Keller Graduate School of Management
Tysons Corner Center

Research Problem Report

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Applied Managerial Statistics and Quality (GM533)

by

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Executive Summary. This report describes a statistical research project to determine if the stock prices of any industry sector are rising faster than the Standard and Poor's index of 500 common stocks (S&P 500). It set out to compute market value-weighted indexes for 113 industry sectors that make up the U.S. economy and compare these to the S&P 500 to identify sectors that significantly outperformed the index over a recent six-month period. Two key assumptions of the study were that the growth rates of all industry sectors would be normally distributed and that the S&P 500 index would be close to, or at, the mean of all sectors. Since these two assumptions did not hold, the study was unable to demonstrate that any industry sectors significantly outperformed the index. However, even though it was not possible to determine signifigance, this study did identify three sectors, financial, technology, and services, where stock prices appear to be rising faster than the S&P 500 index, and it identified that the S&P 500 index has risen at a much faster rate than the majority of industry sectors.

A.   Background

This study, which was performed as a statistical research project for the Keller Graduate School of Management's General Management course number 533, Applied Managerial Statistics and Quality, originated as a result of the author's attempt to learn more about Finance and to gain a broader understanding of the workings of the stock market.

For purposes of this project, the stock market is defined as the broad market of publicly traded shares of common stock on the three major exchanges, the New York Stock Exchange (NYSE), the American Exchange (AMEX), and the National Association of Securities Dealers Automated Quote (NASDAQ) system. This market includes shares of over 16,000 companies that are traded as investors buy and sell rights to these companies' earnings and dividend cash flows. The S&P 500 is a

market capitalization-weighted index of 500 large company stocks from all industries that is commonly used to approximate the average movement of share prices throughout the entire stock market. A company's share price is largely driven by its current and projected earnings, and as the US economy changes, macroeconomic conditions favor some industry sectors while creating obstacles for others. Since the S&P 500 is an average, changes in the index should reflect changes in prices that rise and fall faster than the average as well as changes that rise and fall more slowly than the average.

In recent years, the S&P 500 index has outperformed the vast majority of managed mutual funds, as well as most small investors. If industry sectors can be identified as growing faster than the index, then investment in good companies within those sectors should lead to better returns than could be obtained by investing in an S&P 500 index mutual fund or in other managed mutual funds.

While it is likely that major investment companies have performed this kind of analysis, the results are not readily available to the public. In addition, because economic conditions and investor expectations of growth change over time, past analyses may be outdated and no longer reflect the activity of the market. As a result, there is no prior work known that can be used to either augment or replace this analysis. However, this work is not expected to be published, so general knowledge will not be extended.

This study, which covers the movement of stock sector prices over a six-month period, required daily closing price data that was purchased from a subscription data service for a total price of $59.70 plus the time required to extract the data from a database, import it into Lotus 1-2-3 for intermediate analysis and consolidate it for computing of the average growth rates for each sector. Because this data had been previously purchased for other uses, there was no actual expenditure

required to obtain the data for this research.

Assumptions. In performing this study, the following assumptions were made:

1. While the movements of the S&P 500 index and of industry sector price changes over the long

   term are not linear, over periods of a few months, they can be approximated by straight lines.

2. The number of shares outstanding for each company in the study is constant for the duration of

   the study at the value provided in the I-Soft Company's listing of fundamental data as of March

   10, 1998.

3. Industry sector growth rates are normally distributed.

4. The expected mean of the industry sector growth rates will be the growth rate of the S&P 500

   index, allowing tests of the significance of individual sectors' variance from the index.

B.   Hypothesis

The working hypothesis for this study is that the capitalization-weighted prices of common stocks in the

industry sectors that make up the US economy do not rise and fall in exact synchronization with the

S&P 500 stock index, but are instead distributed about the index so that investments in some sectors

outperform the S&P 500 index while others under perform it. The S&P 500 index measures the

change in the market capitalization-weighted stock price movement of the 500 stocks making up the

index. By computing the market capitalization-weighted average of each industry sector in the

economy, changes in the sector's growth rate can be compared to changes in the S&P 500 index to

identify the sectors that outperform the index. The average rate of change in a sector's growth rate can

be computed using linear regression to determine the slope, b_1, of the line that most closely

approximates the increase or decrease in the change in capitalization-weighted daily closing prices of

the companies in each sector. This regression slope for the sector, $b_1(S)$, can then be compared to the

slope of the S&P 500 index, $b_1(I)$ to determine if the sector's rate of increase or decrease deviates

significantly from the index. The formal statement of this hypothesis is:

$$H_1: \quad b_1(S) \ldots b_1(I)$$

and the null hypothesis is:

$$H_0: \quad b_1(S) \, ' \, b_1(I)$$

C.   Data

This study used the daily closing share price and number of shares outstanding for each company in

each of 113 industry sectors for the six-month period from November 1, 1997 through May 1, 1998.

