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SPECIAL REPORT

**CORPORATE
PRODUCTIVITY
AND
I/S INVESTMENT

SCATTERGRAM ANALYSIS**

**Center for Research on Information Technology
and Organizations (CRITO)**
Graduate School of Management
University of California, Irvine

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I/S INVESTMENT**

SCATTERGRAM ANALYSIS

Intercorporate Measurement Program

**Center for Research on Information Technology
and Organizations (CRITO)**
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About IMP

The Intercorporate Measurement Program (IMP) is an industry-university cooperative research program conducted by the Center for Research on Information Technology and Organizations (CRITO) at the University of California, Irvine. It is supported by grants from the United States National Science Foundation and IBM Corporation. The program's earlier years were supported by grants from CSC Research and Advisory Services. Our purpose is to further the state of the art of I/S performance measurement and to improve I/S performance in practice. IMP conducts annual surveys of management practice, business value, and I/S performance in corporations. It feeds back the knowledge gained to survey participants and to IMP sponsors through publications, workshops, and client programs. For further information on the IMP Program, please contact Dr. Kenneth L. Kraemer at (714) 824-5246 or kkraemer@uci.edu.

About the Authors

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EXECUTIVE SUMMARY

The idea of a positive relationship between I/S investment and corporate productivity continues to raise questions and doubts from information technology specialists to economists.

“There still is no evidence suggesting that investments in I/S are paying off.” (Paul Straussman, *Computerworld*, 1996)

“I must confess that I am having second thoughts as to whether we have reached the promised land ... These doubts have caused me to rethink many of the glorious conclusions that I have long argued would be part of the sacred productivity-led recovery.” (Stephen Roach, Chief Economist at Morgan-Stanley)

The Intercorporate Measurement Program’s (IMP) data on 517 manufacturing and services firms in 20 industry sectors contradicts the above conclusions. It shows that:

- greater investment in I/S is positively and significantly linked to greater corporate productivity;
- the chief benefits of I/S investment are less in reductions of administrative overhead than in direct improvements in operations throughout the value chain.

While the data does not prove that greater I/S spending causes greater corporate productivity, the theoretical argument, based on IMP’s research, supports such a conclusion.

At any point in time, a corporation has a certain level of I/S spending and corporate productivity. Since greater I/S spending is expected to result in greater productivity as a result of automational, informational, or transformational effects, it is valid and useful to assess the payoff from I/S investment by its correlation with corporate productivity. By plotting the value for the total I/S budget per corporate employee against the value for total corporate revenue per corporate employee, and comparing this point with the paired values from other corporations in the same or similar industry, we are able to measure the payoff from a company’s I/S investment. The expectation is that the higher the investment in I/S, the higher the productivity of the corporation. *Comparison of these values among corporations also provides a useful benchmark for assessing an individual firm’s relative position versus its competitors for a specific industry.*

CORPORATE PRODUCTIVITY AND LEVEL OF I/S INVESTMENT: SCATTERGRAM ANALYSIS

I. INTRODUCTION

In a recent article in *Computerworld*, Paul Straussman argued that there still was no evidence suggesting that investments in I/S are paying off.¹ The logic of his argument was that if I/S had payoffs, then it should show up in reduced GS&A (general, sales and administrative) expenses on the grounds that the major contribution of I/S was to the “administrative component” of organizations. Accordingly, in an analysis of 138 firms, he found that while I/S expenses as a percent of corporate revenues was increasing, the percent of revenues for GS&A was not decreasing and therefore there are no productivity gains.

The results in this special report contradict Straussman’s analysis and conclusion. Our analysis shows that greater investment in I/S is positively and significantly linked to greater corporate productivity. Moreover, our data emphasizes the need to look at I/S payoffs by industry sector. While our analysis does not prove that greater I/S spending causes greater corporate productivity, our theoretical argument and other research support such a conclusion, especially when one recognizes that these two factors are interactive.²

At any point in time, a corporation has a certain level of I/S spending and corporate productivity. Greater spending for I/S is expected to result in greater productivity as a result of automational, informational, or transformational effects. Automation refers to the substitution of technology for labor and usually results in greater productivity in operations. It might also result in greater productivity in administrative (GS&A) activities, but such effects are far less likely to occur or to be noticeable. This is because the administrative ratio (GS&A as % of revenues) is low to begin with and cannot be ratcheted downward on a one-to-one basis with operations. Additionally, there are time delays in adjustments to the

¹ Straussman, Paul, “Spending without results?,” *Computerworld*, April 15, 1996, vol. 30, no. 16.

² Hitt, L., and E. Brynjolfsson, “The Three Faces of IT Value: Theory and Evidence,” *Proceedings of the Fifteenth International Conference on Information Systems*, Vancouver, B.C., December 1994, 263-276.

administrative ratio, as well as the possibility of task realignments where administrative staff take on operational responsibilities without changing their place in the corporation.³

As found with automational effects, many of the major informational impacts of I/S show up in operations rather than administration. Several examples are illustrative. One example is that of inventory control. Information and inventory are substitutes for one another, meaning that detailed and timely information about inventory levels can support just-in-time logistics. The utilization of just-in-time logistics, in turn, saves money for suppliers, manufacturers, and customers by lowering needed inventories, warehousing, and staffing. Another example are yield management models used in airline, car rental, and hotel reservation systems to increase firm revenues by setting pricing in relation to demand. The transformational impacts of I/S operate in similar fashion to the automational and informational impacts just discussed in that it will directly affect operations but may not noticeably affect GS&A. By realigning corporate structure, control systems, human resource practices, and I/S to better fit with corporate strategy, firms are able to increase their effectiveness in bringing new products to market ahead of competitors, providing superior customer service and support, and optimizing their own operations as well as those of suppliers and customers in the value chain.

In summary, the impact of automational, informational, and transformational effects will not show up in GS&A expenses. However, they will show up in greater revenues and decreased costs, thereby contributing to both the top-line and the bottom-line of corporate productivity. The chief benefits of I/S investment are found more in direct improvements in operations throughout the value chain than in reductions of administrative overhead. This is why we find payoffs and Straussman does not. He is looking in the wrong place.

We argue that it is valid and useful to assess the payoff from I/S investment by its correlation with corporate productivity. We, therefore, plot the value for the total I/S budget per corporate employee against the value of total corporate revenue per corporate employee, and compare this point with the values from other corporations in the same or similar industry.

³ Pinsonneault, A., and K. Kraemer, "The Impact of Information Technology on Middle Managers," *MIS Quarterly*, v17, n3 (Sep. 1993), 271-292; Pinsonneault, A., and K. Kraemer, "Middle Management

We expect that the higher the investment in I/S, the higher the productivity of the corporation. Corporate productivity can be measured in a variety of ways, and factors other than I/S investment can be associated with a given value. However, the analyses we have conducted for the past three years along with that performed by others,⁴ have consistently indicated that for many types of firms, I/S investment is associated with corporate productivity. Comparison of these values among corporations provides a useful benchmark for assessing an individual firm's relative position in its industry.

Downsizing," *Management Science* (Forthcoming, February, 1997).

⁴ Brynjolfsson, E., and L. Hitt, "Is Information Systems Spending Productive? New Evidence and New Results," *Proceedings of the Fourteenth International Conference on Information Systems*, (Orlando, FL, December, 1993), 47-64. Hitt and Brynjolfsson, *op. cit.*

This report provides such benchmarks for 20 industry sectors, as follows:

Manufacturing

- Food Processing
- Forest Products
- Printing & Publishing
- Chemicals
- Pharmaceuticals
- Petroleum & Refining
- Building Materials, Glass, and Metals
- Industrial & Farm Equipment
- Computer & Office Equipment
- Electronics & Electrical
- Automotive and Aerospace
- Instrumentation

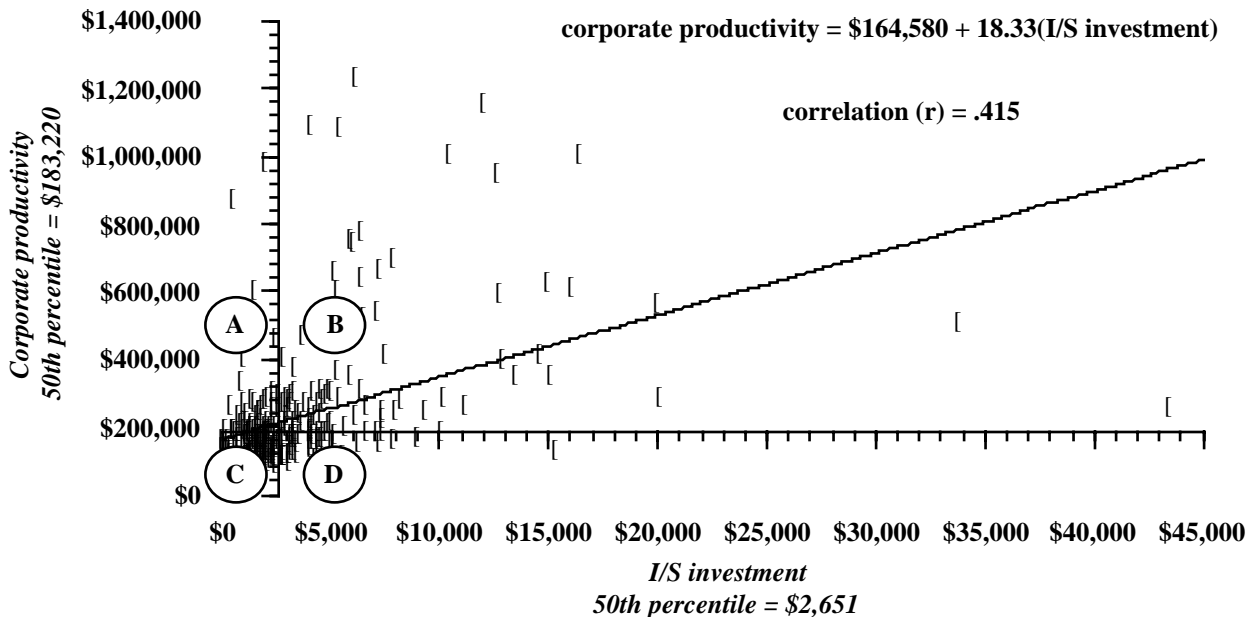
Services

- Transportation Services
- Communications
- Utilities
- Wholesale Trade
- Retail
- Banking and Finance
- Insurance
- Business Services

GUIDE TO THE SCATTERGRAM

The scattergram in Exhibit 1 below is an example of the type of analysis that is produced. It is based on regression analysis. Each point on the scattergram represents a corporation and its position, and is based on that corporation's values for total revenue per employee and for I/S budget dollars per employee.⁵

Exhibit 1. Scattergram of Corporate Productivity and I/S Investment



Vertical and Horizontal lines. Exhibit 1 shows I/S investment (I/S budget dollars per corporate employee) on the horizontal line and corporate productivity (total sales revenue per corporate employee) on the vertical line. The two lines intersect at the respective median values (50th percentile). Although not directly shown in Exhibit 1, the median corporate productivity is \$183,220, which means that 50% of the firms earned more per employee and

⁵ Data for the analysis is obtained from a variety of sources including the IMP survey and published accounts in *Computerworld*, *Datamation*, and *InformationWeek*. The primary source for corporate sales and revenues and number of employees in the corporation is through COMPUSTAT. The data is from fiscal years 1994 and 1995.

50% of the firms earned less per employee. Similarly, the median I/S investment is \$2,651, which means that 50% of the firms spent more than \$2,651 per employee and 50% spent less.

Investment Quadrants. In order to assess the relative value of investments, we divide Exhibit 1 into four investment quadrants as shown with the circled letters, A, B, C and D. Datapoints to the left of the vertical line in Exhibit 1 represent “low I/S investment” and datapoints to the right of the vertical line as “high I/S investment”. Datapoints above the horizontal line in Exhibit 1 represent “high corporate productivity” and datapoints below the horizontal line in Exhibit 1 represent “low corporate productivity”. The resulting four investment quadrants are shown in Exhibit 2.

Exhibit 2. Interpretation of the Four Quadrants

A	B
High corporate productivity and low I/S investment	High corporate productivity and high I/S investment
C	D
Low corporate productivity and low I/S investment	Low corporate productivity and high I/S investment

A corporation can approximately be assigned to one of the four quadrants in the scattergram by locating its point on the scattergram and noting whether its average I/S budget per employee is above or below the median, and similarly whether its average total corporate revenue per employee is above or below the median. The scattergram is useful for benchmarking a corporation relative to others in a particular industry.

- *Quadrant A*, while very attractive, is shown empirically to have very few members and a company’s position in that quadrant is most likely transient.
- If a company is in *Quadrant B*, its I/S investment is paying off.

- Companies in *Quadrant C* may want to consider the possible benefits of increased I/S investment, especially if major competitors are showing payoff from a strategy of greater I/S investment.
- Companies positioned in *Quadrant D* should investigate why I/S investment might not be “paying off” in terms of corporate productivity. It is possible that the level of I/S spending has been insufficient to build an information infrastructure for the company or that spending has been poorly applied. It is also possible that a company or its I/S function is undergoing a major transition, or that its values are a statistical oddity or simply incorrect.

Diagonal Line. The diagonal line in Exhibit 1 describes the association between corporate productivity and I/S investment. The slope indicates how correlated these two variables are. Correlation can vary from -1.00 to +1.00. The closer the correlation is to -1.00 or +1.00, the more associated the two variables are. A correlation of ‘0’ means that the two variables are not associated. For the kind of data and the number of companies used in the analyses, an appropriate assumption for these graphs is that corporate productivity is associated with I/S investment if the correlation is .30 or higher.

An equation [corporate productivity = \$164,580 + 18.33 (I/S investment)] is provided in Exhibit 1 which describes the diagonal line on the scattergram. If one were to replace the ‘x’ (I/S investment) with a corporation’s value for I/S expenditure per corporate employee and then solve the equation, the value of ‘y’ (corporate productivity) would equal what *would be expected* as the total revenue per corporate employee given the level of I/S investment currently measured for that corporation. A particular firm can compare itself with all firms, with manufacturing or services firms, with one of the 20 industry sectors, or with all of these.

Calculating the difference between actual revenue per employee and the expected value (the calculated ‘y’) may provide additional information about a corporation. For example, a negative value may indicate that there is a “potential productivity loss” that needs investigation. A positive difference, that is, a corporate revenue per employee greater than expected by the equation, indicates that I/S investments appear to be paying off.

