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A Liquidity Ratio Analysis of Lean vs. Not-Lean Operations

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EXECUTIVE SUMMARY

A study of liquidity analyses examines whether systematic differences exist between the current, quick, and cash conversion cycle ratios of companies that use Lean principles and those that do not.

Companies adopting Lean principles have a primary goal of continuous improvement, which includes focusing on eliminating waste from business processes. A common interpretation of waste is anything that does not add value from the customer's perspective. Properly eliminating waste, such as a buildup of unnecessary inventory costs, will impact the financial statement numbers. Since successful Lean operations can lead to significantly lower costs, improved operating efficiencies, and increased profitability, advocates for Lean contend that successful Lean operations will lead to improved financial measures, including liquidity ratios. We conducted a study to perform liquidity analyses measuring the current, quick, and cash conversion cycle (CCC) ratios to determine whether differences exist between Lean companies and those that are not Lean regarding these ratios.

Assessing a company's liquidity is important to many stakeholders. Consider investors, analysts, creditors, auditors, and vendors. Investors and analysts perform liquidity analyses to determine a company's ability to generate cash flows to meet current operating demands. Creditors often incorporate minimum liquidity levels into loan covenants. Auditors perform liquidity analyses when analyzing going-concern issues. And vendors often rely on liquidity analyses when setting credit

terms and evaluating a customer's ability to pay for purchased goods. A declining liquidity position can indicate a company is under financial duress and potentially at a greater risk of bankruptcy. Knowing whether systematic differences exist for these three ratios between Lean companies and those that are not Lean could have an impact on those various assessments.

Of interest in our study is the CCC, a relatively unknown liquidity ratio that research has suggested gives powerful insight into a company's liquidity position.[1] When performing liquidity analyses, the most common financial ratios used are the current ratio and the quick ratio. These easily computed ratios are based on current assets and liabilities at a specific moment in time. Unlike these static measures of liquidity, the CCC incorporates the element of time into its calculation. With an increasing emphasis on risk assessment and management in the business world, stakeholders need reliable measures of liquidity to help understand and manage vulnerabilities.

Our study used a matched-pairs design, matching Lean companies with those that are not Lean, and assessed whether differences exist regarding the current, quick, and CCC ratios. While there was no significant difference regarding the static measures of liquidity (current and quick ratios), results indicated that Lean companies produced a significantly more favorable result on the CCC ratio than those that are not Lean.

BACKGROUND AND LITERATURE REVIEW

Many accounting information users rely on ratio analysis for internal and external purposes. Liquidity analysis examines a company's ability to meet its short-term obligations. The current ratio and the quick ratio (also called the acid test ratio) are two of the most common liquidity analyses. To calculate the current ratio, divide current assets by liabilities. The quick ratio is a similar but more conservative version of the current ratio. It is calculated by dividing quick assets (cash, short-term investments, and current receivables) by current liabilities. When evaluating the current and quick ratios, a higher value is generally better, but too high a value could indicate a company is using assets inefficiently.

Although these ratios are easy to compute, they represent a single specific moment in time. Using these static performance measures has its disadvantages since they are subject to manipulation, can be difficult to interpret, and do not measure the length of time to convert current assets into cash or the length of time to pay current liabilities.

Verlyn Richards and Eugene Laughlin, professors who worked in the College of Business Administration at Kansas State University, suggested the CCC approach to liquidity analysis at the time of their study in 1980.[2] The CCC remedies many limitations of static measures of liquidity analysis "by reflecting the net time interval between actual cash expenditures on a company's purchase of productive resources and the ultimate recovery of cash receipts from product sales, establishes the period of time required to convert a dollar of cash disbursements back into a dollar of cash inflow from a company's regular course of operations."[3] The CCC ratio measures the length of time it takes the company to sell inventory, collect receivables, and pay its accounts. The CCC ratio is expressed as:

CCC = Days' Inventory Outstanding +
Days' Receivables Outstanding —
Days' Payables Outstanding

The expanded version is:

CCC = [Average Inventory / (Cost of Goods Sold / 365)] +
[Average Accounts Receivable / (Net Sales / 365)] —
[Average Accounts Payable / (Cost of Goods Sold / 365)]

The first two parts of the CCC formula measure the number of days a company takes to convert inventory to sales and collect on credit sales. The third measures the days to defer payment of its accounts payable. A shorter CCC (i.e., a lower relative value) indicates a more liquid working-capital position. It is even possible to have a negative CCC, which indicates that a company, on average, is able to purchase inventory, sell inventory, and collect the resulting receivable before it pays the corresponding payable from the inventory purchase.

