

HOW TO EVALUATE FINANCIAL LIQUIDITY OF A COMPANY USING THE DISCRIMINANT ANALYSIS

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Abstract

In this paper authors analyse the problem of liquidity evaluation in a company and come to the conclusion that there are many approaches to this phenomena and it is difficult to conclude if the company situation in this field is good or not. Managers can wait until the bankruptcy moment when it is known for sure that there is no liquidity in a company or they can check it and act earlier. Many companies are falling and many are operating on the edge since managers are not able to focus on every liquidity aspect simultaneously. With the model proposed in this paper, based on the discriminant analysis, it is possible to evaluate the company liquidity situation and improve it if necessary.

Keywords: Liquidity, discriminant analysis, profitability

Introduction

Liquidity is a complicated and complex phenomenon associated with the time structure of assets, efficiency of operations and profitability. Usually this problem is not discussed in a complex manner connected to profitability, cost of capital and risk associated with working capital management. Liquidity management and its relationship to profitability, debt and investing makes it one of the main areas where key decisions are taken for the enterprise. In the literature we can distinguish several approaches to liquidity. Analysis of the structure of assets allows to determine the level of liquidity in terms of how easy assets can be converted to cash, wherein the cash themselves have a highest degree of liquidity. The second approach is to analyze the ratio of current assets to current liabilities, taking into account the level of net working capital. This approach is considered to be the most classical and is also used for the evaluation of the condition of the company and the risk of bankruptcy. Another approach is to assess the cash conversion cycle as a dynamic measure related to the rate of circulation of cash.

Liquidity can also be measured as cash flow from operating activities. Liquidity assessment is possible in relation to the objectives of the company. One of them is to achieve such a profitability, which covers the cost of capital and generates added value. Obtaining the cheapest capital on the market, accurate investment decisions, both in fixed assets and working capital are important elements of liquidity management.

The variety approaches to define and measure liquidity and its essence in the financial management of enterprises led the authors to develop such a measure that takes into account all the above-mentioned approaches to liquidity in one meter defining liquidity as good or bad. The purpose of this paper is to analyze the concept of liquidity and ways to measure it in terms of profitability. Altman Z-score model has inspired the construction of the indicator, which allows to determine the status of company's liquidity through various measures in relation to the profitability and cost of capital. Therefore, the hypothesis will be verified here that the measure based on discriminant model can satisfactorily indicate the liquidity of the company, and the level of liquidity can be defined as good or bad in relation to the profitability compared to the weighted average cost of capital.

Problem Overview

The academicians have been trying to determine the liquidity and managers use proposed technics to make companies profitable enough to satisfy investors. The current and quick ratios have been recognized as the traditional measures of a firm's liquidity. Both these ratios are characterized as static and have been questioned for their appropriateness (Largay and Stickney, 1980). To overcome this static feature, other researchers have recommended more dynamic liquidity measures such as the cash conversion cycle, (Hager,1976, Richards and Laughlin, 1980), the lambda (Emery,1984), the net liquid balance (Shulman and Cox, 1985). Since the decade of the '80s the cash conversion cycle (CCC) has been recommended as the most appropriate liquidity measure [(Richards and Laughlin (1980), Nordgrem (1981), Kamath (1989), Moss and Stine (1993), Lyroudi and McCarty (1993), Gallinger (1997), Apergis,]. The cash ratio (CaR) was determined by Papaioannou et al. (1992) and Deloof (2001) and the higher this indicator, the more liquid a company is. Bernstein (1985) suggested free cash flow from operations as the best liquidity measure. The target level of cash can be determined by models based on knowledge of the transactions carried out in the company. Baumol model (1952) allows to determine the optimal level of cash at a steady and predictable environment. In turn, the Miller-Orr model (1966) allows to determine the optimal cash balance in a changing and complex environment of company, when the projected cash flows are uncertain.

Shilling (1991) advised cash conversion cycle as the best liquidity measure calling it the Net Liquidity Float because it measures the float associated with the time that company resources (i.e. cash) are invested in current assets offset by the float associated with the time that the investment is being financed by trade credit. Nobanee and AlHajjar (2009b) recommended more accurate measures of working capital management, such as the optimal cash conversion cycle, the optimal operating cycle, and the optimal net trade cycle, based on the results of their research indicating a significant negative impact of the cash conversion cycle and the payables deferral period on the firm's profitability. This can imply that lengthening the payables deferral period hurts the firm's credit reputation and probably reduces its suppliers, thus reducing its sales and its profitability. On the other hand, there was a significant and positive impact of the receivables conversion period and the inventory conversion period on profitability, in contrast to a majority of studies. This can imply that by shortening the inventory conversion period, the stock out costs of inventories may increase, hence, sales will decrease and profitability will be reduced. Reducing the receivables conversion period causes a reduction also in the firm's profitability, because the company might lose its good credit customers, hence it will have less sales, reduced revenues and fewer profits. Moreover the quick ratio was negatively related to profitability. McCell and Lipman (1986) presented a precise definition of liquidity in terms of time until an asset is exchanged for money. Whereas academic economists do not possess a definition of liquidity as a measurable concept, other workers in the area casually respond that liquidity is the length of time it takes to sell an asset. Despite of so many approaches each of them is important and that is why the authors of this paper decided to use already defined liquidity measurement for assessing the liquidity position of a company.

The problem of liquidity corresponds to the bankruptcy. John (1993) states that a general view of financial distress is that it results from mismatch between the available current assets and its financial obligations. Mechanism for dealing with financial distress rectify the mismatch by reconstructing the assets structure or contracts obligations. The Altman Zeta Score (2000) deals with the probability of company failure therefore this solution inspired authors of this paper to use the Altman methodology for the liquidity assessment.

We have to remember, that liquidity is not only connected to the bankruptcy but also it allows the company to develop. Almeida et al. (2004) modeled a firm's demand for liquidity to develop a new test of the effect of financial constraints on corporate policies. The effect of financial constraints is captured by the firm's propensity to save cash out of cash flows (the cash flow sensitivity of cash).