In addition, the daily value of the S&P 500 index was required. Since the number of shares of company

stock outstanding changes slowly, for the purpose of this study, it was assumed to be constant at the

value provided by I-Soft Corporation as of March 10, 1998.

Appendix I lists the 12 sectors and 101 industries that were used in this study. These industries

provide additional analytical value because they offer the possibility of identifying high performing

industries within the larger sectors.

The database for this study consisted of 124 daily closing price observations covering six

months of price history data for each of 7,525 companies, plus an additional 124 observations for the

S&P 500 index, for a total of 933,224 observations consisting of ticker symbol, date, and closing share

price. In addition, the database included one observation per company consisting of the ticker symbol and the number of shares outstanding.

D.   Level of Significance

The level of significance chosen for this study was 5% ($\alpha = 0.05$), to provide a 95% confidence interval around the S&P 500 index.

E.   Testing Statistic

The testing statistic chosen was Z, based on the assumption of a normal distribution around the broad market as represented by the S&P 500 index. It was chosen over Student's t statistic because, with 113 industry sectors, Z closely approximates t and provides easier calculation.

F.   Decision Criteria

Because the study is only concerned with identifying industry sectors that perform better than the S&P 500 index, this study used a one-tailed test, so that any sector whose deviation from the growth rate of the S&P 500 is greater than 1.645 should have caused rejection of the null hypothesis and acceptance of the alternative hypothesis. However, due to the violation of critical assumptions about the data, it was not possible to apply this criteria.

G.   Computations

The S&P 500 is a market value-weighted index of large companies trading in the U.S. stock markets. As described in a current textbook on securities analysis:

> "The S&P 500 is computed by calculating the total market value of the 500 firms in the index and the total market value of those firms on the previous day of trading. The percentage increase in the total market value from one day to the next represents the increase in the index. The rate of return of the index equals the rate of return that would be earned by an investor holding a portfolio of all 500 firms in the index in proportion to

their market value, except that the index does not reflect cash dividends paid by those firms."[1]

In this description of the S&P 500 index, total market value is calculated by multiplying the number of shares outstanding by the share price to determine the market capitalization of each company.

In order to compare the price movement of industry sectors to the S&P 500, the daily price data and the number of shares outstanding for all of the companies in each industry sector were extracted from the StockWiz98 Pro[2] database into files containing the data for each company in the sector using a comma-separated format with the stock symbol, date, open, high, low, close, and volume traded. These files were filtered using the Practical Extraction Report Language (PERL) to remove all data except the date, stock symbol, and closing price and to incorporate the number of shares outstanding into the data file. This program formatted the data to make each company's price data comprise a single row that contained the number of shares outstanding, the stock symbol, and the price for each of the 124 days of the study period.

Following this reformatting, the data for each industry sector was loaded into Lotus 1-2-3, Release 5, for the following computations:

1.   The industry capitalization-weighted price, $WP_{c,d}$ for each company, c, in the industry, and for each day, d, was computed as:

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[1]Essentials of Investments, 3rd Edition, by Bodie, Kane, and Marcus; Irwin McGraw-Hill pub.; Page 45.

[2]Trademark of I-Soft Corporation

$$W_{c,d} = P_{c,d} \times \frac{O_c}{TIS}$$

where P$_i$ is the share price, O$_i$ is the number of shares outstanding, and TIS is the total

number of shares outstanding in the industry.

2. The daily weighted proportionate price movement, M$_{c,d}$, for each company was

computed as:

$$M_{c,d} = \frac{W_{c,d} \& W_{c,d-1}}{W_{c,d-1}}$$

3. The daily industry sector index S$_d$ is computed as:

$$S_d = \sum_{c=1}^{n} M_{c,d}$$

where n is the number of companies in the industry.

Following these computations, during which a spreadsheet was created for each industry sector, the

daily index values for each sector were copied into a single, consolidated spreadsheet for final analysis.

