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High Liquidity or Low Liquidity Is Better to Achieve High Profitability? Evidence from Banks in Central and Southern Europa

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Abstract

This work investigated the impact of the bank's liquidity management in the profitability of the bank, considering the fact that different research has found that their relationship is negative in some other positive research. The relationship between these two components depends on the variables used to measure them. In this study are included commercial banks operating in southern and central Europe for the period 2009-2017. Following the study, it was possible to determine which is the optimal level of liquidity that gives us the highest level of profitability, and the results showed that not necessarily the high-level liquidity banks can achieve high-level profitability. The data had non-normal distribution, so as a technique of analysis non-parametric tests were used.

Keywords: bank liquidity, optimum, profitability, relationship, ROE, Equity, Cash ratio, Debt equity ratio

1. Introduction

This study studies the relationship between liquidity and bank profitability in the South East Europe region. Both of these factors are very important for every financial institution as indicators indicating the diagnosis of any business whether it is healthy or not. This type of mechanism Intertwined has a parallel movement, any business that wants to maximize the profit of the shareholders (Patnaik & Patnaik, M. 2005) considering not only investment but also financing and dividends, with the aim of optimizing of earnings (Bordeleau & Graham, 2010), definitely on the other hand should manage its liquidity or ability to pay short-term liabilities (Salim & Bilal 2016; Saleem & Rehman 2011). Prudent liquidity management is vital to business operations by keeping it in the right settings between the two extreme edges. When excessive liquidity means fund accumulation and low profitability, insufficient liquidity or less than 1 indicates a lack of ability bankers to pay debts in the short term (Amengor, 2010) (Morrel, 2007). Often, liquidity management, though important to businesses, is misunderstood and overlooked, so it is very important to understand the nature and impact of liquidity in business profitability (Fuertes et al., 2009).Various studies show that there is a link between liquidity and profitability. This study seeks to find out how this relationship is in the central and south European countries and which banks have the highest benefit those with high liquidity or low liquidity. Commercial banks as financial intermediaries absorb financial surpluses from depositors and make them available to borrowers. This investment activity carries risks and problems because the bank, on the one hand, seeks to maximize its profit through these investments and on the other hand the bank is exposed at all times to meet the obligations of its customers and depositors wishing to withdraw their savings. The problem lies in how banks choose the optimal level in which they can hold their assets in order to achieve both objectives together. Therefore, the objective of this research is to examine the effect of bank liquidity management on profitability in commercial banks in Central and Southern Europe, taking into account their need to maintain a greater balance between liquidity and profitability at the same time. The 2007-2008 financial crisis revealed that liquidity plays an important role in bank operations, but not only because it also has a direct impact on profitability (Lancaster & Stevens, 1998; Lartey et al., 2009). Therefore, financial management decisions are very important in determining the level of liquidity of a bank with a view to maximizing its profit (Ibe, 2013). High liquidity ratios show a business financial power (Chandra, 2001), but the very high liquidity ratio also indicates the problems of bank mismanagement (Matarazzo, 2003). Therefore, the appropriate balance which avoids short-term liquidity pressures requires the removal of excessive or inadequate liquidity appropriate to the desired operating level of the bank (Bourzgarru et al., 2018).

2. Literature Review

The banking sector plays an essential role in the development of the business sector as well as of the economy as a whole. Banks as financial institutions carry out the role of financial intermediaries by collecting deposits from individuals and firms on one side and by providing these funds with loans to clients and institutions. The purpose of banks, like any business, is to maximize their profits by using as many of these resources but being conditioned by the fact that they have to be able to fulfill their obligations to customers in the short term. There are various controversies from researchers, who have come to different conclusions regarding liquidity management policies and their influence on banks' profitability. This problem will be part of our study, to determine whether there is a long-term influence on the banks' profitability? Is it better to have a high level of liquidity or a low level? What is the optimum level of liquidity to have a high level of profitability? Liquidity management is a very important part of the management's financial decisions, where efficient liquidity management is achieved when the bank is managing trade-offs between liquidity and profitability (Bhunia & Khan, 2011). Profitability and profitability are two factors (Kosmidou, 2008). The high liquidity levels for banks are costly as they cause reductions in profitability (Fuertes & Milne, 2012). Profitability and liquidity are two very important components for banking operations and prudent liquidity management is the main determinant of market value for a bank, as it has a direct effect on profit. Determining an optimal level of liquidity and profitability is not affected only by the asset management policy that the bank does, but also by the way the bank finances these resources. Figure 1 reflects the relationship between liquidity and profitability.

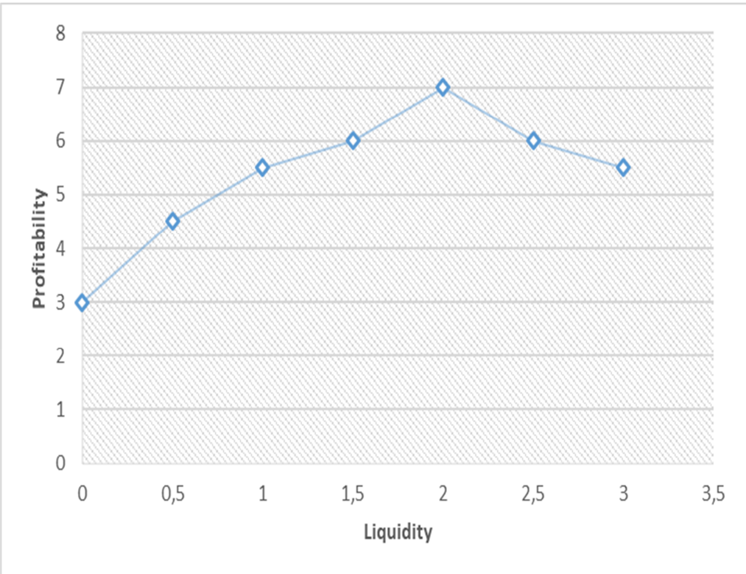

Figure 1. Liquidity –profitability relationship, source: Author own study

The liquidity value, which will give us the maximum profitability, is related to the determination of an optimal liquidity level. If we increase the value of liquid assets in the total assets, this will be accompanied by the increase in the level of liquidity but will also result in a decrease in profit. On the other hand, an increase in the level of short-term liabilities to the total of liabilities causes a decrease in the level liquidity, but contributes to increasing the level of profit. On the other hand, an increase in the level of short-term liabilities in total liabilities causes a decrease in the level of liquidity, but contributes to the increase in the level of profit. This negative relationship between liquidity and profitability

(Gajdka & Walinska, 2008) shows that when the level of liquidity falls below the optimum level of liquidity, it causes a decrease in profit but, on the other hand, places the bank on unmanageable positions to meet short-term liabilities over time (Wojciechowska, 2001).Good management of current assets and current liabilities can have a good influence on the profitability and the establishment of a bottom line is to build a balance between liquidity and profitability (Parmil & Kumar, 2012). This equilibrium is seen as a condition for having financial stability for banks (Renato, Schwambach Vieira, 2010). An aggressive policy of liquidity management has a positive impact on profitability, implying low liquidity and higher profitability (Jose et al., 1996).Financial decisions related to liquidity management are very important for banking operations and the impact they will have on banks' main goal to maximize profit. Liquidity management is an immediate need for the banking sector and banks need to set a level optimum solvency for solving this problem (Ibe, 2013).

