

Inventory Turnover Of Fortune 500 Manufacturing Companies After 2001 And Its Relationship To Net Earning

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ABSTRACT

*In order to determine whether the largest United States manufacturers had changed their inventory policies after the terrorist attacks in 2001, averages of inventory turnover ratios of 157 manufacturing companies in the 2002 Fortune 500 list (2001 ranking) calculated for the 3-year pre-2001 (1998 to 2000) period were compared with that of the 3-year post-2001 (2002 to 2004) period in aggregate, by the 2001 Fortune 500 ranking and by industry using paired-samples *t*-tests. Overall results indicate that there is no significant change in inventory turnover before and after 2001. This is in contrast to the significant inventory reduction found in the two decades before 2001 as reported in previous literature. However, the finding in this study that inventory turnover is not related to net earning is consistent with other studies. Possible explanations and areas for future research are also discussed.*

Keywords: inventory turnover; Fortune 500; manufacturing companies; net earning

INTRODUCTION

Since the early 80s, U.S. manufacturing companies have been embracing the Just-In-Time (JIT) philosophy of inventory reduction. Studies have shown that their efforts have generally been quite successful. For example, using data published by the U.S. Census Bureau, Rajagopalan and Malhotra (2001) studied trends in raw materials, work-in-process and finished goods inventory ratios during the period 1961 to 1994 in 20 manufacturing industry sectors and the total U.S. manufacturing sector to determine whether a significant decrease was seen in these ratios. Overall, the analysis provides an encouraging but somewhat mixed picture about the results of U.S. manufacturing inventory-reduction efforts. In a more recent study, Chen, Frank and Wu (2005) examined the inventories of publicly traded American manufacturing companies between 1981 and 2000. They found the median of inventory holding periods were reduced from 96 days to 81 days and the average rate of inventory reduction was about 2% per year. The greatest reduction was found for work-in-process inventory, which declined by about 6% per year, while finished goods inventory did not decline.

However, results of the above studies were based on inventory information of U.S. manufacturing companies before the terrorist attacks on September 11, 2001 (9-11). It is doubtful whether companies continue their inventory reduction efforts in midst of increased uncertainties in their supply chains after 9-11. Phillips (2001) cautions that as a result of the attacks, shippers will face higher costs and fewer options, and some may be forced to redesign their just-in-time supply chains and distribution systems. Sheffi (2001) predicts the impacts of the new era will challenge supply chain managers to adjust relations with suppliers and customers, contend with transportation difficulties and amend inventory management strategies. Therefore, it is likely that U.S. manufacturing companies may have reversed their inventory management strategy from just-in-time to just-in-case to deal with the heightened uncertainties. The main purpose of this research study is to determine whether this is true for the Fortune 500 manufacturing companies which are most likely to be involved and affected by global logistics changes. Another objective is to determine the significance of inventory turnover ratio on a manufacturing firm's net earning.

LITERATURE REVIEW

Inventory turnover ratio is commonly used in JIT research because it is a simple and accurate measure of inventory management performance, which is not dramatically affected by price changes in raw materials, component parts and finished goods (Billesbach & Hayen, 1994). Huson and Nanda (1995) concluded that, between 1980 and 1990, inventory turnover improved by 23.7% for firms adopting JIT compared to only 7.7% for non-adopting firms. Chang and Lee (1995) also indicated that JIT firms achieved higher inventory turnover than non-JIT firms from 1984 to 1990. Because higher inventory turnover is often associated with JIT adoption, Kinney and Wempe (2002) actually used greater improvement in inventory turnover as an indicator to identify JIT adopters. Alternatively, instead of comparing inventory turnover of JIT and non-JIT firms, Vergin (1998) analyzed the changes in inventory turnover ratios, for the years 1986 through 1995, of 427 firms from the Fortune 500 industrial corporations (the 1994 list) and found that the improvement in inventory turnover averaged about 1.5% per year over the 1986-1995 decade. This research study extends the Vergin (1998) study to cover years 1998 through 2006 using the 2002 Fortune 500 list (2001 ranking) of manufacturing firms to determine any significant change in inventory turnover before and after the terrorist attacks in 2001.

DATA AND RESEARCH METHODOLOGY

Initially, 180 manufacturing firms were identified in the 2002 Fortune 500 list (2001 ranking) with the first 2-digit Standard Industrial Classification (SIC) codes between 20 and 39 (Division D—Manufacturing). However, only 157 of these manufacturing firms had complete data available from 1998 to 2006 to be used in this study. Table 1 shows the composition of the 157 manufacturing companies studied.