Qualitative Assessment. The quantitative analysis indicated by the scattergram is not *the final word* on “good” or “bad” I/S investments. Rather it is one piece of evidence (a red or green light) indicating a corporation’s “successful” or “problematic” investment in I/S. A major complementary piece of evidence is the assessment of the Business Value of IT investment by the heads of major business units in the firm who are customers of the I/S unit. This qualitative assessment can be very helpful in understanding where senior executives see payoffs from I/S and where they do not. We include this assessment as part of the IMP annual survey and is covered in other IMP reports.

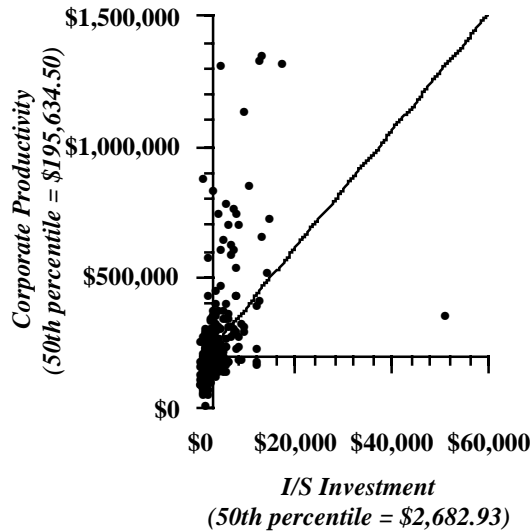
II. I/S INVESTMENT AND CORPORATE PRODUCTIVITY

GROSS COMPARISONS

Exhibit 3 displays the relationship between corporate productivity and I/S investment for 279 manufacturing firms and 238 services firms. The regression equation and correlation are statistically significant (indicating that there is an association between the two variables) for manufacturing and services firms.

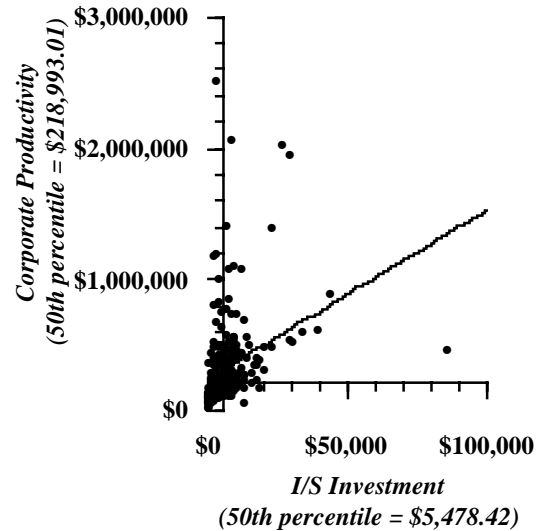
Exhibit 3. Corporate Productivity and I/S Investment

Manufacturing (1995)



Corp. Productivity = \$98,936 + 44.03 (I/S investment)
correlation = .597 (variance explained = 35.6%)

Services (1995)

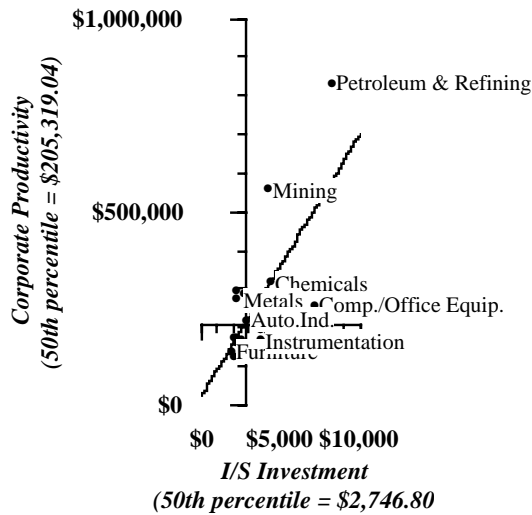


Corp. Productivity = \$239,074 + 12.82 (I/S investment)
correlation = .322 (variance explained = 10.4%)

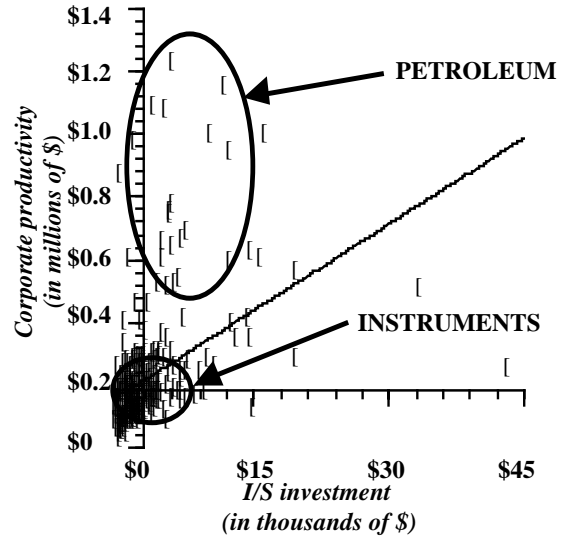
These two gross characterizations are useful in that they show that the association between I/S investment and corporate productivity is higher in manufacturing than in services. This is indicated by the slope of the diagonal line for manufacturing versus services.

Exhibit 4. Scattergram Manufacturing and Services Industry Sector Maps

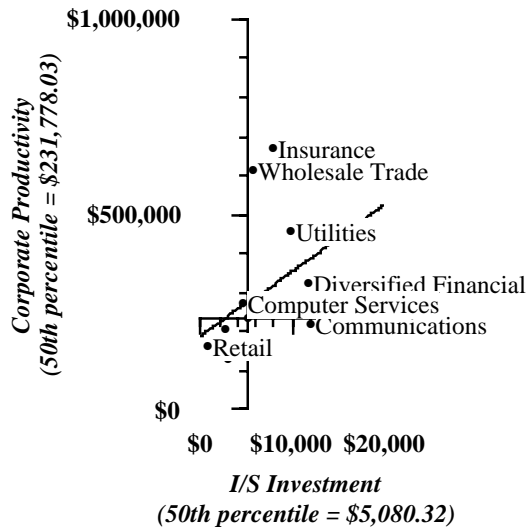
Manufacturing Sector Medians



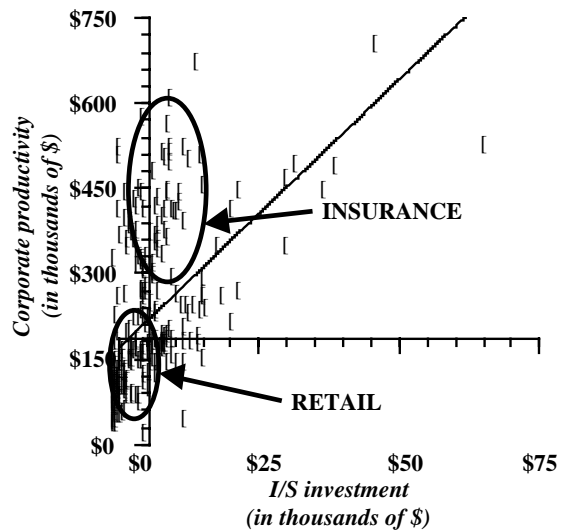
Selected Manufacturing Clustering



Services Sector Medians



Selected Services Clusterings



INDUSTRY AND SECTOR COMPARISONS

Exhibit 4 shows a finer breakdown of manufacturing and services firms by industry sector and also shows the reason why industry sector is important. The graphs on the left hand side of Exhibit 4 depict the relative location of industry sectors for manufacturing and services. We have plotted the various industry sectors by each sector's mean value for I/S budget dollars per corporate employee and mean value for total revenue per corporate employee.

The resulting spread of the industry sectors in Exhibit 4, especially the spread in services, points to the fact that there are considerable differences among the various industries.

In these scattergrams we have maintained the 'x' and 'y' intersections of Exhibit 3 to indicate the relative location of the various industries by sector across the quadrants. It is important to note that the points highlighted on the left hand side of Exhibit 4 do not indicate the actual spread of each of the industry sectors. In addition, further analysis by industry sectors reveals that industries are more apt to be clustered within a range than dispersed. Examples of this clustering are shown in the graphs on the right hand side of Exhibit 4.

Analysis by industry sector complements overall industry analysis by noting the differing ranges of I/S investment dollars and corporate productivity dollars, thus pointing out considerable variations among industry sectors. In addition, sector analysis allows us to study industry sectors within the context of the four quadrants. For example, manufacturers of forest products and metals are almost all clustered in Quadrant A, while chemical and pharmaceutical manufacturers are all clustered in Quadrant B. Shifting to services, we can see that entertainment, business, and healthcare firms are primarily grouped in Quadrant C, and that communication services is found in Quadrant D. This clustering by industry means that both corporate productivity and I/S investment form a range of values that is specific to an industry. Again, the importance of these findings is that "industry" or "peer group" analysis provides the more accurate reading of a corporation's association of I/S investment with corporate productivity.

It seems clear from this analysis that different industry sectors may be better or worse at gaining productivity from their I/S investments. For those in Quadrants C and D, there may be "missed opportunities", poor planning, or a need for re-engineering to gain results. Additionally, it just may be that certain industry environments require careful consideration of other critical success factors that might inhibit full payoff (i.e., the competitive entertainment and communications industries).

Consequently, to assess a corporation's performance, it is best to compare it within its own industry and, therefore, against its direct competitors. One can also compare a corporation

with firms that are not located in one's own industry, but are otherwise similar. In addition, one could also benchmark a particular firm with corporations that are "leaders" regardless of industry.

III. INDUSTRY SECTOR SCATTERGRAMS

We have constructed 20 scattergrams by industry sector, which we have listed below. Each scattergram contains a list of all of the corporations that are included in that chart, the regression equation, and the correlation.

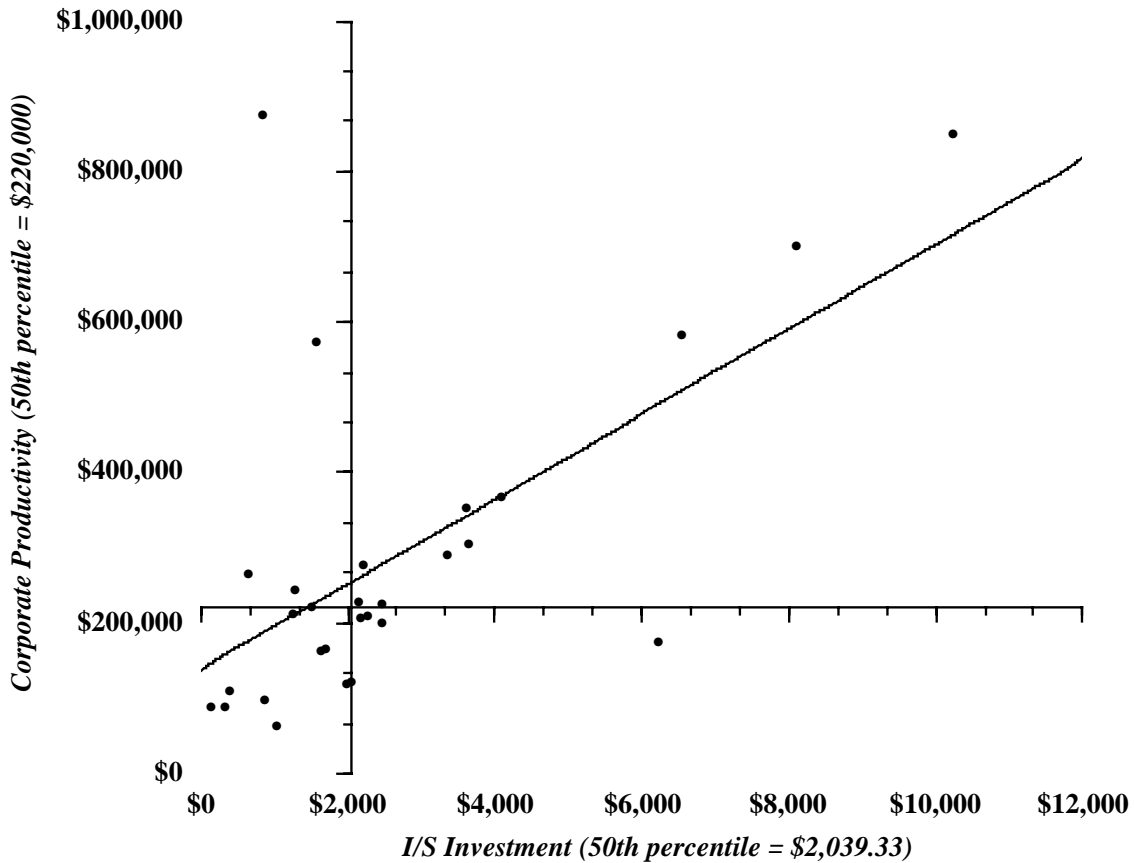
Manufacturing

- Exhibit 5. Food Processing
- Exhibit 6. Forest Products
- Exhibit 7. Printing & Publishing
- Exhibit 8. Chemicals
- Exhibit 9. Pharmaceuticals
- Exhibit 10. Petroleum & Refining
- Exhibit 11. Building Materials,
Glass, and Metals
- Exhibit 12. Industrial & Farm
Equipment
- Exhibit 13. Computer & Office
Equipment
- Exhibit 14. Electronics & Electrical
- Exhibit 15. Automotive and Aerospace
- Exhibit 16. Instrumentation

Services

- Exhibit 17. Transportation Services
- Exhibit 18. Communications
- Exhibit 19. Utilities
- Exhibit 20. Wholesale Trade
- Exhibit 21. Retail
- Exhibit 22. Banking and Finance
- Exhibit 23. Insurance
- Exhibit 24. Business Services