2.1 Bank Liquidity Concept

Banking securitization means the bank's ability to meet its short-term liabilities (Kasmi, 2007, Van Ness, 2009). The term liquidity is multifaceted, the first and most important understanding of how quickly, costly and costly the bank's assets are invested in money (Berger & Bouwmann, 2008). There is some theory of liquidity management: Shift-ability Theory-is an approach to keeping banks liquidity by supporting the shifting of assets. When a bank is short of ready money, it is able to sell assets to a more liquid bank. Under the shift-ability, the banking system strives to avoid liquidity crises by allowing banks to sell or repurchase at good prices (Alshatti, 2015). Liability management theory - there is no need to follow old liquidity norms such as maintaining liquid assets, liquid investments, banks have to focus on the liabilities side of the balance sheet. Banks can satisfy liquidity needs by borrowing money and capital markets (Emmanuel, NR, 1997). Different reports are used for the measurement of liquidity: Current ratio (CR) is expressed as the ratio of short-term assets to short-term liabilities and is one of the most used ratios for measuring liquidity (Czekaj & Dresler 2001). Current assets are those that can be converted within one year to cash and current liabilities means an obligation that must fulfill within one year. The high values of this report show a high bank's ability to meet them. Cash ratio (CARR)—shows how much cash bank has to meet the short term requirements. CARR is expressed as a cash ratio with short-term liabilities. Interest coverage ratio or otherwise known as TIE interest earned ratio expressing the bank's ability to pay its interest cost on its debt. TIE is expressed as a ratio of interest and tax earning to total and cost interest over the same period. The Debt of Equity ratio is another important ratio calculated as a ratio between the total liabilities of the shareholder's equity. Debt of Equity ratio is negatively related to the ROA because when the Debt grows in the bank's capital structure, then the bank It also increases the weight of the cost of capital, the bank shrinking its lending policy, this leads to retail sales and thus reduces profitability. Capital ratio, which is calculated as a ratio of equity to the total of assets. Niresh (2012) in its study of the relationship between liquidity and profitability, I conclude that there was no relationship between the liquidity ratio measured by the capital ratio and the profitability measured with the Return on equity. Various studies related to the impact or reliability of profitability have found that their findings are mix (Note 1). The effect or the relationship between liquidity and profitability may be positive or negative depending on the variables used to measure liquidity or profitability (Rasul, 2013).

2.2 Profitability

Profitability is the ratio that shows the bank's ability to generate profit in relation to sales, total assets and equity (Sartono, 2001; Aburime, 2008). There are several ways to improve profitability, such as breakeven analysis, cost control, Ibe (2013). However, the main purpose of commercial banks is to maximize profits, but it is not easy to achieve because so many variables are concerned (Tosmocos, 2003). The bank's profitability is always measured by the ROE, ROA and ROCE ratios (Miller & Bromily, 1990). ROA - Return on assets means how much profit the bank generated by asset management. ROA is calculated as the ratio between net profit and total assets. ROE - means the return earned in relation to the total invested capital. ROE is calculated as the ratio between net profit and total equity. ROCE is a profitability ratio that tells how a company is using its capital. ROCE Ratio is calculated as the ratio of Net Operating Income (EBIT) to the difference between (Total Assets - Current Liabilities). There are various dilemmas regarding the impact and level of liquidity in profitability. The liquidity ratio lower than 1 indicates that the bank has no liquid cash to repay the short-term debt (Morrel, 2007). The high liquidity ratio signals a situation of (Chandra, 2001), but for some other researchers, the high level of liquidity shows maladministration of the bank (Matarazzo, 2003). Hirigoyen (1985) in his study concludes that profitability and profitability are determinations of the banks equilibrated survival Both these factors are at the same time the result of the consequences and the restrictions.

2.3 Research Questions

To reach the conclusions of this study, the following research questions will be tested:

H1: Liquidity management and profitability are not related to each other?

H2: Banks with high-levels liquidity would be able to achieve a better performance?

H3: What is the optimum level of liquidity where we get a high level of profitability?

3. Data and Methodology

This study points out the relationship between liquidity management and profitability in the banking sector in Central and South Europe, using various reports for measuring liquidity and profitability. The liquidity ratio included in the study is Current ratio, Cash ratio, Capital ratio, Interest coverage ratio and Debt to Equity ratio while the measurement of profitability will be made by ROE, ROA and ROCE. Liquidity management is the independent variable in our model while profitability is the dependent variable. The data used in this study are collected from the consolidated annual reports of banks operating in Central and Southern Europe for the period 2009-2017. The data are analyzed in the Real Statistic Programme. The research model used is the following:

$$Yit=\alpha i+\beta 1*Xit+\beta 2*Xit+\beta 3*Xit+\beta 4*Xit+\beta 5*Xit+\varepsilon it \quad (1)$$

Where:

Yit = profitability, i refers to an individual bank, t refers to year, α = constant,

ßi is the matrix of variable coefficients

ε = Error term.

Three models were used in the study, where each model determines the effect of banks' profitability on liquidity management in Central and South Europe.

$$ROE = \alpha i + \beta 1*CR_{it} + \beta 2*TIE_{it} + \beta 3*CRR_{it} + \beta 4*Capital\ ratio_{it} + \beta 5*Debt\ Equity\ ratio_{it} + \varepsilon_{it} \quad (2)$$

$$ROA = \alpha i + \beta 1*CR_{it} + \beta 2*TIE_{it} + \beta 3*CRR_{it} + \beta 4*Capital\ ratio_{it} + \beta 5*Debt\ Equity\ ratio_{it} + \varepsilon it \quad (3)$$

$$ROCE = \alpha i + \beta 1*CR_{it} + \beta 2*TIE_{it} + \beta 3*CRR_{it} + \beta 4*Capital\ ratio_{it} + \beta 5*Debt\ Equity\ ratio_{it} + \varepsilon_{it} \quad (4)$$

Table 1. Determinants of Liquidity management and Banks profitability banks

Determinants	Variables	Measures
	ROE	Net profit/Total Equity
	ROA	Net profit/Total Assets
	ROCE	EBIT/(Total Assets- Current Liability)
	CR	Current Assets/Current Liability
	TIE	EBIT/Interest expensive
	CRR	Cash/Current Liability
	Capital Ratio	Equity/ Total Assets
	Debt Equality Ratio	Total Liability/Equity

Source: Authors' assumptions.