In this spreadsheet, simple linear regressions were computed for each industry sector, S, and for the

S&P 500 index, I, using the date of the observation as the independent variable and the daily sector

index, S$_d$, or the daily S&P 500 index value, I$_d$, as the dependent variable, respectively. The results of
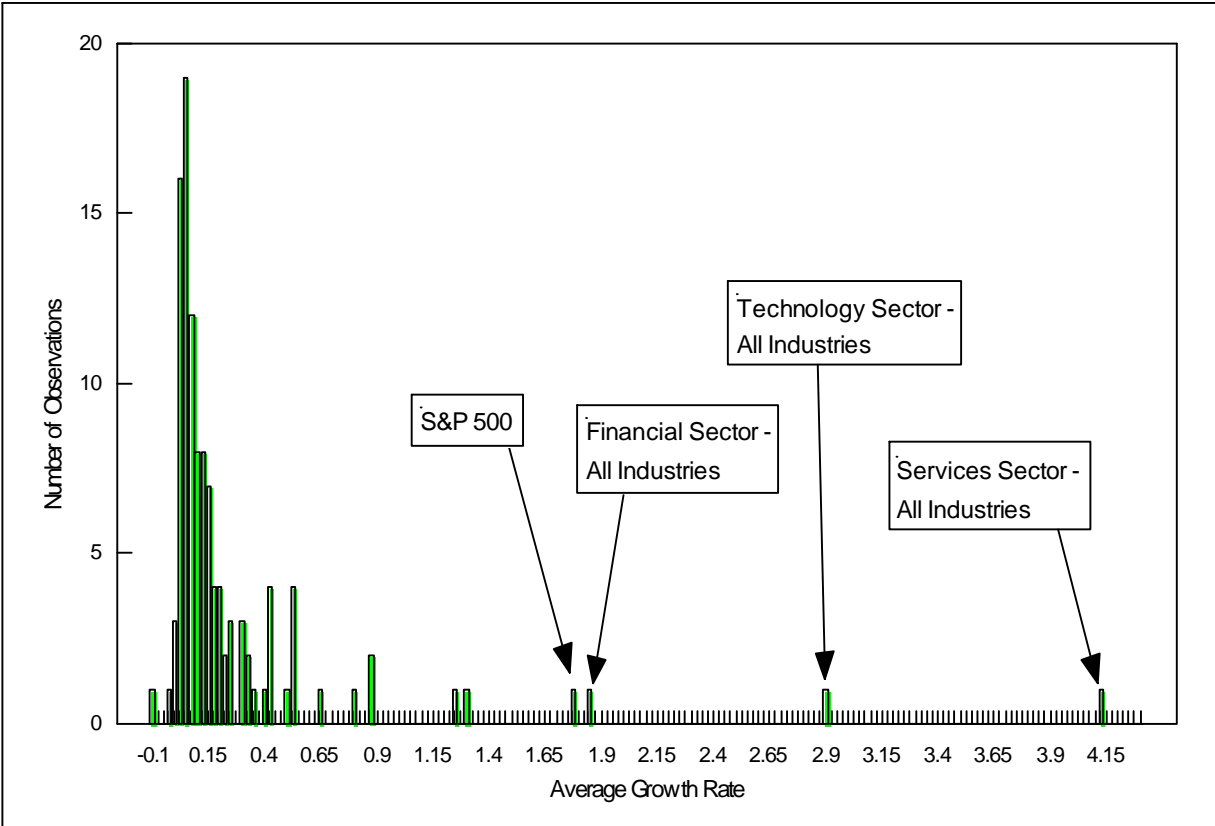
Figure 1 — Frequency Distribution of Industry Growth Rates

these regressions, sorted by the slope of the regression line, b_1, are shown in Appendix II. Using these

slopes, the mean and standard deviation were computed and used to calculate the Z score for each

sector. The data was also graphed to provide a visual evaluation of the distribution.