Exhibit 5. Food Processing, 1995

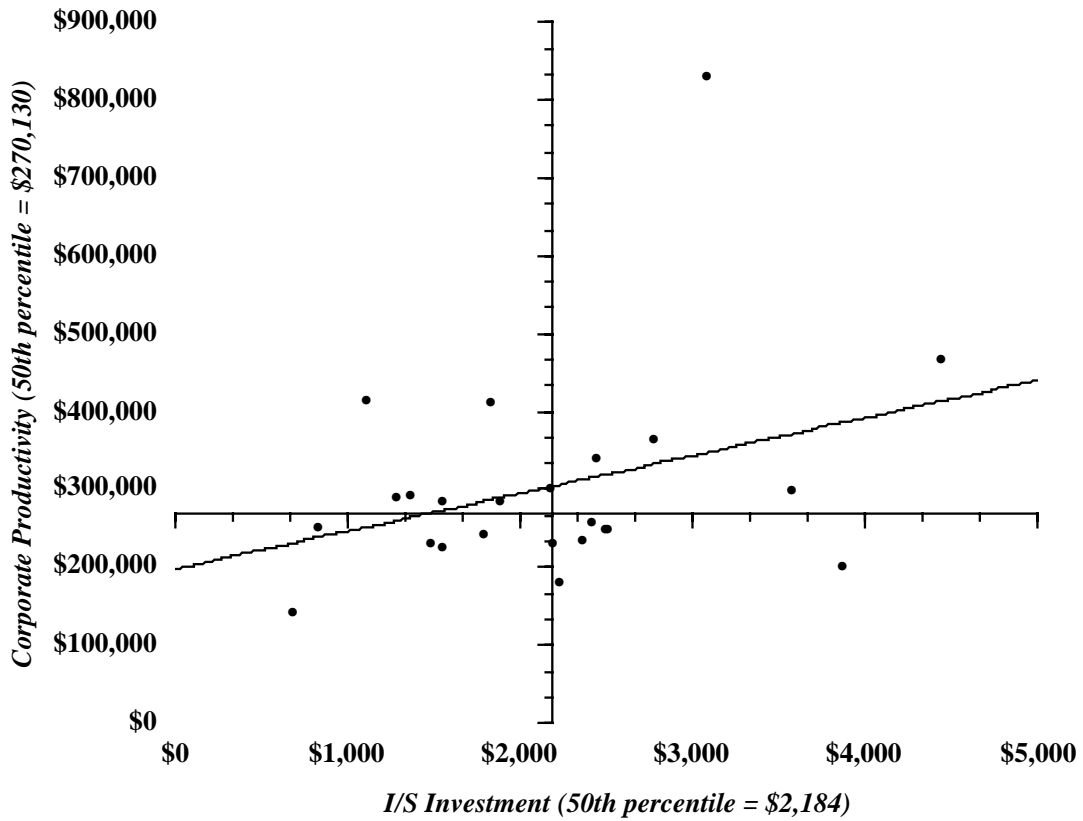


expected corporate productivity = \$138,224.65 + 56.54 (i/s investment per employee)
correlation = .615 (variance explained = 37.9%)

Anheuser Busch Cos., Inc.
Borden, Inc.
Campbell Soup Co.
Cargill Inc.
Coca-Cola Enterprises, Inc.
ConAgra
Continental Grain Co.
CPC International Inc.
Dean Food Inc.
Dole Food Co., Inc.
Farmland Industries Inc.
General Mills, Inc.
Gold Kist Inc.
Hershey Foods Corp.

International Multifoods Corp.
Interstate Bakeries
JR Simplot Co.
Land O' Lakes
McCormick & Co., Inc.
Nabisco Foods
PepsiCo, Inc.
Pillsbury Foods
Quaker Oats
Ralston Purina Co.
Sara Lee Corp.
Triarc Cos., Inc.
Tyson Foods Inc.
W.M. Wrigley Jr., Co.
Whitman Corp.

Exhibit 6. Forest Products, 1995

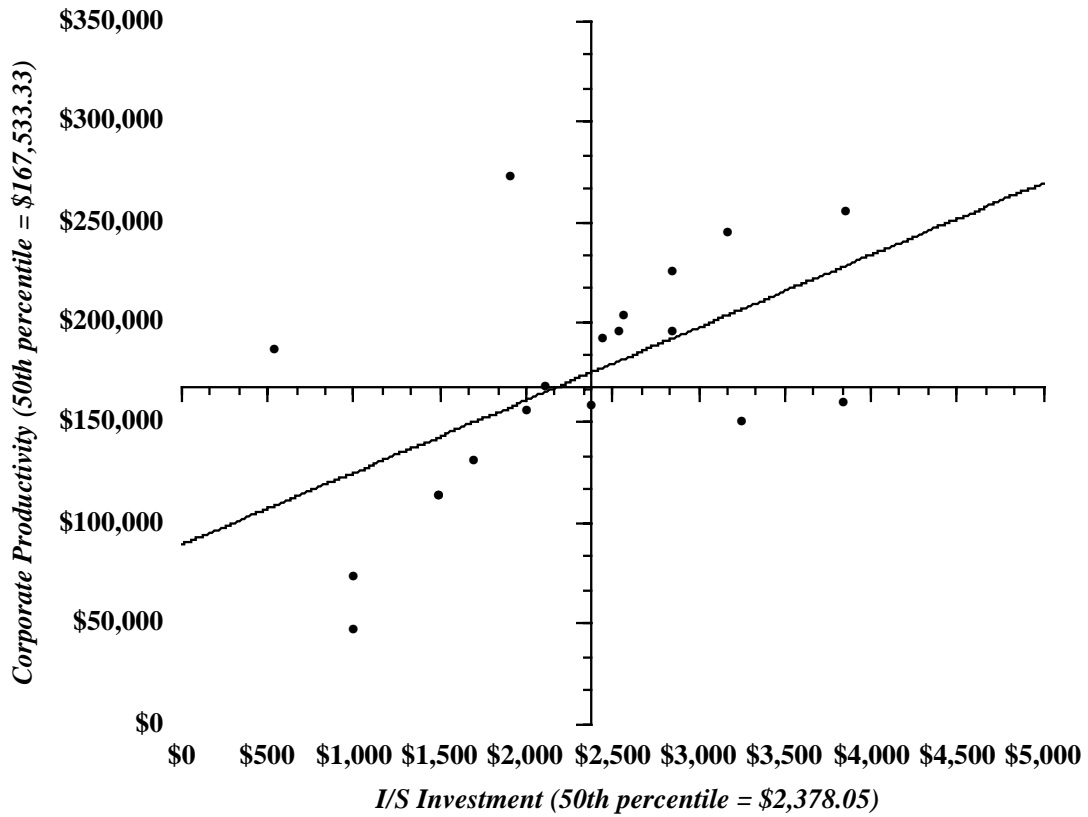


expected corporate productivity = \$198,004.60 + 48.47 (i/s investment per employee)
correlation = .332 (variance explained = 11%)

Avery Dennison
Bemis Co., Inc.
Boise Cascade Corp.
Bowater
Champion International Corp.
Chesapeake Corp.
Gaylord Container Corp.
Georgia-Pacific
International Paper Co.
James River Corp. of Virginia
Jefferson Smurfit
Kimberly Clark

Manville Sales Corp.
MacMillan Bloedel
The Mead Corp.
Rayonier
Simpson Investment Co.
Sonoco Products
Stone Container Corp.
Temple-Inland, Inc.
Union Camp Corp.
Westvaco Corp.
Weyerhaeuser Inc.
Willamette Industries

Exhibit 7. Printing and Publishing, 1995

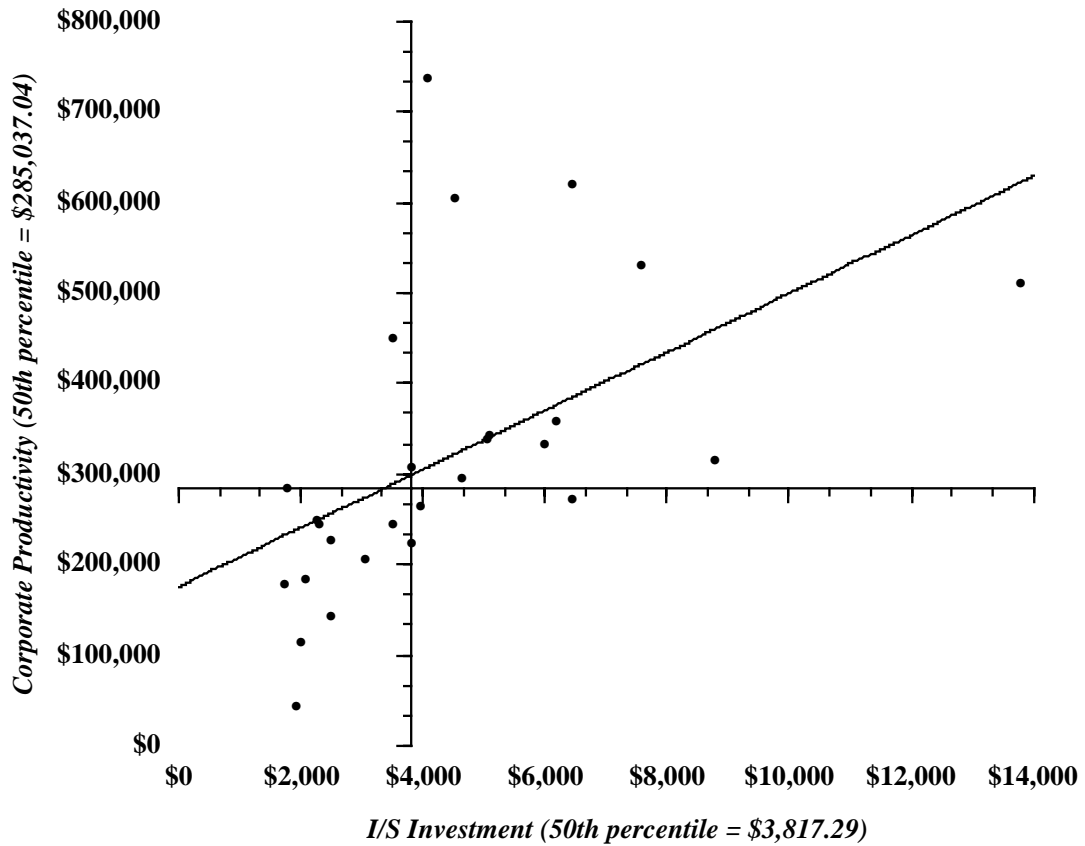


expected corporate productivity = \$89,189.04 + 36.05 (i/s investment per employee)
correlation = .568 (variance explained = 32.3%)

Advance Publications Inc.
Banta Corp.
R.R. Donnelley & Sons Co.
Dow Jones & Co.
EW Scripps Co.
Freedom Communications
Gannett Co., Inc.
Hearst Corp.
Journal Communications Inc.
K III Holdings

Knight-Ridder, Inc.
McGraw-Hill, Inc.
MediaNews Group Inc.
New York Times Co.
Reynolds and Reynolds Co.
Time Warner Inc.
Times Mirror Co.
Tribune Co.
Washington Post Co.

Exhibit 8. Chemicals, 1995

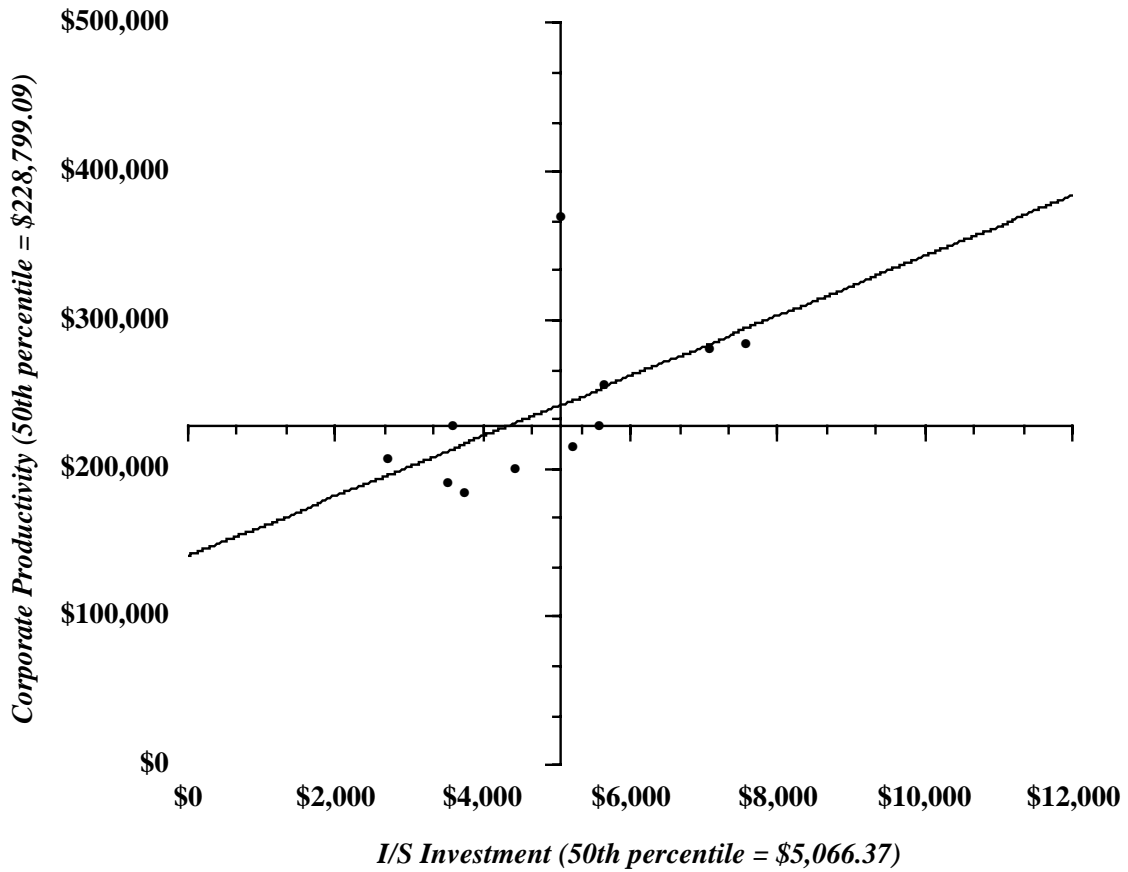


expected corporate productivity = $\$175,762.18 + 32.34$ (i/s investment per employee)
 correlation = .529 (variance explained = 28%)

Air Products and Chemicals, Inc.
Avon Products, Inc.
Cabot
Colgate-Palmolive
The Dial Corp.
Dow Chemical Co.
DuPont Co.
Ethyl Corp.
FMC Corp.
GAF Corp.
Geon
The B.F. Goodrich Co.
W.R. Grace & Co.
Hercules Inc.