4. Data Analysis

This study implements, describes, reports and econometric analysis in determining the effect of liquidity management on profitability in commercial banks in CEE (Central and Southern Europe) and the determination of the optimal level of liquidity over the time period (2009-2017), including analysis of profitability and liquidity indicators, regression analysis, correlation analysis, which are estimated by the OLS (Real Statistics) based on annual reports issued by commercial banks.

4.1 Statistical Analysis and Interpretation

Table 2. Summary Statistic Southern Europa

Variables	ROE	ROA	ROCE	CR	TIE	Cash ratio	Capital ratio	Deb. Equity ratio
Mean	0.046	0.006	0.048	1.178	0.847	0.187	0.152	6.955
Median	0.056	0.007	0.048	1.148	0.403	0.159	0.135	6.369
St.Deviation	0.153	0.022	0.135	0.210	2.599	0.144	0.082	3.637
Kurtosis	25.836	24.065	17.742	117.305	79.559	42.477	23.330	16.814
Skewness	-3.664	-2.789	-1.144	7.969	7.281	4.812	3.591	2.572
Maximum	0.451	0.107	0.789	4.216	34.239	1.756	0.872	39.069
Minimum	-1.324	-0.184	-1.008	0.136	-5.387	0.000	0.025	0.334
Count	378	378	378	378	378	378	378	378
Shapiro - Wilk Test								
W-stat	0.690	0.683	0.738	0.517	0.451	0.686	0.741	0.851
p-value	0	0	0	0	0	0	0	0
alpha	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
normal	no	no	no	no	no	no	no	no
d'Agostino - Pearson								
DA-stat	339.44	286.46	160.92	582.41	544.05	418.29	330.89	256.698
p-value	0	0	0	0	0	0	0	0
alpha	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
normal	no	no	no	no	no	no	no	no

Source: Authors' calculations.

Table 3. Summary Statistic Central Europa

	ROE	ROA	ROCE	CR	TIE	Cash ratio	Capital ratio	Deb. Equity ratio
Mean	0.0185	0.0032	0.0323	1.7091	1.6190	0.1365	0.1015	10.0678
Median	0.0390	0.0038	0.0367	1.1100	0.3141	0.0731	0.0980	9.2085
Standard Deviation	0.2028	0.0174	0.1368	2.4612	12.9814	0.5436	0.0348	4.3226
Kurtosis	25.0707	42.9044	25.377	12.862	212.444	209.739	3.2844	9.7309
Skewness	-4.1876	-5.0175	-4.0705	3.8277	14.3771	14.2486	1.2721	2.3517
Maximum	0.5631	0.0594	0.3292	13.219	192.747	8.1144	0.2497	38.2159
Minimum	-1.4449	-0.1621	-1.0261	0.1075	-7.9348	0.0000	0.0255	3.0043
Count	225	225	225	225	225	225	225	225
Shapiro - Wilk Test								
W-stat	0.598	0.597	0.661	0.276	0.113	0.126	0.919	0.824
p-value	0	0	0	0	0	0	9.73881E-10	2.88658E-15
alpha	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
normal	no	no	no	no	no	no	no	no
d'Agostino - Pearson								
DA-stat	231.521	272.005	228.199	199.668	494.330	492.227	62.984	137.617
p-value	0	0	0	0	0	0	2.10942E-	0
alpha	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
normal	no	no	no	no	no	no	no	no

Source: Authors' calculations.

Table 2 shows the results of all variables included in the three models for banks operating in south Europe. The results show that the ROE has an average value of 0.046, which indicates that the value the average return on equity for banks is 4.6%. The value of the standard deviation for ROE is 0.153. Regarding the control variables used to measure the independent liquidity variable, the results of the study show that CRR has an average value of 0.1871 and a standard deviation value of 0.144. The average value of the TIE variable is 0.847 and the standard deviation value is 2.599, which indicates that the bank presents less risk to investors and creditors in terms of solvency. So from this point of view, banks are considered as banks with acceptable risk. The mean values and the standard deviation for the CR variable are 1.178 and 0.2102. This shows that the bank has easy to repay its debts. The results of table 2 show that the values of capital ratio are 0.1522 for the average and 0.082 standard deviation and the debt equity ratio deviation standard is 3.6373 and 6.955 average values. The average ROA value for banks is 0.006 and the standard deviation value is 0.022. Also in the study is used another variable to measure ROCE profit, where the value of the standard deviation 0.048 and the value of the average 0.135. Table 3 shows the results of the banks operating in the Central Europe, the ROE has an average value of 0.019, which indicates that the value the average return on equity for banks is 1.9%, so 2.7% less than the average return on equity for banks operating in south Europe. The standard deviation value for ROE is 0.203. The average ROA value for banks is 0.003 and the standard deviation value is 0.017. For the other ROCE variable, the value of the standard deviation 0.14 and the mean value of 0.032. Regarding the control variables used to measure the independent liquidity variable, the results of the study show that CRR has an average value of 0.14 and a standard deviation value of 0.544. The average value of the TIE variable is 1.62 and the standard deviation value is 12.98, mean values and standard deviation for the CR variable are 1.71 and 2.46. From the results of Table 3, it is shown that the values of the explanatory variables capital ratios are 0.101 for the average value and 0.035 standard deviation, and the debt equity ratio deviation standard is 10.07 and 4.322 average values. The Kurtosis and Skewness values show that the data used in the analysis are not normally distributed. Also, two tests were used to verify the normality of the data: a) Anderson Darling test and b) Shapiro-Wilk test. The hypotheses in this case are:

H0: The data are normally distributed

H1: The data are not normally distributed

The condition for the Anderson Darling test is: If, P-value> alpha, we keep the null hypothesis and reject the alternative hypothesis. Based on the results of tables 2 and 3, all variables included in the study have abnormal distribution because P-values are less than alpha 0 05.

