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ANNUAL REPORT

PERFORMANCE BENCHMARKS FOR I/S IN CORPORATIONS

**ANNUAL REPORT &
DATA WAREHOUSE
1988-1994**

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

**Kenneth L. Kraemer
Vijay Gurbaxani
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Graduate School of Management
Center for Research on Information
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University of California, Irvine

**PERFORMANCE BENCHMARKS
FOR INFORMATION SYSTEMS
IN CORPORATIONS**

***REPORT AND
DATA WAREHOUSE***

Intercorporate Measurement Program

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

and

CSC Research and Advisory Services
Cambridge, Massachusetts

December, 1995

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**PERFORMANCE BENCHMARKS FOR
INFORMATION SYSTEMS IN CORPORATIONS**
Survey of I/S Directors

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About IMP

The Intercorporate Measurement Program (IMP) is a sponsored research program conducted by CSC Research and Advisory Services and the Center for Research on Information Technology and Organizations at the University of California, Irvine 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. Nicholas P. Vitalari at (617) 499-1389 or Dr. Kenneth L. Kraemer at (714) 824-5246 or kkraemer@uci.edu.

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PERFORMANCE BENCHMARKS FOR INFORMATION SYSTEMS IN CORPORATIONS

I. INTRODUCTION

QUALITY, PERFORMANCE AND MEASUREMENT

Manufacturing and services companies alike have come to see quality as a strategic tool in competition and to engage in total quality management. As a result they have begun to develop measures of performance which go beyond the traditional concern for financial performance. The measures involve broader concern for successful performance in national, international and global markets. This broader view of performance leads them to look at measures such as market share, client satisfaction, defect rates, response time, and delivery commitments to evaluate the performance of their products, services and operations.

Moreover, advanced companies are no longer satisfied with looking only internally at their own performance in relation to prior period results, current budget, or results of other departments within the company. They are increasingly interested in comparative benchmarking.

Benchmarking involves identifying companies in other industries that exemplify best practice in some activity, function, or process and then comparing

one's own performance to theirs. This externally oriented approach makes people aware of improvements that can be orders of magnitude beyond what they would have thought possible. But, benchmarking also goes beyond measurement. It involves networking with the better performing companies to learn more about *how* they achieve better performance, and *how what they do might fit* another company's circumstances.

THE I/S INTERCORPORATE MEASUREMENT PROGRAM

The Intercorporate Measurement Program (IMP) is aimed at such performance measurement and benchmarking in order to improve I/S practice. The focus is on information systems, including computers, telecommunications, office automation and related software and services.

The Program focuses on information systems because they represent the single largest capital expenditure that many corporations make. Information systems are also increasingly recognized as a critical factor in corporate competitiveness, both at home and abroad.

Yet the management of information systems is a complex task which is not well understood. In fact, the top managers of many organizations believe that they are not receiving an adequate return on their investments in information technologies. This has manifested itself in many ways, ranging from the decision by some organizations to outsource their information systems function to the absence of measurable gains in the productivity statistics of American industry.

The I/S Intercorporate Measurement Program, which is a collaborative project between CSC Research and Advisory Services, industry and academia, is aimed at meeting the challenge of performance measurement, benchmarking, and improvement of I/S practice.

Framework for I/S Services Production

The provision of I/S services can usefully be viewed as comprised of two major subsystems (Exhibit 1):

- (1) the production subsystem, and
- (2) the use subsystem.

The *production subsystem* is concerned with the major production processes that constitute information systems: systems development and computer operations. The *use subsystem* is concerned with the processes of delivering information services and their integration with business processes and decision making. *Resource inputs* of labor, capital, and

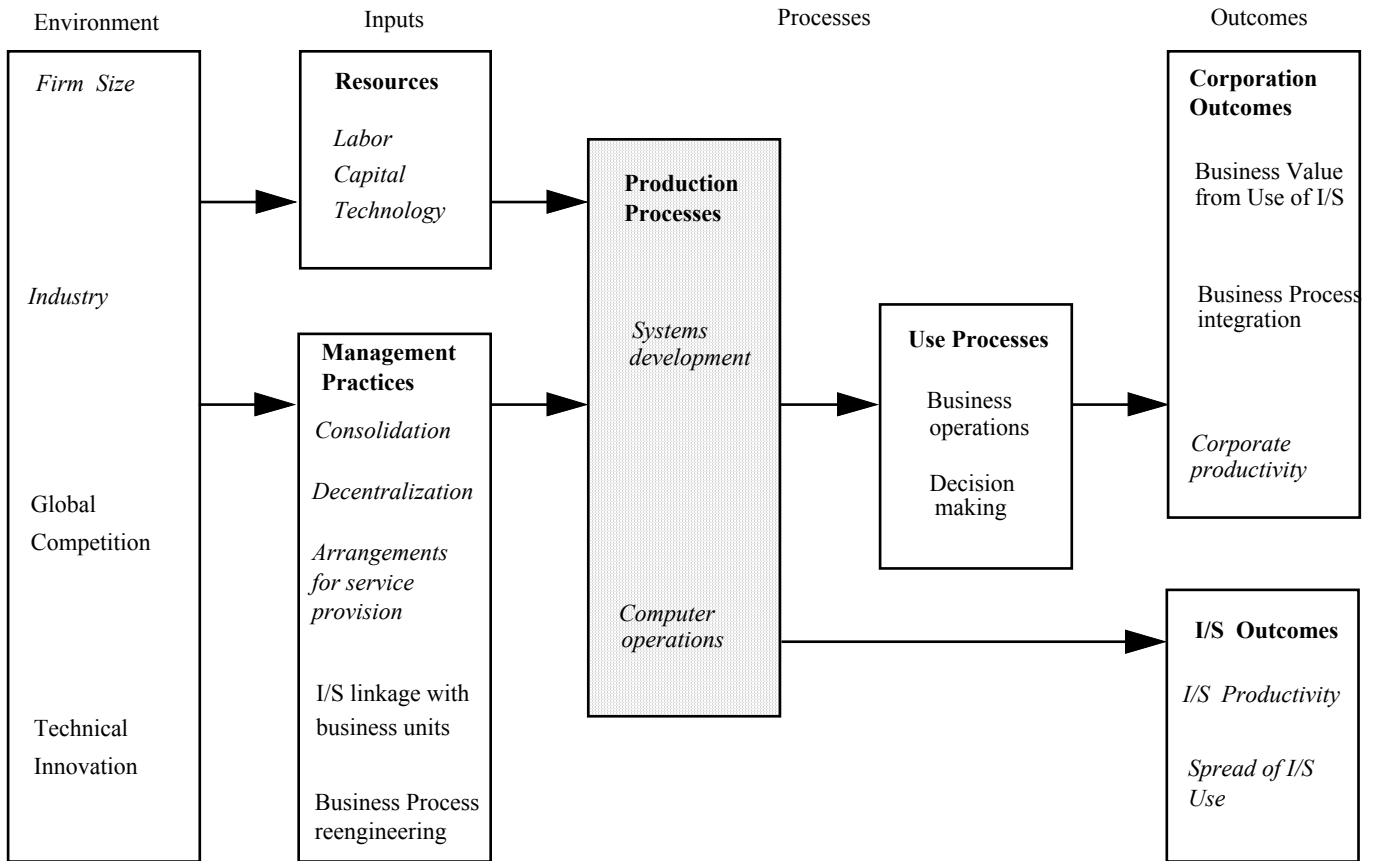
technology are transformed into business applications and information services for the business as a whole and for end users. *I/S management practices* are a key determinant of the efficiency and effectiveness of the production subsystem. Among the various management practices of importance in production are the *arrangements for service provision*. Services might be provided by I/S departments, user departments, or outsourcers. These different arrangements have implications for both production processes and outcomes.

The *outcomes* of production and use can be described by the *productivity of service provision* (e.g., labor-capital ratio, or the relative mix of personnel and hardware in production), *the penetration of I/S use* in the corporation, and the *business value derived from I/S use*.

In this report, we focus on the production subsystem, which is shown as the shaded area of Exhibit 1. Within the production system, we systematically examine production by I/S departments and their relationship with both the productivity of I/S service provision and the penetration of I/S use. We also note the roles of end user computing and outsourcing in services provision, but do not examine them systematically. Throughout the report, we examine whether there are differences due to industry sector.

The specific variables of interest in this analysis are shown in italics in Exhibit 1 on the next page.

Exhibit 1. Framework for I/S Services Production*



*Variables in *italics* are focus of this report.

IMP Approach to Performance Measurement

Our approach is to produce a "balanced scorecard" that is based on Kaplan and Norton I/S framework (*Harvard Business Review*, 1991). We look at performance measurement and benchmarking for the I/S function as involving four major perspectives (Exhibit 2).

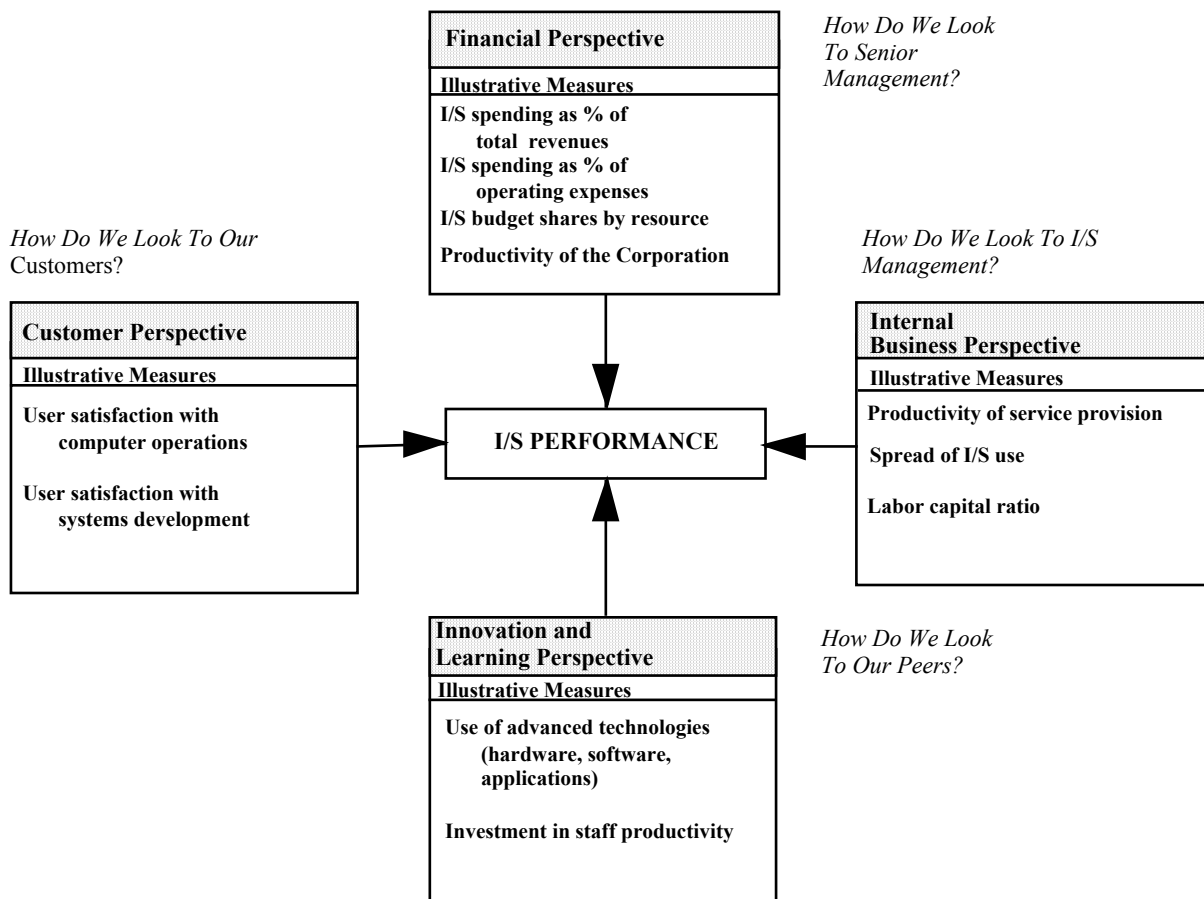
The financial perspective looks at I/S budgets as indicators of the relative cost structure and performance of I/S departments.

The internal business perspective focuses on the performance of systems development and data center operations within I/S departments.

The innovation perspective examines the extent of R & D into new technologies and applications, and use of new tools and techniques by I/S departments.

The customer perspective analyzes the relationship of I/S departments to the broader business and the satisfaction of clients with I/S products and services.

**Exhibit 2.
Balanced Scorecard for Information Systems**



Adapted from Kaplan and Norton, *Harvard Business Review*, 1991.

THE ANNUAL SURVEY OF I/S DIRECTORS AND USER MANAGERS

We gather data for IMP through the annual survey of I/S directors and user managers. Over 100 corporations have participated in the survey since its beginning in 1987. Nearly half have participated more than once and some have participated every year. The Data Warehouse accompanying this report contains a list of the corporations that have participated in the survey.

The survey measures I/S performance at two levels:

1. The corporation as a whole.
2. Individual I/S departments within firms.

This report presents the findings *for the corporation as a whole*. It is based on the seventh annual survey of the I/S Intercorporate Measurement Program (fiscal year 1994), and provides a comparison with the findings of six previous years (1988, 1989, 1990, 1991, 1992, 1993).

The eighth annual survey covering fiscal year 1995 will be administered during the early months of 1996. This questionnaire will retain the relevant parts of previous questionnaires to enable continued comparison of particular results over time. This type of longitudinal analysis is capable of generating some of the most significant findings.

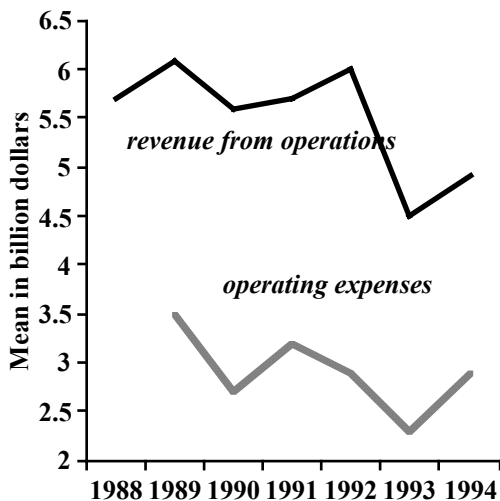
However, the survey and the performance measures which it produces are only one aspect of benchmarking. An equally critical aspect is networking among I/S directors, the client managers they serve, and the corporate managers to whom they report. This aspect of the I/S Intercorporate Measurement Program is carried out through discussions at meetings, problem solving in workshops, and intercorporate exchanges which are an integral part of various CSC Consulting programs. This report, and related reports, provide the stimulus and the beginning point for these discussions and exchanges.

II. THE CORPORATE ENVIRONMENT OF I/S

CORPORATE SIZE

The average corporation had \$4.9 billion in revenues, \$2.9 billion in operating costs, and 22,000 employees (Exhibits 3 & 4).

Exhibit 3. Mean Revenue and Operating Expenses, 1988-1994

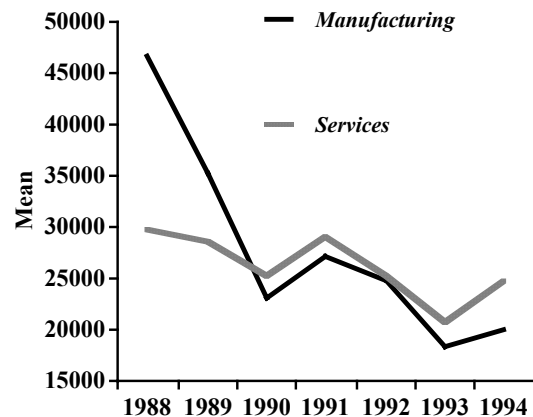


INDUSTRY SECTOR

We classify the corporations participating in the study into two broad sectors: manufacturing and services.

The services firms are primarily from the insurance, financial, communications and utilities sectors whereas the manufacturing firms are primarily from the food, electronics and electrical machinery, and chemical and pharmaceutical sectors.

Exhibit 4. Mean Number of Employees, 1988-1994



Capital and Information Intensity

The capital intensity and the information intensity of manufacturing and services firms are expected to have implications for the provision of information services. Manufacturing tends to be more capital intensive and services more labor intensive. It is unclear whether this relationship also holds for the production of information services.

A parallel issue arises with regard to the information intensity of industry. In the services industry, information is the primary product or service and is integral to everything that goes on in a services firm. In manufacturing, information is only one input, either as part of a product, or as a means of coordination and control of processes in, and related to, manufacturing. Consequently, one might expect differences between sectors.

III. RESOURCE INPUTS TO PRODUCTION OF I/S IN CORPORATIONS

I/S SPENDING

Corporate spending for I/S through the I/S function is in decline overall, but some firms continue to spend at historically high rates. Corporate spending can be usefully benchmarked by two different but related measures: 1) percent I/S expenses of total corporate revenue, and 2) percent I/S expenses of total corporate operating expenses.

These measures are useful for several reasons. First, they are widely used and have been used for a decade or longer. Therefore, comparison measures usually can be found quite readily for different industries. Second, an absolute measure such as average I/S spending is not useful for comparison because of size differences among firms. These two measures take size into account. When used together, these two measures help to identify firms which have low operating expenses compared to revenues. Third, the measures show different things. The ratio of I/S spending to revenue tends to be more stable than the ratio to operating expenses because of differences in how firms define operating expenses. On the other hand, the ratio I/S spending to operating expenses is sometimes a more realistic figure because some firms (e.g., firms in the oil and gas industries) have very high revenues relative to operating expenses and therefore a revenue-based ratio masks the real level of spending.

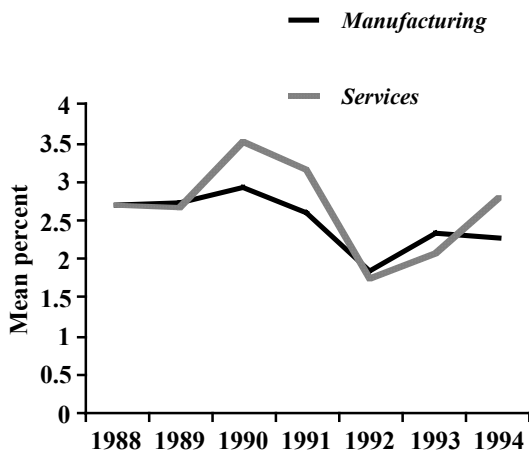
The appropriate level of spending is best determined on an individual basis. The benchmarks here show that the average firm spent around 2.5% of revenues and 7% of operating expenses on I/S in 1994. The range in spending was from 0.50% to 8.3% of total revenues. The best way to determine the appropriate level for a particular firm is to compare spending with other firms in the industry, especially firms considered to be serious competitors.

In order to facilitate such comparison, this report breaks down spending by the manufacturing and services sectors. Because of the number, size and geographic distribution of firms in the study, we feel the benchmarks are reliable for these two sectors.

Percent I/S Expenses of Total Corporate Revenue

The average corporation's total spending on information systems through I/S departments accounted for approximately 2.6% of total corporate revenue in 1994, a decline from a high of about 3.2% in 1990 (Data Warehouse, Table 5). This overall pattern of I/S spending as a percent of corporate revenues is essentially similar between manufacturing and services corporations (Exhibit 5).

Exhibit 5. Mean Percent I/S Spending of Total Corporate Revenues, 1988-1994



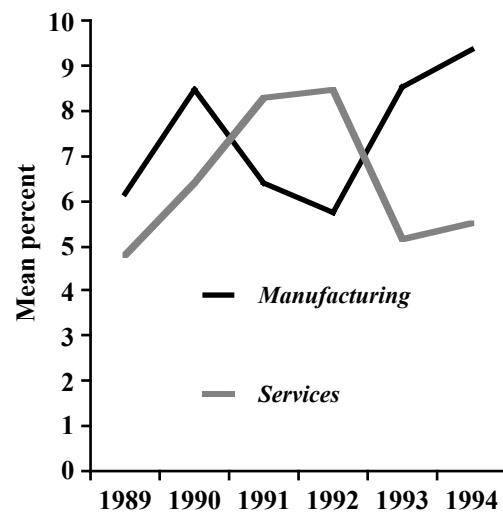
Percent I/S Expenses of Total Corporate Operating Expense

I/S spending as a percent of corporate operating expenses shows a different pattern overall. Here I/S expenses are steady among all firms since 1990 with the mean around 7% of total corporate

operating expenses (Data Warehouse, Table 6).

