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MONITORING ACCOUNTING INFORMATION USING RATIO ANALYSIS AND CONTROL CHARTS

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Abstract

Control charts associated with the statistical quality control of manufacturing processes are proposed as a means to continuously monitor financial processes that “manufacture” financial statements. Financial ratios are normalized to allow comparison of values over time. An example using quarterly data from Compustat is used to demonstrate the potential utility of the approach.

Keywords: Continuous monitoring, control charts, financial ratio analysis

Introduction

Over the past two decades, the proliferation of technology has led to the availability of financial information. Although the timing of financial reporting has not changed significantly, there is currently much being written about increasing the frequency and timeliness of financial reporting and assurance (Vasarhelyi 2002). Generally people agree that increasing the frequency may be useful, but have reservations about the feasibility of the implementation of continuous reporting and assurance. The current research suggests using traditional ratio analysis and extending it with control charts to assist auditors in the identification of patterns in the underlying processes that produce financial statements. Control charts have historically been used for monitoring manufacturing processes and identifying when processes become “out of control”. By visualizing financial ratios, financial information can be monitored with “interesting” patterns being identified. Once interesting patterns are identified, auditors may focus on the underlying processes that generated the financial ratio patterns.

The objective of continuous monitoring is detecting abnormalities as near as possible to the time of occurrence of the underlying event that generated the data. If an error or irregularity occurs, the situation can be corrected, and the effect mitigated. Overall, the purpose for monitoring financial information is to gain confidence in the reliability of the results produced by the financial systems, i.e., the financial systems are operating as intended, through the ability to identify and resolve errors, irregularities, or inconsistencies.

Ratio Analysis

Historically, financial analysts and accountants use financial ratios as a basis to analyze a firm’s position using the firm’s financial statements. The number of financial ratios that can be computed is a function of the number of accounts reported in a firm’s financial statements (van Horne 1980; Welsch et al. 1976). For example, the value of the current ratio (current assets / current liabilities) is an indicator of a firm’s liquidity, the value of the net profit margin ratio (profit after taxes / sales) indicates the profitability, and the total asset turnover (sales / total assets) attests to the utilization of a firm’s assets. When using financial ratios to analyze financial statements, one must be aware of potential seasonal variation. Since in this research we are using control charts (see below) to identify patterns of activity, seasonal variations should not be an issue. In this paper, due to page limitations, we only report a small sample of the possible ratios that could be used to monitor the financial statements.

Control Charts

Manufacturing processes have been monitored through the use of control charts (Shirland 1993). By viewing, metaphorically speaking, financial statement creation as a manufacturing process, control charts can be applied to determine whether the “financial statement creation process” is going “out of control.” If a process is in control, the control chart will appear as if the variation in the control chart is randomly distributed. If a process is out of control, the data will appear to have a pattern or some abnormality. Even if a process is in statistical control, it does not necessarily guarantee that the process will produce a valid or usable product. However, if a process is out of control, the likelihood of the process producing a usable product is low (Shirland 1993).

Through the application of the manufacturing metaphor and control charts, it is possible to identify potential problem areas within the financial statements. Such problems could be due to systems errors, fraud, or accounting irregularities. The charts only serve to raise flags to notify the auditors that additional investigations may be necessary. This implies that the use of control charts to identify potential problems should only be one of the approaches used. As such, control charts may provide auditors a method to monitor information identified as “high risk” to the financial health of an organization.

Methods

The data used to develop the control charts in this paper were collected from Compustat. The authors selected financial information relating to several companies with a history of financial irregularities that have been investigated by the Securities and Exchange Commission. We chose to present in the current paper, information relating to Cendant Corporation. Cendant Corporation currently self-describes as “one of the foremost providers of travel, real estate, vehicle, and financial services in the world” (Cendant 2003). The SEC alleged that Cendant management, made adjustments to quarterly information for over a decade, overstating operating income (SEC 2003). For demonstration purposes, the authors extracted quarterly information for a ten year time period, providing forty data points for each graphic. In practice, an individual monitoring the financial statements ideally should have access to the actual values in a more continuous manner.