The condition for the Shapiro Wilk test is: If, P- value < alpha at level 0.05, we reject the null hypothesis. The results of tables 2 and 3 confirm that the data have abnormal distribution. Based on the results of the two tests Shapiro-Wilk and Anderson Darling use non-parametric test for further data analysis. To test whether time series of explanatory variables and dependent variables are stationary or not, we applied the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test to see the existence of a network unit.

H0: The series is stationary.

H1: There is a unit root. The series is not stationary.

Table 4. Results of KPSS

	Southern Europa		Central Europa	
Variables	KPSS-statistic	P-value	KPSS-statistic	P-value
ROE	3.987	0.06	2.187	0.11
CR	4.856	0.11	5.089	0.08
TIE	2.098	0.1	3.132	0.13
CRR	6.345	0.07	4.089	0.09
Capital ratio	7.654	0.09	5.324	0.1
Deb equity ratio	3.056	0.077	3.932	0.22
Variables	KPSS-statistic	P-value	KPSS-statistic	P-value
ROA	5.345	0.09	4.123	0.21
CR	3.645	0.13	3.046	0.07
TIE	5.534	0.07	1.934	0.23
CRR	6.089	0.1	3.254	0.15
Capital ratio	8.675	0.12	6.453	0.09
Deb equity ratio	4.321	0.056	2.191	0.06
Variables	KPSS-statistic	P-value	KPSS-statistic	P-value
ROCE	6.587	0.075	2.089	0.12
CR	3.756	0.17	4.043	0.07
TIE	1.798	0.08	2.098	0.17
CRR	5.345	0.09	3.203	0.21
Capital ratio	4.067	0.095	4.324	0.41
Deb equity ratio	3.083	0.067	5.423	0.06

Source: Authors' calculations.

The results of Table 4 show that P-value values for explanatory and dependent variables for banks operating in CEE(*Central East Europa, include these countries: Albania, Kosovo, Nord Macedonia, Montenegro, Bulgaria, Serbia, Bosnia Herzegovina, Croatia, Romania, Slovenia, Slovakia, Czech*) are higher than the significance level alpha 0.05, so we should keep the null hypothesis H0 and reject the alternative hypothesis. So the series is stationary and there is no unit root for the series.

4.2 Correlation Analysis

To analyze the correlation test, we need to examine the correlation between dependent variables and independent variables. For this we have two hypotheses:

H0: There is no correlation between liquidity management and banks profitability.

H1: There is a correlation between liquidity management and bank profitability

Table 5. Model 1, ROE—Correlation analysis

				Cash	Capital	Deb equity
South Europa	ROE	CR	TIE	ratio	ratio	ratio
ROE	1.000					
CR	0.162	1.000				
TIE	0.823	0.270	1.000			
CRR	0.150	0.270	0.170	1.000		
Capital ratio	0.037	0.590	0.220	0.140	1.000	
Debt equity ratio	-0.037	-0.590	-0.220	-0.140	-0.450	1.000
Spearman coefficients						
Rho		0.162	0.822	0.158	0.037	-0.037
T-stat		2.457	21.582	2.384	0.554	-0.556
P-value		0.070	0.000	0.017	0.570	-0.578
Kendall's coefficients						
Z		2.520	14.374	2.359	0.624	-0.627
Z-crit		1.950	1.959	1.959	1.959	1.959
P-value		0.011	0.000	0.018	0.530	0.530
					Capital	Debt equity
Central Europa	ROE	CR	TIE	CRR	ratio	ratio
ROE	1.000					
RC	0.053	1.000				
TIE	0.085	-0.016	1.000			
CRR	0.039	0.305	-0.006	1.000		
Capital ratio	0.050	0.013	0.101	-0.116	1.000	
Debt equity ratio	-0.009	-0.011	-0.085	0.236	-0.826	1.000
Spearman coefficients						
Rho		0.157	0.822	0.153	0.037	-0.037
T-stat		2.388	21.568	2.323	0.561	-0.562
P-value		0.017	0.000	0.021	0.575	0.574
Kendall's coefficients						
Z		2.457	14.396	2.299	0.623	-0.627
Z-crit		1.959	1.959	1.959	1.959	1.959
P-value		0.013	0	0.021	0.532	0.53

Source: Authors' calculations.

From Table 5 we see that the correlation between CRR and ROE is very weak and positive, while the TIE variable has a strong correlation with ROE in the value of 0.823. On the other hand, the CR variable has a weak and positive correlation with ROE. So we can say that the two CRR and CR variables have a non-zero correlation with the dependent ROE variables. Spearman and Kendall's Tau test scores, used to test the hypothesis:

H0: The variables are not correlated.

H1: The variables are correlated.

The decision rule as follow:

Accept H0 if (P-value)> 5%

Accept Ha if (P-value) <5%

The analysis outputs show that among the dependent variables ROE and independent variables CR, TIE and CRR, there is a statistically significant difference or relationship between them. As long as the values of P-value (0.014 (0.0172); 0 (0); 0.018) are smaller than 0.05 and Z values are greater than the values of Z critics, between the variables has a relationship. While the Capital ratio and the debt ratio do not have a correlation with ROE, since the P-values values are greater than 0.05 so I can not reject the null hypothesis. Also the TIE variable is correlated positively and has a strong relation r (0.823) with ROE. In Banks operating in Central European countries, the variables CR, TIE and CRR are positive and weak links with the ROE. Two dependent variables Capital ratio and Debt ratio have no correlation or correlation with ROE.

Table 6. Model 2, ROA—Correlation Analysis

South Europa	ROA	CR	TIE	Cash ratio	Capital ratio	Deb equity ratio
ROA	1.000					
CR	0.252	1.000				
TIE	0.830	0.270	1.000			
CRR	0.220	0.270	0.170	1.000		
Capital ratio	0.205	0.590	0.220	0.140	1.000	
Debt equity ratio	-0.205	-0.590	-0.220	-0.140	-0.450	1.000
Spearman coefficients						
Rho		0.251	0.870	0.226	0.205	-0.205
T-stat		3.873	26.310	3.459	3.126	-3.127
P-value		0.000	0.000	0.000	0.002	0.001
Kendall's coefficients						
Z		3.958	15.758	3.251	3.178	-3.182
Z-crit		1.959	1.959	1.959	1.959	1.959
P-value		7.55E-03	0.000	0.001	0.001	0.001
Central Europa	ROA	CR	TIE	CRR	Capital ratio	Deb equity ratio
ROA	1.000					
CR	0.041	1.000				
TIE	0.100	-0.016	1.000			
CRR	0.025	0.305	-0.006	1.000		
Capital ratio	0.134	0.013	0.101	-0.116	1.000	
Deb equity ratio	-0.093	-0.011	-0.085	0.236	-0.826	1.000
Spearman coefficients						
Rho		0.245	0.87	0.1061	0.206	-0.206
T-stat		3.787	26.349	1.594	3.148	-3.149
P-value		0.0001	0	0.114	0.0018	0.001
Kendall's coefficients						
Z		3.869	15.797	1.61	3.194	-3.198
Z-crit		1.959	1.959	1.959	1.959	1.959
P-value		0.0001	0	0.1	0.0013	0.0013

Source: Authors' calculations.