Hercules Inc.
Hoechst Celanese Corp.
IMC Global
MA Hanna Corp.
Monsanto Co.
Morton International Inc.
Occidental Petroleum Corp.
Olin Corp.
PPG Industries
Procter & Gamble
Rohm and Haas Co.
Sherwin-Williams Co.
Union Carbide Corp.
Witco Corp.

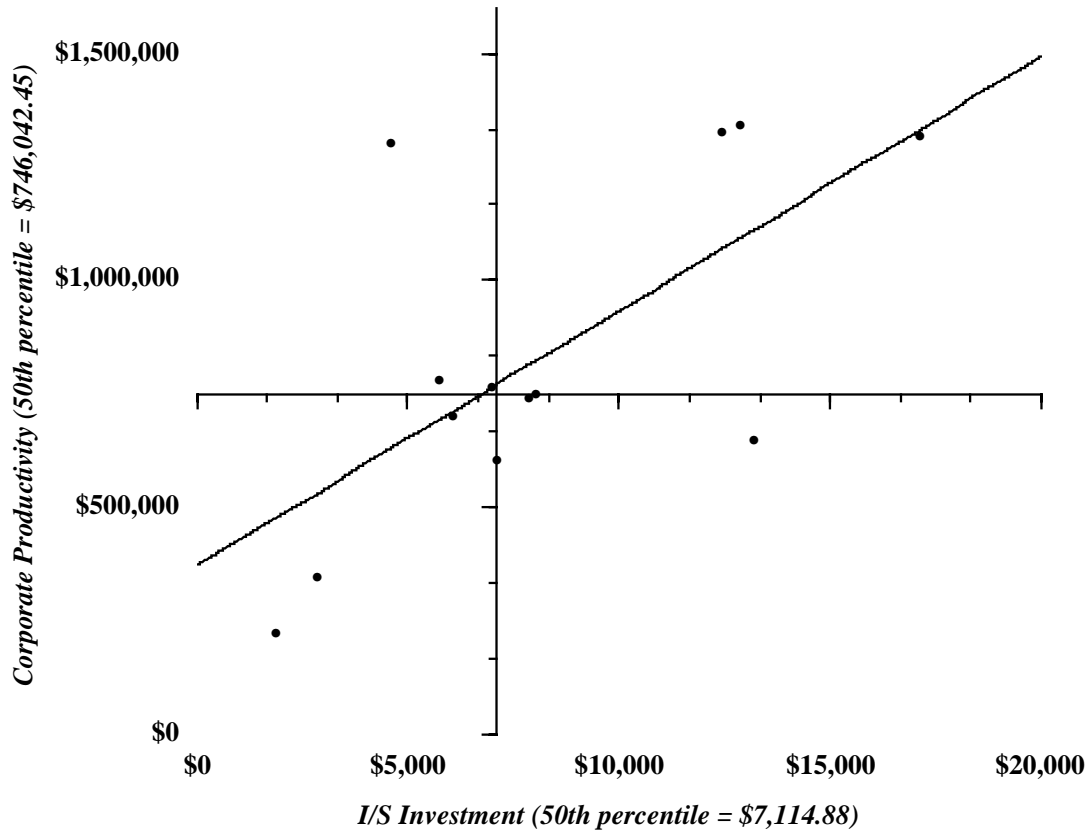
Exhibit 9. Pharmaceuticals, 1995



**expected corporate productivity = \$140,436.06 + 20.30 (i/s investment per employee)
 correlation = .563 (variance explained = 31.7%)**

- Abbott Laboratories*
- American Home Products Corp.*
- Bristol Myers Squibb Co.*
- Johnson & Johnson*
- Eli Lilly & Co.*
- Mallinckrodt Medical, Inc.*
- Merck & Co.*
- Pfizer Inc.*
- Rhone Poulenc Rorer, Inc.*
- Schering-Plough Corp.*
- Warner-Lambert Co.*

Exhibit 10. Petroleum and Refining, 1995

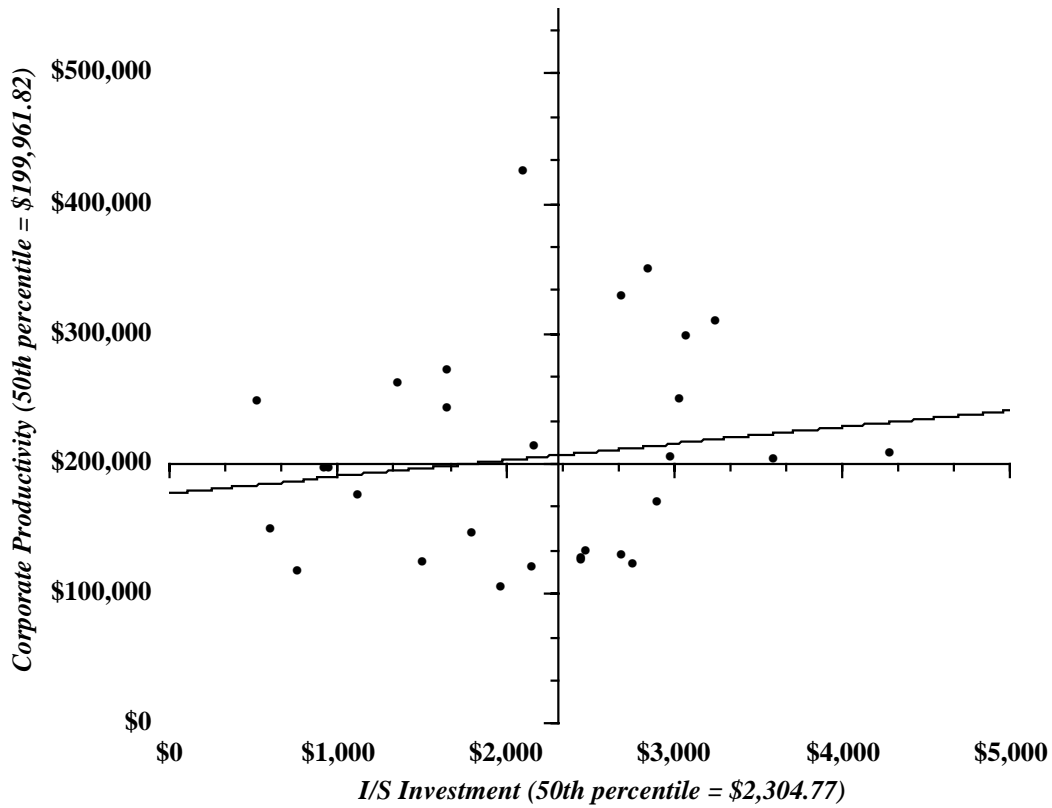


expected corporate productivity = $\$370,705.77 + 56.12$ (i/s investment per employee)
 correlation = .667 (variance explained = 44.5%)

Amoco
Ashland Oil
Atlantic Richfield Co.
Chevron Corp.
Exxon Corp.
Kerr-McGee Corp.
Mobil Corp.

Phillips Petroleum Co.
Quaker State
Shell Oil
Sun Co., Inc.
Texaco Inc.
Unocal Corp.

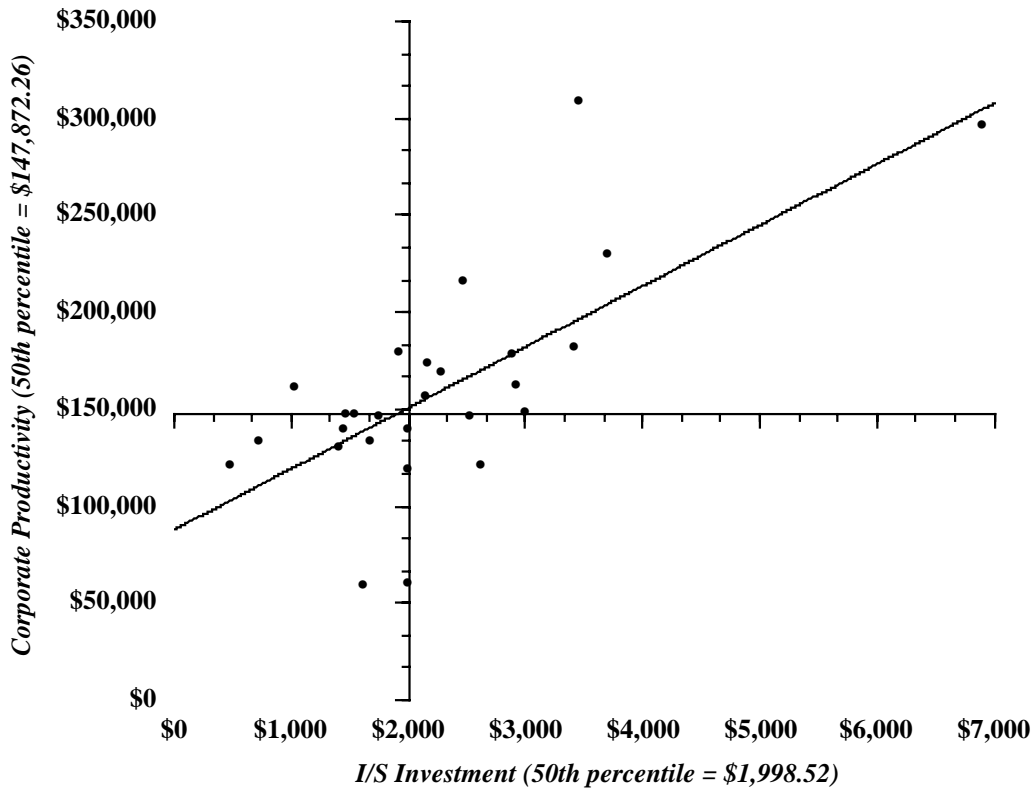
Exhibit 11. Building Materials, Glass and Metals, 1995



**expected corporate productivity = \$177,466.76 + 12.77 (i/s investment per employee)
 correlation = .179 (variance explained = 3.2%)**

- | | | |
|---------------------------------------|---------------------------------|----------------------------|
| <i>Alumax, Inc.</i> | <i>Harsco Corp.</i> | <i>Reynolds Metals Co.</i> |
| <i>ALCOA</i> | <i>Illinois Tool Works Inc.</i> | <i>Snap-On Tools Corp.</i> |
| <i>Armco, Inc.</i> | <i>Inland Steel Industries</i> | <i>The Stanley Works</i> |
| <i>Armstrong World Industries</i> | <i>Kohler Co.</i> | <i>Trinova Corp.</i> |
| <i>Asarco, Inc.</i> | <i>LTV Corporation</i> | <i>USG Corp.</i> |
| <i>Ball Corporation</i> | <i>Maxxam, Inc.</i> | <i>USX Corp.</i> |
| <i>Bethlehem Steel Corp.</i> | <i>Owens-Corning</i> | <i>3M Company</i> |
| <i>Corning Corporation</i> | <i>Owens-Illinois</i> | |
| <i>Crane</i> | <i>Parker Hannifin Corp.</i> | |
| <i>Crown Cork & Seal Co. Inc.</i> | <i>Phelps Dodge Corporation</i> | |
| <i>Gillette Co.</i> | <i>Premark International</i> | |
| <i>Goodyear Tire Co.</i> | | |

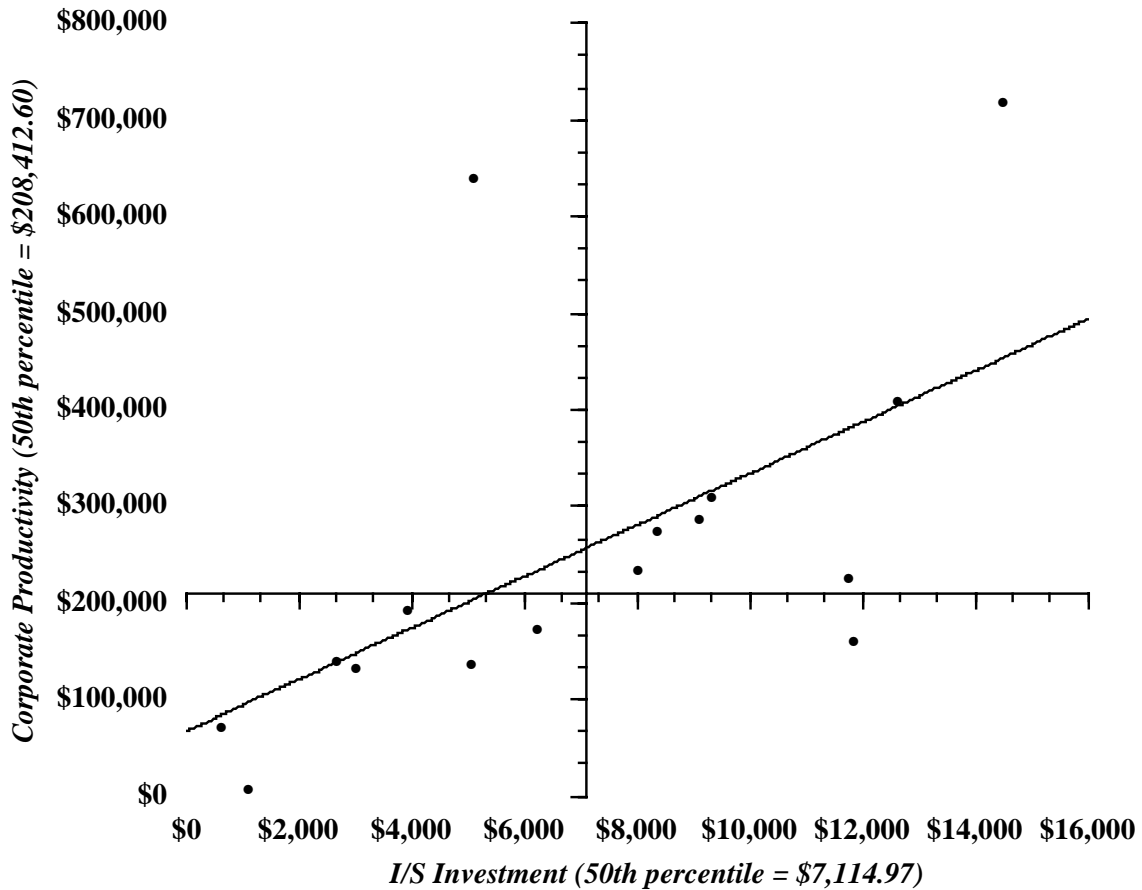
Exhibit 12. Industrial and Farm Equipment, 1995



expected corporate productivity = $\$88,120.19 + 31.38$ (i/s investment per employee)
 correlation = $.699$ (variance explained = 48.9%)