According to Richards and Laughlin, relying on static

balance sheet liquidity ratios created an inherent potential for misinterpreting a company's relative liquidity position. They stated that CCC analysis provided more insights for managing a company's working capital position in a manner that will assure the proper amount and timing of funds available to meet a company's liquidity needs.

A study by Li-Hua Lin, Szu-Hsien Lin, Yi-Min Lin, and Chun-Fan You examined performance-based liquidity indicators of two Taiwanese companies over a 10-year period.[4] The researchers examined the companies' financial data from 1996 to 2005 and calculated their current ratio, quick ratio, and CCC. The findings suggested that CCC indicators better reflect the company's actual short-term debt-paying ability and liquidity. The researchers, however, stated the CCC approach was not without limitations. Primarily, computation of the CCC does not consider certain current liabilities, including interest, wages, and taxes. These issues can have a significant effect on liquidity. Since the current ratio indicators consider all the current liabilities, the researchers advised observing the current ratio and CCC to evaluate liquidity. They concluded that investors, creditors, suppliers, and accounting auditors could increase their understanding of a company's liquidity and working capital management through CCC indicators.

Muhammad Yasir, Abdul Majid, and Zahid Yousaf examined the relationship between the CCC and returns on assets (ROA) in companies within the cement industry in Pakistan.[5] They studied 16 companies from 2007 to 2012. Their results indicated that the length of the CCC influenced the profitability of companies that operated in the cement industry. They concluded that a higher CCC length reduces a company's profitability while a smaller CCC length enhances a company's profitability. These findings suggest that the efficient management of current assets and liabilities, as the CCC measured, can increase a company's profitability positively.

Corey S. Cagle, Sharon N. Campbell, and Keith T. Jones compared Best Buy and Circuit City during the 10 years leading up to Circuit City's bankruptcy in 2008.[6] They noted that Statement of Financial Accounting Concepts No. 5, *Recognition and Measurement in Financial Statements of Business Enterprises*, from the Financial Accounting Standards Board (FASB) describes liquidity as reflecting "an asset's or liability's nearness to cash," yet the current ratio (the most common ratio for assessing liquidity) fails to incorporate a measure of "nearness" to cash. They further pointed out the CCC is a powerful tool for examining working capital management over time, though accounting textbooks have almost completely ignored the CCC. Their conclusion: Investors, creditors, vendors, and accounting professionals should understand how a company manages working capital. To do so, it is vital to be familiar with the CCC.

A study by Jay J. Ebben and Alec C. Johnson investigated the relationship between the CCC and levels of liquidity, invested capital, and performance in small companies over time.[7] These researchers used asset turnover and return on invested capital as measures of performance. The sample, which included 879 small U.S. manufacturing companies and 833 small U.S. retail companies, found the CCC was significantly related to all three measures. Companies with more efficient CCCs were more liquid, required less debt and equity financing, and had higher returns. Their results also indicated that owners and managers of small companies may be reactively managing the CCC and highlighted the importance of small company owners using the CCC as a proactive management tool. Since proactive attention to working capital may help small companies avoid periods of financial distress, the researchers suggested focusing on educating small company owners about the importance of working capital management.

Finally, Manuel L. Jose, Carol Lancaster, and Jerry L. Stevens examined the relationships between profitability measures and the CCC for 2,718 companies from 1974 to 1993.[8] They analyzed data from Compustat by industry classification and company size. Taken as a whole, results indicated a lower CCC was associated with higher profitability for several industries, including natural resources, manufacturing, service, retail/wholesale, and professional services. These findings offered evidence that aggressive working capital management policies that minimize the CCC tend to enhance performance.