Profitability is recognized as a goal of company operations (the classical concept). There are many papers analyzing the relationship between the liquidity and profitability. Filbeck and Krueger (2005) examined the working capital management between industries and found that profitability increased due to lower financing costs that occurred because the firms decreased their current assets, as a means to finance their expansion instead of issuing more debt. Garcia-Teruel and Martinez-Solano (2007) examined the effects of working capital management on the profitability. Their results indicated that when the cash conversion cycle was reduced the firm's profitability increased. Managers can increase their firm's value and their profitability by reducing their inventories and the number of days accounts receivable are outstanding, hence, reducing their receivables and their cash conversion cycle. Chakraborty (2008) examined the relationship between working capital management and firm profitability for a sample of Indian companies. He found out that working capital was negatively related to profitability and that an investment in working capital was necessary to keep the firm operating, thus there is a positive relation between working capital and firm profitability. Singh (2008) supported that findings by statement that the inventories were the most crucial variable in working capital management and the firm's profitability, so they should be managed carefully and efficiently. Dash and Hanuman (2009) stated in their research that there was a negative relationship between liquidity as expressed by the current ratio and profitability as expressed by the profit margin ratio. Nobanee and AlHajjar (2009a) studied the relationship between working capital management represented by the cash conversion cycle, the firm profitability represented by the operating income to sales ratio and operating cash flows measured by the operating cash flows to sales ratio. They found that there was a significant and negative relationship between the cash conversion cycle and the firm's profitability, as well as with the receivables conversion period and profitability. There was a significant and positive relation between the inventories conversion period and profitability, which implied that as the inventory conversion period increased, the operating income to sales ratio increased and the reverse. Reduced sales could cause lower revenues, thus lower profits. There was also another unexpected result, not consistent with what the authors hypothesized. The payables deferral period was negatively and significantly associated with the firm profitability, instead of the expected positive relationship. This implied that by delaying to pay its accounts payable, the company damaged its credit reputation and ended up with bad performance and lower profitability. Regarding the relation of the cash conversion cycle and the firm's operating cash flows there was a negative relationship. The receivables conversion period had also a negative impact on the operating cash flows, as well as the

payables deferral period, while the inventories conversion period had a positive impact. Nobanee and AlHajjar (2009c) studied the relationship between the cash conversion cycle and profitability and they found it negative. In other words, in order to increase the company's profitability the cash conversion cycle should be decreased, either by shortening the receivables conversion period or the inventories conversion period, or by lengthening the payables deferral period. The profitability variable, return on investments (ROI), was negatively related to the receivables and inventories conversion periods as well as the cash conversion cycle and positively related to the payables deferral period. The authors concluded that the Japanese firms were more efficient in their working capital management. Desai and Joshi (2011) investigated the relationship between working capital management and firm profitability for a sample of Indian companies. As a measure of working capital management they used the cash conversion cycle. They applied regression analysis and found that there exists a strong, significant negative relation between the cash conversion cycle and profitability. Therefore, the firm's managers should try to reduce the length of their company's cash conversion cycle in order to increase profitability and eventually, create value for their firm by having an optimal level of cash conversion cycle. Eljelly (2004) in his study empirically examined the relation between profitability and liquidity, as measured by current ratio and cash gap (cash conversion cycle). Using correlation and regression analysis the study found significant negative relation between the firm's profitability and its liquidity level, as measured by current ratio. This relationship is more evident in firms with high current ratios and longer cash conversion cycles. At the industry level, however, the study provided the conclusions that the cash gap is of more importance as a measure of liquidity than current ratio that affects profitability.

Kim et al (1998) modeled the firms' decisions to invest in liquid assets. They stated that the optimal level of liquidity is determined by a tradeoff between low return on liquid assets and benefit on minimizing costly external financing. They proposed a model predicting that the optimal investment in liquidity is increasing in the cost of external financing, the variance of future cash flow, and the return on future investment opportunities, while it is decreasing in the return differential between the firm's physical assets and liquid assets. This problem was also discussed by Huberman (1984). A study on the Polish capital market (Bolek and Wolski 2012) indicates that investors prefer profitability than liquidity and therefore managers should take this information into account when making decisions related to liquidity. The measures of liquidity and profitability are so different in every research that it is difficult to compare the results between countries and develop universal liquidity management model.

Research Methodology

Authors of this paper propose a practical solution and present the model based on discriminant analysis to indicate the liquidity as bad or good linking it to the profitability measured by Return on Assets (ROA) less Weighted Average Cost of Capital. If a company generates ROA higher than Weighted Average Cost Of Capital it means that liquidity management based on chosen ratios is good since the company is able to cover costs of capital. On the other hand if the return is lower than the cost of capital it means that the expectations of investors and requirements of debtors are not satisfied and the reason maybe the bad liquidity.

The inspiration to build one model assessing the liquidity of company came from the bankruptcy models. The discriminant analysis was proposed by Altman (1968) to overcome the subjective ratio-analysis connected to the company performance. The purpose of Altman's paper was to attempt an assessment of quality ratio analysis as an analytical technique in assessing bankruptcy potential of firms. He noticed that the works of Foulke (1961), Smith and Winakor (1933), Hickman (1958), Merwin (1942), Beaver (1967) and Tamari (1966) established certain important generalizations regarding the performance and trends of particular measurements. The adoption of their results for assessing bankruptcy potential of firms, both theoretically and practically is questionable. The separate ratio analysis can be confusing bringing signals that they are contradictory and we usually do not know which ratio is more important and how should the weights be objectively established. The same problem is with liquidity indicators while we do not know which ratio is the most important for the managers decisions.

The multiple discriminant analysis (MDA) was chosen by Altman as the appropriate statistical technique that has been utilized in a variety of disciplines since its first application. Walter (1959) utilized the MDA model to classify high and low price earnings ratio firms, Smith (1965) applied the technique in the classification of firms into standard investment categories. There were some more MDA applications that time: Wall and Duning (1928), Cochrane (1964) and Myers and Forgy (1963). In more recent times MDA was also used by Altman et al (1994) to analyze the comparison between traditional statistical methodologies for distress classification and prediction, i.e., linear discriminant (LDA) or logit analyses, with an artificial intelligence algorithm known as neural networks (NN). Blum (1974) constructed the Falling Company Model to aid in assessing the probability of business failure. Taffler (1982) identified British companies at risk of failure and raised a number of issues related to the use of multivariate statistical techniques in the finance area. Ramanujam et al. (1986) employed the discriminant analysis to evaluate the ability of specified in the paper dimensions to distinguish between more and less effective planning systems,

using three different criteria of planning effectiveness. The MDA model was used by Koh and Killough (1990) in the assessment of the going-concern status of an audit client. Authors constructed an objective, statistical classification model and demonstrated how this model can help the auditor in making going-concern judgments. Barnes (1990) focused on predictions of takeover targets in the U.K. by means of multiple discriminant analysis. He stated that the use of accounting data for predictive purposes is at the heart of financial decision especially in case of the failure prediction. Barnes (2000) in his next study examined whether multivariate models using published financial data have predictive accuracy to successfully identify targets, thereby earning excess stock market returns.