H. Decision

Figure 1, Frequency Distribution of Industry Sector Growth Rates shows the distribution of growth

rates obtained from the data. This distribution clearly shows that the growth rates are not normally

distributed, which violates assumption 3, above, which assumes that industry sector growth rates are

normally distributed. In addition, the mean of these growth rates is 0.257, with a standard deviation of
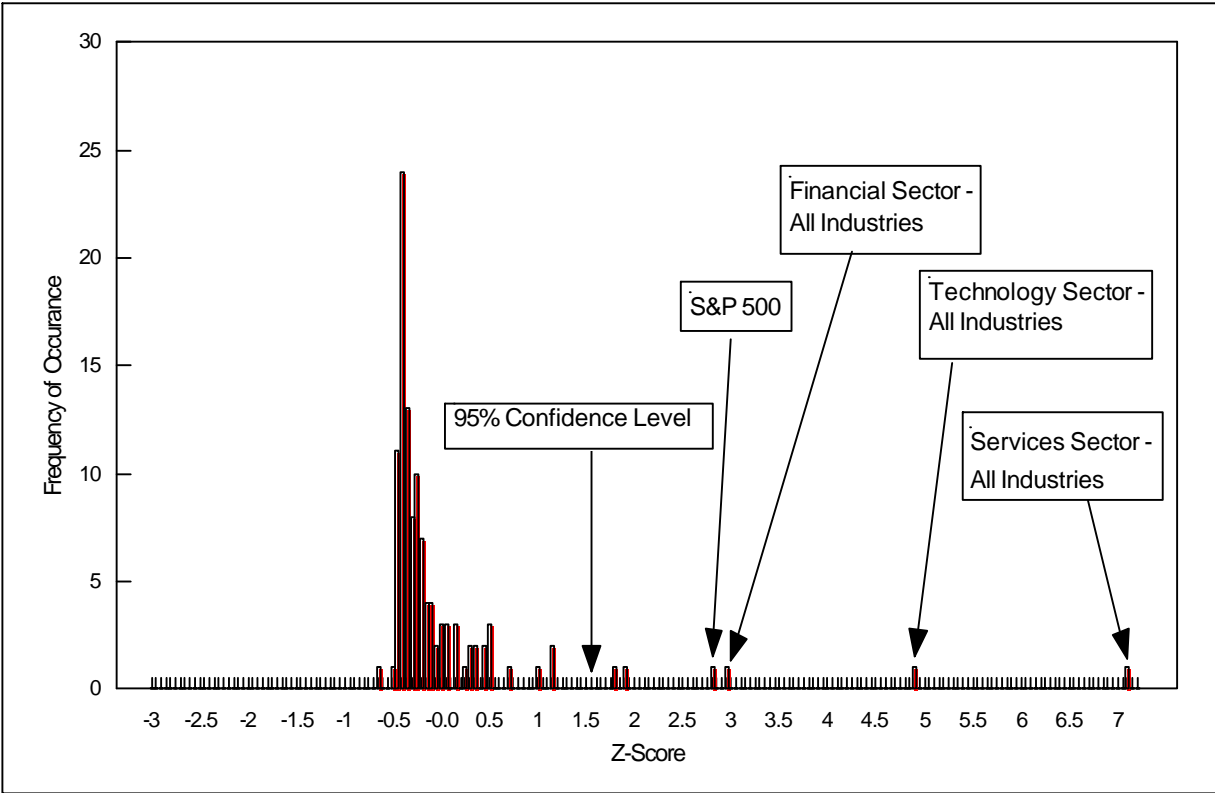
Figure 2 — Frequency Distribution of Industry Z Scores

0.542, which is well below the growth rate of 1.766 for the S&P 500 index, which violates assumption

4, above, which assumes that the expected mean of the industry sector growth rates will be the growth

rate of the S&P 500 index. As Figure 2, Frequency Distribution of Industry Z Scores, shows, the Z-

score for the S&P 500 is 2.786, which is well outside a 95% confidence interval that the growth rate of

the S&P 500 is the mean of the growth rates of all market sectors. As a result of violating these two

assumptions, the original objective of this study could not be realized.

I.   Recommendation

Based on this study, the S&P 500 index is performing significantly better than the overall stock market, as measured by the mean growth rate of the industry sectors making up the economy. To achieve higher rates of return over the period of interest, one could have selected carefully-chosen investments in the Financial, Technology, or Services sectors, although it is not possible to determine if their performance is statistically better than the S&P 500. Selection of investments in the Financial, Technology, or Services sectors would require identification of specific companies that are providing high share-price growth and avoiding those whose price is not growing as fast as the sector as a whole. While these sectors have outperformed the market over this recent six-month period, there are many factors that affect the perceived value of a stock and hence the price. The economic factors that lead to high price-performance can change, so that the performance shown in this study may not be achieved in the future.