LEAN ACCOUNTING

The origins of Lean operations come from Japan, most notably Toyota and the Toyota Production System (TPS).[9] For manufacturers and service providers, Lean describes a way of doing "more and more with less and less—less human effort, less equipment, less time, and less space—while coming closer and closer to providing customers with exactly what they want."[10] Lean accounting and Lean operations represent an improvement upon traditional production and accounting philosophies that came to the forefront throughout the last century. Advocates claim that a successful transformation from a traditional company to one that uses Lean accounting will improve productivity while reducing errors, inventory, lead times, and overall costs.[11]

Supporters of Lean accounting philosophies believe Lean operations provide solutions for problems caused by both traditional batch-and-queue operations and the use of financial accounting practices for management accounting purposes. Transformation from a traditional to a mature Lean company typically takes several years and requires not only a total culture change, but also a commitment from every level of the organization. Ultimately, successful Lean operating practices should impact a company's liquidity measurements positively.

RESEARCH METHODOLOGY AND RESULTS

Our study focused on whether Lean companies experienced different performance on various liquidity ratios than did companies that are not Lean. We examined hypotheses concerning three liquidity ratios:

- The current ratio measured as current assets divided by current liabilities;
- The quick ratio measured as the sum of cash, short-term investments, and accounts receivable divided by current liabilities; and
- The CCC ratio measured as the days' inventory outstanding plus days' receivables outstanding minus days' payables outstanding (see above for expanded version).

To compare Lean companies to ones that are not Lean, each hypothesis used individual company averages for each liquidity measure for five fiscal years of data from 2008 to 2012. The three hypotheses tested are:

H1: Lean companies' current ratios will be equal to the ratios of companies that are not Lean.
H2: Lean companies' quick ratios will be equal to the quick ratios of companies that are not Lean.
H3: Lean companies' CCC ratios will be equal to the CCC ratios of companies that are not Lean.

Due to the extended time that Lean transformations require, we did not include companies in the earliest stages of Lean transformations. James P. Womack and Daniel T. Jones stated, "Three years is about the minimum time required to put the rudiments of the lean system fully in place and two more years may be required to teach enough employees to see so that the system becomes self-sustaining."[12] Accordingly, we did not classify a company as Lean if it had not publicly stated in a 10-K annual report by fiscal year 2009 that it was engaged in Lean operations.

Matched-Pairs Design

Our study used a matched-pairs design, which is appropriate when the sample size is relatively small and heterogeneous for the dependent variable (here, the three liquidity ratios). As Jeffrey A. Gliner and George A. Morgan said in *Research Methods in Applied Settings: An Integrated Approach to Design and Analysis*, "In the matching design, we are trying to make each pair of participants as though they were the same participant by matching on a criterion relevant to the dependent variable."[13]

Since liquidity ratios vary systematically by industry, we matched each Lean company with a company that was not Lean on two measures: their four-digit Standard Industrial Classification (SIC) code and company size (based on total sales revenue for the five-year period). Matched-pairs designs are considered to be repeated-measures designs and, accordingly, use similar statistical procedures.[14] For this study, a within-subjects repeated-measures design is appropriate, where we considered the companies that were not Lean as a pretest control group and the Lean companies as a posttest treatment group.

Tests of Normality

Frequently when using a data set comprised of financial-performance measures, the data is not normally distributed, which is especially true for small sample sizes. We used the Shapiro-Wilk test to test for normality of distribution. For each hypothesis, we tested the five-year average observation values for Lean companies and those that were not Lean for normality. The data for all hypotheses had nonnormal distributions using the Shapiro-Wilk test at $a = 0.013$ or lower. The Wilcoxon signed-rank test is an appropriate statistical procedure to use with nonparametric data.

Wilcoxon Signed-Rank Test

The Wilcoxon signed-rank test is appropriate for matched pairs when:

- There is one independent variable with two levels (here, a Lean company or a company that is not Lean);
- The pairs of participants have been matched on one or more relevant variables (here, the four-digit SIC code and total sales revenue); and
- The dependent-variable data is at least ordinal (here, continuous data) and not normally distributed.[15]

The Wilcoxon signed-rank test incorporates the direction or sign of the differenced observation, then sums the absolute values of each of the signed ranks within each group. For hypothesis testing, we compared the absolute-value sums of the signed ranks that generate a score to a critical value based on the sample size and significance level. This design tests the differences between the respective values within each matched pair. The main inferential question for Wilcoxon tests for each hypothesis was whether the respective financial-performance measures for Lean companies significantly differed from those financial-performance measures for those companies that are not Lean.