Table 1: Composition Of Manufacturing Companies In The Studied Sample From The 2002 Fortune 500 List

SIC Code	SIC Code Description	Number of Firms	%
35	Industrial machinery and computers (Computer)	29	18.47
28	Chemicals and allied products (Chemical)	24	15.29
20	Food and kindred products (Food)	19	12.10
37	Transportation equipment (Transport)	17	10.83
36	Electronic and electrical equipment (Electronic)	13	8.28
38	Instruments and related products (Instrument)	9	5.73
29	Petroleum and coal products (Petroleum)	8	5.10
26	Paper and allied products (Paper)	7	4.46
33	Primary metal industries (P-Metal)	5	3.18
25	Furniture and fixtures (Furniture)	4	2.55
27	Printing and publishing (Printing)	4	2.55
30	Rubber and plastic products (Rubber)	4	2.55
34	Fabricated metal products (F-Metal)	4	2.55
23	Apparel and textile products (Apparel)	3	1.91
32	Stone, clay, and glass products (Stone)	3	1.91
24	Lumber and wood products (Lumber)	2	1.27
22	Textile mill products (Textile)	1	0.64
39	Miscellaneous Manufacturing (Misc)	1	0.64
	Total:	157	100.00

For each of the 157 manufacturing companies studied, cost of goods sold and net earning figures were obtained from annual income statements while year-end total inventory figures were obtained from balance sheets for years 1998 through 2006. Then, for each year, each company's annual inventory turnover ratio was calculated by dividing annual cost of goods sold by year-end total inventory as in Vergin (1998). In order to determine any significant change in inventory turnover before and after the terrorist attacks in 2001 and to provide smoothing for any one-year anomalies, averages of inventory turnover ratios of manufacturing companies calculated for the 3-year pre-2001 (1998 to 2000) period were compared with that of the 3-year post-2001 (2002 to 2004) period in aggregate,

by the 2001 Fortune 500 ranking and by industry using paired-samples t-tests which required that the differences had a normal distribution. This requirement was satisfied by performing the 1-sample Kolmogorov-Smirnov (K-S) test on all 157 average differences yielding the K-S Z value of 4.106 which was statistically significant at the 0.01 (2-tailed) level. In addition, for years 1998 through 2006, with net earning as the dependent variable, the significance of inventory turnover ratio was determined in aggregate, by the 2001 Fortune 500 ranking and by industry using simple linear regressions. The studies by ranking were performed by classifying the 157 firms into 3 groups based on their 2001 Fortune 500 rankings—T (top third, 52 firms), M (middle third, 52 firms) and B (bottom third, 53 firms). The studies by industry were performed on firms in each of the 16 2-digit SIC codes which had at least two firms. Table 2 indicates the average 2001 Fortune 500 rankings of manufacturing firms studied in different groupings.

Table 2: Average 2001 Fortune 500 Rankings Of Firms Studied

SIC Code	SIC Code Description	Number of Firms	2001 Ave Rank	2001 S.D. of Rank	2001 C.V.
T	Top third in the 2001 ranking	52	82.80	46.74	0.56
29	Petroleum and coal products	8	152.41	127.53	0.84
24	Lumber and wood products	2	186.50	47.85	0.26
37	Transportation equipment	17	199.36	162.30	0.81
20	Food and kindred products	19	205.89	118.59	0.58
28	Chemicals and allied products	24	227.24	141.35	0.62
36	Electronic and electrical equipment	13	246.07	146.35	0.59
All	All 18 SIC codes	157	253.06	143.70	0.57
M	Middle third in the 2001 ranking	52	259.49	53.27	0.21
38	Instruments and related products	9	260.02	119.71	0.46
25	Furniture and fixtures	4	274.19	142.90	0.52
35	Industrial machinery and computers	29	275.27	136.89	0.50
26	Paper and allied products	7	275.94	163.85	0.59
30	Rubber and plastic products	4	306.57	142.81	0.47
34	Fabricated metal products	4	322.28	71.54	0.22
33	Primary metal industries	5	336.51	123.96	0.37
27	Printing and publishing	4	367.75	81.34	0.22
32	Stone, clay, and glass products	3	374.96	74.67	0.20
23	Apparel and textile products	3	388.40	48.99	0.13
B	Bottom third in the 2001 ranking	53	413.30	46.23	0.11

