IOSR Journal of Economics and Finance (IOSR-JEF)
e-ISSN: 2321-5933, p-ISSN: 2321-5925.Volume 8, Issue 5 Ver. III (Sep.- Oct .2017), PP 01-07
www.iosrjournals.org

Empirical Analysis of Liquidity-adjusted Capital Asset Pricing Model in the Banking Sector of Dhaka Stock Exchange

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Abstract: *This study endeavors to provide an empirical evidence of comparatively new model of asset pricing named Liquidity-adjusted Capital Asset Pricing Model. Testing five years data from 2011 to 2015 of the banking sector of Dhaka Stock Exchange this study reveals that the explaining variables of LCAPM has failed to explain the return of the banking sector thus it has been concluded that this new model is not good enough to analyze the pricing of assets in DSE. Finally, considering some limitations of this analysis it is expected to be useful for future researchers as it is supposed to provide new evidence regarding the asset pricing tools of DSE.*
Keywords: *BLUE, LCAPM, liquidity, market return, trading volume.*

Date of Submission: 21-08-2017 Date of acceptance: 14-10-2017

I. Objectives Of The Study And Research Goal

This study provides the empirical evidence from Bangladesh stock market by examining how well the Liquidity-adjusted Capital Asset Pricing Model (LCAPM) work to quantify the risk and return relationship in the banking sector of Dhaka Stock Exchange (DSE). LCAPM as proposed by Acharya and Pedersen (2005) [1] as well as by Liu (2006) [2] represent a new research direction of asset pricing. Existing studies show that well known models of asset pricing cannot explain expected return whilst LCAPM provides satisfactory explanation for expected return (Acharya and Pedersen, 2005 [1]; Liu, 2006 [2]; Tam, 2007 [3]). In this backdrop, this study is expected to provide some additional insights into the risk-return relationship for the selected DSE shares. So far as I know this is the first attempt in Bangladesh to analyze the model of LCAPM in order to identify the effectiveness of this asset pricing model for analyzing DSE instruments. Specific research goal of the study is as follows:

1. Whether the model of LCAPM is successful for analyzing the banking sector of Bangladesh stock market?

II. Literature Review And Needs Assessment Of Present Study

The basic intuition of this study is to provide empirical evidence to LCAPM proposition base on the DSE data of the banking sector. Tam (2007) [3] provides a review and comparison of three models for asset pricing including classic CAPM, Fama-French (FF) Three-Factor Model and Liquidity-adjusted CAPM using UK stock market data. His research shows that existing models such as CAPM and FF model cannot effectively explain the abnormal returns in the modern market where newly proposed model LCAMP by Acharya and Pedersen (2005) [1]; Liu (2006) [2] attempt to challenge the old ones claiming that it can provide better explanation. The evidence on the applicability of CAPM and FF in DSE is not conclusive (see, for example, Rahman *et al.*, 2006 [4]; Mollik and Bepari, 2011 [5]; Azam and Ilyas, 2011 [6]; Hasan *et al.* 2011 [7]; Chowdhury and Sharmin, 2013 [8], Alam *et al.* 2014 [9]; Sayeed *et al.* 2014 [10]). Therefore, this research examines the emerging role of LCAPM in the context of the applicability of new asset pricing model in DSE considering the banking sector. For the economic development of a country stock market plays an important role. While investment being a vital variable for development, stock market's contribution as a prime source of financing cannot be ignored. This study has particular relevance with the economic development of the nation because the government efforts to develop the market. The stock market crashes of 1996 and 2011 in Bangladesh indicate that there exist much indiscretions regarding asset pricing of stock market. Present scenario of the stock market is also not satisfactory. The participants of the stock market, e.g. general investors, institutional investors and fund managers may get benefited using the findings of the study. Most of the participants are seemed to vacillate between hope and fear regarding investment for lack of knowledge. Usually the investors from developing countries like Bangladesh manage their portfolios and evaluate their assets using single factor model (CAPM). Empirical evidence from this study is expected to help investors to choose the best asset pricing model in making investment decision. Thus, it will be of great advantage to the nation by

contributing to knowledge about asset pricing model and by providing more accurate solutions to help reduce the investment risk levels in DSE.