**Table 1. Two Years of Values for the Net Profit Margin Ratio for Cendant Corporation
Based on Compustat Quarterly Account Data (April 1991-1993)**

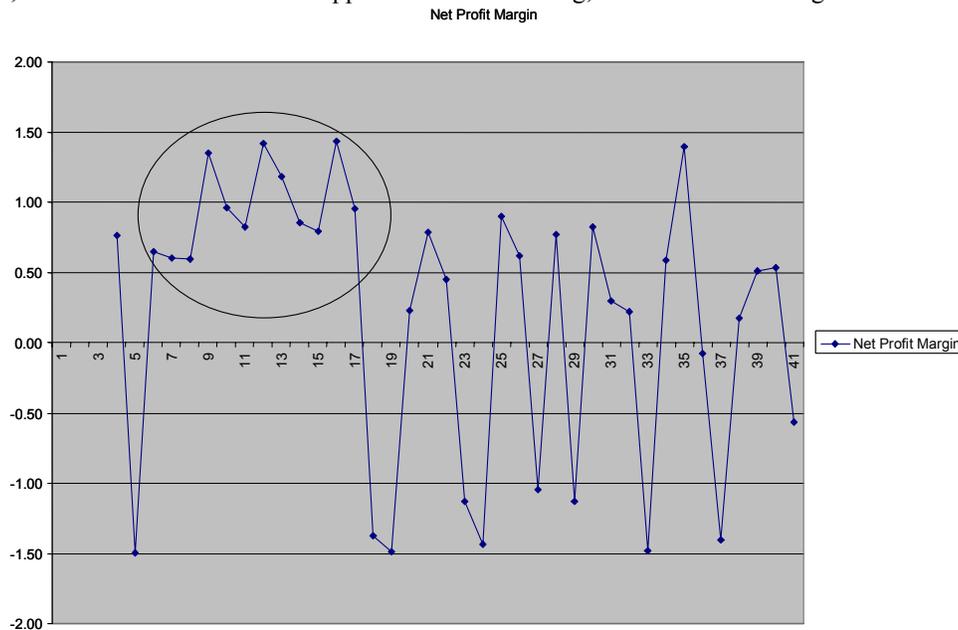
	Apr-91	Jul-91	Oct-91	Jan-92	Apr-92	Jul-92	Oct-92	Jan-93
Actual Account Values								
Sales-Net Qtly	122.877	152.17	157.481	162.167	169.469	173.917	180.532	187.113
Income Before Extra Items Qtly	5.832	8.945	9.634	10.191	-3.64	12.485	13.478	15.049
Assets-Total Qtly	238.871	255.369	269.835	275.922	321.801	325.286	327.928	331.705
Ratio Values								
Net Profit Margin	0.05	0.06	0.06	0.06	-0.02	0.07	0.07	0.08
Total Assets Turnover	0.51	0.60	0.58	0.59	0.53	0.53	0.55	0.56
Moving Averages								
Net Profit Margin				0.06	0.04	0.04	0.05	0.05
Total Assets Turnover				0.57	0.57	0.56	0.55	0.54
Moving Standard Deviations								
Net Profit Margin				0.01	0.04	0.04	0.05	0.05
Total Assets Turnover				0.04	0.03	0.03	0.03	0.02
Z-Score Transformations								
Net Profit Margin				0.76	-1.50	0.65	0.60	0.60
Total Assets Turnover				0.46	-1.48	-0.73	0.02	1.21

As an example, Table 1 gives the first two years worth of values for the Sales, Income, and Total Assets accounts used in the Net Profit Margin and Total Asset Turnover ratios presented (see Actual Account Values in Table 1). First, we calculate the financial ratios of interest (see Ratio Values in Table 1). Second, a moving average of four data periods (quarters) was used to provide the base line for the control chart. In this case, the first period in which a moving average was computable was for Jan 92 (see Moving Averages in Table 1). Third, we used a “z-transformation” of the data to set the base line to zero and standardize the periodic ratios. Next, we computed a moving standard deviation that in conjunction with the moving average could be used to compute a Z-score for each of the “4-period windows.” Examples of control charts using ten years of financial data for the Net Profit Margin and Total Asset Turnover ratios are shown in Figures 1 and 2.