Ave=Average, S.D.=Standard Deviation, C.V.=Coefficient of Variation

RESULTS AND ANALYSIS OF INVENTORY TURNOVER DIFFERENCES

Table 3 shows the correlations and paired-samples t-test results of 1998-2000 average inventory turnover ratios (A1) and 2002-2004 average inventory turnover ratios (A2). The correlations between A1 and A2 are all positive and are significant in almost all groupings indicating that manufacturing firms which have higher/lower inventory turnovers continue to have higher/lower inventory turnovers. However, only two industries, the petroleum and coal products industry (SIC code 29) and the fabricated metal products industry (SIC code 34), exhibit significant improvements between averages of inventory turnover ratios for the 3-year pre-2001 (1998 to 2000) period and that of the 3-year post-2001 (2002 to 2004) period.

Table 3: Correlations And Paired-Samples T-Test Results Of 1998-2000 Average Inventory Turnover Ratios (A1) And 2002-2004 Average Inventory Turnover Ratios (A2)

SIC Code	SIC Code Description	Number of Firms	Average of A1	Average of A2	Correl of A1 & A2	Ave Ave A2 – A1	T Value
All	All 18 SICs	157	9.03	9.39	0.834**	0.36	0.606
T	Top 3 rd	52	8.60	10.15	0.920**	1.55	1.599
M	Middle 3 rd	52	10.66	9.70	0.947**	-0.96	-0.656
B	Bottom 3 rd	53	7.86	8.35	0.966**	0.49	1.931
35	Computer	29	13.76	12.93	0.803**	-0.83	0.264
28	Chemical	24	4.65	4.94	0.894**	0.29	1.128
20	Food	19	8.85	8.80	0.948**	-0.05	-0.125
37	Transport	17	9.15	10.13	0.871**	0.98	1.565
36	Electronic	13	6.26	6.41	0.311	0.15	0.226
38	Instrument	9	3.91	4.60	0.918**	0.69	2.144
29	Petroleum	8	15.54	18.33	0.819*	2.79*	2.478
26	Paper	7	7.36	7.79	0.762*	0.43	1.100
33	P-Metal	5	6.17	6.72	0.922*	0.55	1.755
30	Rubber	4	5.36	5.41	0.957*	0.05	0.122
34	F-Metal	4	3.71	4.78	0.986*	1.07*	4.991
25	Furniture	4	17.24	17.60	0.959*	0.36	0.271
27	Printing	4	24.40	26.79	0.980*	2.39	1.040
23	Apparel	3	3.73	4.30	0.903	0.57	1.818
32	Stone	3	8.00	8.46	0.969	0.46	0.812
24	Lumber	2	6.40	6.92	1.000**	0.52	0.690

Correl=Correlation,

* and ** denote statistical significance at 5% and 1% levels (2-tailed), respectively

RESULTS AND ANALYSIS OF RELATIONSHIP BETWEEN INVENTORY TURNOVER RATIO AND NET EARNING

For years 1998 through 2006, with net earning as the dependent variable, the significance of inventory turnover ratio was determined in aggregate, by the 2001 Fortune 500 ranking and by industry using simple linear regressions. Tables 4 and 5, respectively, show the 1998-2006 average inventory turnover ratios and average net earnings of manufacturing companies studied in various groupings.

Table 4 indicates that companies in the printing and publishing industry (SIC code 27) has the highest average inventory turnover ratio of 25.79 while the industrial machinery and computer industry (SIC code 35) has the most inventory turnover variation (coefficient variation of 2.33) among all industries. On the other hand, interestingly, the apparel and textile products industry (SIC code 23) has both the smallest average inventory turnover ratio of 4.12 and the least inventory turnover variation (coefficient variation of 0.13). Table 5 illustrates that despite there are substantial disparities in the average net earnings between and within industries, only the stone, clay and glass products industry (SIC code 32) has a negative average net earning in years 1998 through 2006.

The regression results of 1998-2006 inventory turnover ratios and 1998-2006 net earnings are given in Table 6.