II. Methodology

In order to achieve the stated objective, the study adopted a methodology of two-stage regressions which is suggested by Fama and MacBeth (1973) [11]. The first stage is a series of time series regression for all sample shares to estimate the beta(s) of each factor. The process of data rearrangement, calculation and analysis has been done using Excel spreadsheet and STATA.

The first stage regression equation for LCAPM is as follows:

$$R_{i,t} - R_{f,t} = \alpha_{i,t} + \beta_i \left(R_{m,t} - R_{f,t}\right) + \lambda_i Liq + \varepsilon_{i,t} \qquad i = 1,2,...,n, \;\; t = 1,2,...,60 \qquad (1)$$

Where subscript *t* indicates in t^{th} month and *i* indicates different stocks of banks; $R_{i,t}$ is the monthly return of stock *i*; $R_{f,t}$ is the risk free rate; $R_{m,t}$ is the market monthly return; $\beta_{i,t}$ is the coefficient to be estimated by regression; Liq is the factor that captures stock's liquidity risk; λ_i is the estimated coefficient; $\varepsilon_{i,t}$ is the residual term and $\alpha_{i,t}$ is the constant.

Here, monthly share return of each Bank ($R_{i,t}$) has been calculated according to the following equation:

$$R_{i,t} = \frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}} \qquad (2)$$

Where,
$R_{i,t}$ = return on share i on t^{th} month
$P_{i,t}$ = price of share i on t^{th} month
$P_{i,t-1}$ = price of share i on day t^{th}-1 month

The market return ($R_{m,t}$) is calculated by the following equation:

$$R_{m,t} = \frac{Index_t - Index_{t-1}}{Index_{t-1}} \qquad (3)$$

Where, Index is the DSE market Index at the end of t^{th} month

Another variable Liq is the variable that measures liquidity risk of holding a definite stock's and λ_i is the estimated coefficient. However, the LCAPM used in the proposed study is a slight deviation from the Acharyarya and Pedersen's (2005) [1], Liu's (2006) [2], and Tam's (2007) [3] models in the way that the liquidity factor is measured in a relatively less sophisticated way due to difficulty in finding data. For convenient sake liq in this paper is constructed as proxies for liquidity risk by following the share turnover of each bank.

$$liq = \frac{total\ monthly\ trading\ volumes}{average\ number\ of\ shares\ outstanding} \qquad (4)$$

To certain extent, trading volumes can reflect liquidity risk. Those stocks with less trading volumes imply that they are relatively difficult to be sold and thus indicate high liquidity risk. In contrary, those stocks with more trading volumes imply that they relatively easy to be sold and thus indicate low liquidity risk. However, the absolute value of trading volumes needs to be adjusted by number of outstanding shares to standardize the measure. The adjustment is necessary since low absolute trading volumes can still has low liquidity risk if the outstanding shares are also few.

The second stage is the following cross sectional regression on the betas and variance of residuals across all the banks enlisted in DSE from the previous regression:

$$Avg(R_i) = \gamma_0 + \gamma_1 \beta_i + \gamma_2 \lambda_i + \gamma_3 \,\mathrm{var}(\varepsilon_i) + \mu_i \qquad (5)$$

The hypotheses for testing LCAMP established following Tam (2007) as,

H1: $\gamma_0 = R_f$
H2: $\gamma_1 > 0$
H3: $\gamma_2 \neq 0$

H4: $\gamma_3=0$

LCAPM is valid if four conditions are met. First, the constant term equals risk free rate. Second, the coefficient of beta relating to market factor is greater than zero. Third, the coefficient of beta relating to liquidity factor is different from zero. Fourth, the coefficient of variance of residual equals zero.

The robustness of the model has been determined by the coefficients, significance level and overall model fit. This methodology examines the significance of the factors suggested by this model. Furthermore, in the study these following standards in the Table 1 for a BLUE (Best Linear Unbiased Estimation) regression have also been considered as Tam (2007) [3] followed.