The pattern for the percent of operating expenses spent on I/S between manufacturing and services corporations is very different over the six years, essentially moving in opposite directions (Exhibit 6). The pattern up through 1992 seemed to indicate that services firms were allocating an increasing portion of operating expenses to I/S, doubling from roughly 4% to 8%; the 1993 and 1994 allocations dropped back to the earlier years. In contrast, manufacturing firms were allocating a declining portion of operating expenses to I/S, with the decline being around one-third since 1990. However, by 1993 manufacturing firms showed an increase in percent allocated. Manufacturing firms have continued to increase in 1994.

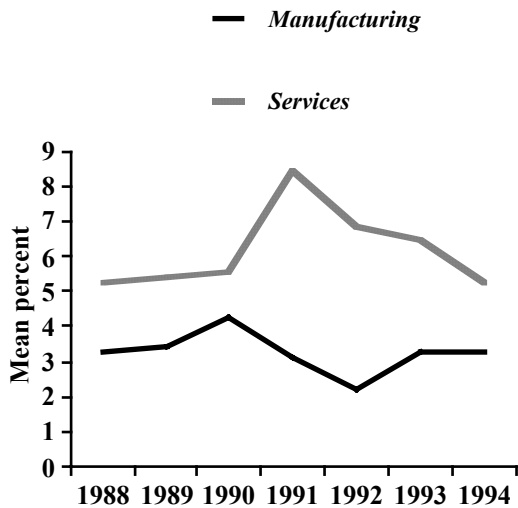
Exhibit 6. Mean Percent I/S Spending of Total Corporate Operating Expenses, 1989-1994



I/S PERSONNEL

The number of personnel in the I/S function continues to stabilize, both absolutely and as a percentage of total corporate employees. Approximately 4.3% of the total employees in a corporation work in the I/S function in 1994 compared to around 5-6% in recent years (Data Warehouse, Table 7).

Exhibit 7. Percent I/S Employees of Total Corporate Employees, 1988-1994



The portion of corporation employees allocated to I/S in manufacturing and services firms shows considerable difference (Exhibit 7). Services corporations on average have more than two times the ratio of I/S employees to total employees than is found in the manufacturing firms. In 1994, approximately 3% of manufacturing employees were in I/S, while approximately 5% of services firm employees were in I/S.

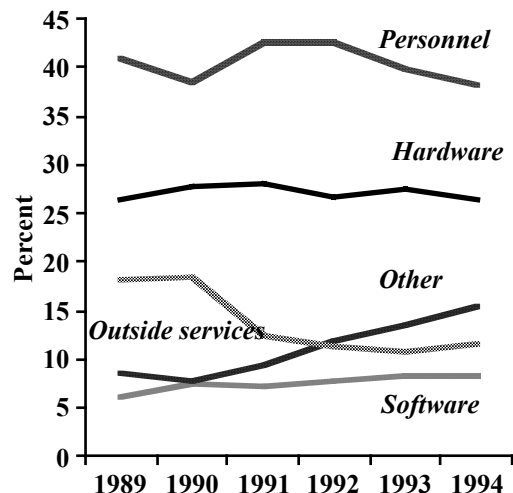
I/S BUDGET SHARES

Budgets by I/S Resources

The budget shares allocated to different I/S resources such as hardware and personnel show remarkable stability over the last six years despite the overall decline in spending for I/S (Exhibit 8). Hardware accounts for around one-quarter of an organization's I/S budget. Personnel expenses consume approximately two-fifths of the budget. Purchased software accounts for less than 10% of the budget. Outside services, such as outside time sharing, telecommunications, consulting, and outside training consume about 10% of the budget. Finally, approximately 10% of I/S budgets are Other expenses, such as rent, utilities, supplies, overhead, in-house training, space.

These overall allocations of I/S budgets by resource do not significantly differ between manufacturing and services firms.

Exhibit 8. Distribution of I/S Expenses, 1989-1994



The fact that these allocations are more or less stable over the last six years is significant because they fail to support two commonly held beliefs. The first is that personnel costs account for a rapidly increasing share of the total I/S budget. In fact, the share is remarkably constant. The second is that purchased software is increasingly being used as a replacement for in-house development of systems. While firms continue to use purchased software, the data indicate that its use in I/S is not increasing at any significant rate.

I/S HARDWARE

Computing capacity has steadily increased in both power (MIPS) and storage (DASD) from 1988 to 1994. This trend is greater in services firms than in manufacturing firms.

The average computational power of all mainframes in the corporations surveyed more than doubled between 1988 and 1994. In 1994, corporations on average reported 110 MIPS per mainframe (Data Warehouse, Table 9). Services firms tend to have on average more MIPS than manufacturing firms; the difference is statistically significant (Exhibit 9).

Total DASD for all mainframes in the corporation has also steadily increased. In 1989, corporations, on average, had approximately 148 gigabytes of DASD per mainframe, while by 1994 the average number of gigabytes of mainframe DASD had increased to 370 (Data Warehouse, Table 10). Similar to the differences between manufacturing and services in average number of MIPS per mainframe, services have significantly more DASD than manufacturing firms (Exhibit 10).

Exhibit 9. Average MIPS Per Mainframe, 1988-1994

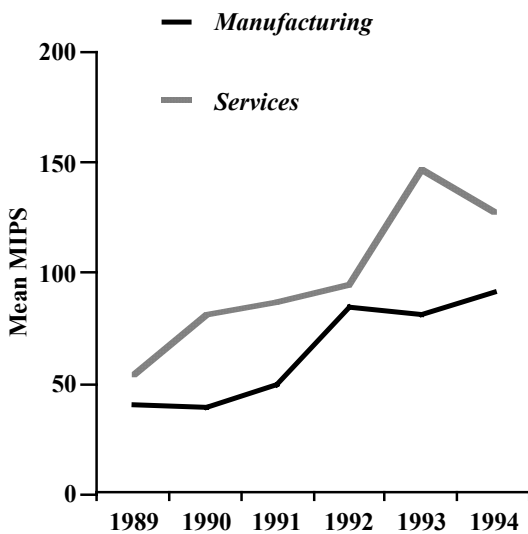
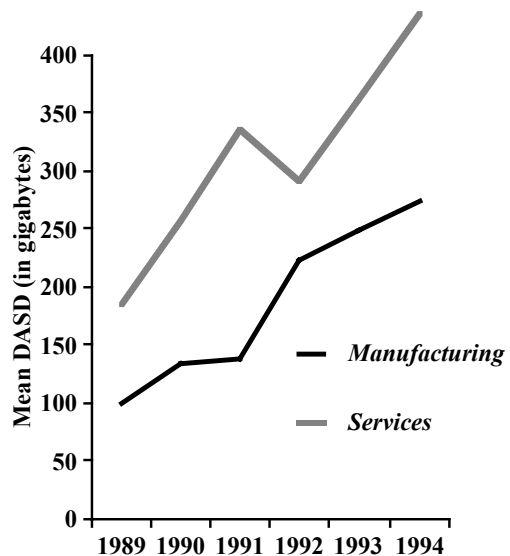
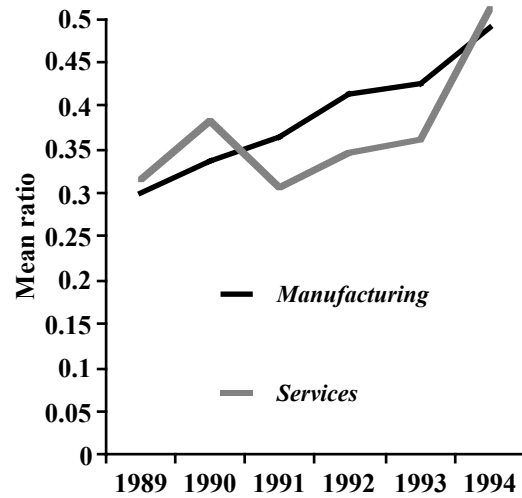


Exhibit 10. Average DASD Per Mainframe, 1989-1994



The overall ratio of MIPS to DASD for the firms in the study is more or less stable at around 0.39 between 1988 and 1994 (Data Warehouse, Table 11). The ratio for manufacturing firms is slightly higher (around 0.38) than for services firms (around 0.35). While services firms have significantly more DASD and MIPS than manufacturing firms, the ratio of MIPS to DASD is very similar between the two industries (Exhibit 11). The distinction between computation intensive and database extensive information systems for manufacturing and services firms noted in previous years is no longer apparent.

Exhibit 11. Mean Ratio of MIPS to DASD, 1988-1994



IV. ARRANGEMENTS FOR THE PRODUCTION OF INFORMATION SERVICES

ORGANIZATION OF SERVICE PROVISION

Overall Trend in Organization

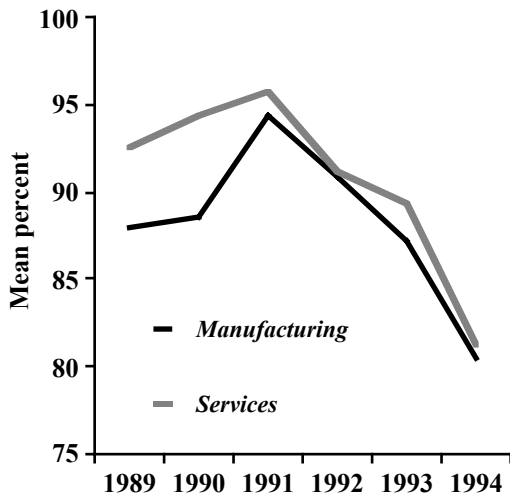
The production of information services has been changing for years from a single mode of provision by a central in-house department to provision by additional sources, such as I/S departments in different business units, end-user computing in individual departments, and outsourcing firms.

decline is remarkably similar for both manufacturing and services firms (Exhibit 12).

ALTERNATIVE ARRANGEMENTS FOR SERVICE PROVISION

Although most firms continue to provide information services through in-house departments, the annual decline in percent in-house has been accompanied by a growing diversity in the arrangements for service provision within a single corporation. The share among different arrangements can be seen by examining the distribution of total corporation I/S spending among three primary sources:

Exhibit 12. Percent In-House Provision of I/S Services, 1989-1994



Despite this diversity, most corporations have the I/S function provided in-house. Approximately 80% of I/S services were provided by in-house I/S departments in 1994 (Data Warehouse, Table 12). Since the beginning of the 1990's there has been a steady decline in the percent in-house provision of I/S services. The

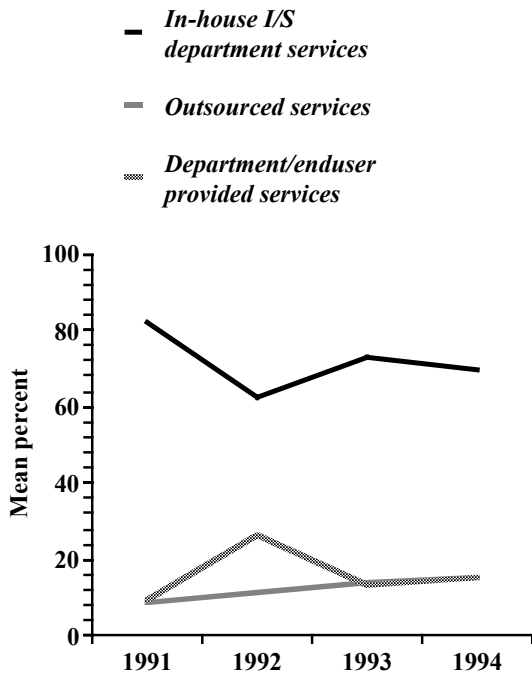
- In-house I/S departments
- User departments
- Outsourcers

"Total corporation I/S budgets" refers to the total of:

- (1) moneys spent by formal I/S departments for in-house services,
- (2) moneys spent by user departments for their own services (estimated by CIOs), and
- (3) moneys spent for outside services by formal I/S departments.

Data Warehouse Table 13 shows that the percent of total corporation spending for I/S by formal I/S departments for in-house services has declined from 80% in 1991 to 70% in 1994.

Exhibit 13. Percent of Total I/S Services Provided by In-House I/S Unit, Departmental Endusers, and Outsourced, 1991-1994



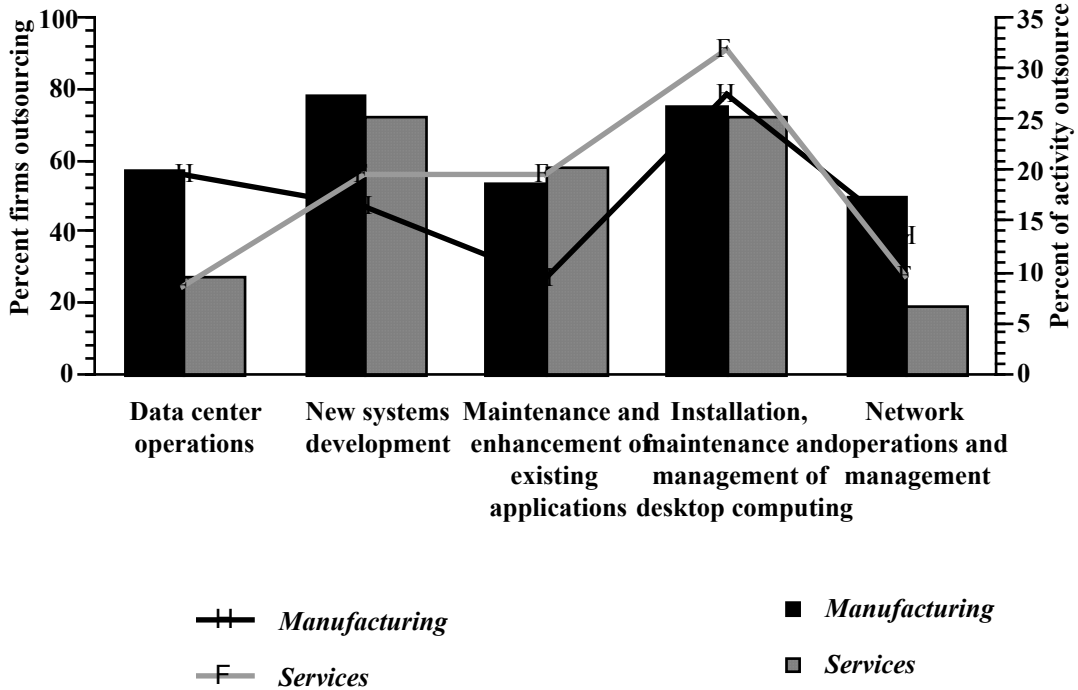
An important change in the production of information services is the provision by user departments themselves. Approximately 15% of the total I/S services in the corporation are produced outside of the I/S department in user departments in the form of departmental computing, distributed computing, or networked personal computers. This trend is equally strong in manufacturing

and services firms. (Exhibit 13 and Data Warehouse, Table 13).

The use of outsourcing also appears to be on the rise. Approximately 15% of I/S services are outsourced. The proportion of outsourcing of an activity varies by activity and by type of industry. Exhibit 14 displays the relative proportion of five types of activities in terms of the average percent of the activity outsourced. See Data Warehouse, Table 14 for the percent of firms outsourcing and the average percent of activity that is outsourced. A high percent of desktop computing activities including installation, maintenance and management are outsourced by firms. Seventy percent of the firms outsourced some segment of desktop computing -- on average approximately 40% of the activity is outsourced.

Manufacturing and services firms significantly differ in outsourcing and the percent of the activity outsourced. While 57% of the manufacturing firms outsourced part of the data center operations (on average, approximately 20% of the activity), only 28% of services firms outsourced data center operations (approximately 8% of the activity). Conversely, while one-half of manufacturing firms outsourced on average 14% of network operations and management, only 20% of services firms outsourced a portion of these activities (an average of 10% of the activity was outsourced).

Exhibit 14. I/S Unit Outsourcing of I/S Activities, 1994



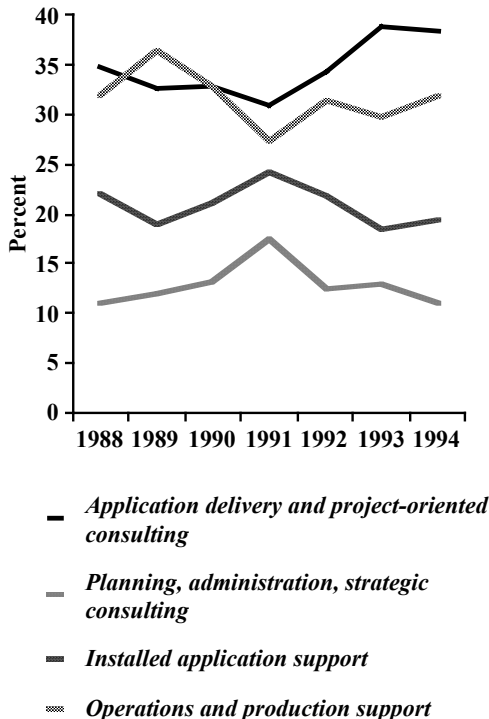
MANAGEMENT OF SYSTEMS DEVELOPMENT

The management of systems development involves three interrelated aspects: the allocation of staff resources, the investment in staff productivity, and the use of modern development tools and techniques.

Allocation of Staff Resources

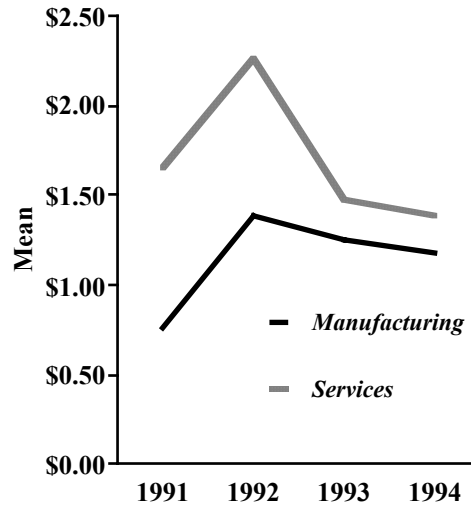
All firms allocate more staff resources for development of new applications than for maintenance of installed applications, but services firms allocate relatively more for development whereas manufacturing firms allocate relatively more for maintenance (Exhibits 15 and 16).

Exhibit 15. Distribution of I/S Personnel Staff by I/S Activity, 1988-1994



Of total staff spending for I/S in corporations, *systems development* represents 58%, computer operations and technical support represents 32%, and management represents 10%. This distribution has not significantly changed over the 6 years of the survey (Data Warehouse, Table 15).

Exhibit 16. Dollars Spent for New Application Development For Each Dollar Spent on Maintenance Of Applications, 1991-1994

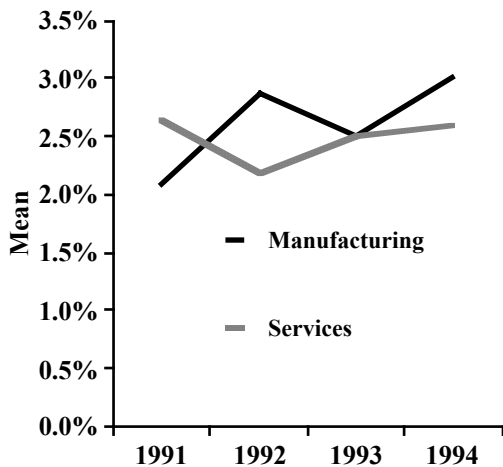


Of the 58% spent on systems development, 38% is for *new development* and 20% for *maintenance*. Services firms on average spend \$1.39 on new development for every dollar spent on maintenance, whereas manufacturing firms spend about \$1.18 for every dollar spent on maintenance (Exhibit 16).

Investment in Staff Productivity

Firms continue to invest in tools, techniques and hardware aimed at increasing staff productivity (Exhibit 17). About 2.8% of the total I/S budget is spent for productivity aids. There is no significant difference between manufacturing and services firms in its proportion of the I/S budget spent for productivity aids.

Exhibit 17. Percent of I/S Budget Spent For Tools, Techniques and Hardware for Enhancing Development Productivity, 1991-1994



Use of Development Methods

Studies of software development show that productivity might be increased by use of development tools and by use of development techniques.