The results of the correlation analysis for the second model for banks in south Europe show that the variables have a weak and positive relationship with the ROA dependent variables.

While the Debt equity ratio has a negative relationship with ROA, only the TIE variable indicates a strong bond with ROA. Also, the P-value and Z values of the Spearman and Kendall Tau tests cast down the null hypothesis, showing that between independent variables and the dependent variables ROA, there is a statistically significant difference or relationship between them.For the model of banks in Central Europe notes that there is a positive, but weak, relationship between CR, TIE and Capital ratios with ROA, while the Debt equity ratio has a negative relationship and is still weak with ROA. The CRR and ROA variables are not correlated, as the test results Spearman and Kendall show that the value P-value (0.112) of the variable is greater than 0.05.

Table 7. Model 3 ROCE—Correlation Analysis

South Europa	ROCE	CR	TIE	Cash ratio	Capital ratio	Deb equity ratio
ROCE	1.000					
CR	0.073	1.000				
TIE	0.834	0.270	1.000			
CRR	0.110	0.270	0.170	1.000		
Capital ratio	0.040	0.590	0.220	0.140	1.000	
Debt equity ratio	-0.040	-0.590	-0.220	-0.140	-0.450	1.000
Spearman coefficients						
Rho		0.073	0.834	0.110	0.034	-0.034
T-stat		1.095	22.565	1.660	0.511	-0.512
P-value		0.274	0.000	0.098	0.608	0.608
Kendall's coefficients						
Z		0.973	14.783	1.680	0.561	-0.561
Z-crit		1.959	1.959	1.959	1.959	1.959
P-value		0.330	0.000	0.092	0.574	0.574
Central Europa	ROE	CR	TIE	Cash ratio	Capital ratio	Deb equity ratio
ROCE	1.000					
CR	-0.022	1.000				
TIE	0.095	-0.016	1.000			
CRR	0.002	0.305	-0.006	1.000		
Capital ratio	-0.006	0.013	0.101	-0.116	1.000	
Debt equity ratio	0.008	-0.011	-0.085	0.236	-0.826	1.000
Spearman coefficients						
Rho		0.067	0.833	0.106	0.035	-0.035
T-stat		1.014	22.518	1.594	0.523	-0.525
P-value		0.311	0.000	0.112	0.600	0.600
Kendall's coefficients						
Z		0.900	14.791	1.610	0.568	-0.568
Z-crit		1.959	1.959	1.959	1.959	1.959
P-value		0.368	0.000	0.107	0.569	0.569

Source: Authors' calculations.

From the results of Table 7, we note that there is a positive and strong correlation between ROCE and TIE with the value r (0.834) while for the other independent variables P-values are greater than 0.05 can not reject the hypothesis null, there is no relationship between the variables. Also for the model in the Central Europa banks, only the TIE variable has a positive and weak relation with ROE with r value (0.095), while the other variables are not related to the variable dependent ROCE. This is supported by the results of P-values greater than 0.05

4.3 Regression Analysis

Table 8. Model 1: Model Summary and Kruskal- Wallis H Test (Dependent Variable: ROE for 2009-2017)

Variables	Coefficients			
		Std.		
South Europa	B	Error	T-value	Significance
Constant	0.18643256	0.05698231	3.27176215	0.00116871
CR	-0.09099347	0.05125244	-1.77539796	0.04765744
TIE	0.02228006	0.00283397	7.8617937	4.1348E-14
CRR	-0.08469119	0.05948199	-1.42381237	0.00345634
Capital ratio	-0.05085124	0.15447032	-0.32919751	0.11296754
Debt Equity ratio	-0.00415975	0.00290429	-1.43228001	0.15290343
		R		
Multiple R	0.40818504	Square	0.16661503	P-value
Adjusted R Square	0.15541362	H	1659.25	0
Durbin-Watson Stat	1.6105			

Source: Authors' calculations.

The regression results in Table 8 show that the value of R Square is 0.166 means that 17% of the variance of the dependent ROE variables can be explained by independent variables. Table 8 shows that the value of the statistical H is 1659.25 and the value of the P-value 2.582E-13, which is less than 0.05, this means that the regression equation is significant and can be used to predict the relationship between the dependent and the independent variables. Looking p values for each independent variable, TIE, CR and CRR are less than alpha (0.05), so we reject the invalid hypothesis and we can say that these variables affect ROE. The value of p for Capital ratio variable and Debt equity ratio variable is greater than 0.05, so we can not reject the invalid hypothesis that there is no correlation and can not say that they affect ROE.

The regression equation for the model is:

$$y= -0.186 -0.091*CR+ 0.022 * TIE -0.084 * CRR \quad (5)$$

Table 9. Model 2: Model Summary and Kruskal–Wallis H Test (Dependent Variable: ROA for 2009-2017)

Variables	Coefficients			
		Std.		
South Europa	B	Error	T-value	Significance
Constant	0.06791215	0.00741207	9.16236945	3.4784E-18
CR	-0.0423426	0.00666675	-6.35131056	6.2324E-10
TIE	0.00320226	0.00036863	8.68685959	1.1961E-16
CRR	-0.02756202	0.00773722	-3.56226296	0.00041546
Capital ratio	-0.00027956	0.020093	-0.01391311	0.00476786
Debt Equity ratio	-0.00130705	0.00037778	-3.45980589	0.00060325
Multiple R	0.5836	R Square	0.34067	p-value
Adjusted R Square	0.3318	H	1811.54	0
Durbin-Watson Stat	1.31862616			

Source: Authors' calculations.

