

The Productivity Paradox: Implications for Libraries

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ABSTRACT

For more than a decade, business and economics researchers have written and discussed the term "productivity paradox." Economist Robert Solow's often quoted remark "we see computers everywhere but in the productivity statistics," neatly summarizes the issue. Despite the promises of computer companies and technology advocates, many researchers believe that companies investing large amounts of capital in computers and information technology are not seeing a payoff in productivity. Productivity is a measure of the efficiency of production and is generally expressed as a ratio of input (labor and capital) to output (a product or service). Writers in many fields have discussed possible reasons for the paradox. Poor software design, underdeveloped computer skills among workers, and poor administrative management of information technology are some often given causes. Recently some economists have been predicting a boom in productivity directly related to computers. These predictions center on four major shifts: 1) improved computer technology, 2) redesigned work activities that make better use of computers, 3) increased knowledge of computers among workers, and 4) modified productivity measures to better account for computers.

The debate over productivity and computers is important for libraries. Libraries have invested great amounts of money in computers. Governments and funding agencies are increasingly calling upon libraries and educational institutions to be accountable or to demonstrate positive "outcomes" for their investments. Libraries also have a special stake in demonstrating effective use of computers and information technology. As information specialists, librarians are skilled at managing and evaluating information technology.

As a measure of computer effectiveness in libraries, productivity is a useful model, though not a familiar one. Many library services appear to defy measurement in productivity terms. More common measures are effectiveness and quality of service. Productivity, however, can account for labor, capital investment, and services. The challenge for libraries will be to develop productivity measures that adequately account for important library services. These measures cannot be limited to traditional productivity definitions if libraries are to be successful in demonstrating positive effects of computers.

For more than a decade, business and economics researchers have written and discussed the "productivity paradox." "We see computers everywhere but in the productivity statistics," said economist Robert Solow.(1) Despite the promises of computer companies and technology advocates, and the obvious ability of computers to perform an unimaginable number of calculations, many researchers believe that companies investing large amounts of capital in computers and information technology are not seeing the expected payoff in productivity. Libraries have invested in information technology, both in hardware and software and

in our professional identity as information specialists. The issues related to the "productivity paradox" could have an enormous effect on the future of libraries and librarians. If computers and information technology are not creating the expected benefits, we need to know and to know why.

To answer these questions we will review some of the literature on computer productivity in environments other than libraries. We will then try to formulate or speculate on ways to evaluate computer productivity in libraries.

What is productivity?

Productivity is an economic measure consisting of input (investment) and output (profit). In the business world, productivity measures investment in capital, such as, buildings, machines, raw materials, and in labor against the profits from the sale of the product. A company that most minimizes input and maximizes output has the highest productivity. In its popular definition, productivity simply refers to the general efficiency of an organization or individual.

Background of the Paradox

Several economic and business trends of recent history are important to understanding the productivity paradox. In the 1970's, economists were very concerned about falling productivity growth statistics in United States industry. Corporations were beginning to establish management information systems, using computer technology to improve management and production. By the 1980's technological advances and plummeting prices were helping create the personal computer industry. Corporations looked to computer technology as a way to reverse stagnant productivity. The other major trend in this era was the beginning of a shift in the U.S. economy from heavy industry to the service industry. In this economic environment, corporations began to commit large investments to information technology and computerization, especially in desktop computers and later in networks. By the mid 1980's, corporations and researchers were starting to notice the lack of the expected payoff in productivity statistics.

The term "productivity paradox" was thus coined sometime in the mid-1980's. Several different writers have been credited with coining it. The reasons for the paradox have a longer history. Economic historians have identified parallel paradoxes in the revolutionary technology of the electric generator in the nineteenth century.

An industrial sociologist studying the introduction of computers in British service industries, documented some disappointing results long before direct connections were made to productivity issues. Keeping in mind this background, what are some of the specific causes for the disappointing payoff from computers?

The literature on this subject identifies a number of issues that libraries should consider when deciding how to evaluate computers:

1. Expectations for computer productivity are often greater than the immediate outcome.
2. Technological revolutions take time to mature.
3. Conversion to computers can be a social as well as technological process.
4. Computers will not overcome poor management.
5. As exemplified in the Client/Server issue of the last several years, the computer industry is not close to maturity.
6. The industry has not yet resolved many basic design issues.
7. There is no consensus on how to quantify computer productivity.

High Expectations

Computer companies and software producers have done a very good job of linking the term "productivity" to their products. The advertising claims of these companies have created a popular notion that computers can enhance productivity in work and other aspects of life. This is not just a popular notion. Economist Geoffrey M. Brooke of MIT writes that economists also expect that technological advances will automatically lead to improved productivity.(2) These great expectations for computers may have led to greater disappointment when the expected payoffs were not immediately apparent.

If we momentarily set aside these unrealistic hopes for computers, there are other identifiable reasons for the paradox. Some of these identified in business and economic literature relate to the nature of all revolutionary technologies. Other answers were found in the specific nature of computers, design problems, management issues and in the limited nature of traditional productivity measures.