Use of Development Tools. *The use of development tools has increased steadily over the past six years (Exhibit 18). Services firms tend to use all forms of development tools somewhat more than manufacturing firms. The difference is statistically significant. Exhibit 19 shows that the most frequently used development tools are CASE tools. Over 60% of the I/S units use CASE tools, whereas only 20% or less use CATI, reverse engineering tools, business process simulation tools, or object-oriented techniques. About one-third of the firms are also using reusable software modules, particularly services firms (43%).*

Exhibit 18. Index of Development Tool Advancement, 1989-1994

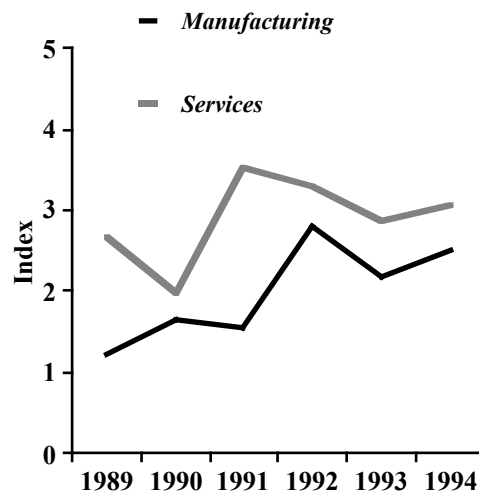


Exhibit 19. Use of Development Tools, 1994

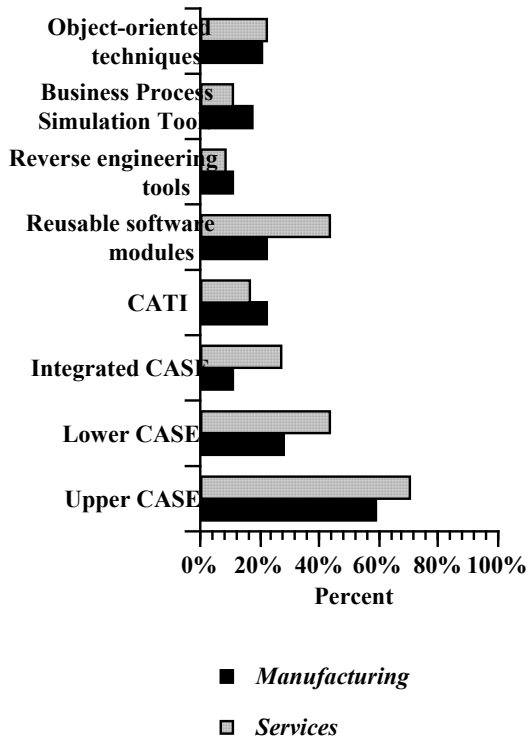
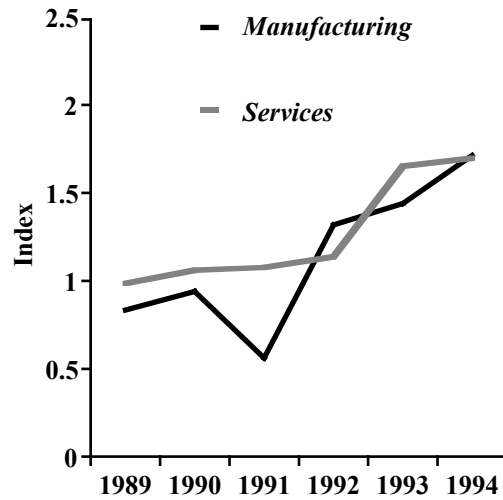
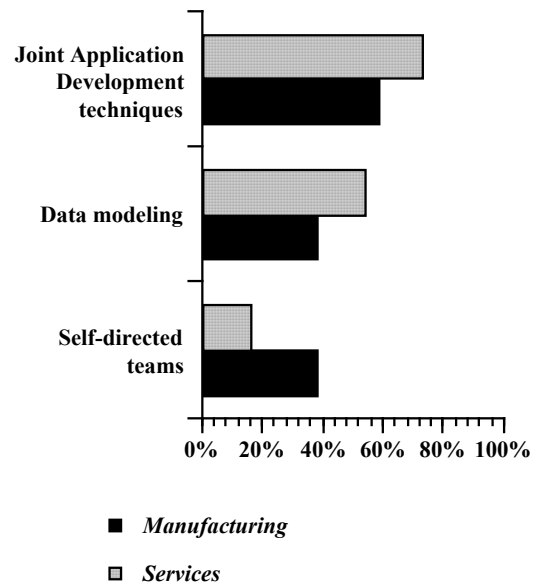


Exhibit 20. Index of Development Technique Advancement, 1989-1994



Use of Development Techniques. *The use of development techniques has risen over the last six years (Exhibit 20). The use of Joint Application Development (JAD) techniques has risen considerably, especially in the services firms (Data Warehouse, Table 21). About two-thirds of all firms use Joint Application Development (JAD), nearly half of the I/S units use data modeling, and one-quarter use self-directed teams (Exhibit 21).*

Exhibit 21. Use of Development Techniques, 1994



Effects of Development Tools and Techniques on I/S Performance

Efficiency is defined as the ratio of labor (personnel spending) to capital (hardware spending) for I/S. Effectiveness is defined by the proportion of total development projects completed within budget, on time, and meeting functional requirements.

implemented CASE tools spent on average \$1.56 on development staff salaries for every dollar spent on hardware in contrast to firms without CASE tools which spent \$3.11.

Effectiveness of Systems Development
Firms which have widely implemented development tools and techniques appear to be more effective in their development activities than those who have not when measured by the percent of delivered projects which were completed on time, within budget and meeting all functional requirements (Exhibit 23).

Exhibit 22. I/S Efficiency (Labor-Capital Ratio) and Use of Advanced Technologies and Techniques

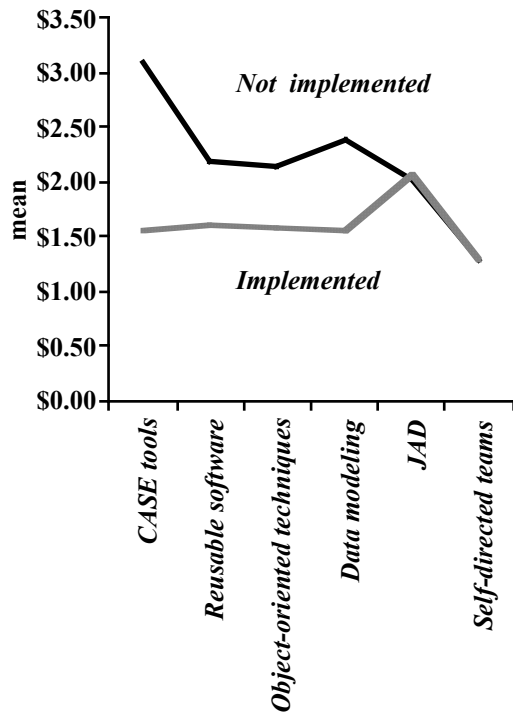
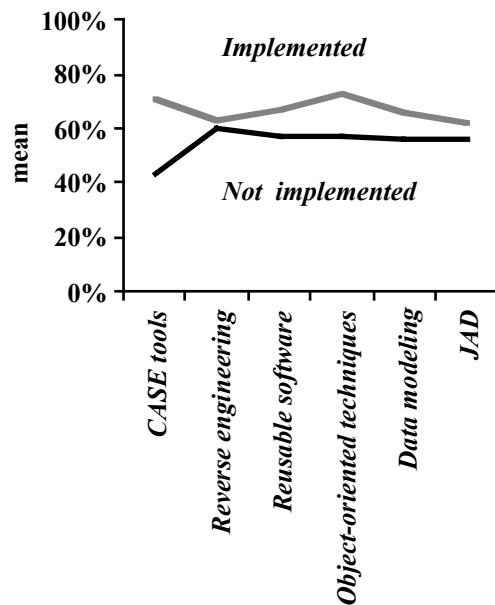


Exhibit 23. I/S Effectiveness (Percent "Successful" Projects) and Use of Advanced Technologies and Techniques.

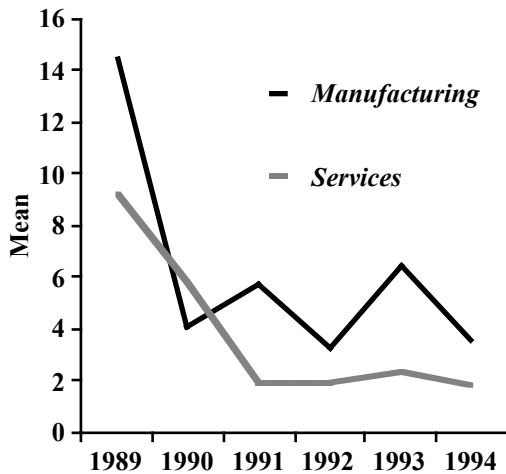


Efficiency of Systems Development.
Firms which have widely implemented systems development tools and techniques appear to be more efficient in their total development activities than those which have not when measured by the labor-capital ratio (Exhibit 22). For example, those firms which have widely

MANAGEMENT OF COMPUTER OPERATIONS

Data centers support the computing infrastructure for the operations of the firm, and therefore are a critical component of I/S performance. The goal of data center operations is to provide stable, reliable, consistent, and low cost computing services. A variety of management practices are being used by successful firms to achieve this goal. These include consolidation and automation of data centers, the standardization of technology platforms and operations, and the deployment of advanced technology. And these management practices seem to be paying off in productivity for computer operations.

Exhibit 24. Mean Number of Data Centers in Corporation, 1989-1994



Consolidation of Data Centers

The biggest change occurring in the management of computer operations is the consolidation of data centers and their automation. Consolidation of data centers is greater in services firms than in manufacturing, but most firms have been consolidating data centers (Exhibit 24). The mean number of data centers in services firms is 2 whereas the mean is 4 in manufacturing.

Allocation of Computing Resources

Computer Technology. *The allocation of mainframe and minicomputer hardware has been remarkably stable over the last five years hovering around 4 mainframes and 65 minicomputers (Exhibits 25 and 26) per corporate I/S unit. Although services and manufacturing firms show some variation, there is no real difference between the two industry sectors.*

Exhibit 25. Mean Number of Mainframes, 1989-1994

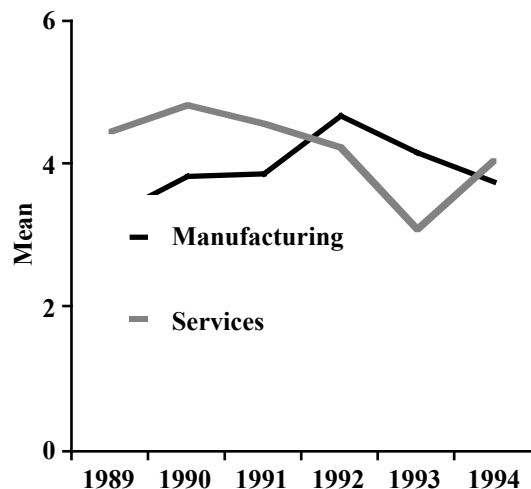


Exhibit 26. Mean Number of Minicomputers, 1989-1994

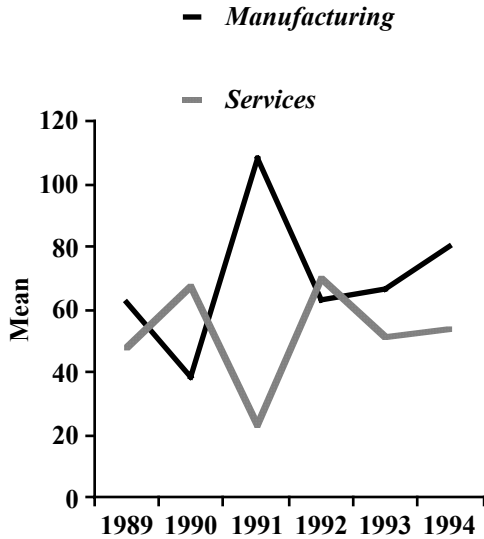
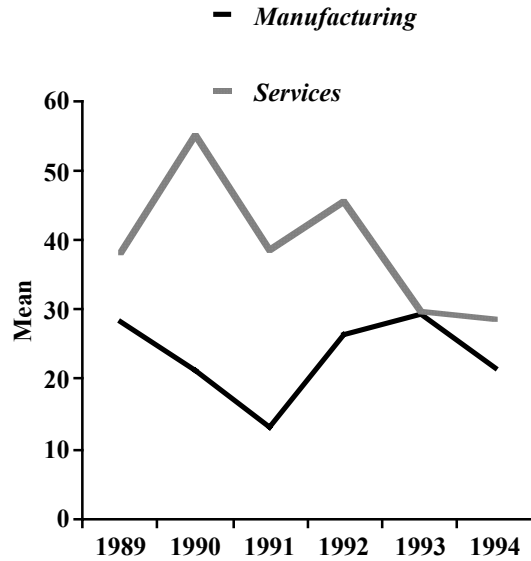


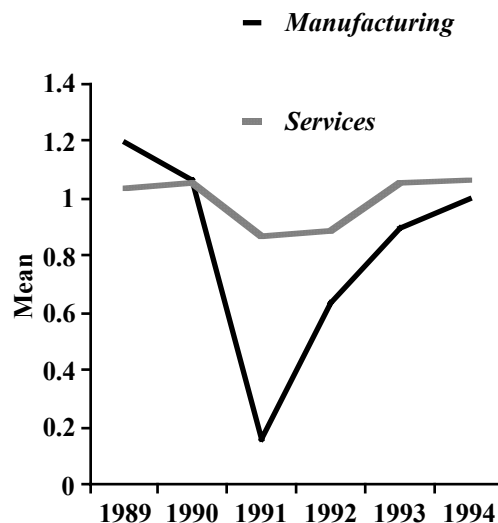
Exhibit 27. Mean Number of Operations Staff Per Mainframe, 1989-1994



Operations Personnel. *The allocation of operations personnel for mainframes and minicomputers has remained remarkably steady over the last five years. The average number of operations staff per mainframe has not varied greatly over the 5 year period averaging approximately 33 FTEs per mainframe for all firms (Exhibit 27). While, there has been a significant difference between services and manufacturing firms in the past, the trend has been moving towards parity for mainframe personnel.*

Similar to FTE per mainframe, the average staff size per mini-computer has been constant. I/S units, on average, assign 1 FTE per minicomputer (Exhibit 28).

Exhibit 28. Mean Number of Operations Staff Per Minicomputer, 1989-1994



While data center staffing for mainframes and minicomputers remains stable, the staffs assigned to support end user computing by corporate I/S units are increasing, especially for LAN administration. The number of staff to support microcomputers is about 11 and the number to support LANs is about 10, when averaged over the last four years (Exhibits 29 and 30). The increase is significant in terms of LAN administration. The data indicates a shift in personnel to support LANS and away from standalone microcomputers. As was noted in Exhibit 14, desktop computing activities are outsourced while the percent of network operations outsourced is significantly lower. Exhibits 29 and 30 show the shift with stabilization/decrease of microcomputer staff in all firms and a steady rise in LAN staff during the same period.

Exhibit 29. Operations Staff to Support All Microcomputers, 1991 - 1994

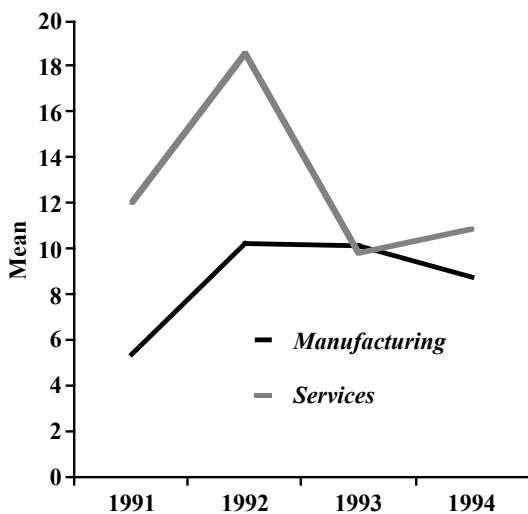
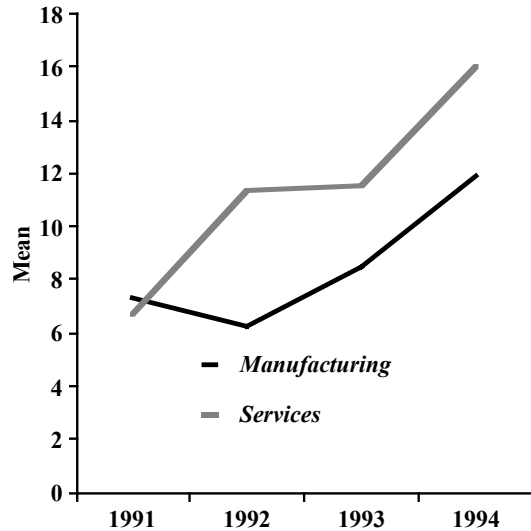


Exhibit 30. Operations Staff to Support All Local Area Networks, 1991-1994



Differences between manufacturing and services in number of LAN staff is significant. This difference between manufacturing and services reflects several broader differences as well. First is the wider and earlier distribution of microcomputers in services firms. Second is the greater linkage of previously independent microcomputers into networks in services firms. Third is the greater centralized management of networks in services firms.

Deployment of Advanced Technology

Hardware Technology. *There has been steady growth in the use of hardware technologies over the past six years (Exhibit 31). Overall, more services utilize advanced technologies than manufacturing firms. Services are also significantly more likely to use voice response technology than manufacturers. By 1994, 73% of the services firms had implemented voice response technology (Exhibit 32). Distributed processing and image technology have increased in use in all firms over the 5 year period (Data Warehouse, Table 32).*

Exhibit 31. Index of Advanced Hardware Technologies, 1989-1994

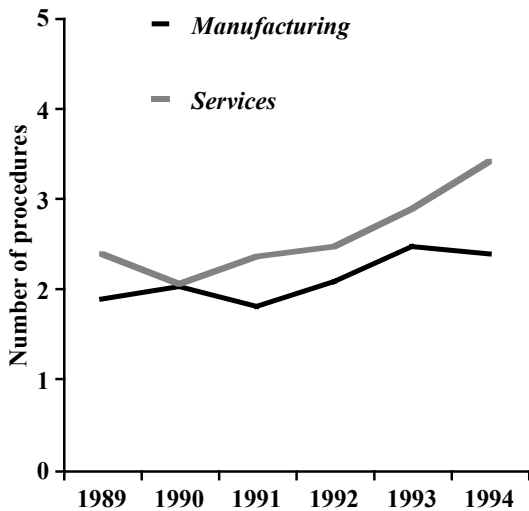
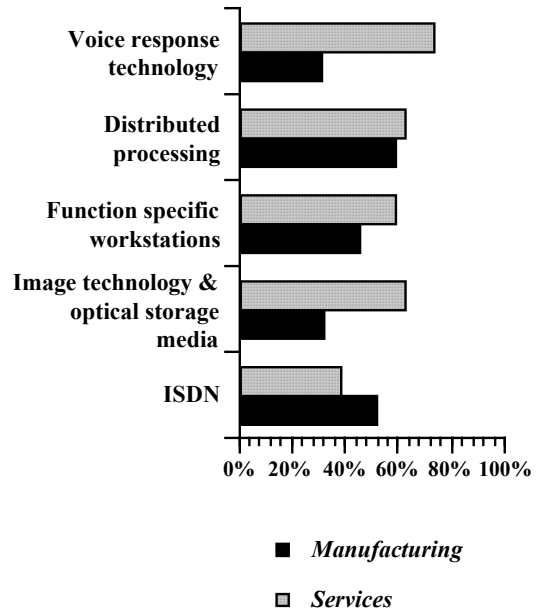
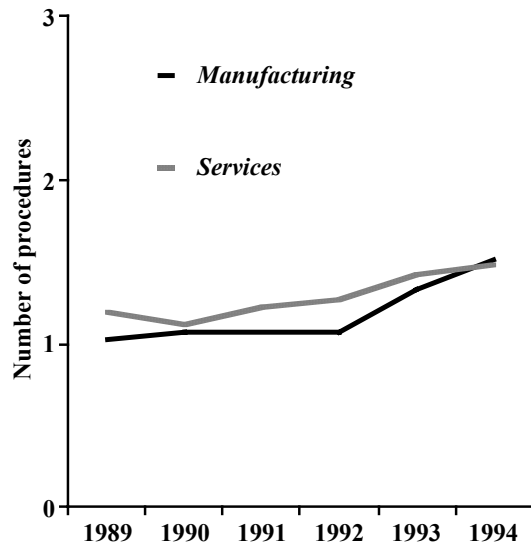


Exhibit 32. Use of Advanced Hardware Technologies, 1994



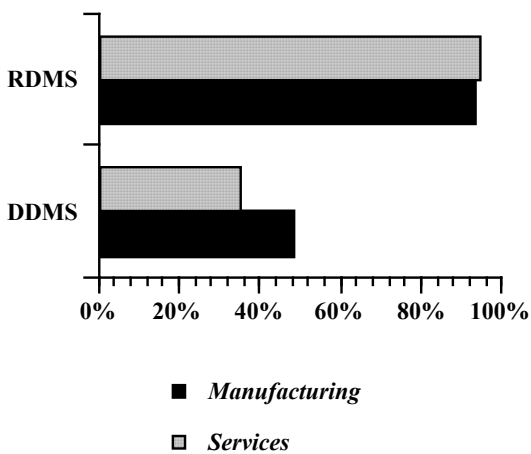
Software Technology. *Advanced software technologies use has been steady over the past 6 years (Exhibit 33).*

Exhibit 33. Index of Advanced Software Technologies, 1989-1994



Relational database management systems are used by more than 90% of the I/S units, but there has been little growth in use over the past four years. Distributed database management systems are used by two-fifths of the corporate I/S units (Exhibit 34).