MDA is a statistical technique used to classify an observation into one of several groups, dependent upon the observation's individual characteristics and the results appear as bankrupt non-bankrupt or good and bad liquidity in our proposal. After the groups are established, data are collected in groups and MDA attempts to derive a linear combination of these characteristics that best discriminates between established groups. There are some advantages of MDA: the technique considers an entire profile of characteristics common to the relevant firms, as well as the interaction between properties, reduces of the analyst's space dimensionality. The discriminant function transforms individual variable values to a single discriminant scoring to the fundamental work of Altman it is given by the equation:

$$Z = v_1x_1 + v_2x_2 + \dots + v_nx_n \quad (1)$$

. where: v – discriminant coefficients, x– independent variables.

The MDA computes the discriminant coefficients, while the independent variables are the actual values. While building the model it is necessary to select the predictive variables carefully. It is another advantage of this model that the number of ratios are limited and constrained to the amount of significant ones. Combinations of ratios can be analyzed together in order to remove misclassifications observed in traditional analysis.

The MDA was criticized by Joy and Tollefson (1975) and Eisenbeis (2012) who stated that it suffers from methodological or statistical problems that limit the practical usefulness of their results. It is because the financial data that seems to be more problematic and the reasons are: the distribution of variables, the group dispersions, the interpretation of the significance of individual variables, the reduction of dimensionality, the definitions of the groups, the choice of the appropriate a priori probabilities and costs of misclassification, the estimation of classification error rates. It should be noted that the variables used in the discriminant analysis should have a normal distribution (Eisenbeis, 1977). The authors using a database of more than 1000 observations assume a priori that the values of the general

population have a normal distribution as the sample selected from the population.

Authors of this paper use the Altman's methodology to assess the liquidity of companies and build one liquidity measure. The process of selecting the final variable to the discriminant classification with respect to the difference ROA-WACC is based on a series of selection factors. The authors analyzed the level of individual indicators correlation with a difference of ROA-WACC, then they take into account the significance of differences in average levels of indicators in the analyzed groups (based on the equality of means test group Wilks' lambda). In addition, according to the authors, selected group of variables should incorporate all possible information regarding the company's liquidity. Such a model construction allows the inference based on all aspects of financial liquidity of companies, allowing to create a universal measure of liquidity. The authors also tried to avoid co-linearity of variables selected for the model based on the analysis of their mutual correlation based on the Pearson correlation coefficient. Variables strongly correlated with each other (negative correlation <-0.6 and positive correlations > 0.6) were rejected. However, construction of indicators often means a common denominator implying a certain level of alignment. According to what Welfe (2009) claims, construction of a model in this way is possible but the possibility of interpreting the estimated parameters for the exogenous variables with the ceteris paribus clause should be rejected. The threat of this type of co-linearity, in the final selected group of variables occurs in the case of the Asset Structure Ratio and the Cash Ratio, because their structures contain a common denominator. Selected indicators are calculated as follows.

Quick Ratio (QR) is given by the formula.:

$$QR = (CA - I - SP) / SL \quad (2)$$

where: CA – current assets, I – inventory, SP – short-term prepayments, SL – short-term liabilities.

Asset Structure Ratio (ASR) is given by the formula:

$$ASR = CA / TA \quad (3)$$

where: AT – total assets.

Working Capital to Total Assets Ratio (WAR) is given by the formula:

$$WAR = WCN / TA \quad (4)$$

where: WCN – net working capital, TA – total assets.

Short-term Liabilities Deferral Period (DSL) is given by the formula:

$$DSL = SL / S * 365 \quad (5)$$

where: S – sales.

Cash Ratio (CaR) is given by the formula:

$$CaR = C/SL \quad (6)$$

where: C – cash and short-term investments.

Cash Conversion Cycle (CCC) is given by the formula:

$$CCC = I/COG * 365 + AR/S * 365 - SL/COG * 365 \quad (7)$$

where: AR – accounts receivables, COG – costs of goods sold.

Since there are some approaches to calculate CCC and turnover ratios itself, short-term liabilities deferral period DSL was calculated with sales as denominator but the same measure, as a component of CCC, was calculated with costs of goods sold. Different combinations were analyzed and those ratios where significantly correlated to the profitability in our model.

Results

In order to verify the theoretical considerations, research on the Warsaw Stock Exchange have been carried out. The study was done using data from non-financial companies in the period 2004-2012. The first step was to calculate the liquidity ratios of potential importance for the development of the company's return. The next step was to calculate the cost of equity using CAPM (beta derived from the Damodaran database). For the risk-free rate of return the yield on 52-week treasury bills was taken into account, while the expected rate of return on the market was taken as 10 year average rate of return of WIG market index. Cost of debt was calculated as the ratio of interest to the interest-bearing liabilities. As the cost of liabilities we assumed the financial costs of the company's income statement, net of loss on sale of investments and loss on revaluation of investments. The final step was to calculate the ROA for every observation and compute the difference between ROA and WACC. After the final elimination of observations for which it was not possible to calculate various indicators or there was lack of the cost of capital, 1,132 observations from 293 companies were left and taken for testing.

On the basis of the data presented in Table 1 it should be noted that the average value of the liquidity ratios clearly differ in profitable and unprofitable companies.