- | | | |
|---------------------------------|---|-------------------------------------|
| <i>A.O. Smith Corp.</i> | <i>Danaher Corp.</i> | <i>McDermott International Inc.</i> |
| <i>American Standard</i> | <i>Deere & Co.</i> | <i>NACCO Industries</i> |
| <i>Baker Hughes Inc.</i> | <i>Dover Corp.</i> | <i>Nortek, Inc.</i> |
| <i>Black and Decker Corp.</i> | <i>Dresser Industries, Inc.</i> | <i>Pentair Inc.</i> |
| <i>Brunswick Corp.</i> | <i>Figgie International Inc.</i> | <i>SPX Corp.</i> |
| <i>Caterpillar Inc.</i> | <i>Great Amer. Mgmt & Innovations</i> | <i>Tenneco Inc.</i> |
| <i>Cincinnati Milacron Inc.</i> | <i>Harnischfeger Industries, Inc.</i> | <i>Timken Co.</i> |
| <i>Coltech Industries</i> | <i>Imo Industries</i> | <i>Tyco Laboratories</i> |
| <i>Cummins Engine Co., Inc.</i> | <i>Ingersoll Rand Co.</i> | |
| | <i>Lennox International Inc.</i> | |

Exhibit 13. Computer and Office Equipment, 1995

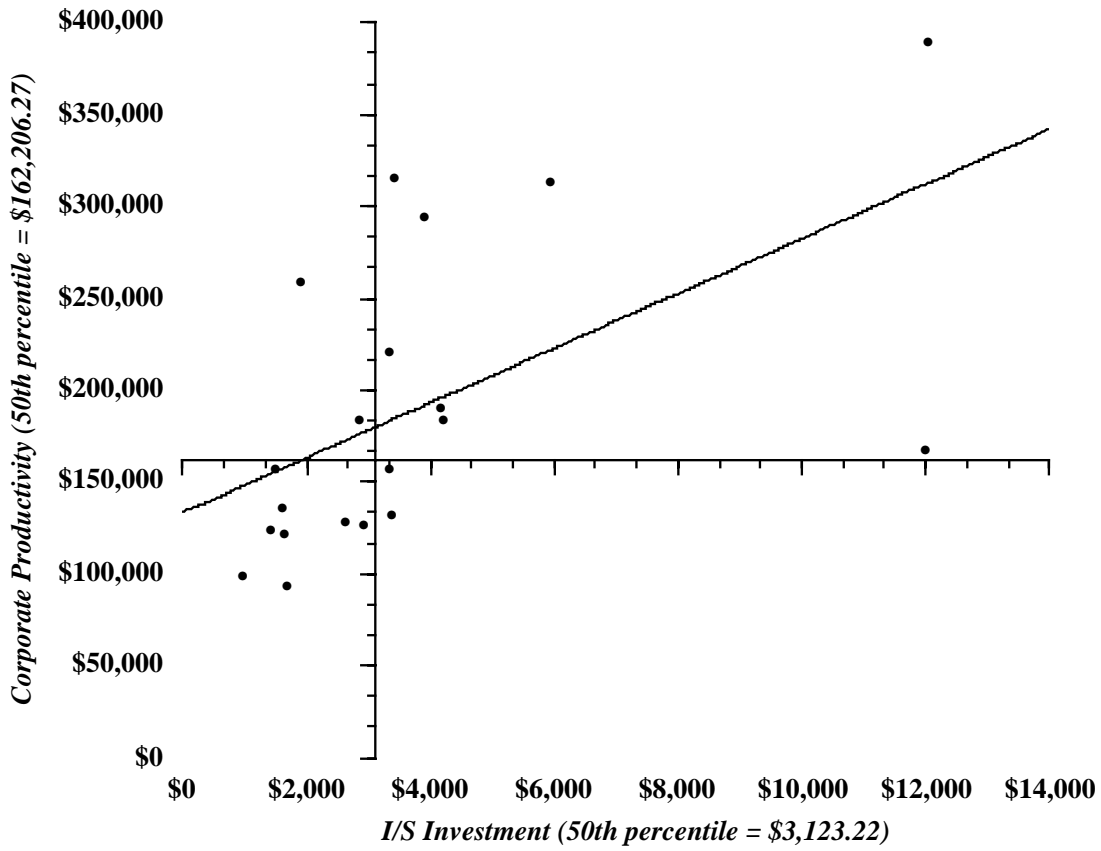


expected corporate productivity = \$67,087.49 + 26.68 (i/s investment per employee)
correlation = .596 (variance explained = 35.6%)

Apple Computer Inc.
Cray Research
Data General Corp.
Dell Computer Corp.
Digital Equipment Corp.
Hewlett-Packard Co.
IBM
Intergraph Corp.

NCS
Pitney Bowes Inc.
Seagate Technology Inc.
Storage Technology Corp.
Sun Microsystems Inc.
Tandem Computers Inc.
Unisys Corp.
Wang Laboratories

Exhibit 14. Electronics and Electrical, 1995



expected corporate productivity = \$133,492.98 + 14.89 (i/s investment per employee)
correlation = .552 (variance explained = 30.5%)

Ametek Inc.

AMP, Inc.

Analog Devices

Cooper Industries, Inc.

Emerson Electric Co.

General Electric

General Signal Corp.

Harris Corp.

J.M. Huber Corp.

Intel Corp.

LSI Logic Corp.

Magnetek Inc.

Maytag Corp.

Motorola Inc.

National Service Industries, Inc.

Nortel

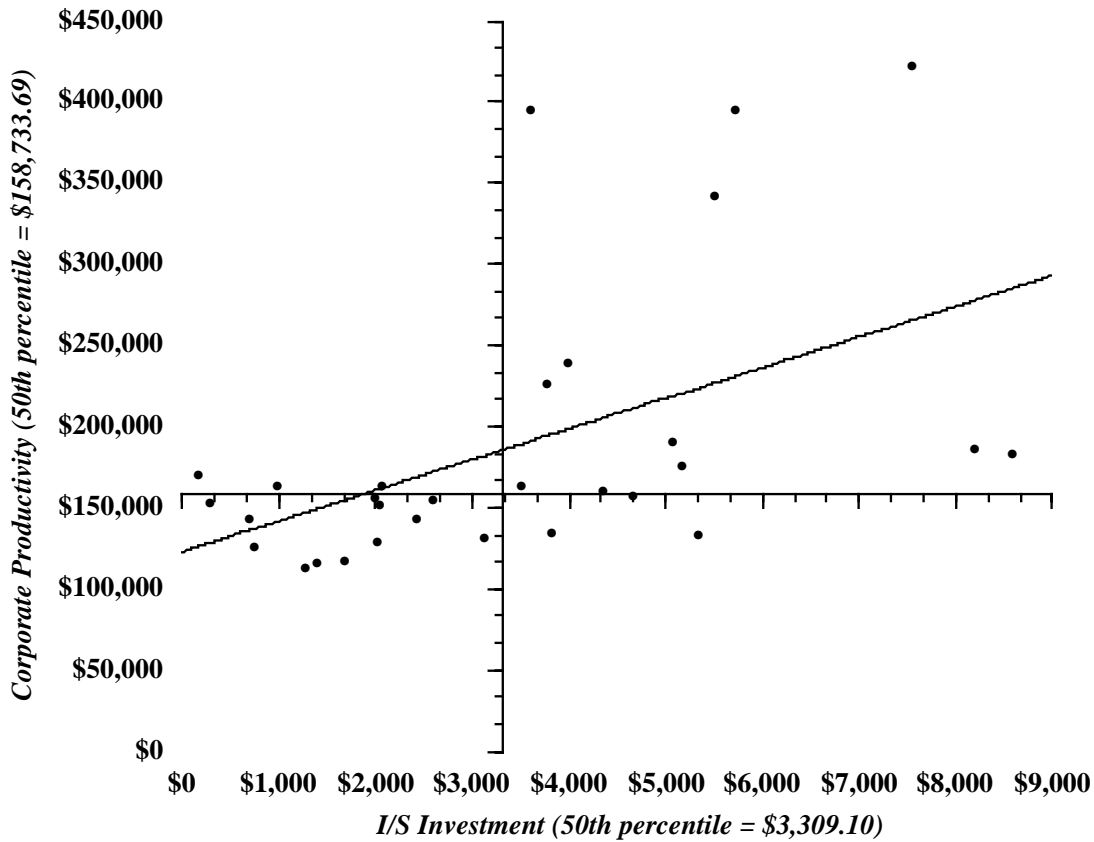
Texas Instruments Inc.

Varian

Westinghouse Electric Corp.

Whirlpool Corp.

Exhibit 15. Automotive and Aerospace, 1995

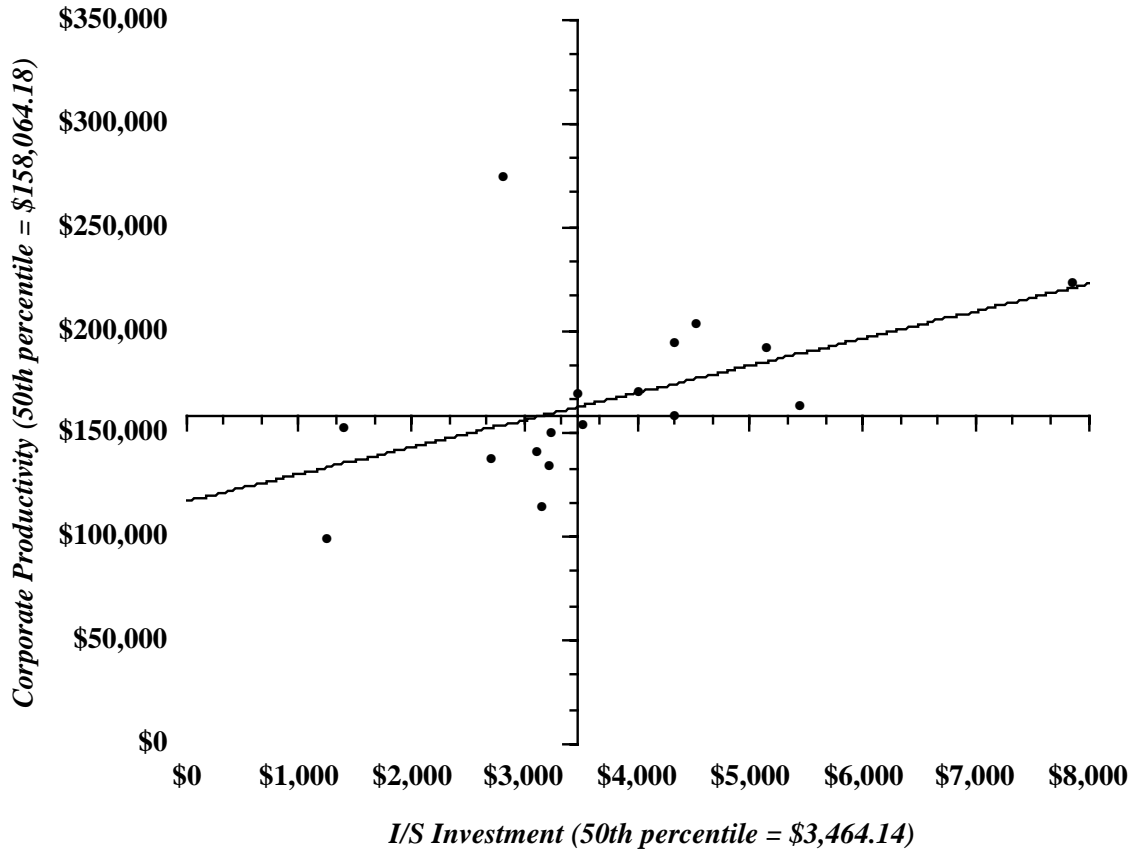


expected corporate productivity = \$123,005.66 + 18.88 (i/s investment per employee)
correlation = .50 (variance explained =25.2%)

Allied-Signal Inc.
Amsted Industries Inc.
Arvin Industries Inc.
Boeing
Borg Warner Automotive Inc.
Chrysler Corp.
Dana Corp.
Eagle Picher Industries Inc.
Eaton Corp.
Echlin Inc.
Federal-Mogul Corp.
Ford Motor Corp.
Gencorp Inc.
General Dynamics
General Motors

Lockheed Corp.
Loral Corp.
Mascotech Inc.
McDonnell Douglas Corp.
Navistar International Corp.
Northrop-Grumman
Paccar, Inc.
Rockwell International Corp.
Sequa Corp.
Sundstrand Corp.
Teledyne, Inc.
Textron Corp.
Thiokol Corp.
TRW
United Technologies Corp.