Exhibit 34. Use of Advanced Software Technologies, 1994



Applications Technology. *Advanced application technologies use has been constant over the past six years (Exhibit 35). The use of advanced applications technologies shows steady growth in the use of electronic data interchange (EDI) and a flattening in use of executive support systems over the past six years (Data Warehouse, Table 36).*

Exhibit 36. Use of Advanced Application Technologies, 1994

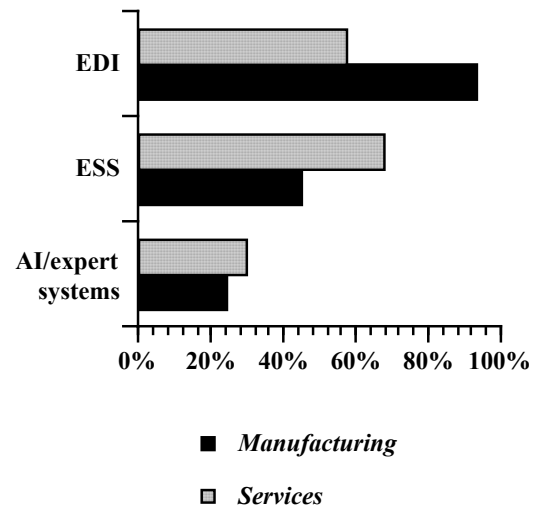
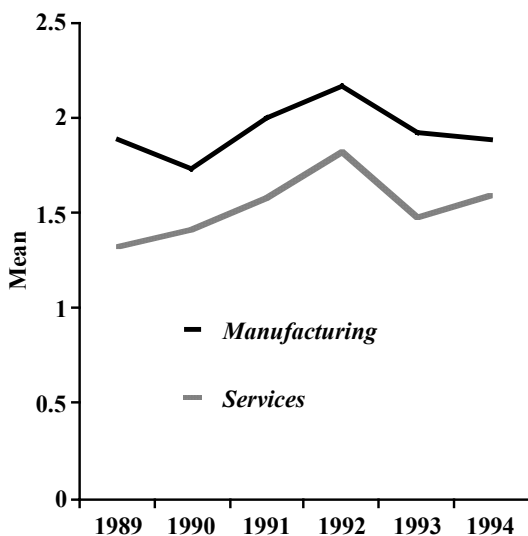
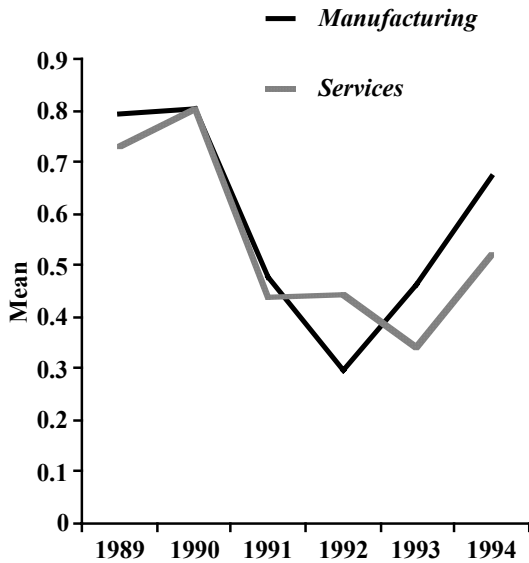


Exhibit 35. Index of Advanced Application Technologies, 1989-1994



The use of artificial intelligence and expert systems while previously showing growth in use has become less widely used. EDI has grown from 60% of the firms to 76%, and executive support systems have stayed flat at around 50% of the firms (Exhibit 36). EDI is used primarily by manufacturing firms (93% in 1994) whereas the other advanced technologies are used about equally by manufacturing and services firms.

Exhibit 37. Number of Computer Operations Staff Per MIP, 1989-1994



Performance of Computer Operations

Efficiency of Computer Operations.

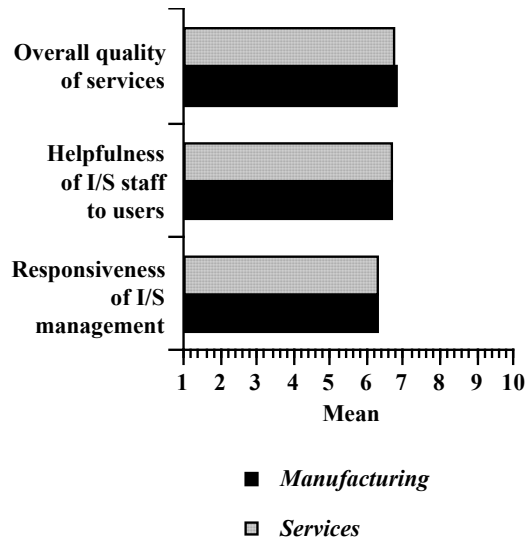
Computer operations clearly have become more efficient over the past five years. Efficiency is indicated by the ratio of data center staff (labor) to computing power measured in MIPS (capital). Exhibit 37 shows this relationship in terms of the average number of operations staff persons per MIP. The figure shows that the ratio has declined over the last five years for both manufacturing and services. Even with the increase shown in 1994, the ratio is still lower than in the earlier years.

Effectiveness of Computer Operations.

The effectiveness of computer operations is indicated by user ratings of the overall quality of service, the helpfulness of I/S staff to users (e.g.,

the help desk), and the responsiveness of I/S management to user department requests. In general, user managers are positive about computer operations, as they consistently rate operations services above 5.0 on a 10.0 scale. Exhibit 38 shows an overall user rating of 6.0 or greater for computer operations, with services firms scoring higher than manufacturing.

Exhibit 38. User Manager Ratings of Computer Operations, 1994



V. MEASURES OF PERFORMANCE IN I/S SERVICES PRODUCTION

We use four broad measures of the outcomes of resource investments and management practices in the production of I/S services. The first is the productivity of service provision. The second is the penetration of I/S services throughout the corporation. The third is overall corporate productivity. And the fourth is overall user satisfaction with I/S services.

PRODUCTIVITY IN I/S SERVICE PROVISION

A central issue in I/S services provision is determining the productivity or relative efficiency of I/S departments. The ratio of labor expenditures to capital expenditures is a useful measure of the internal productivity of I/S departments. It says nothing about the return on investment or the business value of I/S in the corporation as a whole, but it is useful for assessing the efficiency of a single I/S department over time, or comparing several I/S departments at any point in time.

Labor refers to personnel expenses whereas capital refers to hardware expenses. The labor-capital ratio can serve as a useful management tool because it measures production efficiency. This ratio reflects the capital intensity of the production process underlying the delivery of information services.

Economists have used this measure with considerable success to explain differences in productivity in other sectors of the economy. In particular, it is argued that labor and capital are substitutes in production. That is, different ratios of labor and capital can be utilized to produce any given level of output. For a given set of labor and capital costs, there is an optimal ratio of labor to capital. As the level of capital to labor is increased towards the optimal point, output increases. However, when the optimal point is exceeded, the increases in productivity are too small to compensate for the costs of the incremental capital investment.

Labor-Capital Substitution and I/S Productivity

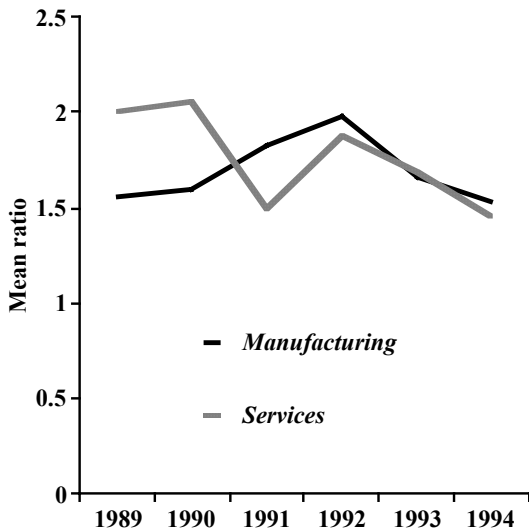
In the case of information systems, since the unit costs of hardware (capital) are dropping very rapidly relative to personnel costs, a critical method of improving the productivity of I/S is by continually substituting capital for labor. However, it is difficult to determine the optimal ratio of labor to capital in the presence of rapidly changing costs and technologies.

In such circumstances, estimates of the labor-capital expenditure ratios for corporations that are leading edge users of information services can have considerable value. These ratios provide a benchmark for I/S managers who are trying to assess the productivity of their departments. In the absence of special

circumstances, a ratio that is significantly higher than the norm suggests the possible existence of inefficiencies in the production of information services and should be further investigated.

Moreover, it will be shown that the time trends in the ratio of these expenditures can also serve as a valuable planning tool for I/S managers who are trying to determine future levels of investment in hardware and personnel.

Exhibit 39. Mean Labor to Capital Ratio, 1989-1994



Labor-Capital Ratios for Corporate I/S

The average ratio for the 1994 sample (Exhibit 39) indicates that *corporations spend about 1.5 times as much on information systems personnel as on hardware.* Moreover, this ratio has stayed roughly constant over time (See Table 39, Data Warehouse).

The magnitude of this ratio and its constancy over the past six years is consistent with other studies of I/S budgets. These studies show that even though the unit costs of hardware have decreased at the rate of 20% per year while personnel unit costs have increased slowly in inflation-adjusted terms, the ratio of these expenditures has not changed in the last 15 years.

The knowledge that labor-capital expenditure ratios have stayed relatively constant is a useful benchmark which should be of particular significance to I/S managers who are responsible for estimating future hardware capacity and staffing requirements.

PENETRATION OF I/S USE WITHIN THE CORPORATION

The overall penetration of technology within organizations is usually considered one useful measure of success, and can be applied to I/S as well. The penetration of I/S use within the corporation is affected by the provision of services through both the I/S function and the individual departments or so-called "distributed" and "end user" computing. We currently measure the penetration of I/S primarily through the I/S function and formal I/S departments.

The overall penetration of information systems through the I/S department has been remarkably stable over the past six years. However, there are interesting differences between manufacturing and services firms. Two broad indicators provide the basis for this conclusion:

1. The *extent* of I/S penetration, measured by the ratio of end user devices to corporate employees.
2. The *intensity* of I/S penetration, measured by the mean *I/S department spending* per corporate employee, and the mean *total corporate I/S spending* per employee.

whereas in manufacturing firms it is around .60. This pattern is as expected, and is a reflection of the higher information intensity of services firms.

Intensity of I/S Penetration

The mean spending per corporate employee by corporate I/S departments is about \$7,345 (Exhibit 41). This mean has fluctuated between \$5,000 and \$7,000 over the past six years. The mean total spending per corporate employee by both I/S departments and end users is about \$9,000 (Exhibit 42).

Extent of I/S Penetration

The average number of end user devices such as terminals, PCs or workstations per employee is around 0.67 for 1994 and has been at about that level for each of the past six years (Exhibit 40). This means that there is at least one end user device for every 1.67 employee in the corporation.

Exhibit 41. Mean I/S Department Spending Per Corporate Employee, 1988-1994

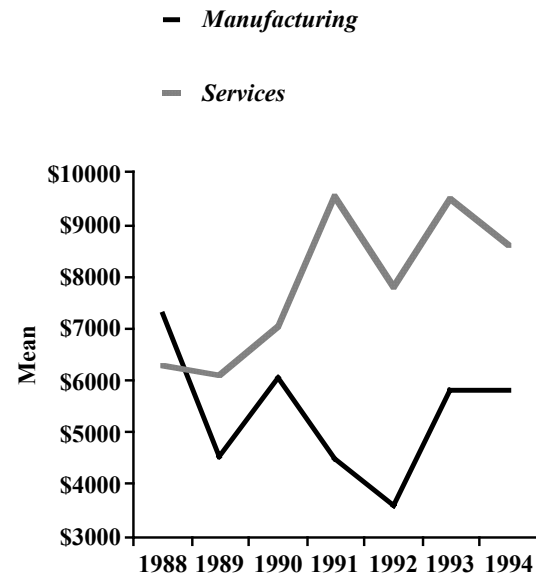
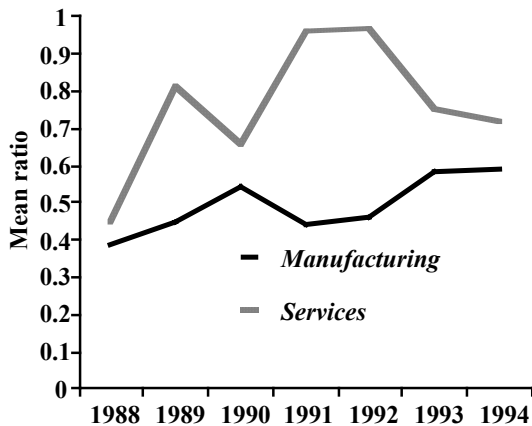


Exhibit 40. Mean Ratio of End User Devices to Employees, 1988-1994



Penetration is higher in services firms than in manufacturing firms. The average number of end user devices per employee in services firms is .75

The mean I/S department spending for services firms (\$8,600) is one-third as high as that for manufacturing (\$5,800). This ratio between services and manufacturing has been fairly constant since 1991.

Exhibit 42. Mean I/S Total Spending Per Corporate Employee, 1991-1994

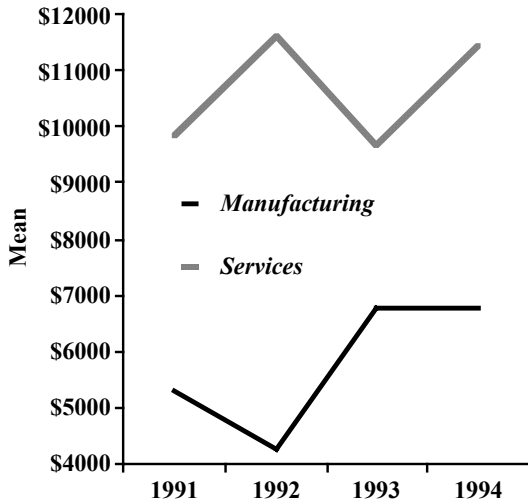
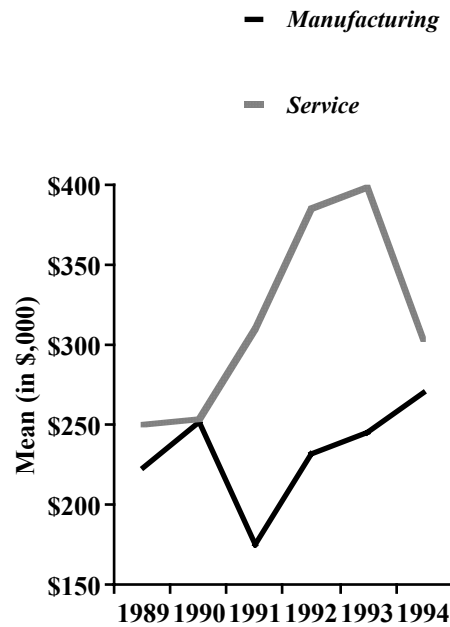


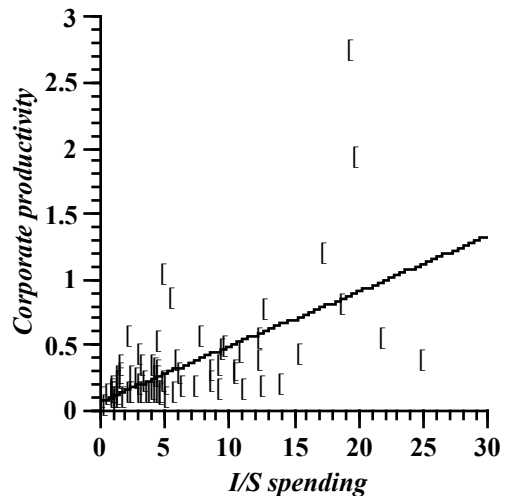
Exhibit 43. Mean Total Revenue Per Corporate Employee, 1989-1994



PRODUCTIVITY OF CORPORATIONS

Corporate revenue per employee is probably the most frequently used benchmark for the productivity of the corporation as a whole. Total revenue per employee for all firms shows little variation during the period 1989 to 1994. Services, however, show a different pattern than manufacturing firms. *From the period 1989 to 1993, services firms have shown increased revenues per employee while for the manufacturing firms, there has been a general stability in total revenue per employee (Exhibit 43).*

Exhibit 44. Association of I/S Spending Levels With Corporate Productivity, All Corporations



As Exhibit 44 indicates, the greater the level of spending for I/S the greater the

payoff (corporate productivity) from I/S use. Exhibits 45 and 46 depict the association for manufacturing firms and for services firms. Investment in I/S is less associated with corporate productivity for manufacturing firms than for services firms. For services firms, there is a strong association between the level of investment made in I/S and corporate productivity.

Exhibit 45. Association of I/S Spending Levels With Corporate Productivity, Manufacturing Firms

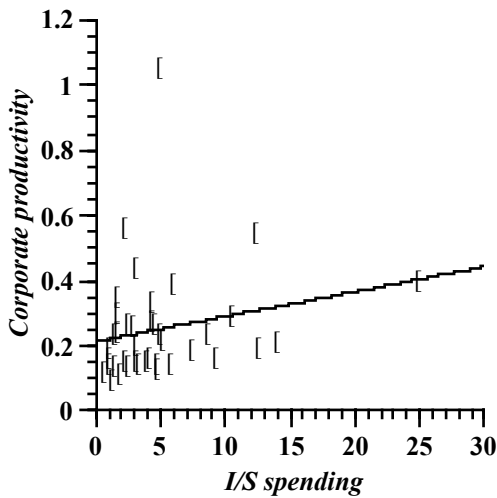
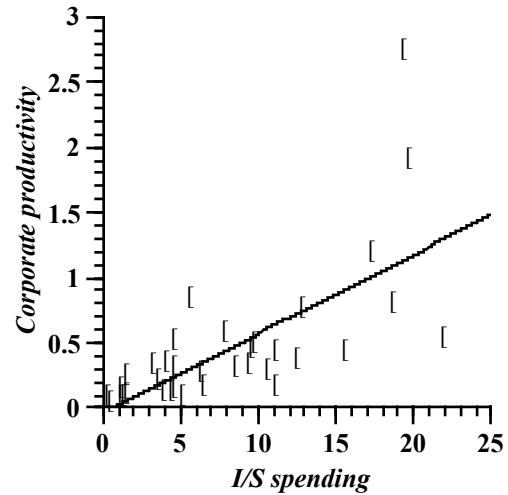


Exhibit 46. Association of I/S Spending Levels With Corporate Productivity, Services Firms

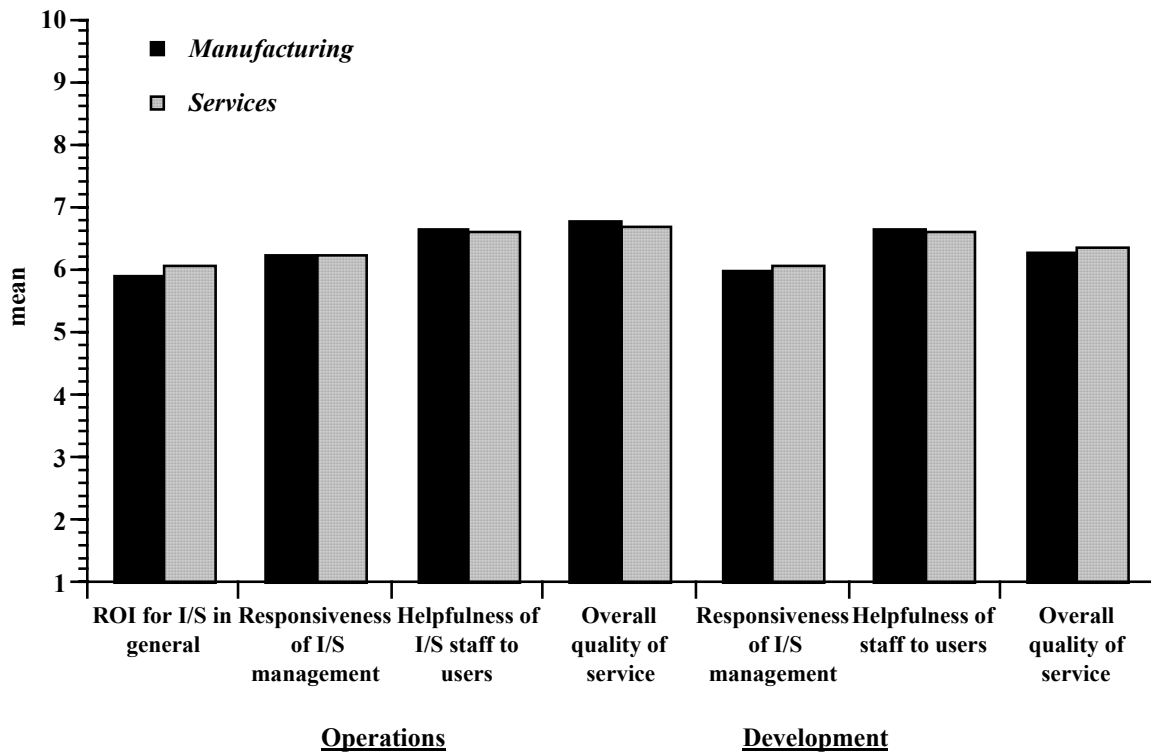


USER SATISFACTION WITH I/S SERVICES

While corporate productivity is the bottom line on I/S spending for senior executives, user satisfaction is usually the bottom line for user managers and for end users themselves. Accordingly, the IMP survey had user managers rate the performance of the I/S units which serve them.

