# INDUSTRY SECTOR AND PRODUCTIVITY GROWTH: POTENTIAL BIAS OF INFORMATION TECHNOLOGY INTENSITY IN SERVICES

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## ABSTRACT

*Overall, productivity growth may be underestimated in the U.S.; despite continued progress, measurement and conceptual barriers remain. The concerns about underestimation of productivity growth have been focused on data for the business sector, especially its service components. Services, broadly defined, include all producing activities outside the goods sector. Productivity in the service sector has not grown as rapidly as productivity in the manufacturing sector. Anecdotal accounts of improvements in technology due to the method of measurement for the two different areas have been similar, which is why the measurement is incorrect. The productivity data does not fully reflect changes in the quality of goods and services due to the new concepts and considerations that must be taken into account in order to evaluate the accomplishments of the service industries, as opposed to the simple manufacturing industries. Economists have to determine if the best techniques are used to introduce new, advanced products into the data series. Current techniques do not capture the impact of new information technology on economic performance. This is why statistics may help to clear up ambiguities and start provide a fresh outlook to properly analyze successes of the service industries as a result of information technology.*

## INTRODUCTION

Economics, like every social science, is incomplete and therefore constantly evolving. A central concern of economics has to do with productivity--the ability to grow wealthier by extracting more value from the same amount of labor. Productivity is the measure of economics, which is the study of how a society uses its limited resources to produce, trade, and consume goods and services. In other words, the world has to satisfy unlimited wants with limited resources.

Looking at the constantly growing amount of new products and technological improvements at the end of the twentieth century, people are tremendously impressed. It seems logical that these inventions and improvements are increasing consumer welfare, and the technical innovations are contributing to output. Then why is the question of whether or not these new products and technological improvements are increasing at a noticeable rate? Logical reasoning supposes one thing, but officially, reported numbers do not support this assumption of productivity growth.

Economic statistics provided by the government demonstrate a modest rise in productivity numbers, which are not consistent with the highly increasing technological advances occurring across the economy. Economists, along with the rest of the world, see more new products, more changes in consumer service, more technical changes, and other innovations. The only problem is that these observations, while promising in terms of growth, are also consistent with the relatively minor increase in government productivity numbers. Many economists go as far to proclaim that society has been experiencing a productivity slowdown despite the apparent growth.

## PRODUCTIVITY RELATIONSHIPS

Even though computers are not the only factor that affects an economy, the world will utilize computer technology as the center of improvement. Since the development of the first computers, society has not only changed in the way people conduct business, but also in the growing efficiency of aspects of daily life. One example is the ability to visually see a person several hundred miles away instead of simply being able to communicate by voice alone. This is achieved with the invention of the computer along with the voice transmission and visual images brought about using programs such as the Netmeeting software.

The relationship between information technology (IT) and productivity is widely discussed but little understood (Brynjolfsson, 1993). Delivered computing power in the U.S. economy has increased by more than two orders of magnitude since 1970, yet productivity in the service sector has stagnated. Because improvements such as technical changes and new product discoveries reportedly bring cause a decrease in government measurements of productivity, many believe that there must be some discrepancy in the data collection and/or analysis (Dean, 1995). Historically, an advancement in industry was the idea of mass production or assembly lines. The complicated production process was broken down to general, less complex tasks that could be performed by one person or a small group. Each person or small group specialized in one task and became very proficient as a result. This increased the quality of the product and speed of production because chances of error are less pronounced when simple duties are performed consecutively. Concurrently, the individual or group became so familiar with the designated job that they produce faster the higher quality products than did one person performing multiple tasks. This innovation enabled mass production of many products such as food, clothing, and transportation. The use of mass production enabled countries like the U.S. to produce enough to meet the demands of the more developed countries and went beyond that level to meet the needs of other lesser-developed countries. Ultimately, the assembly line concept beat Malthus' prediction that the world's population growth would outgrow the food supply growth. One would think that a similar success will come from the widespread application of information technology.