J.   Project Summary

This project set out to identify industry sectors whose aggregate market value-weighted growth rate exceeded that of the S&P 500 stock index over a recent six-month period. The S&P 500 index was chosen as the benchmark because it was assumed to be representative of the performance of the stock market as a whole. In the course of performing this study, it was determined that the market value-weighted growth rates of individual industry sectors are not normally distributed, and the S&P 500 index is not representative of the overall market.

While the reasons for this cannot be identified from this study, a possible explanation may be that the S&P 500 index is an index of 500 large companies, while the 7525 companies included in the

113 sectors and industries reviewed in the study include companies of all sizes. It is also possible that

certain industries or sectors are over-represented in the S&P 500 index while others are under-

represented.

Even though the original objective of this study could not be achieved conclusively, it was

possible to identify three industry sectors, Financial, Technology, and Services, whose share-price

performance exceeded both the overall market and the S&P 500 over the period of the study.

The following list of sectors and industries identifies the major industrial groups that were included in this study. The number in parentheses following the name of each sector identifies the number of companies included in that sector. The number of companies listed for "All Industries" is the total number of companies of all subsectors within the group.

Basic Materials - All Industries (500)
    Chemical Manufacturing (101)
    Chemicals - Plastics & Rubber (21)
    Containers & Packaging (50)
    Fabricated Plastic & Rubber (43)
    Forestry & Wood Products (15)
    Gold & Silver (60)
    Iron & Steel (46)
    Metal Mining (33)
    Misc. Fabricated Products (93)
    Non-Metallic Mining (3)
    Paper & Paper Products (35)

Capital Goods - All Industries (496)
    Aerospace & Defense (58)
    Constr. & Agric. Machinery (38)
    Constr. - Supplies & Fixtures (60)
    Construction - Raw Materials (21)
    Construction Services (138)
    Misc. Capital Goods (167)
    Mobile Homes & RVs (14)

Conglomerates - All Industries (45)

Consumer Cyclical - All Industries (486)
    Apparel Accessories (106)
    Appliance & Tool (20)
    Audio & Video Equipment (33)
    Auto & Truck Manufacturers (28)
    Auto & Truck Parts (77)
    Footwear (27)

Furniture & Fixtures (50)
Jewelry & Silverware (13)
Photography (20)
Recreational Products (88)
Textiles - Non Apparel (16)
Tires (8)

Consumer Non-Cyclical - All Industries (311)
    Beverages (Alcoholic) (25)
    Beverages (Non-Alcoholic) (22)
    Crops (18)
    Fish/Livestock (6)
    Food Processing (122)
    Office Supplies (26)
    Personal & Household Prods (77)
    Tobacco (15)

Energy - All Industries (324)
    Coal (4)
    Oil & Gas - Integrated (20)
    Oil & Gas Operations (205)
    Oil Well Services & Equipment (95)

Financial - All Industries (1,320)
    Consumer Financial Services (101)
    Insurance (Accident & Health) (32)
    Insurance (Life) (50)
    Insurance (Miscellaneous) (22)
    Insurance (Prop. & Casualty) (128)
    Investment Services (68)
    Misc. Financial Services (127)

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[3]Source: StockWiz98 Pro software, published by I-Soft Corporation, 1998

Money Center Banks (12)
Regional Banks (382)
S&Ls Savings Banks (398)

Healthcare - All Industries (840)
    Biotechnology & Drugs (377)
    Healthcare Facilities (166)
    Major Drugs (14)
    Medical Equipment & Supplies (284)

Services - All Industries (1707)
    Advertising (32)
    Broadcasting & Cable TV (73)
    Business Services (227)
    Casinos & Gaming (59)
    Communications Services (171)
    Hotels & Motels (39)
    Motion Pictures (46)
    Personal Services (32)
    Printing & Publishing (61)
    Printing Services (24)
    Real Estate Operations (240)
    Recreational Activities (54)
    Rental & Leasing (54)
    Restaurants (124)
    Retail (Apparel) (59)
    Retail (Catalog & Mail Order) (36)
    Retail (Department & Discount) (30)
    Retail (Drugs) (13)
    Retail (Grocery) (52)
    Retail (Home Improvement) (13)
    Retail (Specialty) (123)

Retail (Technology) (17)
Schools (25)
Security Systems & Services (33)
Waste Management Services (73)

Technology - All Industries (1,589)
    Communications Equipment (194)
    Computer Hardware (62)
    Computer Networks (127)
    Computer Peripherals (120)
    Computer Services (107)
    Computer Storage Devices (35)
    Electronic Instruments & Controls (226)
    Office Equipment (26)
    Scientific & Technical Instruments (154)
    Semiconductors (149)
    Software & Programming (390)