In general, the user managers who responded to the survey are positive about the services they receive. They consistently rate their I/S units above 5.0 on a 10 point scale. Moreover, they consistently rate the overall quality of service and the helpfulness of staff higher than the responsiveness of I/S management. And computer operations usually are rated higher than systems development (Exhibit 47).

Exhibit 47. User Manager Ratings of I/S Units, Manufacturing and Services, 1994



VI. SUMMARY

This report clearly demonstrates that I/S departments in manufacturing and services firms are on very different development trajectories. Each reflects key features of their industry environment. Consequently, it is important to provide benchmarking profiles within industry. In Exhibit 48, we display the summary of I/S in manufacturing and services firms as we observe them in the middle 1990's.

Exhibit 48. Profile of Manufacturing and Services Firms: Resource Inputs

Manufacturing Firms	Services Firms
A. I/S Spending	
• 2.3% of total revenues	• 2.8% of total revenues
• 9.4% of operating expenses	• 5.5% of operating expenses
• \$5,838 per employee	• \$8,625 per employee
• estimated total \$6,750 per employee	• estimated total \$11,440 per employee
B. I/S Personnel	
• % I/S of total employees	• % I/S of total employees
C. I/S Budget Shares	
• 27% hardware	• 26% hardware
• 8% software	• 9% software
• 38% personnel	• 38% personnel
• 14% outsourcing	• 17% outsourcing
• 13% all other	• 11% all other
D. I/S Hardware	
• 91 MIPS per mainframe	• 127 MIPS per mainframe
• 275 gigabytes DASD per mainframe	• 436 gigabytes DASD per mainframe
• .49 MIPS per 1 GB DASD	• .51 MIPS per 1 GB DASD

Exhibit 49. Profile of Manufacturing and Services Firms: Arrangements for Production of Information Services

Manufacturing Firms		Services Firms	
A. Alternative Arrangements for Service Provision			
• 71% in-house I/S unit(s)		• 69% in-houe I/S unit(s)	
• 14% outsourced		• 17% outsourced	
• 15% department/endusers		• 15% department/endusers	
B. Allocation of Staff Resources			
• 37% application, delivery and project-oriented consulting		• 40% application, delivery and project-oriented consulting	
• 11% planning, administration and strategic planning		• 11% planning, administration and strategic planning	
• 20% installed application support		• 19% installed application support	
• 32% operations and production support		• 31% operations and production support	
C. Management of Systems Development			
• \$1.18 new application development for every \$1.00 maintenance of application		• \$1.39 new application development for every \$1.00 maintenance of application	
• 3% of I/S budget spent for tools, techniques and hardware for enhancing development productivity		• 2.6% of I/S budget spent for tools, techniques and hardware for enhancing development productivity	
1. Use of Development Tools			
• Upper CASE	58.6	• Upper CASE	70.3
• Lower CASE	27.6	• Lower CASE	43.2
• Integrated CASE	10.3	• Integrated CASE	27.0
• CATI	22.2	• Reusable software modules	43.2
• Reusable software modules	22.2	• Objected-oriented Techniques	21.6
• Object-oriented techniques	20.7	• CATI	16.2
• Reverse engineering tools	10.7	• BPST	10.8
• BPST	17.2	• Reverse engineering tools	08.1
2. Use of Development Techniques			
• Joint Application Development	58.6	• Joint Application Development	73.0
• Data modeling	37.9	• Data modeling	54.1
• Self-directed teams	37.9	• Self-directed teams	16.2

Exhibit 49. (continued on next page)

D. Management of Computer Operations	
Manufacturing Firms	Services Firms
1. Structure	
• 4 Data Centers	• 2 Data Centers
2. Computer Technology	
• 4 mainframes	• 4 mainframes
• 80 minicomputers	• 54 minicomputers
• 15,860 enduser devices	• 12,500 enduser devices
• 35 LANS	• 69 LANS
3. Operations Personnel	
• 32% of all I/S staff	• 31% of all I/S staff
• 22 operations staff per mainframe	• 29 operations staff per mainframe
• 1 operations staff per minicomputer	• 1 operations staff per minicomputer
• 9 operations staff support for micros	• 11 operations staff support for micros
• 12 operations staff support for LANS	• 16 operations staff for LANS
4. Efficiency of Computer Operations	
• .67 operations staff per mainframe MIP	• .52 operations staff per mainframe MIP

Exhibit 50. Profile of Manufacturing and Services Firms: Measures of Performance

Manufacturing Firms	Services Firms
A. Productivity in I/S Service Provision	
<ul style="list-style-type: none"> • \$1.53 spent for I/S staff for each \$1.00 spent on hardware 	<ul style="list-style-type: none"> • \$1.46 spent for I/S staff for each \$1.00 spent on hardware
B. Penetration of I/S Use Within Corporation	
<ul style="list-style-type: none"> • .59 enduser devices per employee 	<ul style="list-style-type: none"> • .72 enduser devices per employee
<ul style="list-style-type: none"> • \$5,838 per employee 	<ul style="list-style-type: none"> • \$8,625 per employee
<ul style="list-style-type: none"> • estimated total \$6,750 per employee 	<ul style="list-style-type: none"> • estimated total \$11,440 per employee
C. Productivity of Corporations	
<ul style="list-style-type: none"> • revenue per employee 	<ul style="list-style-type: none"> • revenue per employee

VII. DATA WAREHOUSE

A. METHODOLOGY OF THE SURVEY

The target population for empirical analysis was Fortune 500 corporations. The core sample frame which we used to represent this population was the CSC Research and Advisory Services member corporations. The sample was stratified in order to insure an adequate distribution on one key control variable: industry sector (manufacturing and services).

We used this variable because both theory and other research indicate that it must be taken into account. Type of industry is important both intuitively and theoretically. Intuitively, manufacturing tends to be more capital intensive and services more labor intensive, but it is unclear whether this relationship also holds for the production of information services. Theoretically, the type of industry is important because various scholars (e.g., Daniel Bell, Simon Nora and Alain Minc, James Beniger, and Marc Porat, Alvin Toffler) argue that services industries will be at the heart of the information economies of the future to which all post-industrial societies are evolving. In the services industry, information is the primary product or service; and, it is integral to everything that goes on in a corporation. In manufacturing, information is only one input, either as part of a product, or as a means of coordination and control of processes in, and related to, manufacturing.

These differences in manufacturing and services firms are expected to have structural implications for the provision of information services. Therefore, it was important that the sampling and data collection schemes ensure adequate representation of each type of industry. We used the two-digit Standard Industrial Classification (SIC) code for typing industries similar to what is done in the Malcolm Baldrige Award Program. In addition, we have taken note of size.

Data Collection. The IMP survey has been conducted for seven years and this report utilizes data from the past six surveys. These surveys encompass the fiscal years for 1988 through 1994. For each of the surveys, data collection was performed by mail questionnaires sent to the chief information officers (CIOs).

Survey Responses. There were two different units for data collection in the survey: the corporation and the I/S department. With respect to both surveys, the overall corporate response rate was about 20%. This report focuses on corporations and corporate I/S units. The total number of corporations responding for each year is shown in Exhibit 51. The number of corporations providing data for fiscal year 1991 is significantly less than for the other years. Because of the smaller number of

corporations represented in 1991, care should be exercised in interpreting the 1991 results.

demographics and selected I/S demographics.

Exhibit 51. Number of Corporations Participating in Each Fiscal Year

	Manufac- turing	Services	All Firms
1988	20	27	47
1989	14	15	29
1990	20	19	39
1991	7	8	15
1992	17	14	31
1993	22	24	46
1994	20	22	42

Corporation I/S Characteristics. *The trend lines for both total number of I/S staff and total I/S budget are similar between the IMP sample and the larger sample of corporations. The IMP sample and the larger sample of corporations evidence a similar pattern -- large drop in the total number of I/S staff from 1989 to 1990 and a fairly flat level of I/S staffing 1990 through 1992 (Exhibit A.1). I/S budgets also show a reduction in total dollars from 1989 to 1992, although the IMP firms' I/S expenses are higher (although not statistically significant) in 1989 and 1990. The very sharp drop in 1991 is most likely a reflection of the small IMP sample size for that fiscal year (Exhibit A.2).*

Applicability of Findings. As part of the IMP survey, we have been collecting existing data on corporate I/S from sources such as the *Computerworld* 100 and *Information Week* 500 for the years 1988-1993. Data on these corporations as well as the IMP survey corporations has also been augmented from data obtainable through Compustat. This database currently contains a total of 518 corporations represented over the 6 year span. Per fiscal year we have data on total I/S employees, I/S budgets and end user devices that ranges from approximately 150 corporations in 1989 to nearly 300 corporations in 1992. This database provides a comparison for the IMP sample in order to determine the applicability of the IMP findings to the general population of corporations.

In Exhibits A1 to A6, comparisons between the two databases are made with respect to corporation

Exhibit A.1 Total I/S Staff in Corporation, 1989-1993

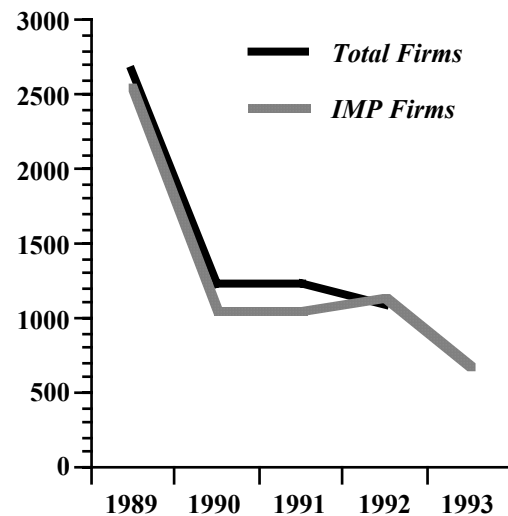
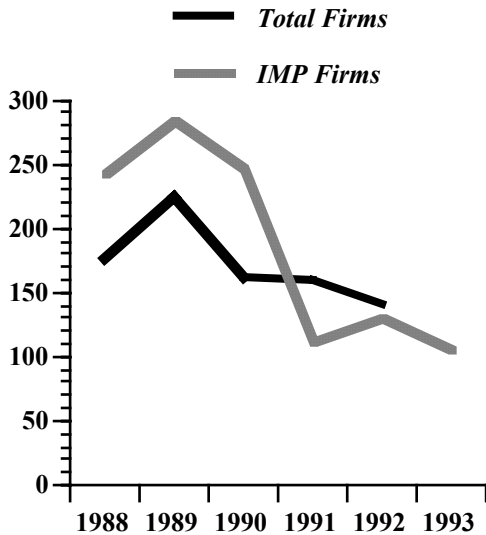


Exhibit A.2 Corporate I/S Expenses (in millions), 1989-1993



Both percent of I/S employees of total corporation employees and percent I/S budget of total corporation revenues (Exhibits A.3 and A.4) reflect similar patterns in the two samples although, the IMP sample peak and decline is primarily one fiscal year later than the comparison sample of corporations.

Exhibit A.3 Percent I/S Budget of Total Revenues, 1989-1993

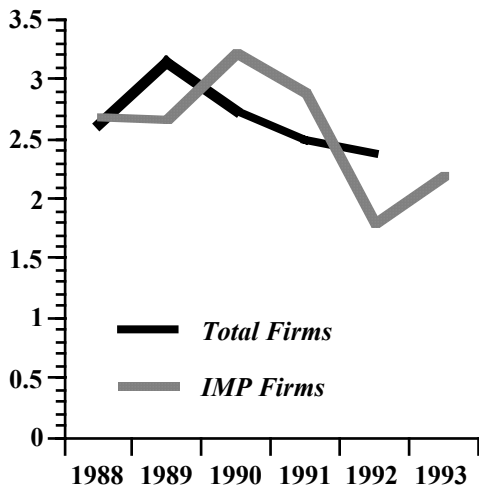
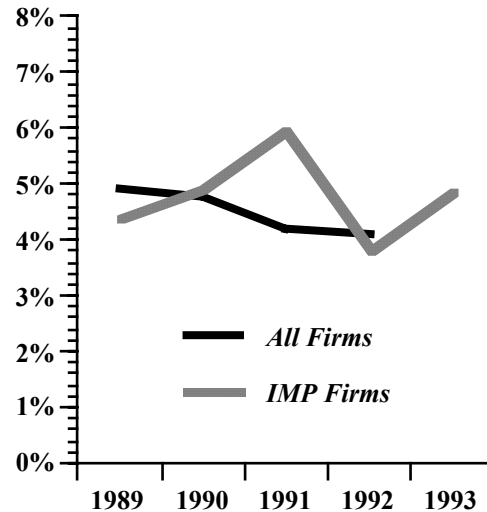
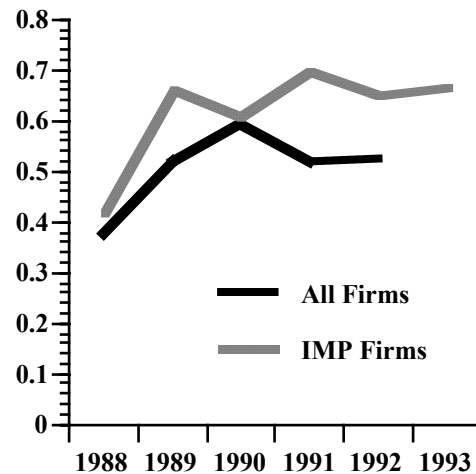


Exhibit A.4 Percent I/S Employees of Total Employees in Corporation, 1989-1993



Spread of end user devices is similar for both the IMP sample and the comparison sample of corporations. Differences between the samples for each Fiscal Year are not statistically significant (Exhibit A.5).

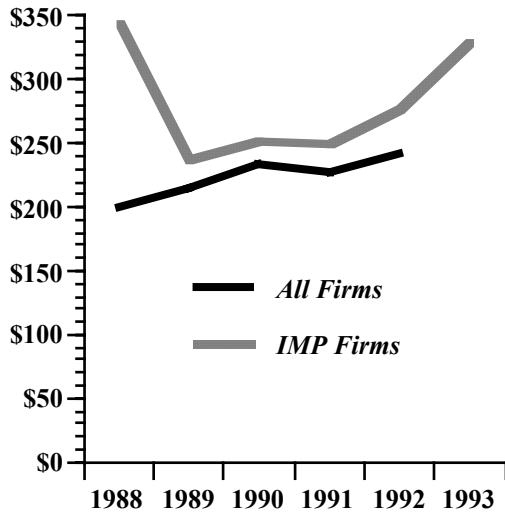
Exhibit A.5 Number of PCs/CRTs Per Corporation Employee, 1989-1993



Corporate Productivity. Measure of corporate productivity by fiscal year is

remarkably similar for the two samples. None of the differences between means per fiscal year are statistically significant.

Exhibit A.6 Corporate Revenue Per Employee (in thousands), 1988-1993



Conclusions. *In general, the trend lines indicate that the relationships found in this survey apply to the general population of I/S departments and corporations.* Furthermore, support for this view is provided by the fact that our benchmarks on I/S budgets and labor-capital ratios fit well with existing research on the economics of information systems. Thus, although the I/S departments in the survey are larger and more leading edge as a whole, the trends in these I/S departments could be considered a harbinger for other corporations and other I/S departments.

List of Participating Corporations

AT&T	Fina	Pacific Bell
Aetna Life and Casualty	First of America Bank Corp.	Pacific Bell Directory
Aid Association for Lutherans	Florida Power & Light Co.	Pennsylvania Power and Light
Airborne Freight Corporation	Ford Motor Company	Pennzoil
Alliant Techsystems	Furr's Inc.	PepsiCo, Inc.
Amdahl Corporation	GTE Service Corporation	Petro-Canada, Inc.
American Airlines, Inc.	General American Life	Phillips Petroleum Company
American Cyanamid Company	Insurance	Pillsbury Company
American Electric Power Corp.	General Dynamics	PMI Food Equipment
American Greetings	General Electric Company	Portland General Electric Co.
American President Companies	Georgia-Pacific	Pratt & Whitney Canada Inc.
Ameritech Services	Goodyear Tire and Rubber Co.	Principal Financial Group
AMP	Grand Metropolitan	Progressive Corporation
Amoco Corporation	Hallmark Cards, Inc.	Public Service Electric & Gas
Apple Computer	Hewlett Packard	Reliance Electric Corporation
Ashland Oil, Inc.	Hoechst Celanese Corporation	Rexnord Corporation
AST Research	J.M. Huber Corporation	Rockwell International
AAA of Southern California	Humana, Inc.	Rogers Cantell
Baltimore Gas & Electric	IBM Corporation	Rohm and Haas Company
Bank of America	IBM Canada, Ltd.	Ryder Transport
Barnett Banks, Inc.	Illinois Power Company	Sandia National Laboratories
Battelle Memorial Institute	Int'ntl Flavor & Fragrances	Sandoz Pharmaceuticals Corp.
Bell Atlantic	JC Penney	Scott Paper Company
BellSouth Telecommunications,	Kroger	Sonat, Inc.
Blue Cross Blue Shield of MI	Land O'Lakes	Southern California Edison
Boeing	Lever Brothers	So. New England Telecomm
Borden, Inc.	Eli Lilly & Company	Sprint Cellular
British Columbia Telephone	Lockheed Corporation	SPS Payment Systems
Brooklyn Union Gas	London Life Insurance	Storage Technology Corp.
Burroughs Wellcome Company	Los Alamos National Lab	Levi Strauss & Company
Campbell Soup Company	Louisville Gas and Electric	Sun Life of Canada
CIBA-GEIGY Corporation	Mallinckrodt Medical, Inc.	Sundstrand Corporation
CIGNA	Marriott Corporation	Syntex Laboratories, Inc.
CNA Insurance Companies	Maytag	Taco Bell Corporation
Colgate-Palmolive Company	McDonald's Corporation	Temple Inland
Colonial Life Insurance	Mercantile Bank N.A.	Tennessee Valley Authority
CONOCO	Miller Brewing Company	Texas Utilities Services, Inc.
Consolidated Edison Co. of NY	Montgomery Ward	Textron Inc.
Consolidated Freightways, Inc.	Mutual of New York	The Southern Company
Consumers Power Company	Mutual of Omaha	Transamerica Insurance Group
Corning, Incorporated	NCR Corporation	The Travelers Companies
Curwood	Nabisco Foods Group	UNUM Life Insurance Co.
Del Monte Foods	National Fuel Gas	Ungermann-Bass, Inc.
Dell Computer	Nationwide Mutual Insurance	Union Camp Corporation
Duke Power Company	National Semiconductor	Union Electric
Eastman Kodak Company	NCS	Uniroyal Chemical Company
El Paso Natural Gas Company	Niagara Mohawk	Unisys Corporation
Electronic Payment Services	Nike Corporation	United Jersey Banks
Elf Atochem North America	Nordstroms	The Upjohn Company
Engelhard Corporation	Northrop-Grumman	USAIR
ENSERCH Corporation	Corporation	US West Technologies
Entergy Services	Northwestern Mutual Life	Varian
Exxon Corporation	Occidental Petroleum Services	Western-Southern Life
Federal Express Corporation	Owens-Corning Fiberglas Corp.	Insurance

Westinghouse Energy Systems
Weyerhaeuser Company
Whirlpool
Xerox Corporation
Yellow Technology Services

DATA TABLES

The tables listed below provide the data used to construct the graphs in the report. Unless otherwise indicated, the mean values were used to construct the report graphs. Each table provides the mean and the median values for manufacturing firms, service firms and all firms combined. The table number is the same as the exhibit number in the report.