Table 1. Average ratio values

Group	QR	ASR	WAR	DSL	CaR	CCC
ROA – WACC <0	0.926	1.158	-0.003	182.225	0.309	-42.438
ROA – WACC >0	1.851	1.296	0.235	74.329	0.777	57.037
All	1.389	1.227	0.116	128.277	0.543	7.299

Source: own study

It should be noted that only the average value of the CCC is higher in the group of companies with a positive difference ROA-WACC and higher CCC means lower liquidity. Other factors indicate lower liquidity in a group of unprofitable companies. For the purposes of the research authors attributed a value of 1 for a positive difference in ROA and WACC and 0 for a negative difference.

By limiting the scope of the variables to 0-1, and bearing in mind the multidimensional nature of the links between measures of liquidity, the authors decided to use the discriminant analysis to identify the relationship between liquidity and profitability. Simultaneous analysis of all liquidity measures allows the estimation of weights for individual indicators. The constructed model is composed of discriminatory weighted liquidity ratios, and thus becomes a universal measure taking into account all aspects of corporate liquidity. The intention of the authors is an indication of discriminatory threshold model, with which it will be possible to assess liquidity. For the "good" level of liquidity authors assume such a configuration of liquidity ratios at which ROA - WACC will be positive. Similarly, for the "bad" level of liquidity authors will take a configuration for which the values of ROA - WACC will be negative. Finally, as an attempt to build the index based on discriminant analysis 180 companies were selected: 90 with positive ROA-WACC (group "1") and 90 with negative ROA - WACC (group "0"). All of the indicators used are characterized by significant differences in the mean values in the groups of companies with positive and negative ROA-WACC. This means that this group of indicators is a good potential classification for the described groups. Discriminant analysis to classify observations according to the criterion ROA-WACC was run and we obtained the following classification model :

$$LS(1) = -0.503 - 0.563 * X_1 + 0.166 * X_2 - 1.798 * X_3 + 0.008 * X_4 + 0.517 * X_5 + 0.001 * X_6$$

where: X_1 – QR, X_2 – ASR, X_3 – WAR, X_4 – DSL, X_5 – CaR, X_6 – CCC.

The assignment of an observation to one of the groups is based on the result of the LS (1). Score lower than 0 assigns observation to the group "1", the result of observation of the above zero assigns it to the "0" group. Despite the impossibility of interpreting the parameters ceteris paribus, we should pay attention to the signs facing the individual indicators. In principle, the classification of observations according to the values of the function LS (1) shows that the lower the overall value of this function, the higher value of ROA-WACC given observation should have .

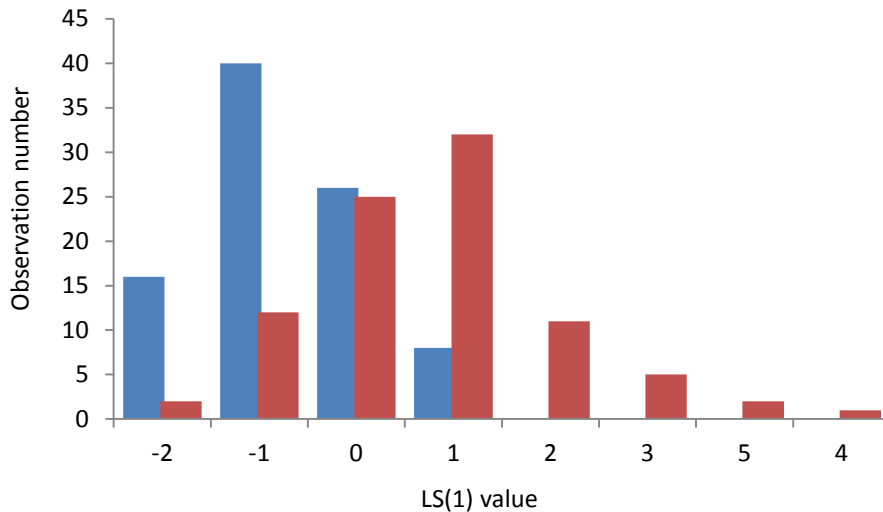
Table 2. Classification results LS(1)

Type	Group	Group affiliation in forecast		Total
		0	1	
Number	0	66	24	90
	1	20	70	90
%	0	73.3	26.7	100
	1	22.2	77.8	100

Source: own study

Based on the results shown in Table 2 it should be noted that only 75.55% of the observations were classified correctly. The relationship between a belonging to a group and value of a function LS (1) is given on a Diagram 1.

Diagram 1. Observation number and value of LS(1) function



Source: own study

Group “0” is given by a red color while the group “1” by the blue one. As can be seen a large part of the observations associated with the group "0" is characterized by a negative value of LS(1) function ,which should be positive. This may mean that companies that were characterized by relatively low values of indicators DSL and CCC and relatively high values of QR and WAR, indicating high liquidity, can be characterized by poor liquidity in the context of profitability. The result indicates the relationship of characters with the parameters estimated for the various liquidity ratios.

In order to identify this problem it was decided to repeat the test of three different groups of selected observations. In the first step, a division of the observations with high and low liquidity levels was made. Observations

characterized by relatively high values of QR, ASR, WAR and CaR and the relatively low values of DSL, and CCC were assigned to the "high liquidity". Observations characterized by relatively low values of QR, ASR, WAR and CaR and also high values of DSL and CCC were classified into groups of those with low liquidity. Then, a division of observations into 3 groups according to the following key was made:

„0” – companies generating a negative ROA-WACC and at the same time assigned as companies with a low level of liquidity.

„1” – companies with positive value of ROA-WACC, while assigned as companies with good liquidity by model 1.

„2” – companies with negative value of ROA - WACC, while assigned as companies with a high level of liquidity.

Such a division is connected with the fact that overliquid company and the company with very low liquidity are not bringing satisfactory results to investors.

Authors in the next step selected 60 observations from each group in order to build another classification model. Table 3 shows the mean values of selected indicators of liquidity in three groups of observations as it was mentioned above.

Table 3. Average ratio values

Group	QR	WAR	ASR	CaR	CCC	DSL
"0"	1.116	0.181	1.161	0.233	158.822	243.854
"1"	1.643	0.211	1.235	0.549	57.332	75.375
"2"	3.885	0.366	1.761	2.563	44.781	55.554
All	2.215	0.253	1.386	1.115	86.978	124.928

Source: own study

Table 3 shows that the mean levels of selected indicators differ in each group of observation. In addition, it is worth noting that, as expected, the levels of these indicators point to an average of better and better liquidity in subsequent groups. It is therefore expected that the companies of the group "2" on average will be characterized by higher levels of indicators CR, WAR, ASR and CaR than those belonging to the group "1" and lower levels of indicators CCC and DSL.