Nature of all revolutionary technologies

A technological revolution cannot take place overnight. Stanford Economics professor Paul A. David looked at a parallel in the history of technology to explain the productivity paradox. David writes that delay in the payoff from computer investment is very similar to the more than two decade period between the development of electrical dynamos, or generators, and the development of really useful electrical functions. Development of practical uses of electricity such as widespread lighting and the use of electric motors in manufacturing followed the development of the generator by many years.(3) Herbert A. Simon, a Nobel Prize winning economist, describes several factors key to the success of a revolutionary technology. Among those are the degree to which a technology stimulates development of other inventions and the degree to which "education by immersion" is accomplished.(4) This analysis might explain some aspects of our paradox. It may simply take a while before the results start to match the expectations. Clearly though, one factor alone is not enough to explain this puzzle.

Living and working with computers

Long before anyone used the phrase "productivity paradox," Enid Mumford, a British industrial sociologist, conducted research that identified many managerial and training issues which tended to lessen the effectiveness of computers, especially when they were first introduced in companies. Among the firms she studied, inadequate planning for introducing computers was common. One of the more common examples of poor planning involved the failure of many of these firms to view the introduction of the computer as a social process as well as a technical process. Some fears of job elimination for clerical workers were justified.(5) The status of the new programmers was often unclear, causing anxiety and conflict among the other staff.(6) The young women who worked as clerks in these companies found that their jobs, and their status had changed. Often the revised jobs required lesser skills and were less interesting.(7) Deskilled jobs, anxiety creating changes in the office social hierarchy, fears of job loss, resentment over increased work loads are not an ideal environment for creating productivity gains. Reg Theriault, in his book How to Tell When You're Tired, describes typical worker reaction to conditions like this. Workers will find ways to offset production speedups, in part to assert control over their own labor. This principle, Theriault says, applies office workers as well as longshoremen.(8)

Other Management Issues

Paul A. Strassmann's book Information Payoff identified many administrative and managerial causes of lost productivity related to the introduction of information technology. Strassmann describes what organizational changes managers can expect to accompany the introduction of computers into the workplace. Employee

dissatisfaction is one outcome about which Strassmann warns. "Poorly managed organizations are likely to have more complaints about computers than are well-managed organizations."(9) Managers can also expect that intensive training is essential to the effective use of computers in an organization. "Substandard technology can produce satisfactory results if superior training has been given to users. However, superior equipment will not produce much if user training is deficient."(10) Training can be time consuming and costly and may negatively affect traditional productivity measures.

Continual Change

Consultant Jessica Keyes has identified features of the client/server model of computing which are, in her term, "productivity busters." The shift from mainframe computing to pc-based client server has led to a decrease in staffing needs for mainframe operations. This in itself could be counted as a productivity increase. However, as Keyes explains, overall staffing needs often increase because of the need to maintain lots of pc's spread out over an organization.(11) Calculating costs to account for these staffing shifts creates further problems. Keyes' solution lies in an integrated approach, combining the best of pc, servers, and mainframe computing.(12)

Erik Brynjolfsson, of the Sloan School of Management, another advocate of restructuring, has an opposing view on client-server effectiveness. He found that "IW [Information Week] 500 companies moving most aggressively to client-server architectures were less interested in cost savings than the other corporations in our sample. Instead, client-server-oriented corporations expect the greater benefits from their investments to come from improved timeliness and better support of organizational reengineering efforts."(13) Companies focusing only on cost savings will be disappointed by the results of their attempts to increase productivity measures. Attempts to improve productivity addressing only the cost side of the productivity formula are likely, Brynjolfsson's work shows, to be unsuccessful.

Design issues

Thomas K. Landauer identifies more reasons computers seem to be productivity drains. The pace of change in the computer industry is one key factor.(14) As an investment, computers depreciate very rapidly. The rapid advances in computer technology also lead to rapid obsolescence, or at least perceived obsolescence. The quick pace of change also means that users are always trying to catch up to learn new systems. Among many other reasons for computer inefficiencies, Landauer identifies the chief culprit as poor software design. Software lacks standardization and is unnecessarily complex.(15) Too often, Landauer says, programmers have no contact with the users and no real understanding of the user's needs. Landauer's solution is "user-centered design."(16) User-centered design is not easy to achieve. It requires advanced planning, active involvement of the user in design, often without the user having much knowledge of the possibilities, and a complete understanding of the desired outcome. At least one author feels this poses special problems for educational institutions. Herbert Simon writes, "[b]efore the computer and all the associated devices can have any great impact on the educational system, there have to be major developments in our understanding of what the educational process is."(17)

How to Quantify?

Recently some researchers have written that the productivity paradox has been solved. Bill Howard, writing in PC Magazine, states, "[f]inally we're almost to the point where virtually everyone agrees the PC has become a tool that boosts productivity in your business and personal life." Near the end of Howard's article, almost an afterthought, he says, "[w]hat remains difficult is quantifying productivity gains."(18) Several researchers have identified the difficulties of quantifying productivity in service functions as the key.