What exactly is productivity? Simply stated, productivity is output per unit of input. The term productivity is often confused with the term production. Although there is a close relationship, production is concerned with the activity of producing goods or services while productivity relates to the efficient utilization of inputs in producing prescribed outputs of goods or services. Calculating a number can become complicated. For example, suppose the accepted formula for calculating productivity output is the Cobb-Douglas Function: $K=a*p*y/w_K$ and $L=b*p*y/w_L$ where Y is the aggregate output, K is the capital stock, L is the labor input, w is the time-period index, and a/b are constants. The problem is not that we have bad equations; it is finding the correct variables for each particular industry. Determining what means input and output, in itself, is often obscure because no one method is standard for all businesses (Hall, 1999).

In an era that is sensitive to performance measurement, there has been an aroused interest in productivity. The definition of productivity, as the general population perceives it now, only matters in repetitive processes that produce or handle similar items. The concept comes from factory work. A factory manufactures a particular kind of thing, in large quantities by methods such as mass production. The more things produced in the same amount of time, the smaller the capital and labor cost of each item, leading to lower prices and higher margins. This is the goal of a typical business. Some white-collar jobs do involve repetitive processes such as call centers, insurance claims processing, and mortgage application processing. Automation with improved technology demonstrably increases productivity in these areas (Triplett, 1999). The types of service industries measurement economists are focusing on do not perform repetitive processes and/or handle similar items. Thus, the norm for measuring productivity in the past is antiquated for analyzing the rapidly evolving IT-service industries of today.

The widespread application of information technology in the U.S. has not resulted in a measurable increase in worker productivity. This paradox is due as much to deficiencies in the tools used to measure productivity as to misuse of IT by developers and users. The four explanations put forth for this paradox are that (1) outputs and inputs have been mismeasured, (2) learning and adjustment cause lags, (3) quality has been omitted from the equation, and (4) information and technology have been mismanaged (Brynjolfsson, 1993).

## INPUTS/OUTPUTS

Although recent productivity growth has rebounded somewhat in manufacturing industries, the negative correlation between the advent of computers and the economy-wide productivity is the basis for many arguments that information technology has been counter-productive. One should keep in mind that relative productivity cannot be directly inferred from the number of information workers put in per unit output. For instance, if a new delivery schedule optimizer allows a firm to substitute a clerk for two truckers, the increase in the number of white-collar workers is evidence of an increase in their relative productivity. A financial service center is another example of how complexly the measurement of output per input is being utilized. Particularly, some banks consider deposits as their input capital while others consider it as their available output capital. One bank may classify deposits as a payback for services made available, while another bank would categorize deposits as credit for future customers. Neither method is more correct than the other. Measurement problems in the service industry arise because many service transactions are idiosyncratic and cannot be evaluated as aggregates. Therefore, classification and/or categorization become arbitrary even with abundant data (Brynjolfsson, 1993).

Even when considerable data on revenues of service industries is available, the data does not provide a measure of output that distinguishes changes in price over time from changes in real output. Measuring service industries' output first involves identifying the unit of output and then dealing with the issue of quality change. The usual way to measure the real output of the industry when employing typical sources of data is to deflate a nominal measure of output for the industry with the price index for the industry's product. When constructing a price index for deflating nominal output, it is necessary to specify first exactly what is being purchased or the basic transaction unit of the product. Then, the characteristics such as cost of production and profit that determine its price are evaluated. The variation that occurs in a given characteristic over time or among suppliers amounts to a change in quality of the product. If the price of a product rises due to an improvement in one of the characteristics of the product, one would attribute the increase to a change in the product's quality, and not to an inflationary price change. One technique attempts to measure the unit of transaction of the service, while the other attempts to measure the outcomes of the service (Sherwood, 1994).