Table 4: 1998-2006 Average Inventory Turnover Ratios

SIC Code	SIC Code Description	Number of Firms	98-06 Ave Invent. Turn.	98-06 S.D. of Invent. Turn.	98-06 C.V.
27	Printing and publishing	4	25.79	15.41	0.60
29	Petroleum and coal products	8	17.66	6.82	0.39
25	Furniture and fixtures	4	17.43	8.44	0.48
35	Industrial machinery and computers	29	13.99	32.62	2.33
37	Transportation equipment	17	10.48	5.77	0.55
M	Middle third in the 2001 ranking	52	10.44	22.52	2.16
T	Top third in the 2001 ranking	52	9.87	11.24	1.14
All	All 18 SIC codes	157	9.45	15.04	1.59
20	Food and kindred products	19	8.83	5.29	0.60
32	Stone, clay, and glass products	3	8.49	2.97	0.35
B	Bottom third in the 2001 ranking	53	8.06	6.73	0.84
26	Paper and allied products	7	7.74	1.62	0.21
24	Lumber and wood products	2	6.90	0.94	0.14
33	Primary metal industries	5	6.63	2.92	0.44
36	Electronic and electrical equipment	13	6.19	2.19	0.35
30	Rubber and plastic products	4	5.44	1.43	0.26
38	Instruments and related products	9	5.24	4.13	0.79
28	Chemicals and allied products	24	4.94	2.97	0.60
34	Fabricated metal products	4	4.68	1.54	0.33
23	Apparel and textile products	3	4.12	0.53	0.13

Ave=Average, S.D.=Standard Deviation, C.V.=Coefficient of Variation

Table 5: 1998-2006 Average Net Earnings

SIC Code	SIC Code Description	Number of Firms	98-06 Ave Net Earning (\$M)	98-06 S.D. of Net Earning	98-06 C.V.
29	Petroleum and coal products	8	4111.76	7713.05	1.88
T	Top third in the 2001 ranking	52	2673.65	4701.55	1.76
28	Chemicals and allied products	24	2019.71	2652.73	1.31
20	Food and kindred products	19	1299.09	2200.33	1.69
All	All 18 SIC codes	157	1115.27	3366.30	3.02
35	Industrial machinery and computers	29	1103.79	2069.40	1.87
36	Electronic and electrical equipment	13	893.52	6438.40	7.21
38	Instruments and related products	9	757.49	912.28	1.20
M	Middle third in the 2001 ranking	52	640.79	1248.65	1.95
37	Transportation equipment	17	598.90	2652.14	4.43
24	Lumber and wood products	2	591.36	284.32	0.48
27	Printing and publishing	4	550.92	453.77	0.82
34	Fabricated metal products	4	349.90	610.54	1.74
26	Paper and allied products	7	344.52	625.74	1.82
25	Furniture and fixtures	4	225.36	414.26	1.84
23	Apparel and textile products	3	212.77	184.30	0.87
33	Primary metal industries	5	206.86	1229.06	5.94
30	Rubber and plastic products	4	130.65	577.77	4.42
B	Bottom third in the 2001 ranking	53	57.85	2595.17	44.86
32	Stone, clay, and glass products	3	-343.55	1038.35	-3.02

Ave=Average, S.D. = Standard Deviation, C.V.=Coefficient of Variation

Table 6: Regression Results Of 1998-2006 Inventory Turnover Ratios (X) And 1998-2006 Net Earnings (Y)

SIC Code	SIC Code Description	Number of Firms	Number of Pairs	Beta for Invent. Turn.	T Value
All	All 18 SIC codes	157	1493	0.003	0.108
T	Top third in the 2001 ranking	52	493	-0.012	-0.265
M	Middle third in the 2001 ranking	52	496	-0.015	-0.342
B	Bottom third in the 2001 ranking	53	504	-0.011	-0.236
35	Industrial machinery and computers	29	258	-0.009	-0.147
28	Chemicals and allied products	24	215	-0.412**	-6.605
20	Food and kindred products	19	171	-0.316**	-4.327
37	Transportation equipment	17	159	0.027	0.344
36	Electronic and electrical equipment	13	146	-0.199*	-2.442
38	Instruments and related products	9	88	0.008	0.070
29	Petroleum and coal products	8	82	0.121	1.093
26	Paper and allied products	7	65	-0.284*	-2.348
33	Primary metal industries	5	53	0.441**	3.512
30	Rubber and plastic products	4	42	-0.242	-1.578
34	Fabricated metal products	4	40	-0.486**	-3.430
25	Furniture and fixtures	4	37	-0.030	-0.176
27	Printing and publishing	4	36	-0.111	-0.649
23	Apparel and textile products	3	35	-0.099	-0.574
32	Stone, clay, and glass products	3	26	-0.127	-0.626
24	Lumber and wood products	2	18	0.229	0.939