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B. DATA TABLES FOR THE EXHIBITS

Table 3. Revenue and Operating Expenses, 1988-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
<i>Total revenue from operations in billions</i>						
1988	\$5.7	\$3.6	\$7.3	\$5.9	\$4.7	\$2.8
1989	\$6.1	\$4.8	\$6.2	\$4.8	\$5.9	\$4.9
1990	\$5.6	\$3.1	\$5.7	\$2.2	\$5.5	\$4.3
1991	\$5.7	\$4.0	\$4.3	\$4.0	\$6.9	\$4.1
1992	\$6.0	\$4.2	\$5.5	\$3.7	\$6.9	\$6.5
1993	\$4.5	\$3.4	\$4.2	\$3.4	\$4.7	\$3.6
1994	\$4.9	\$3.3	\$4.9	\$3.1	\$4.9	\$3.6
<i>Total operating expenses in billions</i>						
1988	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1989	\$3.5	\$2.2	\$3.7	\$1.6	\$3.3	\$2.8
1990	\$2.7	\$1.4	\$2.3	\$1.4	\$2.9	\$1.4
1991	\$3.2	\$2.1	\$3.1	\$2.1	\$3.4	\$1.8
1992	\$2.9	\$.9	\$2.8	\$.9	\$3.1	\$1.6
1993	\$2.3	\$1.4	\$1.2	\$.9	\$3.3	\$2.6
1994	\$2.9	\$1.5	\$2.0	\$0.9	\$3.5	\$2.5

Table 4. Number of Employees in Sample Corporations, 1988-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1988	36,966	17,600	46,597	26,700	29,832	8,397
1989	31,621	19,627	35,202	28,129	28,517	19,453
1990	24,069	13,650	23,041	13,000	25,096	14,300
1991	28,079	21,000	27,114	24,000	28,923	10,941
1992	24,795	16,000	24,632	16,000	25,094	16,042
1993	19,553	10,000	18,398	9,230	20,658	12,000
1994	22,667	9,611	20,065	9,100	24,810	10,040

Table 5. Percent I/S Spending of Total Corporate Revenues, 1988-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1988	2.70%	1.69%	2.69%	1.71%	2.71%	1.67%
1989	2.68%	1.98%	2.72%	1.84%	2.65%	2.18%
1990	3.23%	2.51%	2.92%	1.84%	3.53%	2.81%
1991	2.90%	2.83%	2.60%	2.07%	3.17%	3.22%
1992	1.81%	1.80%	1.84%	1.80%	1.74%	1.70%
1993	2.20%	1.75%	2.35%	1.75%	2.06%	1.73%
1994	2.57%	1.80%	2.28%	1.72%	2.81%	1.93%

Table 6. Percent I/S Spending of Total Corporate Operating Expenses, 1989-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	5.44%	3.37%	6.16%	5.31%	4.79%	2.68%
1990	7.20%	5.47%	8.50%	5.73%	6.37%	4.71%
1991	7.40%	5.55%	6.37%	5.55%	8.31%	5.84%
1992	6.75%	5.88%	5.76%	5.88%	8.48%	6.16%
1993	6.81%	4.25%	8.55%	6.48%	5.15%	3.14%
1994	7.18%	4.51%	9.37%	6.13%	5.52%	3.50%

Table 7. Percent of I/S Employees of Total Corporate Employees, 1988-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1988	4.43%	3.35%	3.30%	2.54%	5.22%	3.79%
1989	4.40%	3.55%	3.39%	2.53%	5.42%	4.81%
1990	4.92%	3.88%	4.25%	3.33%	5.58%	4.65%
1991	5.95%	4.62%	3.15%	2.76%	8.40%	9.80%
1992	3.81%	2.33%	2.18%	1.84%	6.81%	5.10%
1993	4.87%	3.42%	3.26%	2.59%	6.49%	4.54%
1994	4.31%	3.55%	3.24%	2.71%	5.26%	4.12%

Table 8. Distribution of I/S Expenses, 1989-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
<i>Total hardware expenses</i>						
1989	26.3%	27.1%	26.5%	25.6%	26.2%	27.1%
1990	27.9%	28.2%	28.7%	29.4%	27.1%	26.3%
1991	28.1%	29.8%	26.5%	29.6%	29.6%	30.1%
1992	26.7%	27.5%	25.0%	24.7%	29.4%	27.7%
1993	27.5%	26.6%	27.0%	26.6%	28.0%	27.2%
1994	26.4%	25.1%	27.1%	26.6%	25.8%	24.8%
<i>Total software expenses</i>						
1989	6.0%	5.7%	5.6%	5.7%	6.4%	5.0%
1990	7.5%	6.3%	6.9%	6.8%	8.1%	6.1%
1991	7.2%	6.8%	6.8%	5.7%	7.6%	7.3%
1992	7.7%	7.2%	7.3%	6.7%	8.2%	7.3%
1993	8.4%	8.7%	8.5%	9.1%	8.3%	8.3%
1994	8.4%	8.2%	8.0%	6.7%	8.7%	8.8%
<i>Total personnel expenses</i>						
1989	40.9%	41.9%	39.2%	38.8%	42.5%	43.2%
1990	38.4%	38.0%	37.8%	36.2%	39.0%	38.7%
1991	42.7%	45.5%	43.0%	46.4%	42.3%	43.1%
1992	42.5%	45.1%	42.4%	41.9%	42.8%	46.7%
1993	42.5%	45.1%	42.4%	40.4%	39.3%	40.2%
1994	38.2%	37.6%	38.4%	38.1%	38.0%	37.2%
<i>Total outside services expenses</i>						
1989	8.6%	5.0%	10.5%	5.0%	6.8%	5.0%
1990	7.8%	6.2%	7.1%	5.0%	8.4%	7.6%
1991	9.5%	4.4%	7.1%	5.0%	8.4%	7.6^
1992	11.9%	7.9%	13.6%	7.2%	9.1%	8.4%
1993	13.4%	9.1%	14.5%	12.8%	12.4%	7.4%
1994	15.4%	10.1%	13.6%	8.0%	16.9%	10.6%
<i>All other expenses</i>						
1989	18.2%	14.4%	18.3%	14.9%	18.1%	13.0%
1990	18.4%	15.7%	19.4%	18.6%	17.5%	13.6%
1991	12.5%	11.2%	13.7%	12.1%	11.3%	10.4%
1992	11.2%	10.4%	11.7%	10.9%	10.5%	9.6%
1993	10.8%	9.1%	9.7%	6.6%	12.0%	11.1%
1994	11.7%	10.4%	12.9%	13.3%	10.6%	9.1%

Table 9. Average MIPS Per Mainframe, 1989-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	48.05	42.26	40.25	33.50	53.90	58.95
1990	59.54	54.00	39.43	35.17	80.70	69.20
1991	71.72	70.00	49.15	44.00	86.77	90.56
1992	89.63	78.50	84.84	58.07	95.11	97.00
1993	116.80	98.67	80.78	68.64	146.27	106.25
1994	110.96	106.00	91.28	75.88	127.47	120.00

Table 10. Average DASD (in gigabytes) Per Mainframe, 1989-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	148.48	137.45	100.12	101.29	184.75	177.30
1990	193.45	143.50	133.39	112.08	256.66	198.00
1991	249.50	176.00	138.86	100.00	335.55	275.00
1992	254.78	255.00	223.86	236.77	290.13	260.75
1993	310.27	257.67	248.45	181.00	360.31	310.00
1994	369.18	310.00	274.84	193.00	436.14	383.33

Table 11. Ratio MIPS to DASD, 1988-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1988	.37	.34	.39	.34	.35	.32
1989	.36	.29	.43	.38	.32	.28
1990	.40	.33	.41	.35	.40	.33
1991	.33	.28	.45	.32	.29	.27
1992	.37	.31	.42	.37	.29	.29
1993	.39	.36	.42	.34	.36	.36
1994	.50	.36	.49	.37	.51	.35

Table 12. Percent In-House Provision of I/S Services, 1989-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	90.3%	95.0%	87.9%	93.0%	92.5%	95.0%
1990	91.4%	95.0%	88.5%	93.3%	94.4%	98.5%
1991	95.1%	96.0%	94.4%	95.0%	95.8%	98.0%
1992	91.0%	95.0%	90.8%	93.6%	91.2%	96.5%
1993	88.3%	91.0%	87.2%	85.0%	89.3%	93.5%
1994	80.8%	90.0%	80.4%	90.0%	81.2%	90.0%

Table 13. Percent of Total I/S Services Provided By In-House I/S Unit, Departmental Endusers and Outsourced, 1991-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
<i>Percent In-House I/S Department Services</i>						
1991	82.2%	81.4%	76.6%	78.8%	87.1%	91.1%
1992	62.6%	62.7%	61.0%	56.5%	65.6%	67.3%
1993	72.6%	73.3%	70.4%	72.8%	74.8%	78.0%
1994	69.9%	71.8%	71.2%	73.0%	68.9%	69.6%
<i>Percent Outsourced</i>						
1991	8.6%	3.9%	9.0%	3.6%	8.2%	5.7%
1992	11.1%	6.9%	13.5%	7.5%	6.8%	6.3%
1993	13.9%	11.3%	15.2%	13.8%	12.6%	7.5%
1994	15.4%	10.1%	13.6%	8.0%	16.9%	10.6%
<i>Percent Provided by Departments and End users</i>						
1991	9.2%	5.0%	14.4%	15.0%	4.7%	2.5%
1992	26.3%	25.0%	25.6%	25.0%	27.6%	30.0%
1993	13.5%	10.0%	14.4%	10.0%	12.6%	7.5%
1994	15.0%	10.0%	14.7%	10.0%	15.3%	10.0%

Table 14. Distribution of I/S Unit Outsourcing by Type of Activity: Percent Firms Outsourcing Portion of Activity and Mean Percent of Activity Outsourced, 1993-1994

	All Firms		Manufacturing		Services	
	% Firms Outsourcing	Mean % of Activity Outsourced	% Firms Outsourcing	Mean % of Activity Outsourced	% Firms Outsourcing	Mean % of Activity Outsourced
<i>Data center operations</i>						
1993	30.5%	22.5%	40.9%	33.7%	20.8%	2.5%
1994	40.6%	13.3%	57.1%	19.5%	27.8%	8.6%
<i>New systems development</i>						
1993	71.8%	22.0%	68.2%	25.5%	75.0%	19.1%
1994	75.0%	18.1%	78.6%	16.3%	72.2%	19.5%
<i>Maintenance and enhancement of existing applications</i>						
1993	47.9%	25.3%	40.9%	19.0%	54.2%	29.7%
1994	56.3%	15.1%	53.6%	9.3%	58.3%	19.5%
<i>Installation, maintenance and management of desktop computing</i>						
1993	69.6%	39.9%	72.7%	37.7%	66.7%	42.1%
1994	73.4%	29.9%	75.0%	27.5%	72.2%	31.8%
<i>Network operations and management</i>						
1993	30.5%	20.7%	36.4%	15.6%	25.0%	27.5%
1994	32.8%	11.3%	50.0%	13.6%	19.4%	9.6%

Table 15. Percent Distribution of I/S Personnel Staff by I/S Activity, 1988-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
<i>Percent application delivery and project-oriented consulting</i>						
1988	34.86	33.14	34.12	32.98	35.40	33.31
1989	32.72	35.83	31.78	36.91	33.24	31.53
1990	32.86	32.44	35.06	38.13	31.16	28.93
1991	30.99	30.01	28.61	29.61	32.01	30.41
1992	34.36	32.34	32.33	32.22	36.99	32.67
1993	38.76	38.32	33.43	30.61	43.36	45.45
1994	38.50	37.53	36.62	34.80	40.06	38.37
<i>Percent planning, administration, strategic consulting</i>						
1988	11.00	9.28	10.29	8.32	11.53	9.86
1989	11.85	9.09	12.02	8.56	11.76	9.30
1990	13.05	10.94	12.64	8.83	13.37	11.97
1991	17.56	19.07	19.06	25.00	16.92	16.15
1992	12.38	11.11	10.90	10.21	14.30	14.95
1993	12.93	12.11	14.63	12.50	11.47	10.32
1994	10.96	10.42	10.76	9.68	11.13	10.70
<i>Percent installed application support</i>						
1988	22.13	20.49	21.53	17.69	22.57	22.47
1989	18.99	18.88	22.13	23.75	17.28	18.61
1990	21.13	20.66	16.19	12.26	24.97	22.73
1991	24.17	24.60	27.13	31.43	22.90	23.42
1992	21.75	24.00	23.54	28.19	19.43	21.78
1993	18.46	18.00	19.37	19.36	17.68	18.00
1994	19.51	19.36	20.15	16.63	18.96	20.35
<i>Percent operations and production support</i>						
1988	32.01	30.73	34.05	33.80	30.50	29.29
1989	36.44	36.71	34.07	32.32	37.73	38.79
1990	32.96	32.60	36.11	38.04	30.51	30.19
1991	27.29	27.15	25.21	28.57	28.18	25.73
1992	31.52	27.88	33.24	31.13	29.28	26.46
1993	29.85	28.04	32.57	28.59	27.50	25.79
1994	31.83	27.86	32.48	30.63	31.28	27.76

Table 16. Number of Dollars Spent for New Application Development For Each \$1.00 Spent on Maintenance Of Applications, 1991-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1991	\$1.35	\$1.44	\$.76	\$.61	\$1.65	\$1.81
1992	\$1.77	\$1.58	\$1.39	\$1.20	\$2.27	\$2.11
1993	\$1.38	\$1.00	\$1.25	\$.68	\$1.48	\$1.27
1994	\$1.31	\$0.89	\$1.18	\$0.68	\$1.39	\$1.00

Table 17. Percent of I/S Budget Spent For Tools, Techniques and Hardware for Enhancing Development Productivity, 1991-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1991	2.366	2.450	2.096	2.400	2.636	2.622
1992	2.636	1.604	2.863	1.494	2.183	2.174
1993	2.506	1.826	2.510	1.783	2.502	1.901
1994	2.795	1.976	3.019	2.143	2.598	1.904

Table 18. Index of Development Tool Advancement, 1989-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	2.0000	1.500	1.2333	1.000	2.6765	2.750
1990	1.7976	1.375	1.6413	1.000	1.9868	1.500
1991	2.6029	2.750	1.5625	1.125	3.5278	3.500
1992	3.0078	3.000	2.8158	3.000	3.2885	3.000
1993	2.5326	2.250	2.1591	1.875	2.8750	2.750
1994	2.8182	2.750	2.4914	2.000	3.0743	3.000

Table 19. Use of Development Tools, 1989-1994

	All Firms	Manufacturing	Services
	Percent use	Percent use	Percent use
<i>Upper CASE</i>			
1989	34.5%	21.4%	46.7%
1990	36.1%	42.1%	29.4%
1991	80.0%	57.1%	100.0%
1992	63.3%	47.1%	84.6%
1993	54.3%	45.5%	62.5%
1994	65.2%	58.6%	70.3%
<i>Lower CASE</i>			
1989	37.9%	28.6%	46.7%
1990	33.3%	31.6%	35.3%

Data Warehouse
Data Tables

1991	46.7%	14.3%	75.0%
1992	43.3%	47.1%	38.5%
1993	37.0%	36.4%	37.5%
1994	36.4%	27.6%	43.2%
<i>Integrated CASE</i>			
1989	6.9%	0.0%	13.3%
	All Firms	Manufacturing	Services
	Percent use	Percent use	Percent use
1990	21.6%	21.1%	22.2%
1991	26.7%	0.0%	50.0%
1992	23.3%	17.7%	30.8%
1993	17.4%	9.1%	25.0%
1994	19.7%	10.3%	27.0%
<i>Computer-Assisted Testing and Implementation</i>			
1989	20.7%	7.1%	33.3%
1990	13.5%	10.5%	16.7%
1991	26.7%	14.3%	37.5%
1992	23.3%	17.7%	30.8%
1993	9.1%	0.00%	16.7%
1994	18.8%	22.2%	16.2%
<i>Reusable software modules</i>			
1989	21.4%	15.4%	26.7%
1990	18.92%	10.5%	27.8%
1991	20.00%	28.6%	12.5%
1992	19.35%	23.5%	14.3%
1993	28.3%	18.2%	37.5%
1994	34.4%	22.2%	43.2%
<i>Reverse engineering tools</i>			
1989	17.2%	0.0%	33.3%
1990	8.11%	10.5%	5.6%
1991	13.33%	14.3%	12.5%
1992	19.35%	17.7%	21.4%
1993	10.9%	9.1%	12.5%
1994	9.2%	10.7%	8.11%
<i>Business Process Simulation Tools</i>			
1989	3.5%	0.0%	6.7%
1990	8.3%	5.6%	11.1%
1991	6.7%	0.0%	12.5%
1992	6.7%	5.9%	7.7%
1993	8.7%	9.1%	8.3%
1994	13.6%	17.2%	10.8%
<i>Object-oriented techniques</i>			
1989	3.6%	0.0%	6.7%
1990	0.0%	0.0%	0.0%
1991	0.0%	0.0%	0.0%
1992	6.5%	11.8%	0.0%
1993	17.4%	18.2%	16.7%
1994	21.2%	20.7%	21.6%

Table 20. Index of Development Technique Advancement, 1989-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	.92	1.00	.84	1.00	.99	.50
1990	1.00	1.00	.95	1.00	1.07	1.00
1991	.84	.50	.56	.00	1.08	1.00
1992	1.25	1.00	1.33	1.50	1.14	1.00
1993	1.55	1.50	1.44	1.50	1.66	1.50
1994	1.71	1.75	1.72	.18	1.70	1.50

Table 21. Use of Development Techniques, 1989-1994

	All Firms	Manufacturing	Services
	Percent use	Percent use	Percent use
<i>Joint application development techniques</i>			
1989	21.4%	23.1%	20.0%
1990	24.3%	36.8%	11.1%
1991	33.3%	14.3%	50.0%
1992	25.8%	35.3%	14.3%
1993	60.9%	45.5%	75.0%
1994	66.7%	58.6%	73.0%
<i>Data modeling</i>			
1989	32.1%	23.1%	40.0%
1990	18.9%	10.5%	27.8%
1991	26.7%	14.3%	37.5%
1992	30.0%	31.3%	28.6%
1993	41.3%	27.3%	54.2%
1994	47.0%	37.9%	54.1%
<i>Self-directed teams</i>			
1989	7.1%	7.7%	6.7%
1990	21.6%	15.8%	27.8%
1991	7.1%	16.7%	0.0%
1992	9.7%	17.7%	0.0%
1993	23.9%	31.8%	16.7%
1994	25.8%	37.9%	16.2%

Table 24. Total Number Data Centers, 1989-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	11.36	2.50	14.44	7.00	9.23	2.00
1990	5.06	2.50	4.07	3.00	5.84	2.00
1991	3.17	2.00	5.75	4.50	1.88	1.50
1992	2.67	1.00	3.31	1.50	1.93	1.00
1993	4.02	2.00	6.47	3.00	2.29	1.00
1994	2.62	1.00	3.57	1.00	1.86	1.00

Table 25. Total Number of Mainframes, 1989-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	6.55	3.00	4.44	3.00	8.00	4.00
1990	4.97	3.00	5.07	2.00	4.90	4.00
1991	5.42	3.00	6.50	5.50	4.88	3.00
1992	5.55	2.00	3.94	2.00	7.50	2.50
1993	3.60	2.00	4.14	1.50	3.09	2.00
1994	3.90	2.00	3.76	1.00	4.03	2.00

Table 26. Total Number of Minicomputers, 1989-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	77.86	18.00	99.67	21.00	61.50	11.00
1990	60.12	7.00	50.47	9.00	68.17	6.00
1991	76.00	7.00	179.25	57.50	17.00	2.00
1992	66.13	15.50	63.06	20.00	70.15	11.00
1993	58.51	5.00	66.29	14.00	51.09	3.00
1994	65.05	5.00	79.76	12.00	53.91	5.00

Table 27. Number of Operations Staff Per Mainframe, 1989-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	34.41	33.33	28.09	27.92	38.30	34.83
1990	40.84	33.50	21.13	19.00	55.07	44.33
1991	31.54	34.00	13.00	15.00	38.50	36.25
1992	36.03	36.25	26.49	27.50	45.57	43.00
1993	29.61	27.50	29.24	28.00	29.91	27.00
1994	25.59	23.00	21.59	19.33	28.68	25.00