Table 1: Detection of regression error

Problem	Test	Statistics	Condition
Multicollinearity	Correlation matrix	1/VIF	>0.1
Heteroscedasticity	Breusch-Pagan	Prob > Chi2	>0.05
Autocorrelation	Durbin-Watson	Durbin-Watson d-statistic	Close to 2

III. Data Collection

The data used in this has been collected mainly from DSE library except the Treasury bill rate which collected from the Bangladesh Bank. Sample selection is a tough job in developing stock market like Bangladesh where lot of anomalies and irregularities exists. However, the banking sector of DSE is chosen in this study because it is the main and country's oldest stock exchange of Bangladesh where of banking sector has a distinctive contribution in the market capitalization. Monthly stock prices of all banks listed in DSE for the period 2011 to 2015 has been included in the analysis. This study has selected 60 months as an estimation period because many studies (see, for example, Fama and French, 1996 [12]) use an estimation period of 60 months when employing monthly returns. Therefore, there are in total 60 (12 months x 5 years) time series observations. Monthly data used in this analysis because the daily data, though better for estimating risk-return relationship, is very noisy (Basu and Chawla, 2010 [13]). The All Share Price Index (DSI) and DSE Board Index (DSEX) are used as a proxy for the market portfolio. DSI and DSEX are a market value weighted index which is comprised of all listed companies of the exchange and reflects general trends of the Bangladesh stock market. Furthermore, cut off yield of Bangladesh government 91 days T-bill has been used as the proxy for the risk-free asset.

IV. Data Analysis And Results Interpretation

Following the first stage regression, base on the time series data of respective banks, the coefficients of each explaining variable has been estimated (Appendix I). For better analysis of result, the first stage regression model is recalled as below.

$$R_{i,t} - R_{f,t} = \alpha_{i,t} + \beta_i\left(R_{m,t} - R_{f,t}\right) + \lambda_i Liq + \varepsilon_{i,t} \qquad i = 1,2,\ldots,n, \;\; t = 1,2,\ldots,60 \qquad (1)$$

Main statistics of first stage regression has been presented in Table 2. From this analysis it can be said that the market return is a significant variable to explain the individual return of banks because the coefficients of market return β_i has a *p*-value of less than 0.05 which indicates that market return significantly positively influence the share prices of banks listed in DSE. The coefficient of liquidity λ_i has a *p*-value of 0.4295 which indicates that the variable liquidity is not significant to explain the return of banking sector. The value of R-square of this model is 0.3989 which indicates that there are many other determinants without market return and liquidity those can explain the return of banks and this model has failed to capture these determinants.

Table 2: Main statistics of 1st stage regression of LCAPM

	β_i	*P*-value	λ_i	*P*-value	R-square
Mean	0.7079	0.0049	0.6095	0.4295	0.3989
Median	0.7477	0.0000	0.1804	0.4929	0.3855
Stan Dev	0.3332	0.0236	1.3806	0.3414	0.1665
Max	1.1334	0.1295	6.0801	0.9580	0.6736
Min	-0.6985	0.0000	-1.2323	0.0000	0.0931

Two charts in Fig.1 and Fig. 2 given below shows the distribution of coefficients of market return (β_i) and liquidity (λ_i) for series of the banks respectively.