* and ** denote statistical significance at 5% and 1% levels (2-tailed), respectively

Table 6 indicates that in 5 industries, namely, food and kindred products (SIC code 20), paper and allied products (26), chemicals and allied products (28), fabricated metal products (34) and electronic and electrical equipment (36), the 1998-2006 inventory turnover ratios are negatively correlated with the 1998-2006 net earnings. Only in the primary metal industries (SIC code 33), they are positively correlated.

CONCLUSIONS AND DISCUSSION

In this study, averages of inventory turnover ratios of 157 manufacturing companies in the 2002 Fortune 500 list (2001 ranking) calculated for the 3-year pre-2001 (1998 to 2000) period were compared with that of the 3-year post-2001 (2002 to 2004) period to determine whether the largest United States manufacturers had changed their inventory policies after the terrorist attacks in 2001. Results indicate that there is no significant change in inventory turnover before and after 2001 in aggregate and by the 2001 Fortune 500 ranking. Table 3 shows that only two industries, the petroleum and coal products industry (SIC code 29) and the fabricated metal products industry (SIC code 34), exhibit significant improvements between averages of inventory turnover ratios for the 3-year pre-2001 (1998 to 2000) period and that of the 3-year post-2001 (2002 to 2004) period. This is in contrast to the significant inventory reduction found across industries in the two decades before 2001 (Chen, Frank & Wu, 2005), thereby, suggesting that the largest U.S. manufacturers might have lessened their inventory reduction efforts in response to the disruptive events in 2001. However, in this study, total inventories are used in calculating the inventory turnover ratios and thus it is unknown which inventory component (raw material, work-in-process or finished goods) has been affected the most. Furthermore, results of this study are applicable only at the company level because inventory turnover ratio is determined only for the entire company and not for the different individual units in the company. Therefore, it is likely that while some units in a company lessen their inventory reduction efforts, other units continue their pursuits. The lack of significant improvement in inventory turnover of manufacturers found in this study may be the result of the increasing practice of vendor-managed inventory (VMI) which has a tendency to shift finished goods inventory storage from retailers to manufacturers. Another explanation is that after decades of reducing inventory, the return from further reduction is diminishing. This is evidenced by the finding in this study and other studies (Vergin, 1998; Vastag & Whybark, 2005) that overall, inventory turnover ratio is not related to net earning. Table 6 shows that in five of the six industries, in which they are related, inventory

turnover ratio is negatively related to net earning, thereby, suggesting that reducing inventory too much can also reduce net earning. This is consistent with the current belief that having inventory available where it is needed (being agile) is as important as simply reducing inventory (being lean) (Schonberger, 2003).

SUGGESTIONS FOR FUTURE RESEARCH

The above discussion implies that the finding in this study that the largest U.S. manufacturers have lessened their inventory reduction efforts in response to the disruptive events in 2001 should be considered as exploratory. The following are fruitful areas for future research to verify and strengthen the results:

1. Disaggregating the total inventory will allow the determination of the contributions of its components of raw material, work-in-process and finished goods inventory.
2. Conducting surveys and case studies of companies will provide insights into the inventory policies adopted by different companies and their individual units.
3. The dynamic relationships between manufacturers and retailers are different in different industries and, therefore, the importance of the practice of vendor-managed inventory (VMI) as a factor in determining a manufacturer's inventory policy is likely to be different and is worthwhile to investigate.
4. Similarly, the importance of being agile or being lean can be different in different industries. A manufacturer needs to be more agile in an uncertain environment while being lean is desirable in a stable environment. Guidelines for developing inventory policies which incorporate different mixes of responsiveness and leanness for different environments are needed.
5. In a broader sense, as Craighead et al. (2007) argue that supply chain disruptions are unavoidable and propose that a supply chain with the capability to proactively and/or reactively respond quickly and effectively to correcting the disruptive event is less likely to be severely affected, this study has focused on changing inventory policies and indicates that manufacturers have used additional inventories after the disruptive events in 2001 to achieve this objective. Studies are needed to discover whether companies have also used other means, such as protective capacity planning and better information-sharing, to manage risks in their supply chains and to compare the costs and benefits of different approaches.

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