Table 28. Number of Operations Staff Per Minicomputer, 1989-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	1.11	.70	1.19	.63	1.04	.70
1990	1.05	1.00	1.06	1.06	1.05	.61
1991	.61	.28	.16	.02	.87	1.13
1992	.75	.36	.64	.23	.89	.50
1993	.97	.60	.90	.70	1.05	.47
1994	1.03	.55	1.00	.50	1.06	.60

Table 29. Operations Staff to Support All Microcomputers, 1991-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1991	9.78	7.00	5.33	4.00	12.00	8.50
1992	13.81	8.00	10.25	5.5	18.56	21.00
1993	9.94	8.00	10.11	8.00	9.79	9.00
1994	9.93	9.50	8.70	6.00	10.85	10.00

Table 30. Operations Staff to Support All Local Area Networks, 1991-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1991	6.89	5.00	7.33	5.00	6.67	6.50
1992	8.59	5.00	6.25	3.00	11.40	7.00
1993	10.05	9.00	8.53	7.00	11.58	11.00
1994	14.21	9.00	11.92	5.00	16.06	11.00

Table 31. Index of Advanced Hardware Technologies, 1989-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	2.16	2.13	1.90	2.00	2.40	2.25
1990	2.05	2.00	2.03	2.00	2.07	2.00
1991	2.10	2.00	1.81	1.50	2.36	2.25
1992	2.26	2.00	2.09	2.00	2.48	2.12
1993	2.70	2.75	2.49	2.12	2.90	3.12
1994	3.01	3.25	2.41	2.00	3.43	3.75

Table 32. Use of Advanced Hardware Technologies, 1989-1994

	All Firms	Manufacturing	Services
	Percent use	Percent use	Percent use
<i>Voice response technology</i>			
1989	39.3%	35.7%	42.9%
1990	24.3%	15.8%	33.3%
1991	33.3%	14.3%	50.0%
1992	41.9%	35.3%	50.0%
1993	54.3%	36.4%	70.8%
1994	54.6%	31.0%	73.0%
<i>Distributed processing</i>			
1989	44.8%	50.0%	40.0%
1990	42.9%	41.2%	44.4%
1991	40.0%	28.6%	50.0%
1992	38.7%	17.7%	64.3%
1993	56.5%	59.1%	54.2%
1994	60.6%	58.6%	62.2%
<i>Function specific workstations</i>			
1989	41.4%	42.9%	40.0%
1990	51.4%	68.4%	33.3%
1991	40.0%	42.9%	37.5%
1992	38.7%	41.2%	35.7%
1993	43.5%	40.9%	45.8%
1994	52.3%	44.8%	58.3%
<i>Image technology & Optical Storage Media</i>			
1989	31.0%	28.6%	33.3%
1990	18.9%	21.1%	16.7%
1991	26.7%	28.6%	25.0%
1992	35.5%	41.2%	28.6%
1993	50.0%	40.0%	58.3%
1994	49.2%	32.1%	62.2%
<i>ISDN</i>			
1989	17.9%	7.7%	26.7%
1990	24.3%	21.1%	27.8%
1991	7.1%	16.7%	0.0%
1992	14.8%	13.3%	16.7%
1993	35.6%	38.1%	33.3%
1994	43.9%	51.7%	37.8%

Table 33. Index of Advanced Software Technologies, 1989-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	1.11	1.00	1.02	1.00	1.19	1.25
1990	1.09	1.00	1.07	1.00	1.12	1.00
1991	1.15	1.00	1.06	1.00	1.22	1.25
1992	1.15	1.00	1.07	1.00	1.27	1.12
1993	1.38	1.38	1.33	1.38	1.42	1.38
1994	1.50	1.50	1.52	1.50	1.48	1.50

Table 34. Use of Advanced Software Technologies, 1989-1994

	All Firms	Manufacturing	Services
	Percent use	Percent use	Percent use
<i>Relational Database Management Systems</i>			
1989	75.9%	78.6%	73.3%
1990	70.3%	68.4%	72.2%
1991	80.0%	71.4%	87.5%
1992	83.9%	82.4%	85.7%
1993	89.1%	86.4%	91.7%
1994	93.9%	93.1%	94.6%
<i>Distributed Database Management Systems</i>			
1989	17.2%	0.0%	33.3%
1990	18.9%	10.5%	27.8%
1991	20.0%	28.6%	12.5%
1992	16.1%	5.9%	28.6%
1993	33.3%	31.8%	34.8%
1994	40.9%	48.3%	35.1%

Table 35. Index of Advanced Application Technologies, 1989-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	1.59	1.88	1.88	2.00	1.32	1.50
1990	1.58	1.50	1.73	1.50	1.41	1.25
1991	1.78	2.00	2.00	2.25	1.58	1.50
1992	2.02	2.00	2.16	2.00	1.82	2.00
1993	1.69	1.88	1.92	2.00	1.48	1.50
1994	1.72	1.75	1.88	2.00	1.59	1.75

Table 36. Use of Advanced Application Technologies, 1989-1994

	All Firms	Manufacturing	Services
	Percent use	Percent use	Percent use
<i>Electronic data interchange (EDI)</i>			
1989	58.6%	78.57%	40.00%
1990	73.0%	89.47%	55.56%
1991	60.0%	85.71%	37.50%
1992	71.0%	88.24%	50.00%
1993	76.1%	95.5%	58.3%
1994	72.7%	93.1%	56.8%
<i>Executive support systems (ESS)</i>			
1989	53.6%	61.5%	46.7%
1990	37.8%	31.6%	44.4%
1991	46.7%	57.1%	37.5%
1992	51.6%	58.8%	42.9%
1993	45.7%	50.0%	41.7%
1994	57.6%	44.8%	67.6%
<i>Artificial intelligence/expert systems</i>			
1989	20.7%	21.4%	20.0%
1990	18.9%	26.3%	11.1%
1991	53.3%	42.9%	62.5%
1992	45.2%	35.3%	57.1%
1993	23.9%	22.7%	25.0%
1994	27.3%	24.1%	29.7%

Table 37. Number of Computer Operations Staff Per MIP, 1989-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	.75	.69	.79	.74	.73	.60
1990	.80	.72	.80	.57	.80	.74
1991	.45	.36	.48	.28	.44	.42
1992	.37	.36	.30	.28	.44	.42
1993	.39	.32	.46	.32	.34	.32
1994	.58	.40	.67	.38	.52	.42

Table 38. User Manager Ratings of Computer Operations, 1990 - 1994

	All Firms	Manufacturing	Services
	Mean	Mean	Mean
<i>Operations: Overall quality of service</i>			
1990	6.92	6.92	6.92
1992	7.02	6.52	7.48
1993	6.71	6.26	7.00
1994	6.74	6.77	6.72
<i>Operations: Helpfulness of I/S staff to users</i>			
1990	6.75	6.82	6.67
1992	7.13	6.74	7.49
1993	6.65	6.34	6.84
1994	6.64	6.66	6.62
<i>Operations: Responsiveness of I/S management</i>			
1990	6.26	6.27	6.25
1992	6.50	5.97	6.25
1993	6.35	5.96	6.59
1994	6.26	6.26	6.25

Table 39. Labor to Capital Ratio, 1989-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1989	1.79	1.59	1.56	1.57	2.00	1.63
1990	1.84	1.36	1.60	1.31	2.05	1.52
1991	1.65	1.39	1.82	1.39	1.50	1.36
1992	1.94	1.76	1.98	1.76	1.87	1.76
1993	1.67	1.57	1.66	1.57	1.68	1.63
1994	1.49	1.31	1.53	1.45	1.46	1.26

Table 40. Ratio of End user Devices to Employees, 1988-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1988	.42	.41	.39	.41	.45	.42
1989	.66	.58	.45	.41	.81	.61
1990	.61	.52	.54	.47	.66	.52
1991	.70	.77	.44	.46	.96	.92
1992	.65	.50	.46	.42	.97	1.02
1993	.67	.61	.58	.53	.75	.72
1994	.66	.63	.59	.55	.72	.72

Table 41. I/S Department Spending Per Corporate Employee, 1988-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1988	\$6,685	\$3,998	\$7,297	\$4,501	\$6,285	\$3,947
1989	\$5,346	\$4,474	\$4,553	\$3,501	\$6,082	\$5,388
1990	\$6,559	\$5,475	\$6,055	\$5,278	\$7,063	\$7,734
1991	\$7,171	\$5,623	\$4,470	\$3,131	\$9,534	\$10,228
1992	\$5,070	\$4,211	\$3,581	\$3,653	\$7,800	\$6,502
1993	\$7,781	\$5,127	\$5,819	\$4,820	\$9,507	\$6,772
1994	\$7,345	\$4,900	\$5,838	\$4,549	\$8,625	\$5,127

Table 42. I/S Total Spending Per Corporate Employee, 1991-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1991	\$7,731	\$5,963	\$5,298	\$3,693	\$9,860	\$10,492
1992	\$6,893	\$5,285	\$4,258	\$4,642	\$11,636	\$10,489
1993	\$8,213	\$5,575	\$6,743	\$5,555	\$9,684	\$8,465
1994	\$9,337	\$5,691	\$6,750	\$5,409	\$11,440	\$7,211

Table 43. Total Revenue Per Corporate Employee (in thousands), 1988-1994

	All Firms		Manufacturing		Services	
	Mean	Median	Mean	Median	Mean	Median
1988	\$344.8	\$155.3	\$428.8	\$122.1	\$283.4	\$160.3
1989	\$238.2	\$189.8	\$223.8	\$149.8	\$250.8	\$232.4
1990	\$252.6	\$189.2	\$252.1	\$190.4	\$253.0	\$188.0
1991	\$250.7	\$204.6	\$174.9	\$163.0	\$309.7	\$350.1
1992	\$278.1	\$214.0	\$232.0	\$200.7	\$385.6	\$441.5
1993	\$329.1	\$254.1	\$245.3	\$216.5	\$399.0	\$305.7
1994	\$287.7	\$240.0	\$269.3	\$223.1	\$302.8	\$263.3

Table 47. User Manager Ratings of I/S Units, 1990 - 1994

	All Firms	Manufacturing	Services
	Mean	Mean	Mean
<i>Development: Overall quality of service</i>			
1990	6.39	6.30	6.49
1992	6.64	5.86	7.35
1993	6.49	6.33	6.60
1994	6.34	6.27	6.39
<i>Development: Helpfulness of staff to users</i>			
1990	6.83	6.75	6.92
1992	6/71	5/86	7/47
1993	6.89	6.75	6.98
1994	6.64	6.67	6.61
<i>Development: Responsiveness of I/S management</i>			
1990	5.97	5.81	6.14
1992	6.23	5.42	6.97
1993	6.54	6.30	6.69
1994	6.04	6.00	6.06
<i>Operations: Overall quality of service</i>			
1990	6.92	6.92	6.92
1992	7.02	6.52	7.48
1993	6.71	6.26	7.00
1994	6.74	6.77	6.72
<i>Operations: Helpfulness of I/S staff to users</i>			
1990	6.75	6.82	6.67
1992	7.13	6.74	7.49
1993	6.65	6.34	6.84
1994	6.64	6.66	6.62
<i>Operations: Responsiveness of I/S management</i>			
1990	6.26	6.27	6.25
1992	6.50	5.97	7.03
1993	6.35	5.96	6.59
1994	6.26	6.26	6.25
<i>ROI for I/S in general</i>			
1990	6.10	6.07	6.14
1992	6.37	5.76	6.92
1993	5.88	5.46	6.13
1994	6.00	5.91	6.06

PERCENTILE CHARTS

Using Percentile Figures for Benchmarking

Individual corporations can usefully compare their own performance with the benchmarks represented by the corporations participating in this study. This is done by calculating the firm's own value of the variables and then locating those values on the curves shown in this Appendix. This will indicate where the corporation lies in the overall distribution of firms in the study.

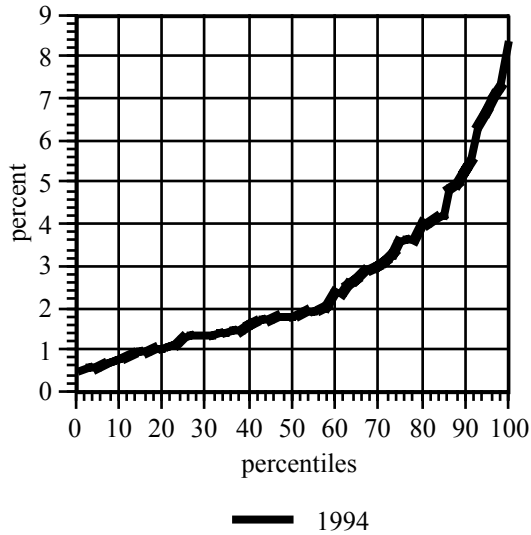
Since many of these benchmarks vary by industry sector, we have provided percentile charts for manufacturing and service firms separately.