Exhibit 16. Instrumentation, 1995

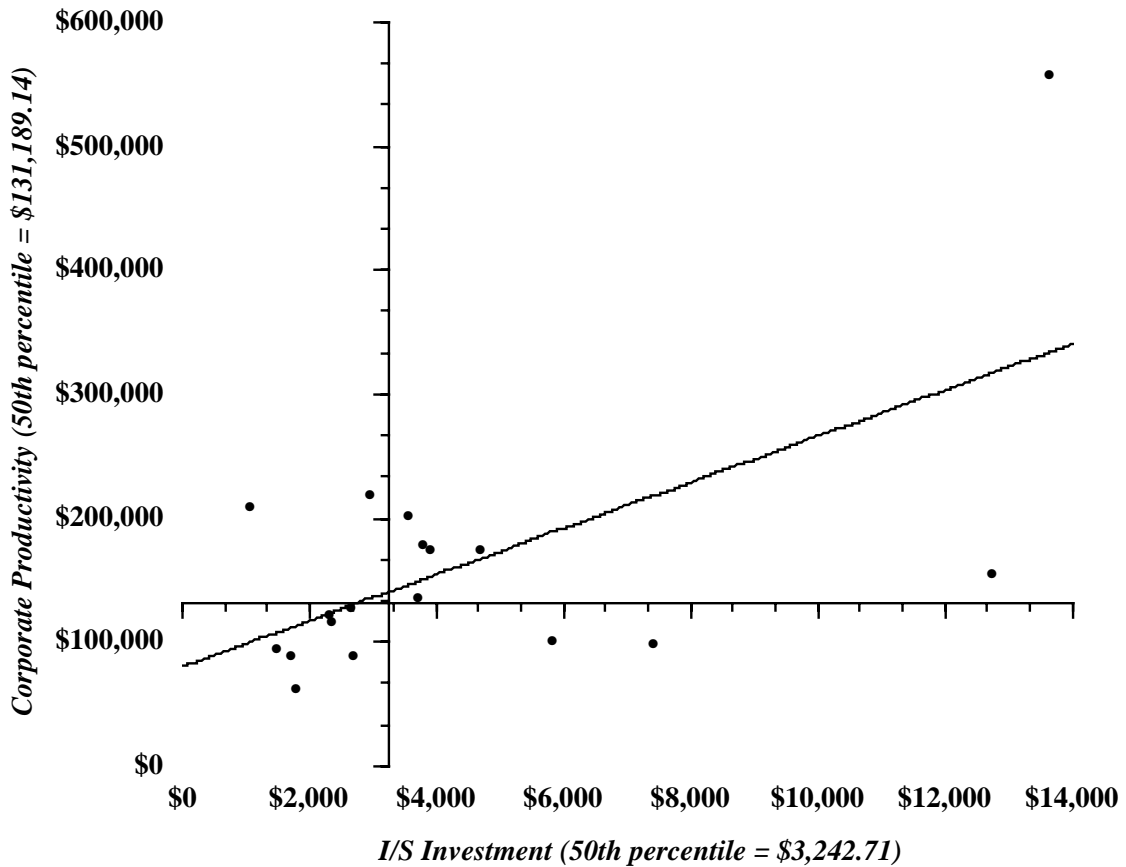


expected corporate productivity = \$117,266.31 + 13.15 (i/s investment per employee)
 correlation = .487 (variance explained = 23.7%)

Bausch & Lomb, Inc.
Baxter International
Beckman Instruments Inc.
Becton, Dickinson & Co.
Eastman Kodak
Honeywell, Inc.
Johnson Controls, Inc.
Litton Industries

Mark IV Industries, Inc.
Medtronic Inc.
Polaroid Corp.
Raytheon Co.
Tektronix Inc.
Thermo Electron Corp.
United States Surgical
Xerox

Exhibit 17. Transportation Services, 1995

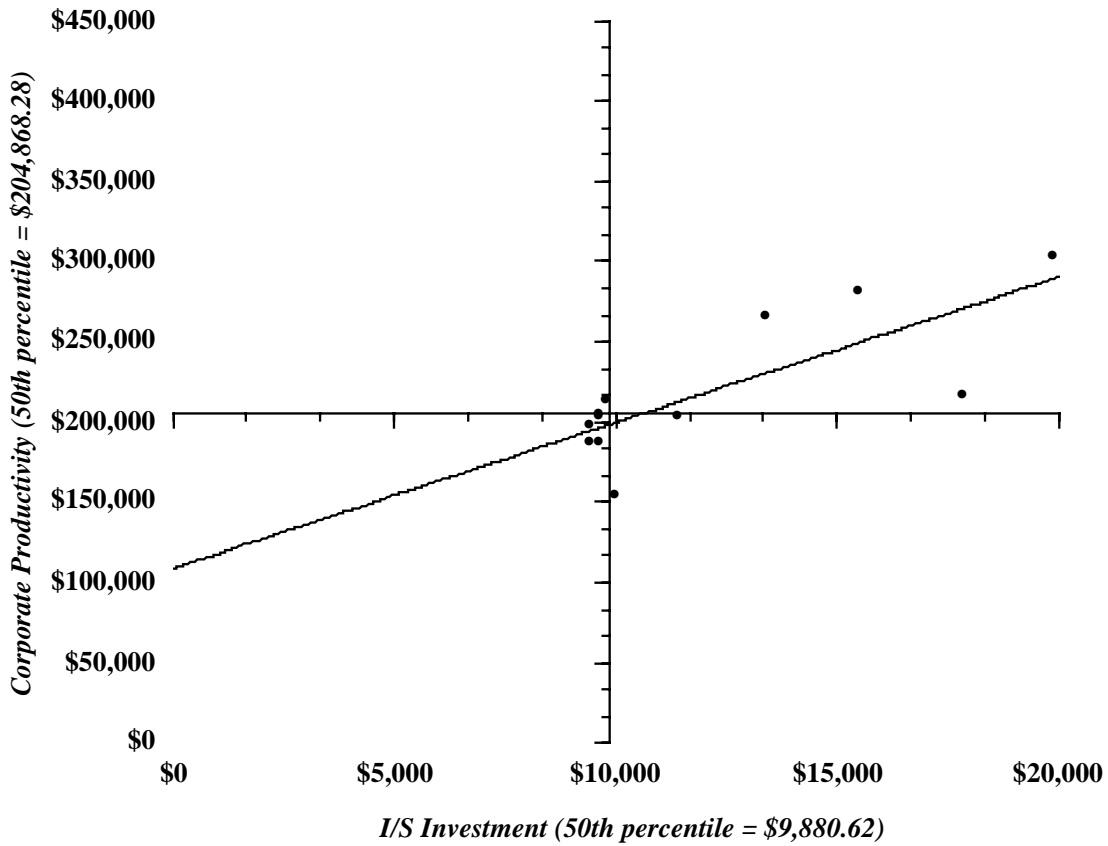


**expected corporate productivity = \$80,125.56 + 18.60 (i/s investment per employee)
 correlation = .611 (variance explained = 37.3%)**

*American Airlines
 American President Companies
 Burlington Northern, Inc.
 Caliber Systems
 Consolidated Freight
 CSX Corp.
 Federal Express Corp.
 GATX Corp.
 Kansas City Southern Industries*

*Norfolk Southern Corp.
 Northwest Airlines, Inc.
 The Pittston Co.
 Roadway Services, Inc.
 Ryder System, Inc.
 Union Pacific Corp.
 United Parcel Service
 USAir Group
 Yellow Freight Systems*

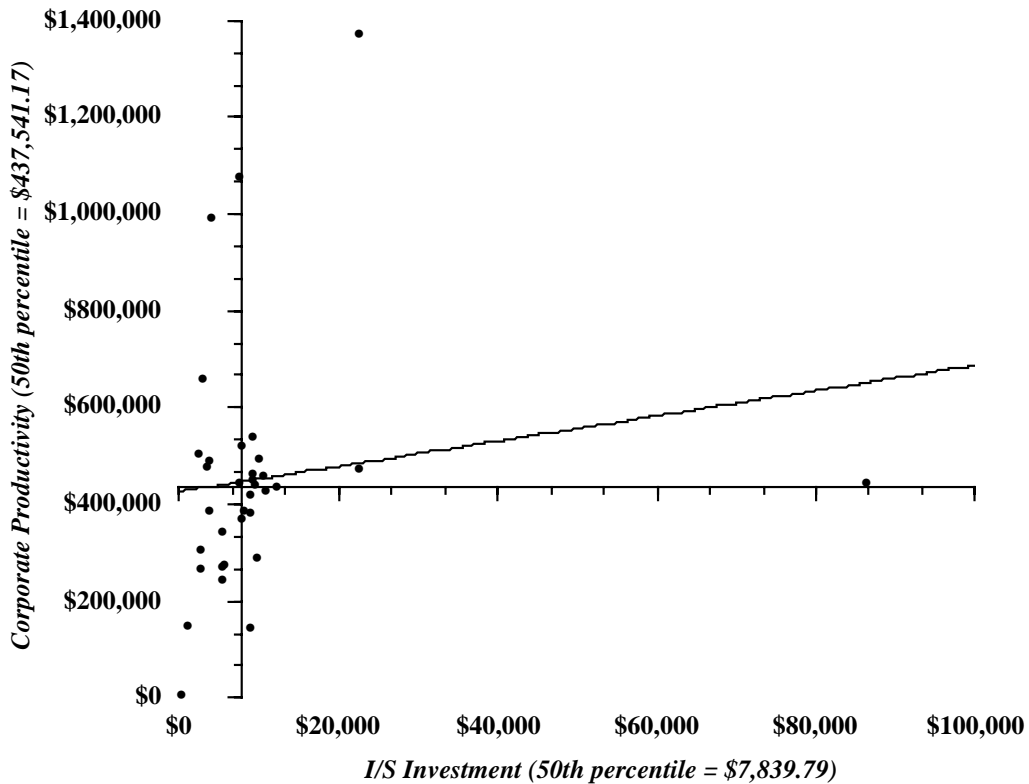
Exhibit 18. Communications, 1995



expected corporate productivity = \$108,805.43 + 9.08 (i/s investment per employee)
correlation = .781 (variance explained = 61%)

- Alltel Corp.*
- Ameritech Corp.*
- AT & T*
- Bell Atlantic Corp.*
- Bell South Corp.*
- GTE Service Corp.*
- MCI Communications Corp.*
- Nynex Corp.*
- Pacific Telesis Group*
- SBC Communications*
- Sprint Corporation*
- US West Communications*

Exhibit 19. Utilities, 1995



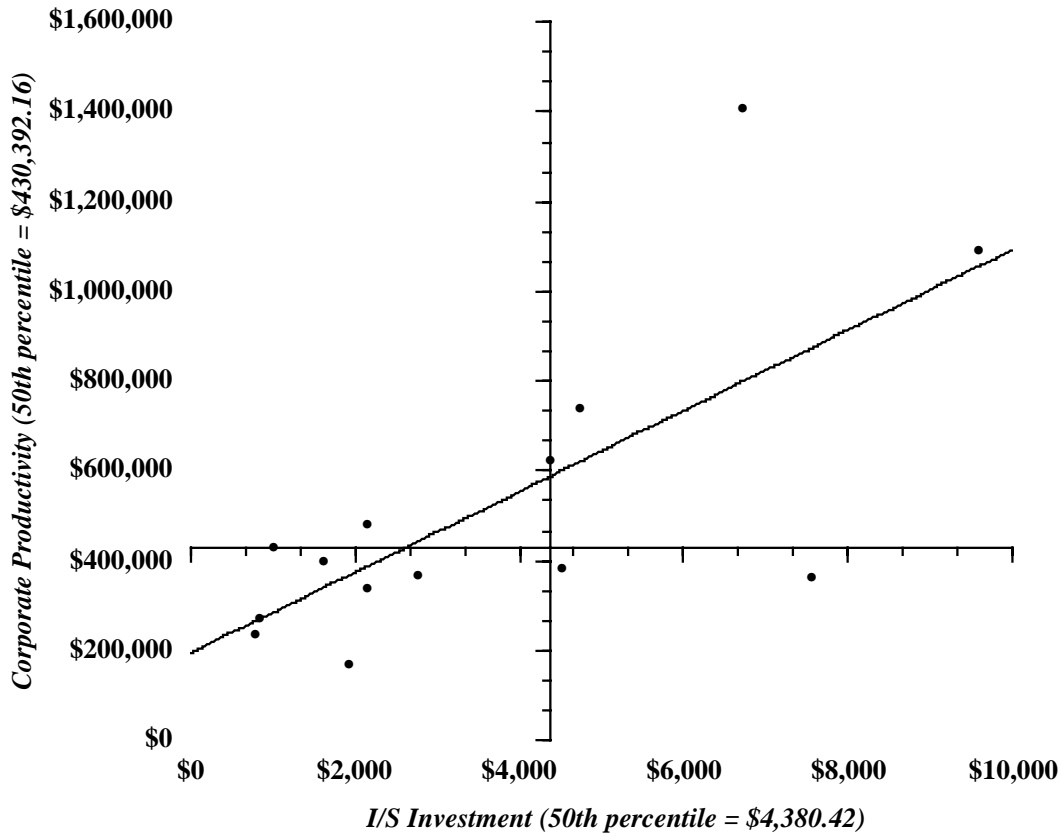
expected corporate productivity = \$426,290.34 + 2.61 (i/s investment per employee)
correlation = .145 (variance explained = 2.1%)

Allegheny Power System
American Electric Power
Carolina Power & Light Co.
Central & Southwest Corp.
CMS Energy Corp.
Coastal Corp.
Columbia Gas System
Commonwealth Edison
Consolidated Edison of New York
Consolidated Natural Gas Co.

Dominion Resources Inc.
DTE Energy (Detroit Edison)
Duke Power Co.
Enron Corp.
Entergy Services
Florida Power & Light
General Public Utilities Corp.
Kansas City Power & Light
New York State Electric & Gas
Niagara Mohawk Power Corp.
Northeast Utilities
Northern States Power Co.

ONEOK
Pacific Enterprises
Pacific Gas & Electric Co.
Pacificorp
PanEnergy
Pinnacle West Capital Corp.
Public Service Electric & Gas
SCE Corp.
Sonat, Inc.
The Southern Co.
Transcanada Pipeline
WMX Technologies, Inc.