The P- value a Kruskal–Wallis H test, which measures the common significance of the explanatory variables, is statistically significant at the 5% level, according to the respective probability value of 0.000. So it shows that the model used is suitable. The results of Table 9 show that the CR coefficient is negative and statistically significant at 5% with a probability of 6.2324E-10. The regression analysis shows that the probability of the TIE coefficient is 0.003 and is statistically significant at the 5% level. Keeping of all the other constant coefficients, an increase of 1 unit in the TIE variable will lead to an increase in the ROA variable with 0.003 units. The results show that the CRR coefficient is statistically significant at the 5% level with a probability of 0.0041 and implies a negative correlation between the variables. Keeping constant coefficients, a 1-unit increase in the CRR variable will lead to a decrease in the ROA variance of 0.0027 units. Capital ratio variable is lower than 5%, and has a negative relationship with ROA. The value of the P-value for the variable Debt equity ratio is lower than 5% and there is a negative relationship between ROA and R2 corrected 0.332 so it suggests that 33.2% of total ROA variation in commercial banks in southern Europe is explained by variations common in independent variables.The model equation in this case is:

$$y = -0.068 -0.042 * CR + 0.003 * TIE - 0.0027 * CRR-0,0002*Capital\ ratio - 0.001* Debt\ equity\ ratio \quad (6)$$

Table 10. Model 3: Model Summary and Kruskal–Wallis H Test (Dependent Variable: ROCE for 2009-2017)

Variables	Coefficients			
South Europa	B	Std. Error	P-value	Significance
Constant	0.057879518	0.049557471	1.167927195	0.243584124
CR	-0.010592562	0.044574206	-0.237638822	0.50334445
TIE	0.021035499	0.002464699	8.534713699	3.61726E-16
CRR	0.015117644	0.051731439	0.292233196	0.60234321
Capital ratio	0.038805902	0.134342717	0.288857504	0.772851323
Debt Equity ratio	-0.003480918	0.002525855	-1.378114774	0.168996189
Multiple R	0.4317	R Square	0.1864	p-value
Adjusted R Square	0.1754	H	1677.84	0
Durbin-Watson Stat	1.55269482			

Source: Authors' calculations.

The regression results in Table 10 show that the value of Square R is 0.186 means that 19% of the variance of the dependent ROCE variables can be explained by independent variables. The value of P-value, which measures the common significance of the explanatory variables, is statistically significant at the 5% level, according to the respective probability value of 0,000. So this shows that the model used is appropriate and the model equation is:

$$y = -0.0578 + 0.00210 * TIE \qquad (7)$$

The results of Table 10 show that the TIE variable P-value is 3,61726E-16 and is statistically significant at 5% level and the relation between them is positive.Keeping all the other constant coefficients, an increase of 1 unit in the TIE variable will lead to an increase in the ROCE variable of 0.0210 units. The results show that all other variables have no connection or impact on ROCE.

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Table 11. Model 1: Model Summary and Kruskal–Wallis H Test (Dependent Variable: ROE for 2009-2017)

Variables	Coefficients			
Central Europa	B	Std. Error	T-value	
Constant	30.04534555	0.108254693	0.124618306	-0.8686901
CR	0.004014489	0.005831585	0.688404556	0.00067654
TIE	0.001281485	0.001053219	1.216731582	0.00756545
CRR	0.006169638	0.027449368	0.22476432	0.00234565
Capital ratio	0.709399776	0.701250841	1.011620571	0.78045345
Debt Equity ratio	0.004467802	0.005781956	0.772714601	0.44052445
		R		p-value
Multiple R	0.687	Square	0.107	
Adjusted R Square	0.087	H	913.139	0
Durbin-Watson Stat	1.15528725			

Source: Authors' calculations.

Table 12. Model 2: Model Summary and Kruskal–Wallis H Test (Dependent Variable: ROA for 2009-2017)

Variables	Ceofficients			
Central Europa	B	Std. Error	T-value	Sig.
Constant	0.007851896	0.010607984	0.740187408	0.04657877
CR	0.000236372	0.000496407	0.476166282	0.00209899
TIE	0.000117735	8.9654E-05	1.313212911	0.00009878
CRR	0.000738154	0.002336595	0.315909962	0.752371716
Capital ratio	0.083229081	0.05969314	1.394282176	0.00012111
Debt Equity ratio	0.000189509	0.000492182	0.385038395	0.00065655
		R		p-value
Multiple R	0.6208	R Square	0.102	P- value
Adjusted R Square	0.0819	H	1023.7	0
Durbin-Watson Stat	1.19935858			

Source: Authors' calculations.

Table 13. Model 3: Model Summary and Kruskal–Wallis H Test (Dependent Variable: ROCE for 2009-2017)

Variables	Coefficients			
Central Europa	B	Std. Error	T-value	Significance
Constant	0.032983391	0.084318691	0.391175324	0.00785777
CR	-0.001266825	0.003945741	-0.321061236	0.70012111
TIE	0.001018216	0.000712625	1.428825135	0.00768767
CRR	0.001740868	0.01857267	0.093732795	0.11978677
Capital ratio	-0.030635543	0.474477261	-0.064566935	0.948577709
Debt Equity ratio	0.000265439	0.003912162	0.067849736	0.65234978
Multiple R	0.9989	R Square	0.2097	p-value
Adjusted R Square	0.1916	H	916.967	0
Durbin-Watson Stat	1.09964878			

Source: Authors' calculations.

Drawing on the values of the coefficients determined in the tables 11, 12, 13, below are the equations of the respective models:

Y = -0.1082 + 0.004 * CR + 0.0012 * TIE + 0.0061 * CRR (ROE) (8)

Y = -0.0079 + 0.0023 * CR + 0.00011 * TIE + 0.0832 * Capital ratio + 0.0018 * Debt equity ratio (ROA) (9)

Y = 0.0329 + 0.0010 * TIE (ROCE) (10)

In the first equation (ROE) is positively influenced by CR, CRR, and TIE, while the other two variables Capital ratio, and Debt equity ratio have no effect on the profitability of banks in central Europe.In the equation where ROA is used to measure profitability, the specific variables CR, TIE, Capital ratio and debt equity ratio are positively with profitability. Keeping all the other constant factors an increase from a unit in CR, TIE, Capital ratio, the Debt ratio will result in an increase in profitability (ROA) of 0.00023 units of CR, 0.00011 units of TIE, 0.0832 units of Capital ratio and 0.00018 units of Debt equity ratio. In the model when ROCE is used to measure the profitability, the variable TIE has a positive effect on profitability.