Based on the presented division, the authors conducted two more discriminatory analysis. The purpose of these studies is to determine to what extent it is possible to assign companies in these two groups as profitable and unprofitable. The use of this type of separation, in accordance with our expectations, allow for the elimination of errors of observation by the assignment of LS (1). Based on the selected observation the following discriminatory function was created.

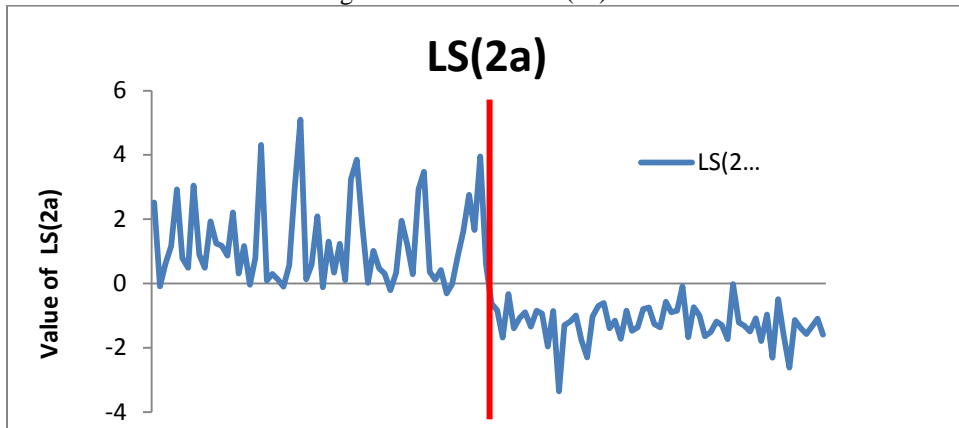
$$LS(2a) = - 1.526 - 0.280 * X_1 - 0.138 * X_2 - 0.408 * X_3 + 0,010 * X_4 - 0.147 * X_5 + 0.006 * X_6$$

$LS(2a) < 0$, means that $ROA - WACC > 0$

where: $X_1 - QR$, $X_2 - ASR$, $X_3 - WAR$, $X_4 - DSL$, $X_5 - CaR$, $X_6 - CCC$.

In the case of LS (2a) function indicators QR, ASR, WAR, and CaR have a positive effect on profitability, while DSL and CCC - negative. These results are consistent with expectations and indicate the low liquidity as the cause of low profitability, and $LS(2a) > 0$ means $ROA - WACC < 0$. Formation of the values of LS (2a) in the analyzed groups of "0" and "1" is given on a Diagram 2.

Diagram 2. Value of LS(2a) function



Source: own study

Observations to the left of the horizontal line are the values for the "0" group, on the right hand - the group "1". As can be observed, the total liquidity ratio with very high efficiency assigns observations with respect to profitability. The effectiveness of model is presented in Table 4.

Table 4. Classification results LS(2a)

Type	Group	Group affiliation in forecast		Total
		0	1	
Number	0	53	7	60
	1	0	60	60
%	0	88.3	11.7	100
	1	0	100	100

Source: own study

The analysis shows that the model fallible indicated 11.7% of the observations in the group of unprofitable companies. Among the observations of $ROA - WACC > 0$ there was no mistake. A total of 94.2% of the initially grouped observations were correctly classified. This means that compared to the LS(1), the results achieved are significantly better. In addition, identification of the problem of classification model LS(1) proved to be correct.

In a further analysis, we took into account the 120 observations in which there were companies belonging to the group "2" and "1". Based on the selected observation the following discriminatory function was created:

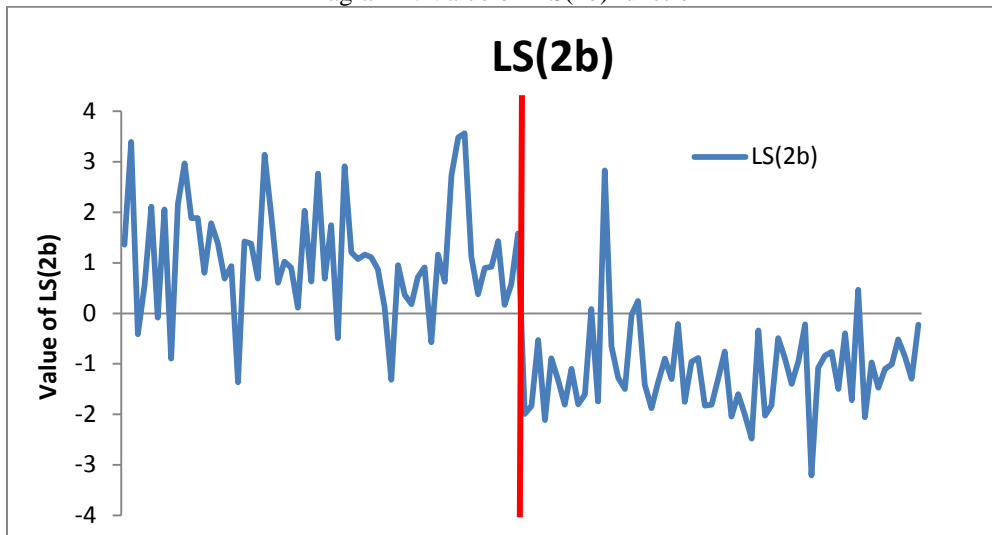
$$LS(2b) = - 1.453 - 0.532 * X_1 - 0.071 * X_2 - 2.952 * X_3 - 0.008 * X_4 - 0.184 * X_5 - 0.011 * X_6$$

$LS(2b) < 0$, means that $ROA - WACC > 0$

where: X_1 – QR, X_2 – ASR, X_3 – WAR, X_4 – DSL, X_5 – CaR, X_6 – CCC

We should pay attention to the signs of the estimated parameters. In the case of $LS(2a)$ function, all indicators have a positive impact on profitability. Only in the case of indicators DSL and CCC the relationship seems to be consistent with the theory. Analysis of the other characters with the parameters estimated for the rest of the indicators may send contradictory signals. To distinguish viable from non-viable companies characterized by surplus liquidity, the importance of these indicators is changing. This means that in the case of unprofitable companies we can expect high liquidity associated with a dynamic liquidity approach. These companies are maintaining a relatively low level of inventories and receivables compared to revenues and may at the same time be characterized by a low static liquidity associated with working capital. Moreover, such a policy limits the ability of sales which may have a direct impact on profitability. One should also pay attention to the relatively low level of current liabilities compared to revenues. This type of situation can indicate a lack of trust in companies and result in the expensive equity capital, which has a direct impact on profitability as described by the authors as $ROA - WACC$.