Exhibit 20. Wholesale Trade, 1995

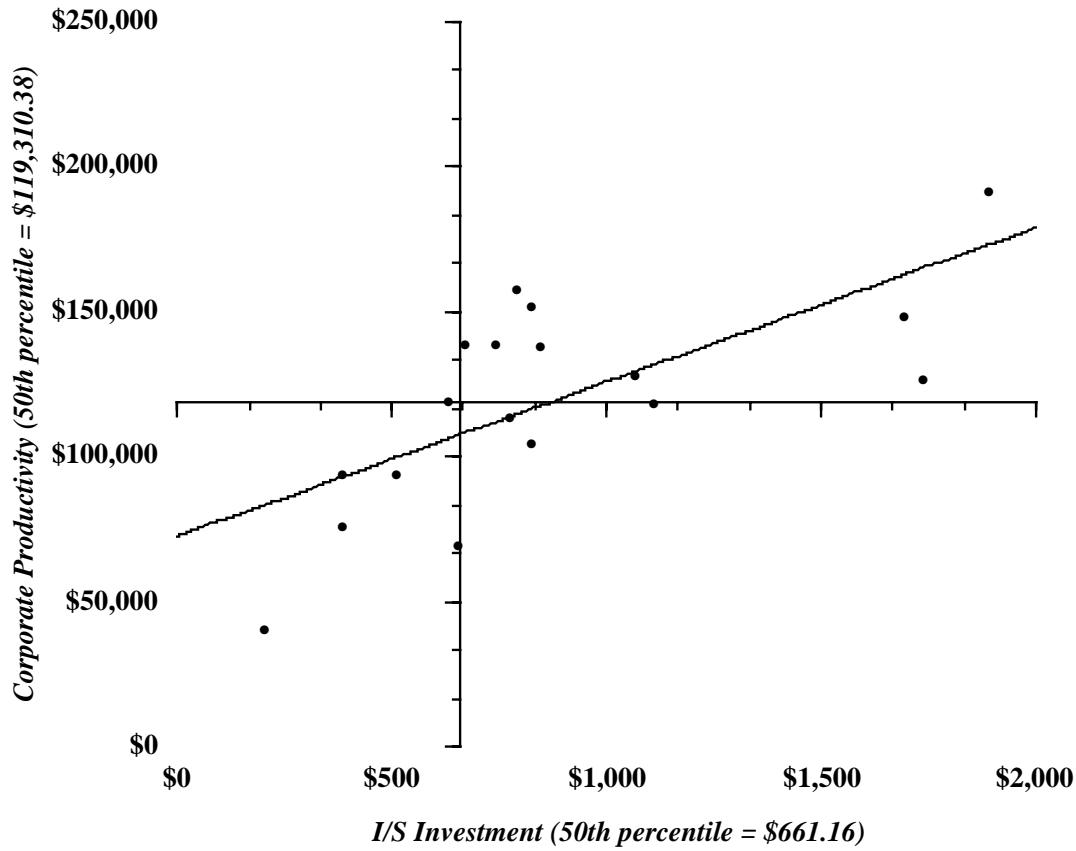


**expected corporate productivity = \$249,174.10 + 65.36 (i/s investment per employee)
 correlation = .604 (variable explained = 36.4%)**

*Ace Hardware
 Alco Standard Corp.
 Anixter International
 Avnet, Inc.
 Certified Grocers of California
 Commercial Metals Co.
 Fleming Companies Inc.
 Genuine Parts Co.*

*Earle M. Jorgensen
 Kaman Corp.
 Mars, Inc.
 McKesson Corp.
 MicroAge Inc.
 SuperValu Stores, Inc.
 Sysco Corp.
 United Stationers*

Exhibit 21. Retail Trade, 1995



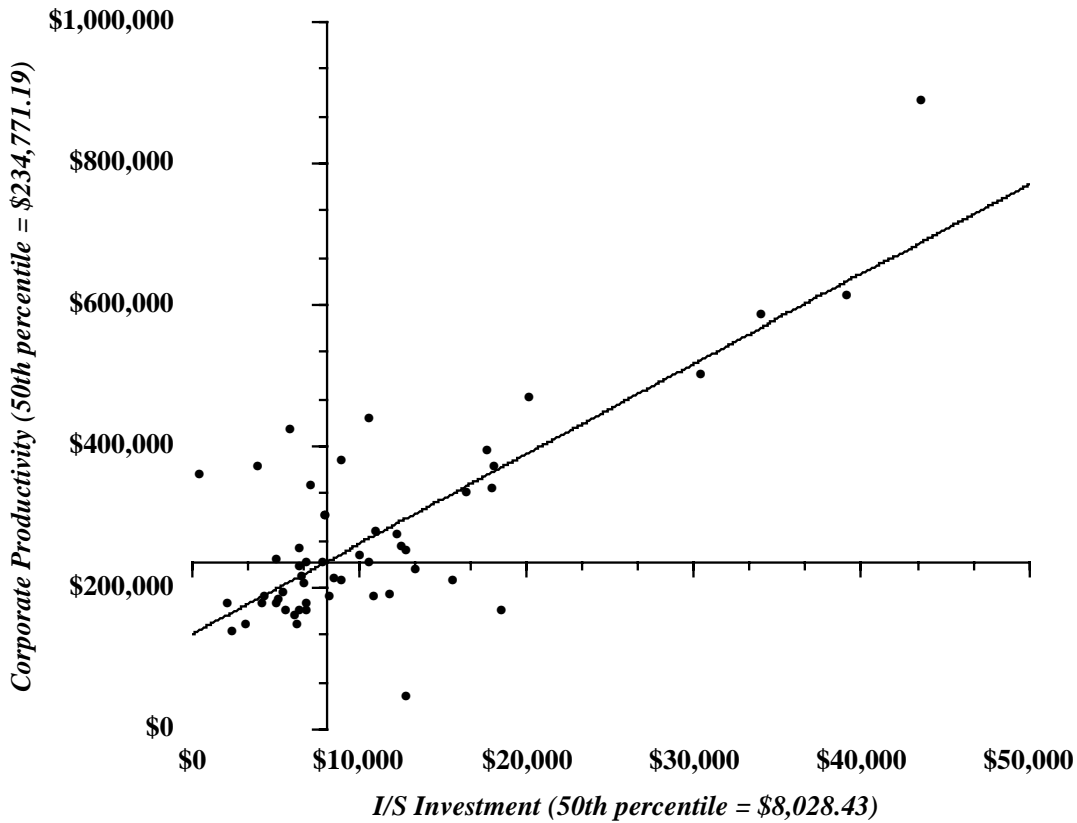
**expected corporate productivity = $-\$85,896.90 + 44.44$ (i/s investment per employee)
correlation = .606 (variance explained = 36.7%)**

*Albertson, Inc.
 American Stores Co.
 Aramark Group Inc.
 Dayton Hudson Corp.
 Federated Department
 Stores
 Food Lion, Inc.
 Harcourt General Inc.
 J.C. Penney Co.*

*K Mart Corp.
 Kroger Co.
 The Limited, Inc.
 The May Department Stores
 Meijer, Inc.
 Melville Corp.
 Montgomery Ward
 Nordstrom
 Payless Cashways
 Penn Traffic Co.*

*Publix Super Markets Inc.
 Safeway Inc.
 Sears, Roebuck & Co.
 Toys R Us, Inc.
 Venture Stores Inc.
 Wal-Mart Stores, Inc.
 Winn-Dixie Stores, Inc.
 F.W. Woolworth Co.*

Exhibit 22. Banking and Finance, 1995



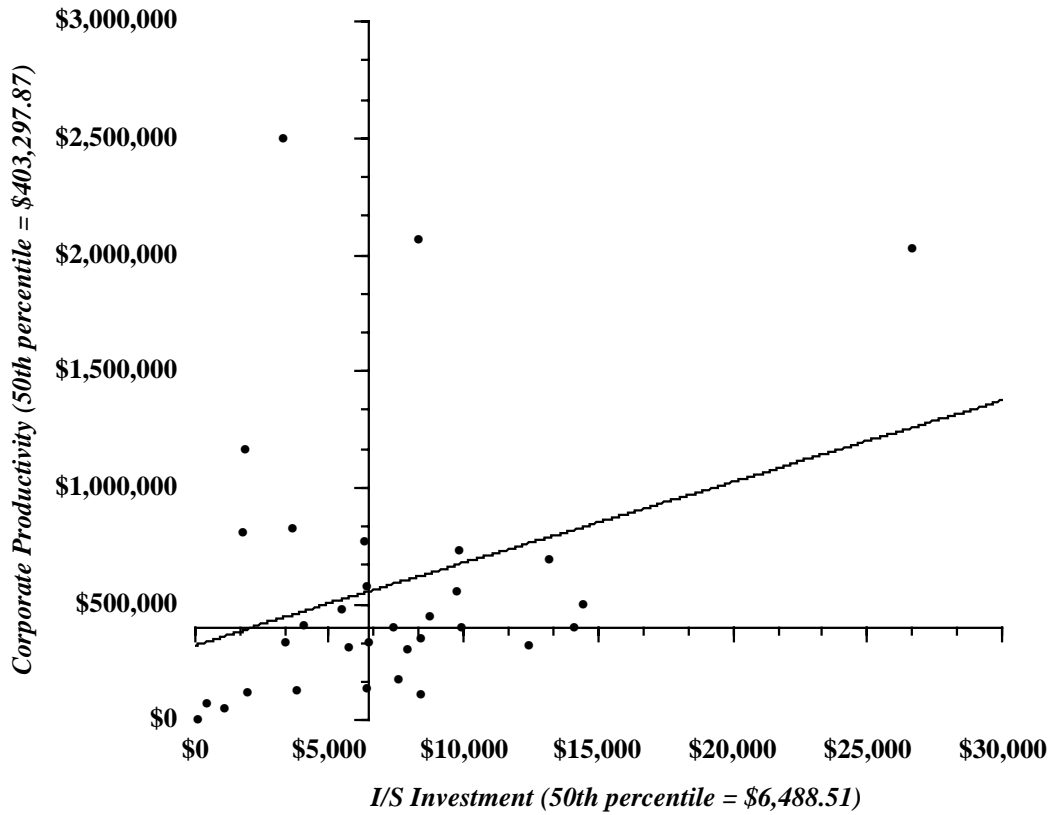
**expected corporate productivity = \$135,154.96 + 12.71 (i/s investment per employee)
 correlation = .779 (variance explained = 60.6%)**

*Marshall & Ilsley Corp.
 Mellon Bank Corp.
 Meridian Bancorp Inc.
 National City Corp.
 NationsBank Corp.
 Norwest Corp.
 PNC Financial Corp.
 Banc One Corp.
 Bank of Boston Corp.
 BankAmerica Corp.*

*Bankers Trust New York Corp.
 Barnett Banks, Inc.
 Boatmen's Bancshares Inc.
 Chase Manhattan Corp.
 Chemical Banking Corp.
 Citicorp
 Comerica Inc.
 Corestates Financial Corp.
 First Bank System Inc.
 First Chicago Corp.
 First Interstate Bancorp
 First of America Bank Corp.*

*First Security Info. Tech.
 First Tennessee National
 First Union Corp.
 Firststar Corp.
 Fleet/Norstar Financial
 Harris Bancorp Inc.
 J.P. Morgan & Co.
 KeyCorp
 Suntrust Banks Inc.
 UJB Financial Corp.
 US Bancorp
 Wachovia Corp.
 Wells Fargo & Co.*

Exhibit 23. Insurance, 1995



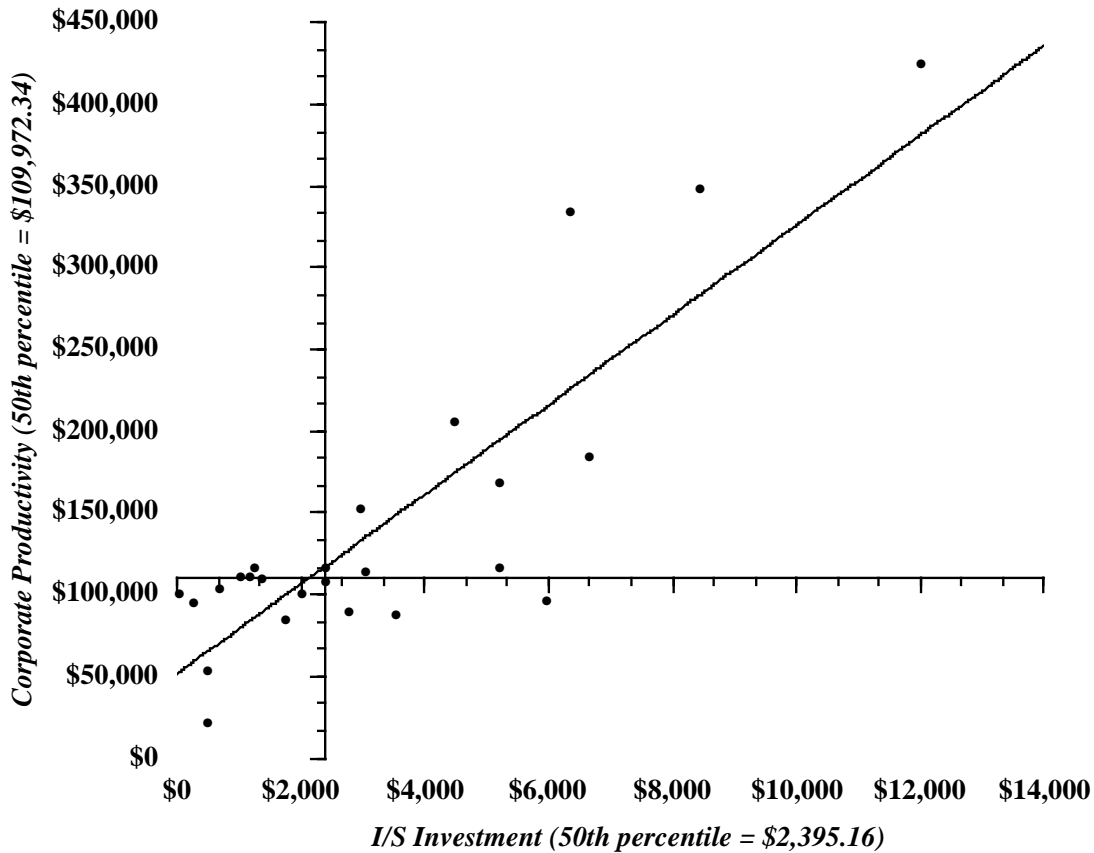
expected corporate productivity = \$324,213.41 + 34.80 (i/s investment per employee)
correlation = .310 (variance explained = 9.6%)

Aetna Life & Casualty
Aid Association for Lutherans
Alexander & Alexander
Allmerica Financial Group
American International Group
American National Insurance
Aon Corp.
Automobile Club of So. Calif.
Chubb & Son

Erie Insurance Group
Guardian Life
John Hancock
Johnson & Higgins
Kemper Corp.
Liberty Mutual Group
Loews Corp.
Metropolitan Life Ins. Co.
NAC Reinsurance

New York Life Ins. Group
Old Republic International
Principal Financial Group
The Prudential Ins. Co.
Reliance Group Holdings
Sammons Enterprises Inc.
State Farm Mutual Ins.
USF&G Corp.

Exhibit 24. Business Services, 1995



expected corporate productivity = \$51,111.93 + 27.51 (i/s investment per employee)
correlation = .853 (variance explained = 72.8%)

ADVO
Automatic Data Processing, Inc.
Booz Allen & Hamilton Inc.
Borg-Warner Corp.
Club Corp. International
Coopers & Lybrand
Deloitte & Touche
Ernst & Young
First Data Corp.

Interpublic Group of Cos.
KPMG Peat Marwick
Maritz Inc.
Omnicom Group Inc.
PHH Corp.
Price Waterhouse LLP
ServiceMaster Partnership
Young & Rubicam Inc.