There are many different rules on which to base the control chart analysis. Currently, we are investigating the use of rules regarding runs in z-transformed account values to identify areas for additional investigation. For example, if the z-transformed value of a specific account has a set of seven positive (or negative) values above (or below) the moving average in seven consecutive time periods, the underlying process could be out of control, i.e., the process that updates the accounts could be producing systematic, non-random errors.. The probability of seven values in a row being above (or below) the mean is less than two percent. This is the so-called “rule-of-seven.” In Figures 1 and 2, data points that fall under this rule are identified with an oval. Also, we are investigating other “runs-based” rules including if 10 out of 11, 12 out of 14, 14 out of 17, or 16 out of 20 consecutive points are above (or below) the mean, then the process is probably out of control. Other rules that we are investigating include:

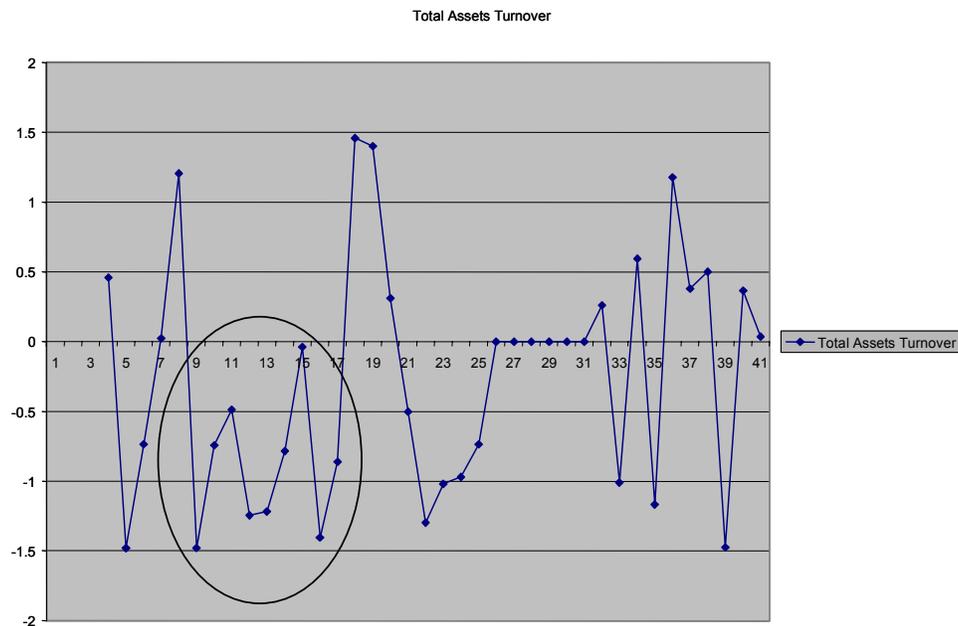
- If an individual point is above (or below) three standard deviations from the mean, then the underlying process is potentially out of control
- If the values trend in the same direction (increasing or decreasing) for seven periods, then it is likely that the underlying process is out of control.
- If the values for two or more periods are greater than two standard deviations ($Z = 2$), but within the actual control limits, then it is likely that the underlying process is out of control.
- If the values for four or more periods are greater than one standard deviation ($z = 1$), but within the actual control limits, then it is likely that the underlying process is out of control.

Through the application of control charts to monitor the ratios, we believe that it is possible to identify problem areas within the financial accounts, in a manner that it has been applied in manufacturing, before the accounts go out of control.



Based on Compustat Quarterly Account Data (April 1991-April 2001)

Figure 1. Control Chart for the Net Profit Margin Ratio for Cendant Corporation



Based on Compustat Quarterly Account Data (April 1991-April 2001)

Figure 2. Control Chart for the Total Asset Turnover Ratio for Cendant Corporation

Conclusion

In this research, we suggest that control charts may provide a way to continuously monitor business and financial processes based on financial ratio analysis. Control charts have been successfully used to monitor manufacturing processes and to identify processes when they become out of control. We believe that they may also be beneficial when monitoring financial processes, by helping identify patterns that may indicate a problem with underlying accounting data. However, there are potential limitations in applying control charts to financial processes. Since this is a new domain for this application, the rules to interpret the charts and identify out of control processes may need to be modified. Alternatively, new rules may need to be developed. Consideration also should be given to the frequency of reporting. For example are standard control charts as useful when monitoring accounting processes at all reporting frequencies, including continuous reporting?

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