Transportation - All Industries (165)
    Air Courier (11)
    Airline (31)
    Misc. Transportation (29)
    Railroads (23)
    Trucking (53)
    Water Transportation (20)

Utilities - All Industries (192)
    Electric Utilities (109)
    Natural Gas Utilities (67)
    Water Utilities (16)

Totals

Sectors: 12
Industries: 101
Companies: 7,525

Appendix II — Industry Sector Growth Rates

	Total	Mean	StdDev
Industry and Sector Growth Rate	114	0.2565	0.5418

Sector/Industry	Companies	Slope	Z-Score
Services - All Industries	1707	4.1012	7.0959
Technology - All Industries	1589	2.8987	4.8765
Financial - All Industries	1320	1.8333	2.9101
Standard & Poor's 500 Stock Index	**500**	**1.7661**	**2.7860**
Health Care - All Industries	840	1.2840	1.8964
Technology - Software & Programming	390	1.2276	1.7922
Basic Materials - All Industries	500	0.8676	1.1279
Capital Goods - All Industries	494	0.8634	1.1200
Consumer Cyclical - All Industries	486	0.7968	0.9972
Health Care - Medical Equipment & Supplies	283	0.6333	0.6954
Services - Retail (Specialty)	123	0.5242	0.4940
Financial - Regional Banks	382	0.5199	0.4860
Services - Communications Services	171	0.5074	0.4631
Services - Business Services	227	0.5003	0.4498
Services - Restaurants	124	0.4895	0.4300
Financial - S&Ls/Savings Banks	398	0.4243	0.3096
Health Care - Biotechnology & Drugs	377	0.4205	0.3027
Technology - Computer Services	107	0.4138	0.2903
Consumer Non-Cyclicals - All Industries	311	0.4108	0.2846
Energy - Oil & Gas Operations	205	0.3799	0.2276
Services - Waste Management Services	73	0.3280	0.1318
Capital Goods - Misc. Capital Goods	167	0.3154	0.1086
Financial - Insurance (Prop. & Casualty)	128	0.3130	0.1043
Energy - All Industries	324	0.2833	0.0494
Capital Goods - Construction Services	137	0.2800	0.0432
Services - Recreational Activities	54	0.2771	0.0379
Consumer Cyclical - Apparel Accessories	106	0.2462	-0.0191
Transportation - All Industries	165	0.2429	-0.0252
Technology - Semiconductors	148	0.2422	-0.0265
Technology - Computer Networks	127	0.2139	-0.0788
Technology - Computer Peripherals	120	0.2086	-0.0886

Sector/Industry	Companies	Slope	Z-Score
Health Care - Healthcare Facilities	166	0.1965	-0.1109
Services - Advertising	32	0.1962	-0.1113
Consumer Non-Cyclicals - Food Processing	122	0.1952	-0.1132
Basic Materials - Fabricated Plastic & Rubber	43	0.1841	-0.1336
Technology - Computer Hardware	62	0.1748	-0.1508
Financial - Financial Services	127	0.1659	-0.1672
Services - Motion Pictures	46	0.1625	-0.1735
Technology - Communications Equipment	194	0.1574	-0.1831
Utilities - All Industries	192	0.1454	-0.2052
Basic Materials - Misc. Fabricated Products	93	0.1452	-0.2056
Basic Materials - Chemical Manufacturing	101	0.1416	-0.2121
Consumer Cyclical - Recreational Products	88	0.1325	-0.2289
Basic Materials - Gold & Silver	60	0.1323	-0.2293
Services - Broadcasting & Cable TV	73	0.1307	-0.2322
Consumer Non-Cyclicals - Personal & Household Prods.	77	0.1272	-0.2387
Technology - Electronic Instr. & Controls	226	0.1192	-0.2534
Technology - Scientific & Technical Instr.	154	0.1178	-0.2562
Financial - Investment Services	68	0.1163	-0.2589
Utilities - Electric Utilities	109	0.1155	-0.2603
Services - Retail (Apparel)	59	0.1138	-0.2634
Financial - Consumer Financial Services	101	0.1113	-0.2680
Consumer Cyclical - Auto & Truck Parts	77	0.1104	-0.2698
Services - Real Estate Operations	240	0.1024	-0.2846
Capital Goods - Supplies & Fixtures	60	0.0970	-0.2945
Services - Casinos & Gaming	59	0.0940	-0.2999
Transportation - Airlines	31	0.0934	-0.3011
Services - Personal Services	32	0.0831	-0.3201
Services - Rental & Leasing	54	0.0828	-0.3206
Transportation - Trucking	53	0.0818	-0.3226
Services - Retail (Grocery)	52	0.0759	-0.3334
Basic Materials - Iron & Steel	46	0.0754	-0.3344
Services - Schools	25	0.0693	-0.3456
Capital Goods - Aerospace & Defense	58	0.0670	-0.3498
Financial - Insurance (Life)	50	0.0669	-0.3501
Consumer Cyclical - Furniture & Fixtures	50	0.0650	-0.3536
Services - Printing & Publishing	61	0.0649	-0.3538