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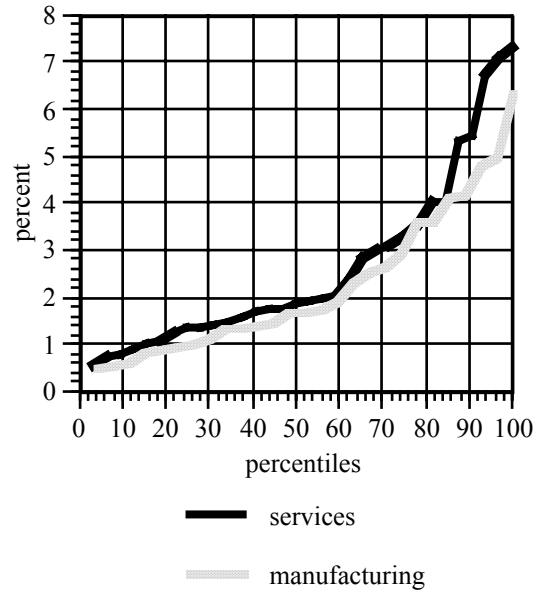
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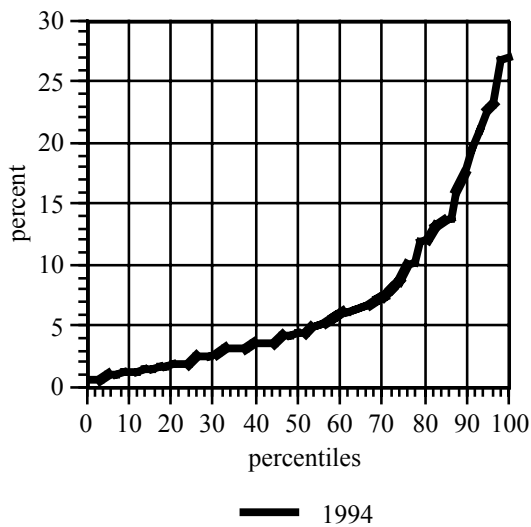
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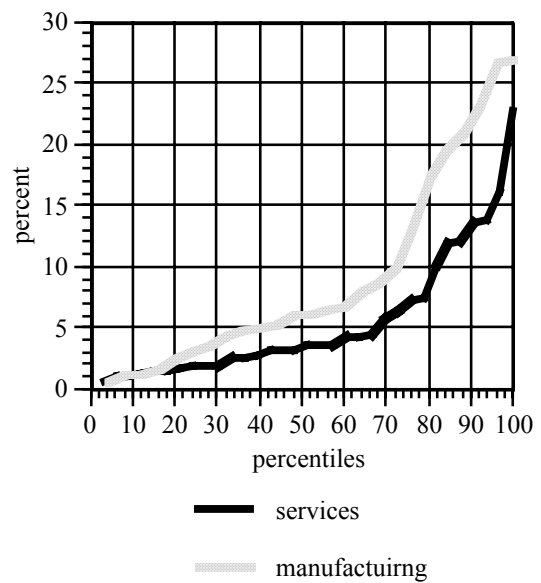
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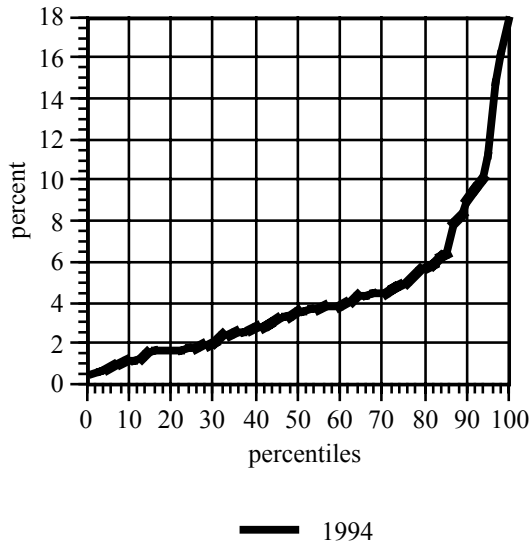
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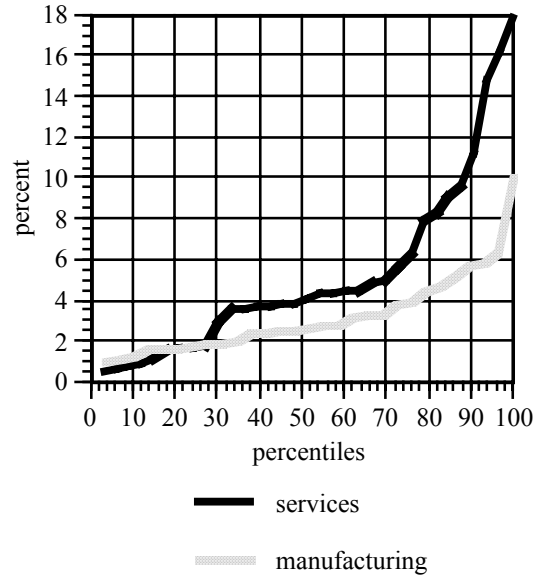
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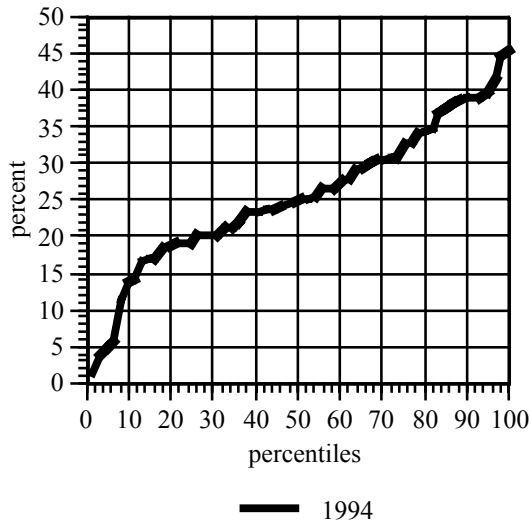
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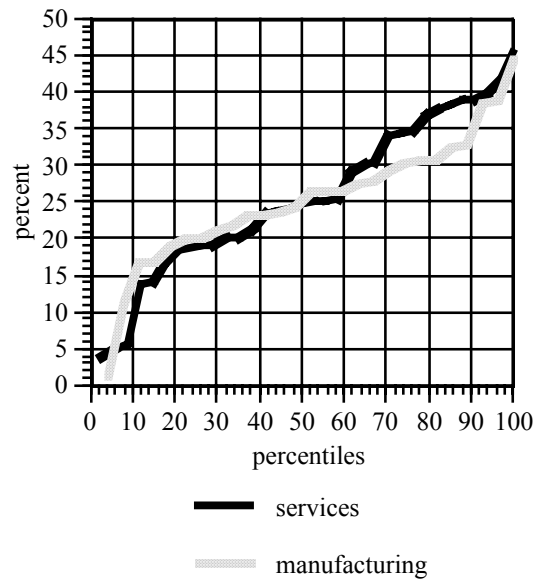
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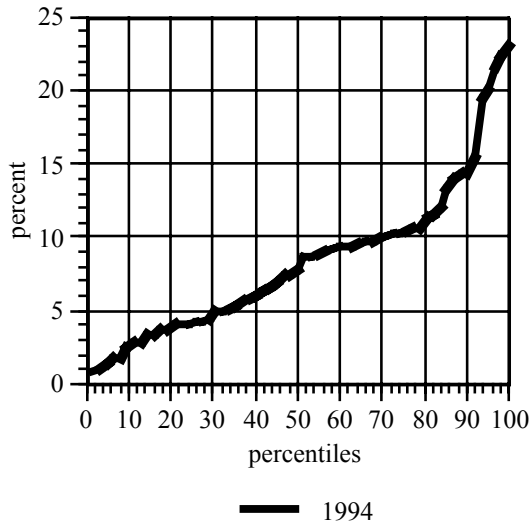
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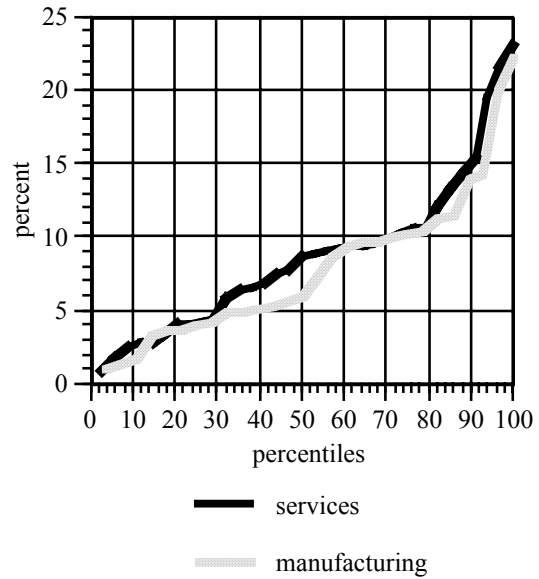
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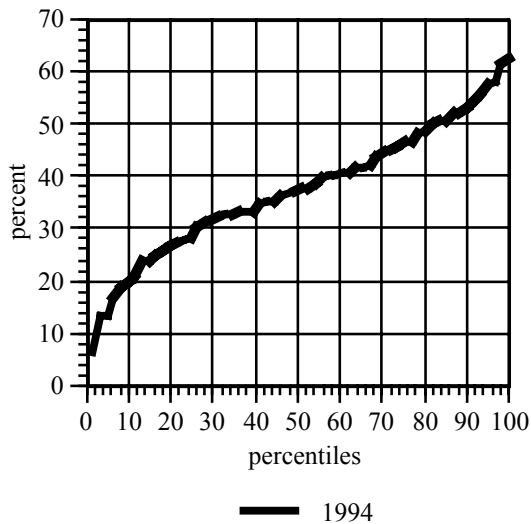
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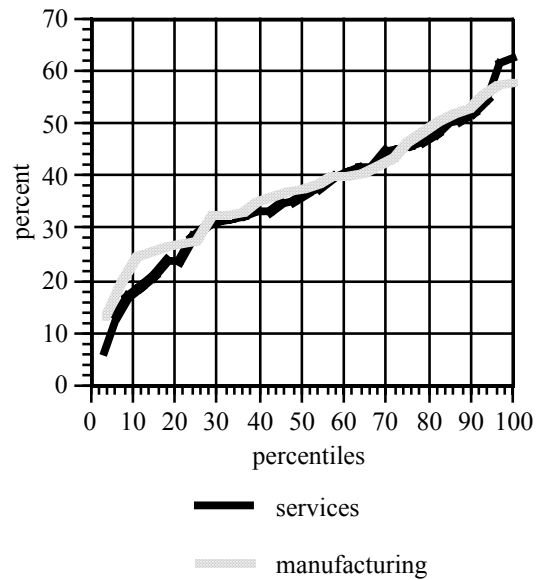
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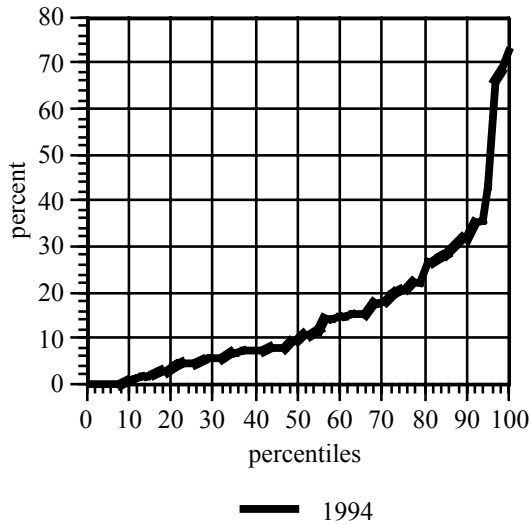
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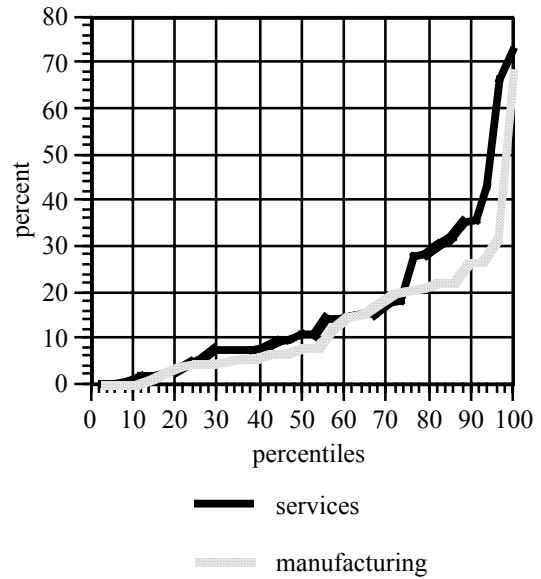
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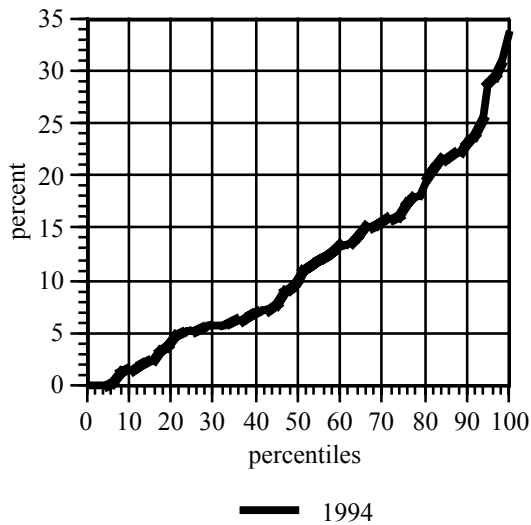
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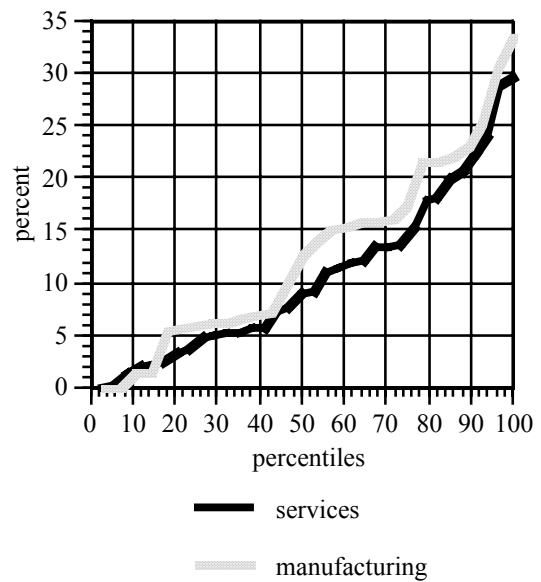
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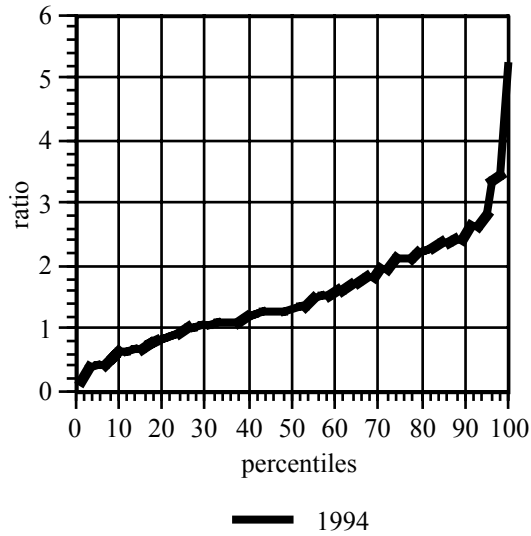
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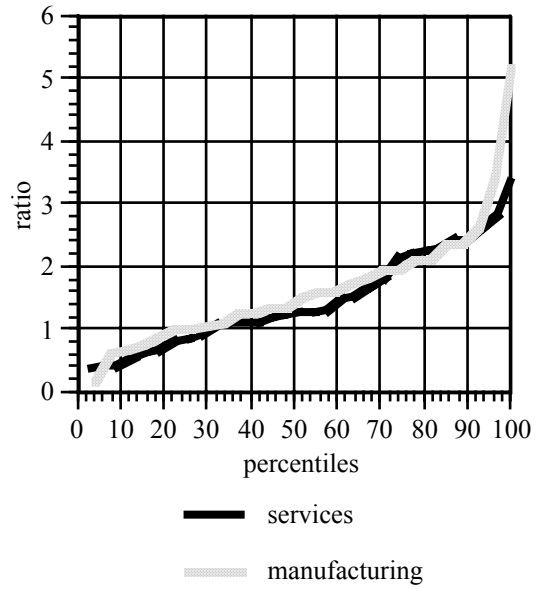
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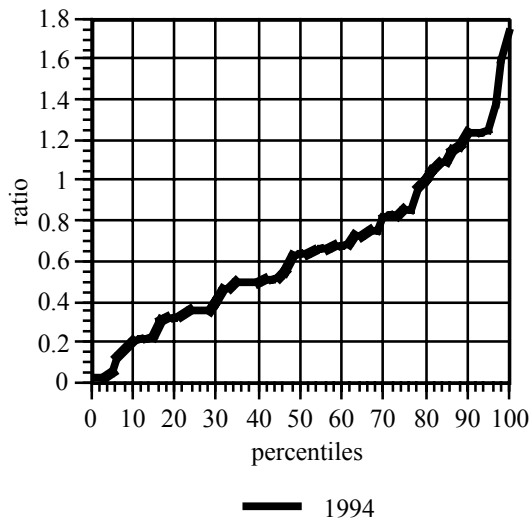
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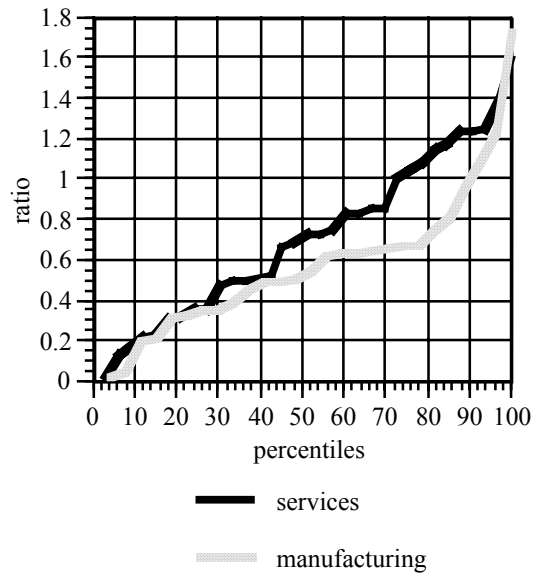
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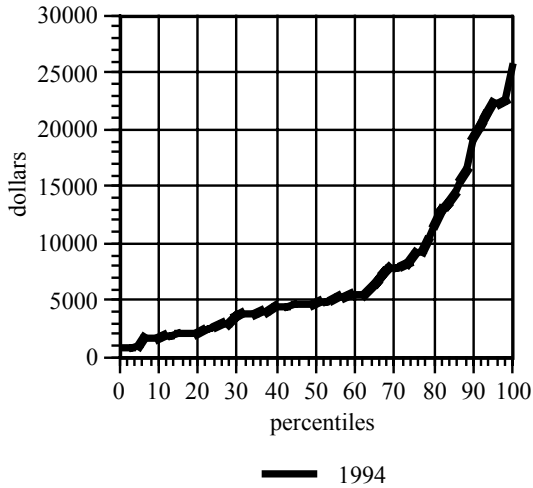
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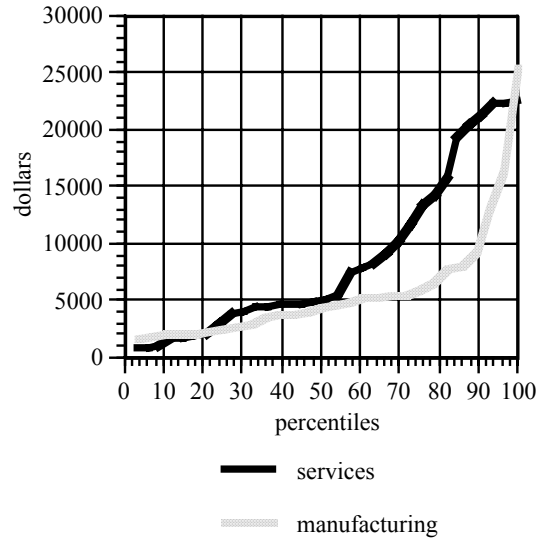
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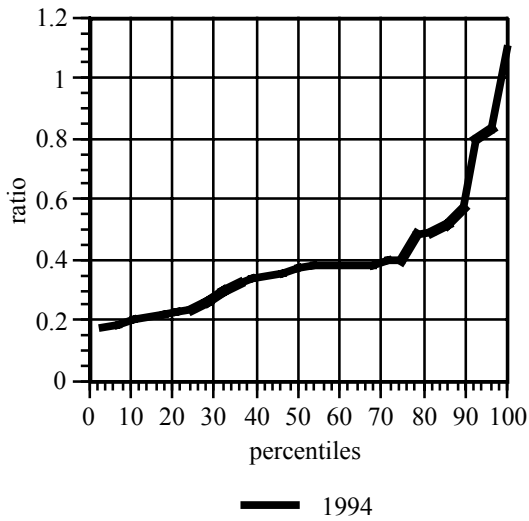
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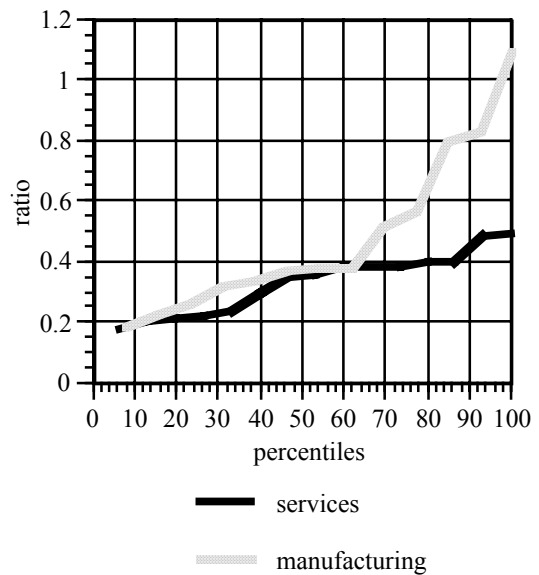
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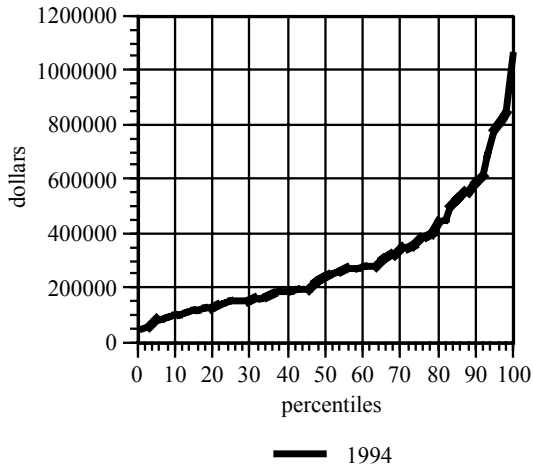
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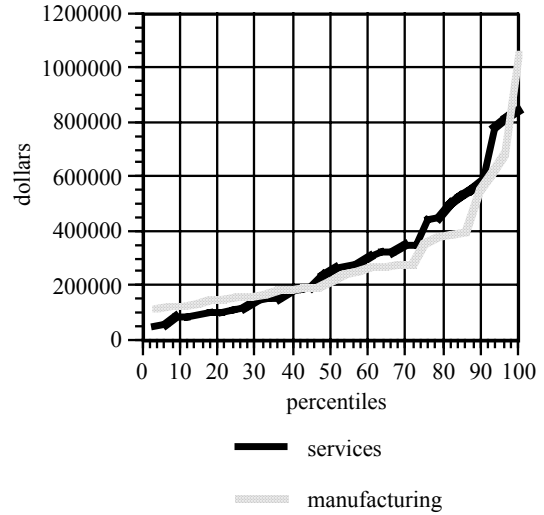
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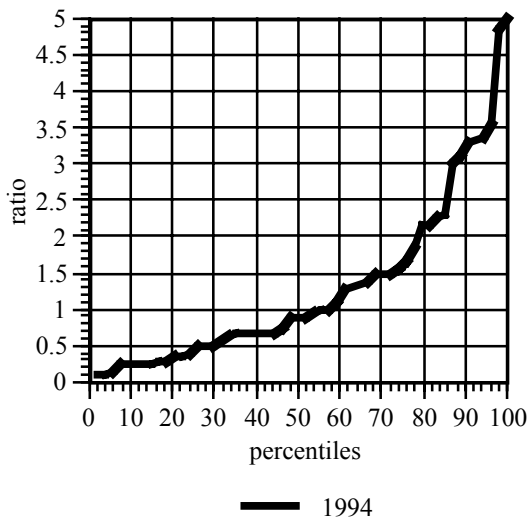
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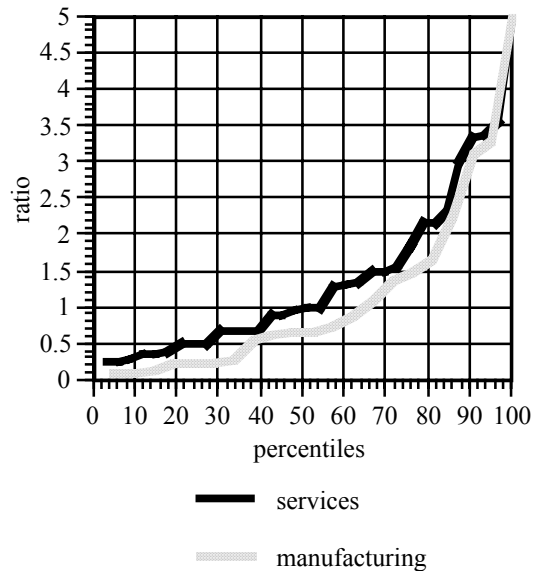
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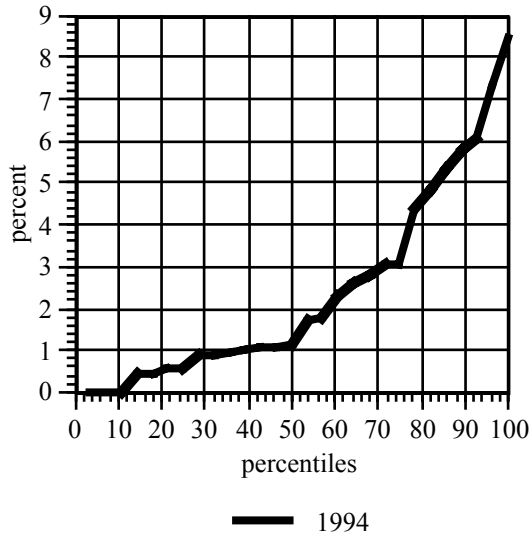
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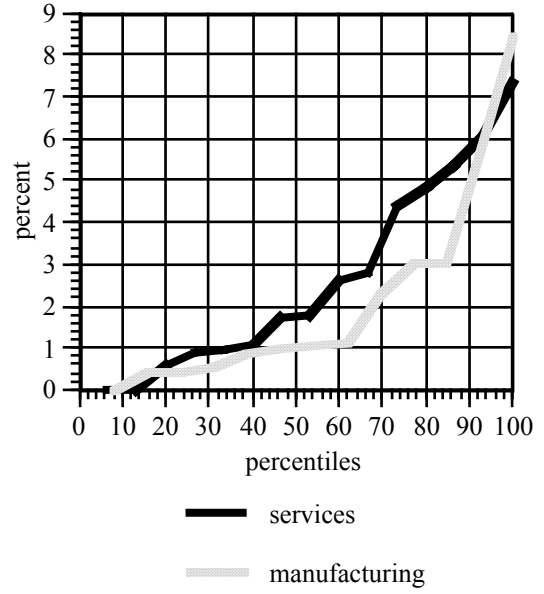
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Corporations interested in obtaining a copy of the full Final Report, participating in the 1996 Survey, or joining the select group of corporations that are Sponsors of IMP are invited to contact:

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