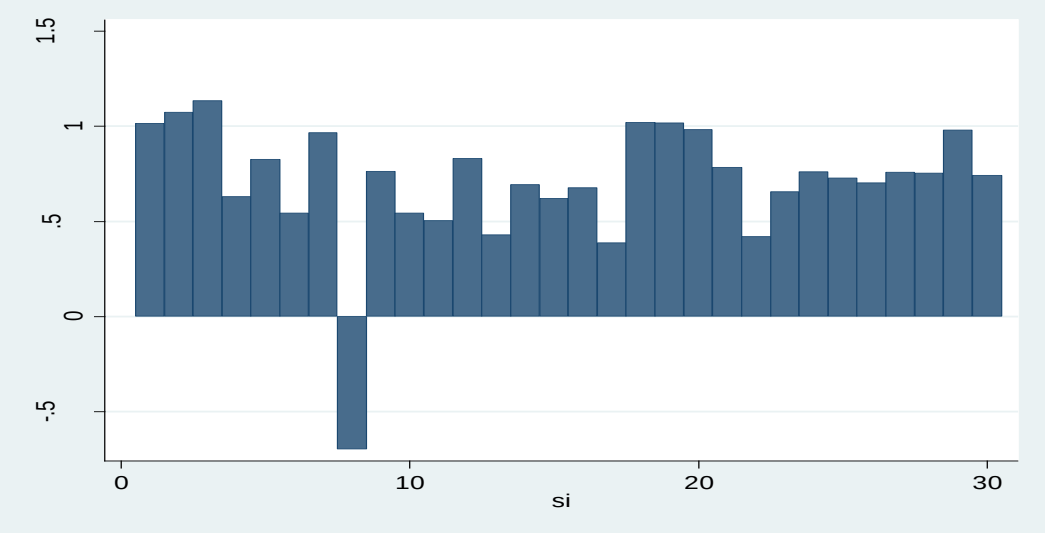

Figure 1: distribution of β_i

From Fig. 1 it can be said that most of the values of coefficient of market return are positive except one value. From Fig. 2 it can be said that most of the values of coefficient of liquidity are also positive but in this case nine values are negative. Negative values means that these values are negatively influencing the return of individual share.

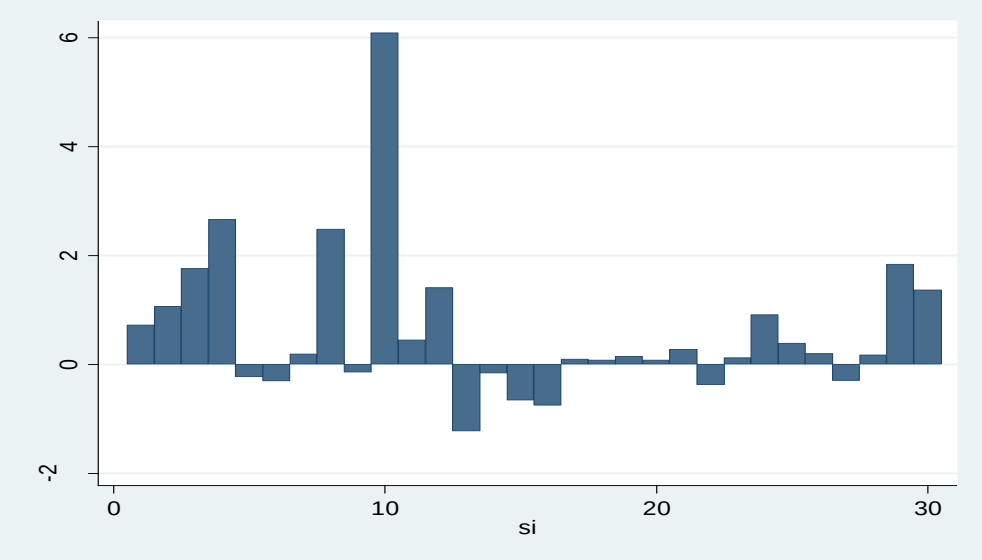

Figure 2: distribution of λ_i

Detection of regression error is very important to see the robustness of the model. According to the standards of Table 1, heteroskedasticity and autocorrelation tests has been done for first stage regression and the results of these tests has been expressed in Table 3. From the Table 3 it can be concluded that there is no problem of heteroskedasticity as well as autocorrelation. Therefore the result of first stage regression is acceptable.

Table 3: Heteroskedasticity and Autocorrelation tests result of 1st stage regression

	Mean	Median	Standard deviation
Durbin-Watson d-statistic	1.951323	1.952012	0.256824
Prob>chi2 (Breusch-Pagan test)	0.233674	0.071148	0.303378

In the Table 4 the summery of second stage regression output has been shown. The second stage is simply a cross sectional regression of the coefficients estimated in the first stage. The second stage regression model is recalled as below.

$$Avg(R_i) = \gamma_0 + \gamma_1\beta_i + \gamma_2\lambda_i + \gamma_3 \text{ var}(\varepsilon_i) + \mu_i \quad (5)$$

Table 4 shows that R square of the model is 0.3925 which means that explaining variables of this model can explain about 39 percent of return of banks on average. Although the explaining variable of λ_i is positive but it has a *p*-value of 0.235 which is greater than 0.05 on the contrary, the *p*-value of negative β_i is 0.007 which is less than 0.05. This express that the explaining variable β_i negatively but significantly influencing the average return where the positive influence of explaining variable of λ_i is not significant. The coefficient of Variance of error terms and the constant term are not also significant in the model since its coefficients are negative with high *p*-value of 0.574 and 0.927 respectively.