5. Hypothesis Two: Banks with High Level Liquidity Would be Able to Achieve A Better Performance?

Over the year of 2017 the banks with higher liquidity would be able to achieve a better performance. To test the hypothesis we group banks into two large groups according to their CR ratio in analysis period 2017:

(A) banks with CR ratio higher than 1,1 (Banks with high liquidity)

(B) Banks with CR ratio lower than 1,1 (Banks with low liquidity)

The respective statistical data for both groups are presented in Table 14:

Table 14. Descriptive statistic

	Central Europa Banks			South Europa Banks		
	High Liquidity (A)	Low Liquidity (B)	Total	High Liquidity (A)	Low Liquidity (B)	Total
Mean	1.144015749	1.077168161	1.128008113	1.211280821	0.997698247	1.158998694
Median	1.124021236	1.073357997	1.111037792	1.178655442	1.043735872	1.142861285
Standard Deviation	0.051725921	0.010540278	0.053004006	0.111260629	0.159478149	0.148783806
Maximum	1.280999945	1.088656823	1.280999945	1.610546449	1.090886247	1.610546449
Minimum	1.095039227	1.066107665	1.066107665	1.106099399	0.580854766	0.580854766
Count	19	6	25	31	11	42
ROA> 0	19	6	25	29	10	39
ROA<0	0	0	0	2	1	3

Source: Authors' calculations.

There are 31 banks (74%) and banks (A) for the banks in southern Europe (11%), while in the group (B) there are 11 banks (26%), while in the Central Bank there are 19 banks (76%) and in group (B) 6 banks (24%), in order to reach the hypothesis we will compare ROA for both groups from the average and the average statistical values we can observe that the high liquidity (A) banks in South Europe and Central Europe do not have any major changes with low liquidity (B) banks, but the difference between the averages (0.213582574) and medians (0.13491957) for banks operating in south Europe is higher than the difference between the averages (0.07) and the medians (0.05) for the banks in Central Europe. In the high liquidity group (A) for Southern Europe there is only 1 bank (6%) and for the same group, but in Central Europe there is no bank showing losses for 2017, while in group (B) with liquidity there are 3 banks (9%) for southern Europe that have a negative income while for banks in central Europe there is no bank with negative performance. This shows that there is no distinction between high liquidity banks with low liquidity banks operating in CEE. For the true measure of whether there are changes we will test the hypothesis:

H0: The average ROA for both groups is the same

H1: ROA for group (A) is higher than group (B),

H0: $\mu a = \mu b$H1: $\mu a > \mu b$

Since the data have abnormal distribution, to prove the hypothesis use The Mann-Whitney U test for nonparametric data. The results of the Mann - Whintey Test show that z can now be checked for relevance by comparing it to the critical standard distribution standard (z-distribution) value.This critical value can be obtained from the table. For the level of meaning of two sides, 0.50 is ± 1.96. If the amount of test statistic is higher than the critical value, the difference is significant. On our own, the banks operating in southern Europe (| 0.976 | <1.96). and those in central Europe have (| 1.78 | <1.96). Therefore, we can say that the two trends do not change (exactly the Mann-Whitney U test for the south Europa banks: U = 150, p = 0.33> 0.05 and the Mann-Whitney U test for a bank in central Europe: U = 29, p = 0.074> 0.05).So based on the results of the test can not reject the hypothesis null arguing that banks with higher liquidity were not able to achieve a better performance in 2017 then banks with lower liquidity.

6. Hypothesis Three: What is The Optimum Level of Liquidity Where We get a High Level of Profitability?

To answer this research question is used a panel two-step GMM(Generalized Method of Moments) procedure:

$$Yit = c + \alpha 1 * Liquidityt + \alpha 2 * Liquidityt * Liquidityt\text{-}1 + \beta X + \varepsilon \quad (11)$$

Where,

Yit = return rate, ROE or ROA

$\alpha 1,2$ = estimated regression coefficients

c = constant

X*ß is the matrix of variable coefficients

ε = Error term.

To measure profitability through ROE, we will use two CR and TIE control variables. When ROA is used as a variable to measure profitability, we use the Capital ratio and the Debt equity ratio variables.

Table 15. Results for dependent variable ROE in Southern and Center Europa

Dependent variable: ROE	South Europa			
Method: Panel Generalized Method of Moments				
Period: 2009-2017				
Total observations: 377				
Instrument specification: CR.TIE				
Variables	Coeff	std err	t stat	p-value
C	2.148181384	0.041587318	3.563138729	0.000413853
			-	
Liquidity	-6.103513197	0.034929808	2.963463126	0.003236659
Liquidity*Liquidity	0.222545579	0.00282642	7.976726953	1.85226E-14
R-squared	0.453483919	Durbin-Watson stat	1.610236625	
adjusted R-Squared	0.348957095			
Dependent variable: ROE	Central Europa			
Method: Panel Generalized Method of Moments				
Period: 2009-2017				
Total observations: 224				
Instrument specification: CR.TIE				
Variables	Coeff	std err	t stat	p-value
C	3.128313756	0.016633754	7.714058943	3.97244E-13
Liquidity	-5.104514561	0.005514783	18.95171021	1.94684E-48
Liquidity*Liquidity	0.211348616	0.00104542	10.85555842	2.47275E-22
R-squared	0.578688792	Durbin-Watson stat	1.156058778	
adjusted R-Squared	0.461256112			

Source: Authors' calculations.

Table 16. Results for dependent variable ROA in Southern and Central Europa

Dependent variable: ROA	South Europa			
Method: Panel Generalized Method of Moments				
Period: 2009-2017				
Total observations: 377				
Instrument specification: Capital ratio. Debt equity ratio				
Variables	coeff	std err	t stat	p-value
C	1.037722397	0.005566718	6.77641568	4.8054E-11
Liquidity	-0.505486374	0.019118022	- 5.517640565	6.42835E-08
Liquidity*Liquidity	-0.021927091	0.000430839	-5.08796335.74049E-07	
R-squared	0.81750181	Durbin-Watson stat	1.332517364	
adjusted R-Squared	0.76839754			
Dependent variable: ROA	Central Europa			
Method: Panel Generalized Method of Moments				
Period: 2009-2017				
Total observations: 224				
Instrument specification: Capital ratio. Debt equity ratio				
Variables	coeff	std err	t stat	p-value
C	2.008415947	1.010364913	1.987812444	0.048050165
Liquidity	-0.910073299	0.05896631	- 15.43378408	4.31651E-37
Liquidity*Liquidity	0.040233531	0.043475158	5.525765598	9.07678E-08
R-squared	0.484692371	Durbin-Watson stat	1.180825121	
adjusted R-Squared	0.480028953			

Source: Authors' calculations

Based on the results of tables 15, 16 we calculate the optimal level of bank liquidity, which will maximize profitability based on the maximization conditions, the equation (11) equates to 0 and the derivative.