It is possible that the benefits of IT investment are extremely large, but that a proper index of its true impact has yet to be analyzed. Traditional measures of the relationship between inputs and outputs fail to account for nontraditional sources of value. To elaborate on this reasoning, total productivity is the overall measure of economic effectiveness based on output per unit of all resources utilized. The only practical way that inputs can be aggregated is in monetary terms (Stainer, 1997). When a comparison is made over a period, the measurements should be kept to base-year prices to allow meaningful comparisons as well as isolate inflation. For this purpose, it is important to select a relatively stable base year, as this will aid that sound types of analysis. Ideally, total output is defined in physical terms. The problem with this is the wide variety of output precludes physical aggregates (Kunze, 1995). In some cases, the measurement can be based on adjusted sales, but what about the areas that do not sell anything? Economists have yet to come to an agreement for measuring the latter areas. Following is a table that lists some industries that classify physical output by measures of output, which might not be the most advantageous method.

To illustrate, does the airline industry measure output by weighing a plane to see how much it carries from point a to point b? Would it be more business-oriented to measure the cost of a flight against the amount of money paid by the passengers, or whether the flight made a profit or lost money? Additionally, even if the airline did not make a profit on the particular flight, the customer service was excellent. This produced future revenue for the company that would make up for the initial loss in revenue. Another example is the determination of output for a university. A deserving student may get a full scholarship to the university resulting in a financial loss for the institution. This may be true, but administrators may look at this as an opportunity for the institution to perform a civic duty of educating a student who has not been too fortunate in the past. As a result, this student remembers this particular university for its generosity and gives back money when he or she becomes successful. In the end, the airline and university do meet their goals despite the calculations between processes. This goes to show how timing is everything, so statistics must measure the right variables at the right time.

Measuring the output and productivity of service industries is difficult. The problem occurs in determining what the basic service unit and in examining quality control changes. In measuring the service unit, the consumer's role, variations in what service is measured, and the difference between value-added and gross output must be taken into account. Additionally, new technologies/IT in production or products also affects output (Sherwood, 1994).

**Table 1: Output measures in total productivity**

| Industry | Measure of output |
|---|---|
| Airline | Tons-kilometers |
| University | High-caliber students |
| Department store | Inventory-adjusted sales |
| Underground coal mine | Giga-joules of saleable coal |
| Hospital | Patients treated |
| Farming | Tons of saleable crop |
| Catering | Meals served |
| Refuse collection | Tons of waste |

The role of the consumer of services may well be different from the role of the consumer of goods. For example, it may not be possible to define medical output adequately without considering whether the patient follows the doctor's advice or ignores that advice. Similar issues arise in the fields of education and entertainment. For instance, the output of a jazz band may not be well defined without considering whether the audience was one thousand people, ten people, or no one at all. The output might be considered to depend on whether or not the performance was recorded for the pleasure of a future audience. Further, the experience of being in the audience may depend on whether other members of the audience are enthusiastic or indifferent to the performance. Yet, in all these possibilities, the music actually performed might be identical. There is no widely accepted model for incorporating the role of the consumer into the measurement of service outputs (Sherwood, 1994). Consequently, output data relating to insurance, banking, construction, health services, and utilities should be scrutinized for their relative accuracy. With better output concepts of the service industries, one could eliminate some measurement discrepancies with the debated statistics.

## WHEN TO MEASURE

It has been said that traditional measures of the relationship between inputs and outputs fail to account for nontraditional sources of value. Another source of the mismeasurement may stem from the significant lags between the cost and the expected benefit. The idea that new technologies may not have an immediate impact is common. While the benefits from investment in infrastructure may be large, they may be indirect and often not immediate. Most of the output of computer-using industries is intermediate, not final (Hall, 1999). By definition, all of business services, except for exports, and all of wholesale trade are intermediate products. Although finance, insurance, and communications contributes to final output in their sales to consumers, much of their output goes to industries that primarily produce intermediate output. If only short-term costs and benefits were measured, then it might appear that the investment was inefficient.

The coincidence of the technological explosion and the falling productivity growth has puzzled many observers (Triplett, 1999). Because of its unusual complexity and novelty, a person entering the IT business often requires some experience before becoming proficient. People may need substantial amounts of learning in order to use computers effectively. After modifying a standard model to require that learning accompany a technological change, the statisticians may discover that a technological change can boost output growth in the end, even though it causes an initial period of lower productivity. The use of computers, in the end, is efficient in increasing the quality of the goods produced (Stainer, 1997).