Table 4: Result of 2nd stage regression of LCAPM

Number of obs	F(3, 26)	Prob> F	R-squared	Adj R-squared	Root MSE
30	5.6	0.0042	0.3925	0.3224	0.00873

	Coef.	Std. Err.	T	P>|t|	[95% Conf.Interval]	
β_i	-0.02006	0.006848	-2.93	0.007	-0.03413	-0.00598
λ_i	0.002939	0.002417	1.22	0.235	-0.00203	0.007907
var(ε_i)	-0.4263	0.748896	-0.57	0.574	-1.96568	1.113079
_cons	-0.00115	0.012335	-0.09	0.927	-0.0265	0.024207

In the Table 5 the result of hypotheses test of LCAPM model has been shown. The coefficient of the constant term in the regression model is not equal to risk free rate. The first hypothesis therefore should be rejected. The coefficient of β_i is negative rather being positive thus the second hypothesis is also rejected. The coefficient of λ_i is greater than zero therefore the third hypothesis is not rejected. Finally the coefficient of Variance of error terms is less than zero and it is rejected.

Table 5: Result of Hypotheses

		Hypotheses	Empirical results	Result
H1	γ_0	≈ 0.078765	-0.00115	×
H2	γ_1	>0	<0	×
H3	γ_2	≠0	>0	√
H4	γ_3	=0	<0	×

The VIF table and correlation matrix shown in the Table 6 and Table 7 confirm that the test is multicollinearity free.

Table 6: VIF table of 2nd stage regression

Variable	VIF	1/VIF
β_i	1.98	0.504919
λ_i	4.24	0.236108
var(ε_i)	5.69	0.175664

Table 7: Correlation matrix of 2nd stage regression

	β_i	λ_i	var(ε_i)	Average Return
β_i	1.0000			
λ_i	-0.1488	1.0000		
var(ε_i)	-0.5220	0.8123	1.0000	
Average Return	-0.5786	0.3076	0.4320	1.0000

From the Table 8 it can be concluded that there is no problem of heteroskedasticity since the statistics in the Breusch-Pagan test is greater than its standard value of 0.05. Furthermore, since the series of data of second stage regression model is no longer in time series hence the test of autocorrelation is avoided.

Table 8: Result of Breusch-Pagan test of 2nd stage regression

Chi2(1)	=	0.22
Prob> chi2	=	0.6408

Following the summary of the test result it can be seen that LCAPM passes only 1 out of 4 hypotheses which highlight poor robustness of the model.

V. Conclusion

There are many debates regarding the robustness of different models for asset pricing. The arguments are difficult to justify because results of empirical tests may vary from different times, markets and methodologies. As LCAMP has better explanatory power (Acharya and Pedersen, 2005 [1]; Liu, 2006 [2]; Tam, 2007 [3]), it is expected that this study will provide additional insight into the issue. Because this study contributes to literature by providing up-to-date empirical evidence on LCAPM considering the data of banks listed in the stock market of Bangladesh. In this study LCAPM is rejected because the coefficients of explaining variables of LCAPM model hardly can explain the return of the banks and this model has failed to support most of the hypotheses. But, the development of LCAPM is still in the beginning stage. The future of LCAPM can be bright when more and more empirical tests are presented to support it (Tam, 2007 [3]). Furthermore, given the relatively small sample size, only banking sector of DSE, the results should be interpreted with caution in case of getting idea regarding the whole stock market of DSE even regarding Bangladesh as well because in this study the data of another stock market of Bangladesh CSE (Chittagong Stock Exchange) has not been considered. Future research therefore might be required to analyze a broader sample size in order to provide more comprehensive evidence.