$$d\,(Yit)=d\,(\,c + \alpha1*Liquidityt + \alpha2\,*Liquidityt*Liquidityt\text{-}1 + \beta\,*X+ \varepsilon\,) = 0 \quad \textit{(Note 3)} \qquad (12)$$

$$\alpha2*Liquidityt\text{-}1 = -\,\alpha1 Liquidityt\text{-}1optimum = -\,\alpha1\,/\,\alpha\,2 \qquad (13)$$

$$Liquidityt\text{-}1optimum\ (ROE) = -\,\alpha1\,/\,\alpha\,2 \quad = \quad -(-6.1035)/0.225 = 27.42\% \qquad (14)$$

$$Liquidityt\text{-}1optimum\ (ROE) = -\,\alpha1\,/\,\alpha\,2 = \ -9\text{-}5.1045)/0.2113 = 24\% \qquad (15)$$

$$Liquidityt\text{-}1optimum\ (ROA) = -\,\alpha1 \quad /\,\alpha\,2 \quad = \quad -(-0.5054)/0.0219 = 23.05\% \qquad (16)$$

$$Liquidityt\text{-}1optimum\ (ROA) = -\,\alpha1 \quad /\,\alpha\,2 \quad = \quad -(-0.9100)/0.0402 = 22.6\% \qquad (17)$$

The optimum level of bank liquidity at the moment t-1, which will give the highest level of return on equity (ROE) is 27.42% for banks in South Europe and 24% for banks in Central Europe. While to maximize ROA, based on equations 16, 17, for banks in South Europe the liquidity level is 23.05% and 22.6% for banks in Central Europa.

7. Conclusion

The purpose of this study is to determine the impact or relationship between liquidity management and profitability in the banking sector in central and south Europe. The data were analyzed using correlation and regression analysis as well as non-parametric tests run through Real-statistic program. Based on the research findings, clarify that the current ratio (CR) and cash ratio (CRR) have a positive but weak relationship with banks profitability, when used as dependent variables for measuring banks' profitability, return on equity (ROE) and return on assets (ROA). While in the case when return on capital employed (ROCE) is used as dependent variable to measure the profitability, the explanatory variable does not show any relation to the dependent variables. The debt equity ratio has a negative and significant relationship with the dependent variable ROA. The findings show that only the Times Interest Rate (TIE) ratio shows how many times the annual interest expenses are covered by the net operating income of the company, shows a positive and strong correlation with the three variables dependent ROE, ROA, ROCE. Also, the results showed that banks with higher levels of liquidity cannot reach a higher level of profitability than banks with lower level liquidity. The results of the Mann - Whitney U test showed that the high level of liquidity is not a prerequisite for achieving a high level of profitability. Mann-Whitney U for Southern Europe U = 150, p = 0.33> 0.05 and for central Europe U = 29, p = 0.074> 0.05. Also, the optimum level of bank liquidity at the moment t-1, which will give the highest level of return on equity (ROE) is 27.42% for banks in South Europe and 24% for banks in Central Europe. While to maximize ROA, for banks in South Europe the liquidity level is 23.05% and 22.6% for banks in Central Europe.

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Notes

Note 1. Khan and Mutahhar Ali 2016, found that there was no significant relationship between liquidity and profitability, where CRT and ROE profitability were used as variables to measure liquidity. While Akter and Muhmund 2014, Al-Nimer et al 2013, concluded that there is a significant and positive relationship between Liquidity and Profitability when CR and Capital ratios are used as liquidity measurement variables, whereas the return on assets is used for profitability.

Note 3. Based on the derivatives regulation we transform the function $d(Yit)=d(c + \alpha1*\text{Liquidityt} + \alpha2 *\text{Liquidityt}*\text{Liquidityt-1} + \beta *X+ \varepsilon)$. $d(Yit)*d(\text{Liquidityt})= d(c) +d(\text{Liquidity}(\alpha1 + \alpha2 *\text{Liquidityt -1}) + d(\beta *X)+d(\varepsilon)$

Appendix

Appendix 1. Derivations and Proofs

In this section we will present the analytical formula used in the model

Analytical Formula. $Rt = c + \alpha1*\text{Liquidityt} + \alpha2*\text{Liquidityt}*\text{Liquidityt-1} +x*ß + \varepsilon$ (1)

find the derivation of the function

$d/d(x)(Rt) = d/d(x)(c + \alpha1*\text{Liquidityt} + \alpha2*\text{Liquidityt}*\text{Liquidityt-1} +x*ß + \varepsilon) = 0$

$d/d(x) (c) + d/d(x) (\alpha1*\text{Liquidityt})+ d/d(x) (\alpha2*\text{Liquidityt}*\text{Liquidityt-1}) + d/d(x)(x*ß) +$

$d/d(x)(\varepsilon)= 0$

$d/d(x) (c) = 0$ (2)

$d/d(x) (\alpha1*\text{Liquidityt})$, apply the constant multiple rule $d/d(x) (\alpha1*\text{Liquidityt})$,=

$d/d(x) (\alpha1* f (\text{Liquidityt})$

$= \alpha1* d/d(x) f (\text{Liquidityt})$, with $\alpha1= \alpha1$ and $f (\text{Liquidityt}) = \text{Liquidityt}$ (3)

Apply the power rule, $d/d(x) (xn) =n*xn-1$, with $n=1$, in other words $d/d(x) (x) =1$

based on the above rules the equation third is transformed:

$\alpha1* d/d(x) (\text{Liquidityt}) = \alpha1* 1 = \alpha1$ (4)

$d/d(x) (\alpha2*\text{Liquidityt}*\text{Liquidityt-1})$, apply the constant multiple rule. $\alpha2*\text{Liquidityt-1}$

I call it a constant k

$d/d(x) (\alpha2*\text{Liquidityt}*\text{Liquidityt-1})= k* d/d(x)f(X)$, with $k= k*y$ and $f(X) = x$

$d/d(x) (\alpha2*\text{Liquidityt}*\text{Liquidityt-1}) = \alpha2*\text{Liquidityt-1}* d/d(x) (\text{Liquidityt})$, apply the power rule:

$d/d(x) (xn) =n*xn-1$, with $n=1$, in other words $d/d(x) (x) =1$

$= \alpha2*\text{Liquidityt-1}* d/d(x) (\text{Liquidityt})= = \alpha2*\text{Liquidityt-1}$ (5)

$d/d(x) (\varepsilon) = 0$

$d/d(x) (x*'ß) = x * d/d(x) (ß) = X*0= 0$

after derivative transformations formula (1) is transformed:

$\alpha1 + \alpha2 * Liquidity_{t-1} = 0$

$\alpha2 * Liquidity_{t-1} = - \alpha1$

$Liquidity_{t-1} = - \alpha1 / \alpha2$