Lean/Not-Lean Variable

No reliable database of publicly traded companies currently exists that identifies companies by their Lean or not-Lean status. Therefore, we hand-collected the Lean or not-Lean variable for this study using a multistep process. The preliminary sample consisted of:

- All companies on the Standard & Poor's 500 Composite Index at the time of the data collection;
- All companies on the Russell 2000 (Small-Cap) Index and classified within 38 Global Industry Classification (GIC) subindustries deemed likely to identify Lean companies; and
- All publicly traded companies represented by one or more registrants at each of the 2005-2012 annual Lean Accounting Summits.

For each company within the preliminary identification sample, we used the EDGAR (Electronic Data Gathering, Analysis, and Retrieval) database to examine every 10-K annual report from 1999 through 2014 for the keyword "lean." Ultimately, to designate a company as Lean, a company within the preliminary identification sample of public companies specifically had to use the keyword "lean" in its 10-K reports to refer to its Lean operations and not merely within an executive's brief biography. The company had to use the keyword at least once within fiscal years 2006 through 2014 and for at least two consecutive fiscal years over the 16-year period from 1999 through 2014. In addition, the first such reference had to be no later than fiscal year 2009.

After we identified the Lean companies, we needed to match each of them with an appropriate company that was not Lean. Accordingly, we sorted by total sales revenue (for fiscal years 2008 through 2012) those publicly traded companies that had the same four-digit SIC codes as the companies we previously identified as Lean. Companies from those SIC codes that were of substantially similar size in terms of total sales revenue to the Lean companies then went through a series of tests for matching purposes. The goal of these tests was to identify companies that had not implemented either substantial Lean or Six Sigma practices.

We searched the 10-K reports for each potential company that was not Lean for fiscal years 1999 through 2014 for the keywords "lean," "just-in-time," and "sigma." For a company to move to the next classification tests, it could not have made any material refer-

Table 1: Results of Three Hypotheses

Hypothesis	H1		H2		H3	
Performance Measure	Current Ratio		Quick Ratio		Cash Conversion Cycle Ratio	
Company Type	Lean	Not Lean	Lean	Not Lean	Lean	Not Lean
Mean	2.761	2.623	1.891	1.632	97.958	119.291
Std. Dev.	1.460	1.283	1.232	0.951	49.412	69.885
Minimum	0.974	0.995	0.534	0.137	15.726	28.328
Maximum	8.445	6.180	6.540	4.555	264.947	334.930
n	41		41		41	
Z	-0.343		-1.017		-2.482	
p-value	0.731		0.309		0.013	

ences to any of the three keywords in any of its 10-K reports for the 16-year period. For the remaining potential companies, we conducted searches of both the Lexis-Nexis® Academic database newswire and Google for significant—and therefore disqualifying—Lean and/or Six Sigma activity. Last, a preliminarily matched pair that had the same four-digit SIC code but a significantly different six-digit GIC code from one another, as reported by Compustat, was not ultimately matched to one another.

The final data set for this study included 90 companies made up of 45 matched pairs. We matched one Lean company and one company that was not Lean based on the four-digit SIC code and total sales revenue over the five-year fiscal period from 2008 through 2012. To acquire financial data for each company, we used the Compustat database. Since four companies were missing the necessary data to calculate the financial ratios, the final data set consisted of 41 matched pairs.

THE RESULTS

Table 1 provides results for each of the three hypotheses:

Hypothesis 1, Current Ratio. For the current ratio, Lean companies had a five-year average of 2.76 and now 2.62. The z-score for the five-year average current ratio was -0.343 for a p-value of 0.731. For hypothesis 1, no significant difference existed between the respective average current ratios for Lean companies and companies that were not Lean. Lean companies had a higher average current ratio, but the difference was not statistically significant.