Diagram 2. Value of $LS(2b)$ function



Source: own study

Diagram 3 shows the formation of values of LS (2b) with respect to belonging to a group "1" and "2". Observations to the left of the horizontal line represent the scoring function for a group of unprofitable companies characterized by a relatively high level of liquidity. It should be noted that compared to the LS (2a), this function has much larger amplitude variations. This may mean that the problem of excessive liquidity is more complicated than for low liquidity. As mentioned in the previous paragraph, a big influence on the assignment of companies are indicators of the CCC and DSL. Assignment errors of observation may therefore result from the occurrence of cases of excessive liquidity in the dimensions beyond the dynamic one. However, the assignment of observation level is better than in the case of the LS (1). The following table shows the effectiveness of the LS (2b).

Table 5. Classification results LS(2b)

Type	Group	Group affiliation in forecast		Total
		0	1	
Number	1	56	4	60
	2	7	53	60
%	1	93.3	6.7	100
	2	11.7	88.3	100

Source: own study

The table shows that the model fallible assigns to 6.7% of the observations in the group of unprofitable companies and 11.7% of the observations in the group of profitable companies. A total of 90.8% of the initially grouped observations were correctly classified.

On the basis of discussions and presented results, it should be noted, that there is a relationship between liquidity and profitability. It is multi-dimensional and possible to include only in the combined analysis of all dimensions of liquidity of the company. We should pay attention to the evolution of profitability in the face of too low or too high overall liquidity (described by varying measures of liquidity). In both cases, the negative impact of extreme levels of liquidity on profitability should be noted. Accordingly, the authors expect that they succeed to create a universal indicator of liquidity consisting of weighted, diverse measures. This can be done in two ways. The first way is to determine the equation of one of already estimated LS (2a), LS (2b), as well as the discriminatory model calculated separately for groups of "0" and "2". In this way we can create a model that will give the opportunity to qualify observations only as "good" and "bad" liquidity.

The second method involves performing discriminant analysis for three groups all together. The estimated model will indicate intervals in which a given observation is characterized by too low, too high, or the

optimum liquidity. Based on the above division into groups, authors developed the final scoring function of liquidity. Characters standing by the following function parameters are consistent, i.e., each dimension of liquidity described by the ratio has the same effect on the direction of LS (2). This means that the function can successfully fulfill the function of ranking for companies in terms of broadly defined liquidity.

$$LS(2) = -0.226 - 0.336 * X_1 - 0.009 * X_2 - 1.664 * X_3 + 0.009 * X_4 - 0.231 * X_5 + 0.007 * X_6$$

where: X_1 – QR, X_2 – ASR, X_3 – WAR, X_4 – DSL, X_5 – CaR, X_6 – CCC.

It is assumed that for $LS(2) > -1.28$ and < 0.74 the company have good liquidity. When the value of function is lower than -1.28 the overliquidity occurs and when it is higher than 0.74 too low liquidity level is recognized. This range allows the correct classification of observations with effectiveness at the level of 92.22%. Among the companies identified by the model as belonging to the group "0", 96.6% was characterized by a negative value ROA-WACC. Among the companies identified by the model as belonging to the group "2", 94.2% was characterized by a negative value ROA-WACC. It must therefore be noted that the final discriminatory model LS (2), allows to achieve the best results in the classification. Furthermore, compared with the previous models, with LS(2) we are able to accurately indicate too high or too low liquidity which in turn means a lack of sufficient profitability from the point of view of investors. The effectiveness of the model fit is presented in Table 6.

Table 6. Classification results LS(2)

Type	Group	Group affiliation in forecast			Total
		0	1	2	
Number	0	59	1	0	60
	1	2	55	3	60
	2	0	8	52	60
%	0	98.33	1.67	0	100
	1	3.33	91.67	5	100
	2	0	13.33	86.67	100

Source: own study

Testing the model on the general population - 1,132 observations led to the appointment of companies with poor liquidity, among which 85.44% was characterized by a negative value of ROA-WACC. This means that the model pointing the company characterized by poor liquidity, giving false signals in less than 15% of cases. It follows that there is a complex relationship between the liquidity and the profitability of companies. Bad liquidity in companies appears when the liquidity ratios in accordance with the theory indicates high liquidity, as well. Among the 97 observations qualified by the model to the "2", 69.07% were those with a negative value

of ROA-WACC. It must therefore be concluded that poor liquidity may also arise where the liquidity ratios are high. The relatively high values of QR, ASR, CaR and WAR and the relatively low value of the CCC and DSL may indicate poor liquidity of companies, and that means a negative ROA-WACC. Among the 267 observations classified by the model to the "0", 91,39% were those with a negative value of ROA-WACC. It should be noted that the model identifies observations with poor liquidity in 91.39% of cases correctly, and also identifies liquidity problems. Relatively low values of QR, ASR, CaR and WAR and relatively high values of CCC and DSL, according to the theory imply poor liquidity and negative ROA-WACC.

On the basis of these results it is clear that there is a relationship between the liquidity of companies and their profitability. Liquidity and its measurability should be based on several indicators simultaneously. Indicators used in the model belong to different groups of liquidity measures. This allows the complexity of the analysis and achievement of optimal results in the evaluation of liquidity. It should also be noted that on the basis of the scoring function LS(2) set out in this article we can create rankings of overall financial performance of enterprises, taking into account each theoretical dimension of liquidity in a weighted manner to give unambiguous results.