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APPENDIX I: RESULT OF 1ST STAGE REGRESSION

Banks	Beta	*p*-value	b_liq	*p*-value	Std	R2
1	1.014354	0.0000	0.721574	0.1454	0.011372	0.547582
2	1.07373	0.0000	1.063789	0.0150	0.011968	0.597518
3	1.133352	0.0000	1.75411	0.0009	0.01349	0.661271
4	0.629172	0.0000	2.655103	0.0013	0.014468	0.399268
5	0.826116	0.0000	-0.22152	0.7576	0.010955	0.312525
6	0.542435	0.0005	-0.31074	0.7384	0.011254	0.19406
7	0.965972	0.0000	0.186191	0.9484	0.011072	0.504598
8	-0.69848	0.1295	2.478392	0.0453	0.027355	0.093141
9	0.763918	0.0000	-0.14099	0.8146	0.010832	0.357922

10	0.543975	0.0000	6.080055	0.0037	0.034911	0.389073
11	0.503529	0.0020	0.448254	0.6767	0.010944	0.156231
12	0.830606	0.0000	1.406367	0.0135	0.011529	0.515363
13	0.429005	0.0055	-1.23232	0.1542	0.013385	0.15702
14	0.693085	0.0000	-0.15409	0.6813	0.010846	0.36452
15	0.620596	0.0000	-0.65954	0.4569	0.011552	0.28147
16	0.675798	0.0000	-0.7467	0.2247	0.01162	0.40744
17	0.386543	0.0019	0.088915	0.6630	0.011516	0.158589
18	1.018792	0.0000	0.07346	0.9580	0.011311	0.568672
19	1.017335	0.0000	0.143639	0.7633	0.011283	0.548767
20	0.983207	0.0000	0.07599	0.8037	0.011167	0.673638
21	0.784697	0.0000	0.276887	0.2571	0.010652	0.346302
22	0.420818	0.0070	-0.37814	0.7292	0.011786	0.121804
23	0.655186	0.0000	0.119652	0.6948	0.010703	0.33738
24	0.761752	0.0000	0.906291	0.1351	0.010836	0.53733
25	0.727613	0.0000	0.382043	0.2907	0.010613	0.450845
26	0.701493	0.0000	0.197838	0.6950	0.010643	0.351818
27	0.757603	0.0000	-0.30048	0.5289	0.010974	0.36432
28	0.753625	0.0000	0.174531	0.6857	0.010654	0.381904
29	0.979476	0.0000	1.834524	0.0012	0.012831	0.556151
30	0.741694	0.0000	1.362572	0.0000	0.01134	0.629662

APPENDIX II: BANKS LISTED IN DSE

1. AB Bank Limited
2. City Bank Limited
3. International Finance Investment And Commerce Bank Limited
4. Islami Bank Limited
5. National Bank Limited
6. Pubali Bank Limited
7. Rupali Bank Limited
8. United Commercial Bank Limited
9. Uttara Bank Limited
10. ICB Islamic Bank Limited
11. Eastern Bank Limited
12. Al-Arafah Islami Bank Limited
13. Prime Bank Limited
14. Southeast Bank Limited
15. Dhaka Bank Limited
16. National Credit And Commerce Bank Limited
17. Social Investment Bank Limited
18. Dutch-Bangla Bank Limited
19. Mutual Trust Bank Limited
20. Standard Bank Limited
21. One Bank Limited
22. Bank Asia Limited
23. Mercantile Bank Limited
24. Exim Bank Limited
25. Jamuna Bank Limited
26. Brac Bank Limited
27. Shahjalal Islami Bank Limited
28. Premier Bank Limited
29. Trust Bank Limited
30. First Security Islami Bank Limited

Monty Adittya. “Empirical Analysis of Liquidity-Adjusted Capital Asset Pricing Model in the Banking Sector of Dhaka Stock Exchange.” IOSR Journal of Economics and Finance (IOSR-JEF) , vol. 8, no. 5, 2017, pp. 01–07.