If managers are rationally accounting for lags, this explanation for low productivity growth is particularly optimistic. In the future, not only should society reap the then-current benefits of technology, but also enough additional benefits to make up for the extra costs that are currently being incurred. While the idea of firms consistently making inefficient investments in IT is abominating the neoclassical view of the firm as a profit maximizer, it can be explained by evolutionary economics which treat the firm as a more complex entity that it is. The fact of the matter is that researchers do not yet have the comprehensive models to evaluate internal organizations of the firms, and these experts could not come into agreement on why or how productivity has slowed while the rest of economy continued on its course (Stainer, 1997).

## QUALITY

The computer industry has long struggled with the problem of showing the business payoff of IT investments in a tangible manner. Traditional methods of productivity measurement do not satisfy many non-information system (IS) executives, who prefer to point to U.S. government statistics showing stagnant white-collar productivity in recent years despite heavy spending on computerization (Triplett, 1999). The payback exercise was challenging enough when mainframe computers were the norm but has become exponentially harder as computers proliferate into nearly every tributary of business. The possible solution is to look at the long-term viability of the corporation, which is very much affected by non-financial measures such as customer satisfaction, quality, and the ability to rapidly deploy customer-driven products. Using only financial measures to improve performance is analogous to concentrating on the scoreboard in a football game. While the scoreboard tells you whether you are winning or losing, it does not provide much guidance about the plays that should be called. What is needed is information about the intermediate decisions that ultimately affect the score. Measures are needed of the underlying processes and prior outcomes that lead to superior financial results.

When comparing two output levels, it is important to deflate the prices so they are in comparable real dollars. Accurate price adjustments should not only remove the effects of inflation but also adjust for any quality changes. Much of the measurement problem arises from the difficulty of developing accurate, quality-adjusted price deflators.

Output is defined as the number of units produced times their unit value, proxied by their real price. Establishing the real price of a good or service requires the calculation of individual price "deflators" that eliminate the effects of inflation without ignoring quality changes (Brynjofsson, 1993).

Performance may be defined as productivity multiplied by quality. It consists of both the amount of work completed and the value of the work to the customer. Increased productivity reduces cost since higher outputs per hour result in lower labor costs per unit. In addition, higher productivity increases service quality because faster delivery improves the timeliness of service, thus increasing quality to the customer. Increases in quality lead to higher revenues since high-quality products increase client satisfaction, sales, and ultimately retention. Furthermore, increased quality improves productivity because performing tasks correctly the first time eliminates the need for inspection and rework, thus reducing costs per unit. Because many organizations only focus on measuring and improving either productivity or quality, they do not grasp the intrinsic relationship between them.

The evaluation of job performance should be geared toward enhancing work quality and productivity. Customers are constantly searching for lower prices, faster responses, better service, and support that is more knowledgeable. If a company fails to differentiate between quality of output and productivity, it will not be successful in reducing operating costs or enhancing profits. Only focusing on productivity or quality will bring about customer dissatisfaction and/or increased production cost/time. For example, a productivity-only company may have a machine that processes work at a frenetic pace. Consequently, the machine makes mistakes that are passed on to the customers. A quality-only company may generate great products accompanied by unacceptable lead times and missed delivery dates.

Systematic quantitative and qualitative measurements bring order, structure, and meaning to a mass of collected data. Qualitative measurement is not a circular definition. It provides a basic direction or common integrated purpose. These broad, open-end methods address verbal and non-verbal behavior. Quantitative measurement shifts to qualitative assessment as the task varies from simple to complex, from repetitive to unique, and from well defined to abstract. Qualitative (descriptive) information and quantitative (numerical) data supplement each other. Therefore, the optimal performance measurement method should assess and associate quantity with quality (Sherwood, 1994).