APPENDIX: FIRMS INCLUDED IN SCATTERGRAMS

Manufacturing Firms

3M Co.
 A. O. Smith Corp.
 Abbott Laboratories
 Advance Publications Inc.
 Air Products and Chemicals Inc.
 Allied-Signal Inc.
 Alumax Inc.
 ALCOA
 American Home Products
 American Standard
 Ametek Inc.
 Amoco
 AMP, Inc.
 Amsted Industries Inc.
 Analog Devices
 Anheuser Busch Cos. Inc.
 Apple Computer Inc.
 Armco Inc.
 Armstrong World Industries
 Arvin Industries Inc.
 Asarco Inc.
 Ashland Oil
 Atlantic Richfield Co.
 Avery Dennison
 Avon Products, Inc.
 Baker Hughes Inc.
 Ball Corp.
 Banta Corp.
 Barnett Banks, Inc.
 Battelle Memorial Institute
 Bausch & Lomb, Inc.
 Baxter International
 Beckman Instruments Inc.
 Becton, Dickinson & Co.
 Bemis Co. Inc.
 Bethlehem Steel Corp.
 Black and Decker Corp.
 Boeing
 Boise Cascade Corp.
 Borden, Inc.
 Borg Warner Automotive Inc.
 Bristol Myers Squibb Co.
 Brunswick Corp.
 Burlington Industries
 Cabot
 Campbell Soup Co.
 Cargill Inc.
 Caterpillar Inc.
 Champion International Corp.
 Chesapeake Corp.
 Chevron Corp.
 Chrysler Corp.
 Cincinnati Milacron Inc.
 Coca-Cola Enterprises, Inc.
 Colgate Palmolive
 Collins & Aikman Corp.
 Coltech Industries
 ConAgra
 Continental Grain Co.
 Cooper Industries Inc.
 Corning Corp.
 CPC International Inc.
 Crane
 Cray Research
 Crown Cork & Seal Co. Inc.
 Cummins Engine Co. Inc.
 Cyprus Minerals Co.
 Dana Corp.
 Danaher Corp.
 Data General Corp.
 Dean Food Inc.
 Deere & Co.
 Dell Computer Corp.
 Dial Corp (The)
 Digital Equipment
 Dole Food Co. Inc.
 Donnelley (R.R.) & Sons Co.
 Dover Corp.
 Dow Chemical Co.
 Dow Jones & Co.
 Dresser Industries, Inc.
 DSC Communications
 DuPont Co.(E.I. du Pont de Nemours)
 Eagle Picher Industries Inc.
 Eastman Kodak
 Eaton Corp.
 Echlin Inc.
 Emerson Electric Co.
 Ethyl Corp.
 EW Scripps Co.
 Exxon Corp.
 Farmland Industries Inc.
 Federal-Mogul Corp.
 Fieldcrest Cannon
 Figgie International Inc.
 FMC Corp.
 Ford Motor Co.
 Freedom Communications
 GAF Corp.
 Gannett Co. Inc.
 Gaylord Container Corp.
 Gencorp Inc.
 General Dynamics
 General Electric
 General Mills, Inc.
 General Motors
 General Signal Corp.
 Geon
 Georgia-Pacific
 Gillette Co.
 Gold Kist Inc.
 Goodrich Co. (The B.F.)
 Goodyear Tire
 Grace & Co., W.R.
 Great American Mgmt & Innovation
 Harnischfeger Industries, Inc.
 Harris Corp.
 Harsco Corp.
 Hearst Corp.
 Hercules Inc.
 Hershey Foods Corp.
 Hewlett-Packard Co.
 Hoechst Celanese Corp.
 Honeywell Inc.
 Huber (J.M.) Corp.
 IBM
 Illinois Tool Works Inc.
 IMC Global
 Imo Industries
 Ingersoll-Rand Co.
 Inland Steel Industries, Inc.
 Insilco Corp.
 Intel Corp.
 Interco
 Intergraph Corp.
 International Multifoods Corp.
 International Paper Co.
 Interstate Bakeries
 James River Corp. of Virginia
 Jefferson Smurfit
 Johnson & Johnson
 Johnson Controls, Inc.
 Journal Communications Inc.
 JR Simplot Co.
 K III Holdings
 Kerr-McGee Corp.
 Kimberly-Clark Corp.
 Knight-Ridder, Inc.
 Kohler Co.
 Land O'Lakes
 Lennox International Inc.
 Levi Strauss & Co.
 Lilly (Eli) & Co.
 Litton Industries
 Lockheed Corp.
 Loral Corp.
 LSI Logic Corp.
 LTV Corp.
 MA Hanna Corp.
 Magnetek Inc.
 Mallinckrodt Medical, Inc.
 Manville Sales Corp.
 Mark IV Industries Inc.
 Marmon Group Inc.
 Masco Corp.
 Mascotech Inc.
 Maxxam Inc.
 Maytag Corp.
 McCormick & Co. Inc.
 McDermott International Inc.
 McDonnell Douglas Corp.
 McGraw-Hill, Inc.
 Mead Corp., The
 MediaNews Group Inc.
 Medtronic Inc.
 Merck & Co.
 Milliken & Co.
 Mobil Corp.
 Monsanto Co.
 Morton International Inc.
 Motorola Inc.
 Nabisco Foods
 NACCO Industries
 National Computer Systems
 National Service Industries
 Navistar International Corp.
 New York Times Co.
 Nortek, Inc.
 Nortel
 Northrop-Grumman
 Occidental Petroleum Corp.
 Olin Corp.
 Oryx Energy Co.
 Owens-Corning
 Owens-Illinois
 Paccar, Inc.
 Parker Hannifin Corp.
 Pentair Inc.
 PepsiCo, Inc.
 Pfizer Inc.
 Phelps Dodge Corp.
 Phillips Petroleum Co.
 Pillsbury Foods
 Pitney Bowes Inc.
 Polaroid Corp.
 PPG Industries
 Premark International Inc.
 Procter & Gamble
 Quaker Oats
 Quaker State
 Ralston Purina Co.
 Rayonier
 Raytheon Co.
 Reynolds and Reynolds Co.
 Reynolds Metals Co.
 Rhone Poulenc Rorer, Inc.
 Rockwell International Corp.
 Rohm and Haas Co.
 Sara Lee Corp.
 Schering-Plough Corp.
 Seagate Technology Inc.
 Sealy Holdings
 Sequa Corp.
 Shaw Industries Inc.
 Shell Oil
 Sherwin-Williams Co.
 Simpson Investment Co.
 Snap-On Tools Corp.
 Sonoco Products
 Springs Industries Inc.
 SPX Corp.
 Stanley Works (The)
 Steelcase Inc.
 Stone Container Corp.
 Storage Technology Corp.
 Sun Co., Inc.
 Sun Microsystems Inc.
 Sundstrand Corp.
 Tandem Computers Inc.
 Tektronix Inc.
 Teledyne, Inc.
 Temple-Inland, Inc.
 Tenneco Inc.
 Texaco Inc.
 Texas Instruments Inc.
 Textron Corp.
 Thermo Electron Corp.
 Thiokol Corp.
 Time Warner Inc.
 Times Mirror Co.
 Timken Co.
 Triarc Cos. Inc.
 Tribune Co.
 Trinova Corp.
 TRW, Inc.
 Tyco Laboratories
 Tyson Foods Inc.
 Union Camp Corp.
 Union Carbide Corp.
 Unisys Corp.
 United States Surgical
 United Technologies Corp.
 Unocal Corp.
 USG Corp.
 USX Corp.
 Varian
 VF Corp.
 Vulcan Materials
 W.M. Wrigley Jr. Co.
 Wang Laboratories
 Warner-Lambert Co.
 Washington Post Co.
 Westinghouse Electric Corp.
 Westvaco Corp
 Weyerhaeuser Inc.
 Whirlpool Corp.
 Whitman Corp.
 Willamette Industries
 Witco Corp.
 WL Gore & Associates Inc.
 Xerox

Services Firms

Ace Hardware Corp.
 ADVO
 Aetna Life & Casualty
 Aid Assoc. for Lutherans
 Albertsons, Inc.
 Alco Standard Corp.
 Alexander & Alexander
 Alleghany Corp.
 Allegheny Power System
 Allmerica Financial Group
 ALLTEL Corp.
 American Electric Power
 American Express Co.
 American Financial Corp.
 American General Corp.
 American International
 Group
 American National
 Insurance
 American President
 Companies
 American Stores Co.
 Ameritech Corp.
 AMR (American Airlines)
 Anixter International
 Aon Corp.
 Apria Healthcare Group
 Aramark Group Inc.
 Arthur Andersen & Co.
 AT & T
 Automatic Data Processing
 Auto Club of So. Calif.
 Avnet Inc.
 Banc One Corp.
 Bank of Boston Corp.
 BankAmerica Corp.
 Bankers Trust New York
 Barnett Banks, Inc.
 Battelle Memorial Institute
 Bear, Stearns Cos. Inc.
 Bechtel Group Inc.
 Bell Atlantic Corp.
 BellSouth Corp.
 Boatmen's Bancshares Inc.
 Booz Allen & Hamilton
 Borg-Warner Corp.
 Burlington Northern, Inc.
 Caliber Systems, Inc.
 Capital Cities/ABC, Inc.
 Cardinal Health Inc.
 Carolina Power & Light
 CBS, Inc.
 Central & Southwest Corp.
 Certified Grocers of Calif.
 Chase Manhattan Corp.
 Chemical Banking Corp.
 Chubb & Son
 CIGNA Corp.
 Citicorp
 Club Corp. International
 CMS Energy Corp.
 Coastal Corp.
 Columbia Gas System
 Columbia HCA Healthcare
 Comdisco Inc.
 Comerica Inc.
 Commercial Metals Co.
 Commonwealth Edison
 Computer Assoc. Int'l
 Computer Sciences Corp.
 Consolidated Edison of New
 York
 Consolidated Freight
 Consolidated Natural Gas
 Continental Cablevision
 Coopers & Lybrand
 Corestates Financial Corp.
 Cox Enterprises Inc.
 CSX Corp.
 Day & Zimmermann Inc.
 Dayton Hudson Corp.
 Dean Witter Discover
 Deloitte & Touche
 Deluxe Corp.
 Dominion Resources Inc.
 DTE Energy (Detroit
 Edison)
 Duke Power Co.
 Dun & Bradstreet Corp.
 Edison International
 EDS Corp.
 EG&G Inc.
 Enron Corp.
 Entergy Corporation
 Equitable Life Assurance
 Erie Insurance Group
 Ernst & Young
 Federal Express Corp.
 Federated Department Stores
 FHP International Corp.
 First Bank System Inc.
 First Chicago Corp.
 First Data Corp.
 First Interstate Bancorp
 First of America Bank Corp.
 First Security Info. Tech.
 First Tennessee National
 First Union Corp.
 Firststar Corp.
 Fleet/Norstar Financial
 Fleming Companies Inc.
 Fluor
 Food Lion, Inc.
 Foster Wheeler Corp.
 FPL
 GATX Corp.
 Genuine Parts Co.
 GPU
 Great Western Financial
 Corp.
 GTE Service Corp.
 Guardian Life
 Halliburton Co.
 Harcourt General Inc.
 Harris Bankcorp Inc.
 Household International
 Houston Industries Inc.
 Ingram Industries Inc.
 Interpublic Group of Cos.
 ITT Corp.
 J.C. Penney Co.
 J.P. Morgan & Co.
 John Hancock Mutual Life
 Insurance
 Johnson & Higgins
 Jorgensen (Earle M.)
 Jostens, Inc.
 K Mart Corp.
 Kaman Corp.
 Kansas City Power & Light
 Kansas City Southern
 Industries
 Kemper Corp.
 KeyCorp
 KPMG Peat Marwick
 Kroger Co.
 Liberty Mutual Group
 Limited, Inc., The
 Loews Corp.
 MacAndrews & Forbes
 Holding
 Maritz Inc.
 Mars Inc.
 Marsh & McLennan Cos.
 Marshall & Ilsley Corp.
 May Department Stores
 MCI Communications
 McKesson Corp.
 Meijer Inc.
 Mellon Bank Corp.
 Melville Corp.
 Meridian Bancorp Inc.
 Merrill Lynch & Co.
 Metropolitan Life Insurance
 Co.
 MicroAge Inc.
 Microsoft Corp.
 Montgomery Ward
 Morrison Knudsen Corp.
 NAC Re Corporation
 National City Corp.
 NationsBank Corp.
 New York Life Insurance
 Group
 New York State Electric and
 Gas
 Niagara Mohawk Power
 Corp.
 Norfolk Southern Corp.
 Northeast Utilities
 Northern States Power Co.
 Northwest Airlines
 Norwest Corp.
 Nynex Corp.
 Ogden Corp.
 Old Republic International
 Omnicom Group Inc.
 ONEOK
 Pacific Enterprises
 Pacific Gas and Electric
 Pacific Telesis Group
 Pacificare Health Systems
 Pacificorp
 Paine Webber Group, Inc.
 PanEnergy
 Payless Cashways
 Penn Traffic Co.
 PHH Corp.
 Pinnacle West Capital
 Pittston Co., The
 PNC Financial Corp.
 Price Waterhouse LLP
 Principal Financial Group
 Prudential Insurance Co.
 Public Service Electric and
 Gas
 Publix Super Markets Inc.
 Pulte Corp.
 Reliance Group Holdings
 Roadway Services, Inc.
 Ryder System Inc.
 Safeway Inc.
 Sammons Enterprises Inc.
 SBC Communications
 Science Applications
 International Corporation
 Sears, Roebuck & Co.
 ServiceMaster Partnership
 Sonat, Inc.
 Southern Co., The
 Sprint Corp.
 St. Paul Companies Inc.
 State Farm Mutual Ins.
 Suntrust Banks Inc.
 Super Valu Stores Inc.
 Sverdrup Corp.
 Sysco Corp.
 Tenet Healthcare Corp.
 Torchmark
 Towers Perrin
 Toys R Us, Inc.
 Transamerica Corp.
 Transcanada Pipeline
 Travelers (The)
 UJB Financial Corp.
 Union Pacific Corp.
 United Parcel Service of
 America
 United Stationers
 US Bancorp
 US West Communications
 USAir Group
 USF&G Corp.
 Venture Stores Inc.
 Viacom Inc.
 Wachovia Corp.
 Wal-mart Stores, Inc.
 Walt Disney Co., The
 Wells Fargo & Co.
 Winn-Dixie Stores, Inc.
 WMX Technologies Inc.
 Woolworth Co.(F.W.)
 Yellow Freight Systems
 Young & Rubicam Inc.

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