Sector/Industry	Companies	Slope	Z-Score
Services - Retail (Department & Discount)	30	0.0637	-0.3560
Services - Retail (Technology)	17	0.0631	-0.3570
Basic Materials - Containers & Packaging	50	0.0598	-0.3632
Consumer Cyclical - Footwear	27	0.0590	-0.3646
Services - Retail (Home Improvement)	13	0.0535	-0.3747
Consumer Cyclical - Audio & Video Equipment	33	0.0532	-0.3753
Consumer Non-Cyclicals - Beverages (Alcoholic)	25	0.0522	-0.3771
Basic Materials - Paper & Paper Products	35	0.0496	-0.3820
Financial - Insurance (Miscellaneous)	22	0.0489	-0.3832
Capital Goods - Construction - Raw Materials	20	0.0436	-0.3931
Basic Materials - Metal Mining	33	0.0385	-0.4024
Financial - Insurance (Accident & Health)	32	0.0383	-0.4027
Services - Printing Services	24	0.0363	-0.4066
Consumer Non-Cyclicals - Crops	18	0.0343	-0.4103
Utilities - Natural Gas Utilities	67	0.0342	-0.4104
Health Care - Major Drugs	14	0.0337	-0.4112
Consumer Cyclical - Jewelry & Silverware	13	0.0332	-0.4122
Consumer Cyclical - Appliance & Tool	20	0.0331	-0.4123
Capital Goods - Mobile Homes & RVs	14	0.0308	-0.4166
Capital Goods - Const. & Agric. Machinery	38	0.0296	-0.4188
Services - Security Systems & Services	32	0.0293	-0.4194
Financial - Money Center Banks	12	0.0284	-0.4211
Transportation - Railroads	22	0.0282	-0.4215
Consumer Cyclical - Auto & Truck Manufacturers	28	0.0275	-0.4227
Consumer Cyclical - Photography	20	0.0264	-0.4247
Conglomerates - All Industries	45	0.0251	-0.4271
Services - Retail (Catalog & Mail Order)	36	0.0246	-0.4280
Basic Materials - Non-Metalic Mining	3	0.0245	-0.4283
Transportation - Air Courier	11	0.0230	-0.4310
Consumer Cyclical - Textiles - Nonapparel	16	0.0213	-0.4341
Services - Hotels & Motels	37	0.0181	-0.4400
Consumer Non-Cyclicals - Beverages (Non-Alcoholic)	22	0.0169	-0.4423
Technology - Office Equipment	26	0.0167	-0.4426
Transportation - Misc. Transportation	28	0.0163	-0.4435
Energy - Oil & Gas - Integrated	20	0.0107	-0.4538
Services - Retail (Drugs)	13	0.0104	-0.4543

Sector/Industry	Companies	Slope	Z-Score
Basic Materials - Chemicals - Plastics & Rubber	21	0.0100	-0.4550
Technology - Computer Storage Devices	35	0.0068	-0.4610
Basic Materials - Forestry & Wood Products	15	0.0067	-0.4612
Consumer Non-Cyclicals - Office Supplies	26	0.0063	-0.4619
Consumer Non-Cyclicals - Fish/Livestock	6	0.0060	-0.4625
Transportation - Water Transportation	20	0.0003	-0.4730
Energy - Coal	4	-0.0034	-0.4797
Utilities - Water Utilities	16	-0.0043	-0.4814
Consumer Cyclical - Tires	8	-0.0111	-0.4941
Consumer Non-Cyclicals - Tobacco	15	-0.0273	-0.5240
Energy - Oil Well Services & Equipment	95	-0.1039	-0.6652

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