level of current asset.

Finally, in the VECM model, the lagged values of risk weighted asset and liquidity ratio have significant effect on NPL. Both the lagged coefficient of the risk weighted asset is expectedly negatively associated with NPL. The lagged values of the return on equity are also not statistically significant. Both the lagged coefficients of the liquidity ratio are positively associated with NPL. The result of the model attributed that the higher NPL adversely affects the risk weighted asset and liquidity ratio. As the coefficient of ce1 is negative and statistically significant, there is long run causality between NPL and the other independent variables. The post estimation test of short run causality refers that all the variables individually and combined has the short run causality running to the NPL to independent variables. Therefore, there are both long-run and short causality between NPL and risk weighted asset, return on equity and liquidity ratio. The LM test of autocorrelation results that the p-value is higher than the 5% infers there is no autocorrelation in the model. The normality test results the p-value is higher than 5% refers the model is normally distributed. Eigenvalue stability condition of the VECM specification imposes 2-unit moduli.

Conclusion

With an ambition to identify the relationship of NPLs with the other variables of CAMEL model of the commercial banks in Bangladesh, the study has developed models of the VECM. The model is found to be statistically significant and strong enough to explain. The CAMEL model used here, is widely used for operational

and regulatory reporting practices (Matthew & Laryea, 2012; Ifeacho & Ngalawa, 2014 and Rahman & Islam, 2018). The measures of CAMEL parameters are readily available to practitioners and regulators. Hence, the VECM model developed from this research can be used as handy models by bankers' and regulators to pinpoint areas of improvement as such to reduce NPL and its relevant measures. Future researchers may use of bank-wise panel data rather than aggregate data of the whole banking sector may provide more generalizable results. Although the VECM model developed in this research demonstrate high explanatory power (stated before), this research has left out the macroeconomic variables and other bank specific variables from analysis. But there is evidence in literature that NPL ratios are affected by these variables. Incorporation of these variables along with the CAMEL parameters used in this research is likely to provide more comprehensive view of the determinants of NPL. Box-Jenkins (BJ) methodology (Box and Jenkins, 1970) of Autoregressive Integrated Moving Average (ARIMA) model can also be used for forecasting the values of the variables.

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APPENDICES

Appendix 1: Serial Correlation Test

Lagrange-multiplier test for autocorrelation test. Where-

H0: no autocorrelation at lag order

H1: Autocorrelation at lag order

Table 12: Lagrange-multiplier test

Lag	chi2	df	Prob>chi2
1	9.3105	16	0.90008
2	13.5962	16	0.62877

Appendix 2: Normality Test

Jarque-Bera test for the normality test. Where

H0: The model is not normally distributed

H1: The model is normally distributed

Table 13: Jarque-Bera test

Equation	chi2	df	Prob>chi2
D_npl	0.334	2	0.84601
D_rwa	2.375	2	0.30496
D-roe	0.622	2	0.73280
D_lr	0.682	2	0.71099
All	4.014	2	0.85590

Appendix 3: Stability condition of VEC estimates

Table 14: Eigenvalue stability condition

Eigenvalue		Modulus
1		1
1		1
.2144708	+.9148722i	.939675
.2144708	- .9148722i	.939675
.7479989	+.2490559i	.788372
.7479989	-.2490559i	.788372
-.6731665	+.2473007i	.717155
-.6731665	-.2473007i	.717155
-.3714762	+.6055182i	.710385
-.3714762	-.6055182i	.710385
-.2316001	+.312631i	.389072
-.231600	+.312631	.389072

The VECM specification imposes 2unit moduli.