Hypothesis 2, Quick Ratio. For the quick ratio, Lean companies had a five-year average of 1.89, while companies that were not Lean had a five-year average of 1.63. The z-score for the five-year average quick ratio was -1.017 for a p-value of 0.309. For hypothesis 2, no significant difference existed between the respective average quick ratios for Lean companies and companies that were not Lean. Although not statistically significant, Lean companies had a higher average quick ratio than ones that were not Lean.

Hypothesis 3, Cash Conversion Cycle Ratio. For the CCC ratio, Lean companies had a five-year average of 97.96, while companies that were not Lean had a five-year average of 119.29. A shorter CCC is favorable. The z-score for the five-year average quick ratio was -2.482 for a p-value of 0.013. For hypothesis 3, there was a significant difference between the respective average CCC ratios for Lean companies and ones that were not Lean. Lean companies had a lower average CCC ratio than those that were not Lean. The difference, which was statistically significant, indicated Lean companies were more efficient in selling inventory, collecting receivables, and paying accounts.

Liquidity analysis results indicated Lean companies showed financial improvements compared to companies that were not Lean. While not statistically significant, Lean companies did have higher five-year average current and quick ratios than those that were not Lean.

Pointing to more efficient operations, Lean companies also had a statistically significant lower five-year average CCC ratio. Overall, results indicated Lean operations lead to improved performance. We expected these results because successful Lean operations should lead to improved financial-performance measures, including liquidity ratios.

As prior research has shown, the traditional method of liquidity analysis based primarily on the current and quick ratios may not be the most effective approach. While Lean companies did show higher five-year averages on these ratios, these static measures can be difficult to interpret, and results may not always provide the complete picture. In performing a liquidity analysis, the CCC ratio is a powerful tool for examining how a company is being managed over time and can show differences where static measures fail. The CCC ratio can lead to a more thorough analysis of a company's liquidity and help create a more complete picture of working capital. Despite these benefits, typically business stakeholders and most accounting textbooks ignore the CCC ratio. ■

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ENDNOTES

1 Jay J. Ebben and Alec C. Johnson, "Cash Conversion Cycle Management in Small Firms: Relationships with Liquidity, Invested Capital, and Firm Performance," *Journal of Small Business and Entrepreneurship*, 2011, pp. 381-396; Corey S. Cagle, Sharon N. Campbell, and Keith T. Jones, "Analyzing Liquidity: Using the Cash Cycle," *Journal of Accountancy*, May 2013, pp. 44-48, www.journalofaccountancy.com/issues/2013/may/20126764.html; and Li-Hua Lin, Szu-Hsien Lin, Yi-Min Lin, and Chun-Fan You, "The Analysis of Company Liquidity a Using Cash Conversion Cycle Application: Evidence from Taiwan," *Global Journal of Business Research*, 2015, pp. 97-103.
2 Verlyn D. Richards and Eugene J. Laughlin, "A Cash Conversion Cycle Approach to Liquidity Analysis," *Financial Management*, Spring 1980, pp. 32-38.
3 *Ibid.*
4 Lin, Lin, Lin, and You, 2015.
5 Muhammad Yasir, Abdul Majid, and Zahid Yousaf, "Cash Conversion Cycle and its Impact upon Firm Performance: an Evidence from Cement Industry of Pakistan," *Global Business and Management Research: An International Journal*, 2014, pp. 139-49.
6 Cagle, Campbell, and Jones, 2013.
7 Ebben and Johnson, 2011.
8 Manuel L. Jose, Carol Lancaster, and Jerry L. Stevens, "Corporate Returns and Cash Conversion Cycles," *Journal of Economics and Finance*, Spring 1996, pp. 33-46.
9 Jeffrey K. Liker, *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*, McGraw-Hill, New York, N.Y., 2004.
10 James P. Womack and Daniel T. Jones, *Lean Thinking: Banish Waste and Create Wealth in Your Corporation* (revised and updated), The Free Press, New York, N.Y., 2003.
11 *Ibid.*
12 *Ibid.*
13 Jeffrey A. Gliner and George A. Morgan, *Research Methods in Applied Settings: An Integrated Approach to Design and Analysis*, Lawrence Erlbaum Associates, Mahwah, N.J., 2000.
14 *Ibid.*
15 *Ibid.*