Conclusion

There are many approaches to liquidity and it is difficult to conclude if the company situation in this field is good or not. There are many ratios, as it was presented, indicating the liquidity condition. In fact it is difficult to link all of them and create a concise strategy for liquidity management. Managers do not assess the liquidity as bad or good and they treat this phenomena as a final result of decisions taken in every other department in a company. We can wait until the bankruptcy moment when we know for sure that there is no liquidity in a company or we can check it and act earlier. When the company is not able to pay obligations we know that this is the end but this moment is a result of earlier decisions registered in financial documents and we can recognize the worsening liquidity. Many companies are falling and many are operating on the edge since managers are not able to focus on every liquidity aspect simultaneously. Liquidity management is complicated and not as easy as it is said in literature.

To assess the liquidity in a complex manner authors of this paper proposed one model that may be called L-score to evaluate the liquidity situation in a company. Bad liquidity influence the bankruptcy probability but also may make investors to recall their capital if the required rate of return will not be generated by a company. It is not a problem of default

because of not matched cash flows only but also the fact, that shareholders may not want to invest additional capital for extension of business.

Every market is different and the model indicators will have to be found. The ratios taken into account maybe different, and moreover results depend on the correlation between the ROA-WACC and liquidity ratios. The developed world is tending to unification and international trade affects this process, but still one model to assess the liquidity is a sound of future. We believe that this approach to liquidity will be tested by other researchers on other markets to help managers in assessing and making decisions in the liquidity field. Managers can evaluate the company condition connected to liquidity by analyzing different ratios or the proposed model can be used, some simple ratios may be calculated and as a result the manager will know if the liquidity of the company is good or bad. If it is bad it maybe a starting point for reengineering and change in the dynamics of operations and working capital management.

Managers may use LS(2) function, calculate proposed by authors liquidity ratios: quick ratio (QR), working capital to total assets ratio (WAR), asset structure ratio (ASR), cash ratio (CaR), short-term liabilities deferral period (DSL), cash conversion cycle (CCC) and if the result is in the range $LS(2) > -1.28$ and < 0.74 it will indicate a good liquidity. If the value is higher than 0.74 than the liquidity is considered to be too low, and if it is lower than -1.28 than it is too high resulting in the profitability not covering the cost of capital. It is very simple idea and clear as the Altman proposal for the bankruptcy prediction.

Liquidity is not a mainstream problem in literature but it is the cause and the result of a wide business approach. Sales and purchases affect the liquidity the same as the production. Investors take into account the profitability that is affected by working capital strategy and liquidity management policy but they also analyze risk that is connected to the liquidity and indebtedness that in turn affects liquidity. We can consider the liquidity as blood in a company, it is necessary to exist and the optimal flow guarantees development and enables achieving strategy goals.

References:

- Almeida H., Campello M., Weisbach M.S., 2004m The Cash Flow Sensitivity of Cash, *The Journal of Finance*, 59 (4), 1777–1804, DOI: 10.1111/j.1540-6261.2004.00679.x
- Altman E.I., 2000, Predicting Financial Distress of Companies: Revisiting the Z-Score and Zeta® Models, 1-54.
- Altman E. I., Marco G., Varetto F., 1994, Corporate distress diagnosis: Comparisons using linear discriminant analysis and neural networks (the Italian experience), *Journal of Banking and Finance*, 18(3), 505-529.

- Apergis, N., Lyroudi, K., McCarty, D., 2007, The Role of Liquidity in Terms of Profitability and Indebtness: A Panel Cointegration and Causality Approach, *Asian-African Journal of Economics and Econometrics*, 7 (1-2), 1-19.
- Barnes P., 2000, The identification of U.K. takeover targets using published historical cost accounting data Some empirical evidence comparing logit with linear discriminant analysis and raw financial ratios with industry-relative ratios, *International Review of Financial Analysis*, 9 (2), 147-162.
- Barnes P., 1990, The Prediction of Takeover targets in The U.K. Means of Multiple Discriminant Analysis, *Journal of Business Finance and Accounting*, 17 (1), 73-84, DOI: 10.1111/j.1468-5957.1990.tb00550.x
- Baumol W.J., 1952, The transactions demand for cash: An inventory theoretic approach, *The Quarterly Journal of Economics*.
- Baskin, J., 1987, Corporate Liquidity in Games of Monopoly Power, *The Review of Economics and Statistics*, 64, 312-319.
- Beaver, W.H., 1989, *Financial Accounting: an Accounting Revolution*, Prentice – Hall Englewood Cliffs, N.J. USA.
- Beaver W.H., 1966, Financial Ratios as Predictors of Failure, *Empirical Research in Accounting, Selected Studies*, 71 – 111.
- Bernstein L.A., 1985, Again now: How do we measure cash flow from operations? *Financial Analysts Journal*, July-August, 74-77.
- Blum M., 1994, Failing company discriminant analysis, *Journal of Accounting Research*, 12 (1), 1-25.
- Bolek M., Wolski R., 2012, Profitability or Liquidity: Influencing the Market Value. The Case of Poland, *International Journal of Economics and Finance*, 4 (9), 182-190.
- Chakraborty, K., 2008, Working Capital and Profitability; An Empirical Analysis of Their Relationship with Reference to Selected Companies in the Indian Pharmaceutical Industry, *The ICFAI Journal of Management Research*.
- Cohran W.G., 1964, On the Performance of the Linear Discriminant Function, *Technometrics*, 6, 179-190.
- Dash, M. And Hanuman, R. , 2009, A Liquidity-Profitability Trade-Off Model for Working Capital Management. SSRN Working Paper Series.
- Desai, J., Joshi, N., 2011, Effect of Working Capital Management on Profitability of Firms in India. SSRN Working Paper Series.
- Eisenbeis R.A., 1977, Pitfalls in the application of Discriminant Anaysis in Business, Finance and Economics, *Journal of Finance*, 32 (3), 875-901.
- Eljelly, Abuzar M. A., 2004, Liquidity - Profitability Tradeoff: An Empirical Investigation In An Emerging Market, *International Journal of Commerce & Management*. 14 (2), 48-61.