Prof. Jaak Jurison of Fordham University's Graduate School of Business, writes that key factors in service industries, such as time, quality of service, and knowledge, are not well measured by traditional productivity formulas. Jurison advocates developing added measures for service industries that "provide improved insight into the linkages between inputs and outputs."(19) Jurison also writes that individual firms should develop their own measures with an eye toward improving "organizational performance." Outcomes defined by customer needs and values are the best way to account for quality and variety(20) As consultant Ken Knight points out in *Investing in Information Technology*, "the technology itself creates no value to the customer. Only if the technology improves the product or service to the customer does he or she sense an improvement" (21) Quantifying gains in productivity was always the problem. The challenge is to produce positive results with measurable improvements for customers.

Implications for libraries

Libraries have made a substantial investment in computers and information technology. Computer technology in libraries has two distinct functions: automating processes and services and accumulating and processing data for evaluation. Both will be important in effective productivity measurements. While recognizing the limits of traditional productivity measures, libraries should use productivity models to measure the effectiveness of their investments in computers. To adequately measure the added value achieved by computers in libraries, we must first know what our investments are. Then we can develop and calculate outputs, (or outcomes.) Colleges and universities are increasingly required to account for their expenditures. Academic institutions, including libraries, are under the same expectations to produce efficiency from investments as are corporations.

The components needed to properly measure investment in information technology include: capital investments (hardware, software, wiring, etc.), labor costs for support personnel, training costs for staff and users, development costs (research and planning), and evaluation costs. In a strict economic model, many desirable outcomes of our services are things considered intangibles or indirect services, which are hard to measure in traditional productivity terms. Libraries do have many traditional measures such as the number of reference questions answered, or the number of titles added to the collection. However, the number of questions answered correctly, or the quality of titles added to the collection, are more difficult measure.

Some Examples

One area of librarianship with established output measures is Collection Development. Collection Development also has established measures of input, namely, the materials budget. Libraries already count collection measures such as titles added, items borrowed and loaned, and items circulated. Computers aid these measures. Yet, the number of titles added by a library is likely to be determined by factors unrelated to the efficiency of an operation. To adequately measure the productivity of collection management services, additional factors must be considered. Some factors to also consider are: length of time to order and pay for materials, number of titles added by call number range, and price trends by publisher and subject, and vendor performance.

Another area that has already received some scrutiny is the online catalog. Two papers from the ACRL 7th National Conference addressed design issues by examining the patron search logs produced by their catalog systems.(22) This kind of analysis is a component of user-centered design.

Interlibrary loan offices that record total number of items lent and borrowed will only be partially able to prove the benefits of computers. If they can also show that they can shorten time from request to delivery, then the user will have a meaningfully improved outcome. Other measures could show value beyond

traditional ones including: the combinations of databases used most frequently in single sessions, the length of the average session at a work station, use of individual titles (print or digital) day and hour of heaviest use of network resources.

Library Management Issues

Libraries must be aware of the management issues involved in incorporating computer technology into our work. The nature of library work is changing rapidly. A reference librarian must now demonstrate proficiency in a variety of database formats and fix the printer that breaks in the middle of a reference interview. Sophisticated word processing has led to a combining of composition and document production functions. Jobs formerly done by assistants have been assumed by librarians. The result is many of the same stresses and unease described by Mumford in the 1960's. Strassmann's warnings about the importance of establishing well-run organizations has been well accepted by libraries, judging from the amount of literature on restructuring and redefinition, and reengineering of library functions.

The Client/Server issue is an important example for libraries. Landauer's comments on user-centered design apply to online catalogs. Librarians must not only take an active role in designing systems, but in representing our users' perspective in developing online catalogs

Conclusions

As a measure of computer effectiveness in libraries, productivity is a useful model, though not a familiar one. Many library services appear to defy measurement in productivity terms. More common measures are effectiveness and quality of service. Productivity, however, can account for labor, capital investment, and services. The challenge for libraries will be to develop productivity measures that adequately account for important library services. These measures cannot be limited to traditional productivity definitions if libraries are to be successful in demonstrating positive effects of computers.

Is there a library productivity paradox? We hope at some time in the future to be able to provide an answer. However, examination of the issues presented can have a "payoff" for librarians. At its most basic level, examining productivity issues for libraries can explain some of the problems of introducing computers into the library environment. Libraries should not expect instant results. They should plan for social and management problems, evaluate network arrangements, and include the user in the design of information systems. On another level, librarians examining productivity issues for computers should find reason to reevaluate library services while designing the way services are delivered. In evaluating what is unique about computerized libraries, we may also learn (or remember) what is important about our human services. Lastly, those organizations with an interest in conducting measurements of computer-related productivity can benefit from the lessons learned in other fields.

NOTES

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22. Sheila Delacroix and Claudine Arnold Jena "Who is Gloria Stineman and Why Can't I Find Her on LUIS," 235-246 and; Jane Scott, Jeffrey A. Trimble, and L. Fleming Fallon "@*&!#@ This Computer and the Horse it Rode in On: Patron Frustration and the Failure of the OPAC," 247-256. Proceedings of the 7th National Conference, ACRL, Chicago, 1995.)