- Emery G., 1984, Measuring Short-Term Liquidity, *Journal of Cash Management*, July/August, 25-32.
- Filbeck, G., Krueger, T., 2005. Industry Related Differences in Working Capital Management. *Mid-American Journal of Business*. 20, 11-18.
- Foulke R.A., 1961, *Practical Financial Statements Analysis*, 5th Ed, McGraw Hill.
- Gallinger, G., Healey, P.B., 1987, *Liquidity Analysis and Management*, editors Reading, Mass. Addison – Wesley Publishing Co..
- Gallinger G., 1997, Drop the Current Ratio – Pick Up the CCC, *Business Credit*. May.
- Garcia-Teruel, P.J., Martinez-Solano, P., 2007, Effects of Working Capital Management on SME Profitability. *International Journal of Managerial Finance*, 3 (2), 164-177.
- Hagan M., Menhaj M., 1996, Training feedforward networks with the Marquardt algorithm, *IEEE T. Neural Network*, 5, 989-993.
- Hager H.C., 1976, *Cash Management and Cash Cycle*. *Management Accounting*, 19-21.
- Hickman W.B., 1958, *Corporate Bond Quality and Investor Experience*, Princeton University Press.
- Hush D., Horne B., 1993, Progress in supervised neural networks. What's new since Lipmann?. *IEEE Signal Processing Magazine*, 10 (1), 8-39.
- John T.A., 1993, Accounting Measures of Corporate Liquidity, Leverage, and Costs of Financial Distress, *Financial Management*, 22 (3), 91-100.
- Johnson, J.M., Campbell, D.R., Wittenbach, J.L., 1980, Problems in Corporate Liquidity, *Financial Executive*, March, 44-53.
- Jose M. L., Lancaster C., Stevens J.L., 1996, Corporate Returns and Cash Conversion Cycle,. *Journal of Economics and Finance*, 20 (1), 35-48.
- Joy O.M., Tollefson J.O., 1975, On the Financial Applications of Discriminant Analysis, *Journal of Financial and Quantitative Analysis*.
- Kamath, R., 1989, How Useful are Common Liquidity Measures? *Journal of Cash Management*, January/February, 24-28.
- Kim C.S., Mauer D.C, Sherman A.E., 1998, The Determinants of Corporate Liquidity: Theory and Evidence, *Journal of Financial and Quantitative Analysis*, 33, 335-359.
- Koh H.C., Killough L.N., 1990, The Use of Multiple Discriminant Analysis in The Assessment of The Going-Concern Status of An Audit Client, *Journal of Business Finance and Accounting*, 17 (2), 179-192.
- Lippman S.A., McCall J.J., 1986, An Operational Measure of Liquidity, *The American Economic Review*, 76 (1), 43-55.
- Lin C.T., Lee C.S., 1996, *Neural fuzzy systems. A neuro-fuzzy synergism to intelligent systems*. Prentice Hall, New Jersey, USA.

- Lyroutdi, K., McCarty D., 1993, An Empirical Investigation of the Cash Conversion Cycle of Small Business Firms, *Journal of Small Business Finance*, 2 (2), 139-161.
- Lyroutdi K., Lazaridis Y., 2000, The cash conversion cycle and liquidity analysis of the food industry in Greece, papers.ssrn.com.
- Maness T.S., Zietlow J., 2002, *Short-Term Financial Management*. Second Edition, Thomson Learning, 3-45.
- Merwin C., 1942, *Financing Small Corporations*, New York, Bureau of Economic Research.
- Miller M.H., Orr D., 1966, A Model of the Demand for Money by Firms, *The Quarterly Journal of Economics*.
- Moss, D.J. and B. Stine, 1993, Cash Conversion Cycle and Firm Size: A Study of Retail Firms. *Managerial Finance*, 19 (8), 25-34.
- Myers H., Forgy E.W., 1963, Development of Numerical Credit Evaluation Systems, *Journal of American Statistical Association*, 50, 797-806.
- Myers, S.C., Rajan, R.G., 2001, The Paradox of Liquidity. *The Quarterly Journal of Economics*, August, 733-771.
- Nobanee, H., AlHajjar, M., 2009a. Working Capital Management, Operating Cash Flow and Corporate Performance. SSRN Working Paper Series.
<http://ssrn.com/abstract=1471236>, pages 12.
- Nobanee, H., AlHajjar, M., 2009b, Optimizing Working Capital Management. SSRN Working Paper Series.
- Nobanee, H. And AlHajjar, M., 2009c, A note on Working Capital Management and Corporate Profitability of Japanese Firms. SSRN Working Paper Series.
- Nordgren, R.K., 1981, The Cornerstone of Liquidity Analysis: Working Capital, *The Journal of Commercial Bank Lending*, April, 11-19.
- Ramanujam V., Venkatraman N., Camillus J.C., 1986, Multi-Objective Assessment of Effectiveness of Strategic Planning: A Discriminant Analysis Approach, *Academy of Management Journal*, 29 (2), 347-372.
- Richards V.D., Laughlin E.J., 1980, A cash conversion cycle approach to liquidity analysis. *Financial Management*, 32-38.
- Schilling G., 1996, Working capital's role in maintaining corporate liquidity, *TMA Journal*.
- Shin, H., Soenen, L., 1998, Efficiency of Working Capital Management and Corporate Profitability, *Financial Practice and Education*. Fall/Winter, 37-44.
- Singh, P., 2008, Inventory and Working Capital Management: An Empirical Analysis. *The ICAI University Journal of Accounting Research*.

- Smith K.V., 1965, Classification of Investment Securities USING MDA, Institute Paper of Purdue University.
- Smith R.F., Winakor A.H., 1935, Changes in the Financial Structure of Unsuccessful Corporations, University of Illinois, Bureau of Business Research.
- Soenen L. A., 1993, Cash Conversion Cycle and Corporate Profitability. TMA Journal, Journal of Cash Management, July/August, 53-57.
- Taffler R. J., 1982, Forecasting Company Failure in the UK Using Discriminant Analysis and Financial Ratio Data, 145 (3),342-358.
- Tamari M. 1966, Financial Ratios as a Means of Forecasting Bankruptcy, Management International Review, 4, 15-21.
- Wall A., Duning W., 1928, Ratio Analysis of Financial Statements, Harper and Row, New York, p.159.
- Walter J.E., 1959, A Discriminant Function for Earnings Price Ratios of Large Industrial Corporations, Review of Economics and Statistics, 41, 44-52.
- Welfe A., 2009, Ekonometria – Metody i zastosowanie, PWE, Warszawa, 150-155.