## MISMANAGEMENT

Many of the difficulties researchers encounter in qualifying the benefits of IT also affect managers. As a result, they may have difficulty in bringing the benefits to the bottom line if output targets, work organization, and incentives are not appropriately adjusted. Therefore, IT might increase organizational slack instead of output or profits. Sometimes the benefits do not even appear in the most direct measurements of IT effectiveness. This stems not only from the intrinsic difficulty of system design and software engineering, but also from the fact that the rapidly evolving technology leaves little time for time-tested principles to diffuse before being supplanted (Sherwood, 1994).

A related argument derives from evolutionary models of organizations. The difficulties in measuring the benefits of information and IT outlined previously may also lead to the use of heuristics, rather than strict cost/benefit accounting to set levels of IT investments. In current institutions, heuristics and management principles evolve largely in a world with little IT. The radical changes enabled by IT may render these institutions outdated. The rapid speedup enabled by information systems may have created unanticipated bottlenecks for each person in the information processing chain. A successful IT implementation process must not simply overlay new technology on old processes (Stainer, 1997).

White-collar productivity is very complex and difficult to measure because it is not like measuring the productivity of a tire-assembly line or a widget line. To alleviate this burden, researchers have suggested ways to measure efficiency and effectiveness. Efficiency shows how well managers are using their resources, and effectiveness lets administrators know how well the managers' services meet their customers' needs. No single formula for PC productivity can apply to all managers because there are too many variables from job to job and organization to organization.

## OTHER ARGUMENTS

A very simple mismeasurement of the productivity lag could be explained by the usage of the arithmetic scale, as opposed to the logarithmic scale. To have an impact on productivity, the rate of new product and new technology introductions must be greater than in the past, and not just in their numbers. Suppose increases in productivity come strictly from the development of new products. For argument's sake, let the initial production rate be five percent. This means that five new products were produced in the period following one in which there existed 100 products. The next period on the measurement must produce six new products. Then, seven new products must come about in the subsequent period. At the end of ten years, a constant productivity growth rate requires 30 new products, and after 20 years, 283 new products and so on. As the economy grows, an ever-larger number of new products are required just to keep up the productivity growth rate constant (Triplett, 1999). There is disagreement on how one goes about comparing the production rate of the past to present developments. Even the elementary task of simply counting and plotting into a chart raises conflicting views among researchers. This illustrates how society needs a deeper understanding of productivity and its intricate components.

Statistics illustrate that personal computers have not brought about productivity gains in many organizations, but employees are deeply tied to them (Triplettt, 1999). Productivity may not be useful to measure and may not apply to every role in a company. Productivity measures how much a person, group, or machine can make in a unit of time and matters only in repetitive processes analogous to factory work. Effectiveness, of which productivity is only one measure, is a more general and far more useful measure of value for IT-services organizations. It can often only be measured subjectively. Technology has transformed the workplace to an extent where people are not necessarily more productive, but they may be more effective. This is possibly why researchers have not found any significant productivity improvements from the introduction of computers to the workplace. Possibly they are measuring the wrong thing; what they need are measures of effectiveness, but these experts have to realize that often, the only measures of effectiveness are subjective.

## EVALUATION

Rapid innovation has made IT-intensive industries particularly susceptible to the problems associated with measuring quality changes and valuing new products. The way productivity statistics are currently kept can lead to bizarre anomalies. For example, to the extent that ATMs lead to fewer checks being written, productivity statistics appear lower (Triplett, 1999). Because information is intangible, increases in the implicit information content of products and services are likely to be underreported compared to increase in materials content.

Information-systems (IS) organizations strive to develop systems that are faster, higher in quality, and lower in cost. It is a constant process that has no definite time frame. One could relate IT work to what the research and development (R&D) department does. A researcher never is completely satisfied with the end result or if there even is an end result. The task is never ending. The two are not similar in day-to-day tasks, but the comparison shows that computers can definitely be differentiated from other physical stocks. Furthermore, one can look at the efficiency of R&D as a function of computer quality, which does not depend on the price of computers.

Asignificant amount of research has been written analyzing service productivity. The research states that there are many disadvantages in the investment policy, technological improvement, quality control systems, organizational behavior, and structural organization of the economy (Triplett, 1999). To address this problem, a great number of productivity improvement programs based on technological modernization, long-term investment policy, and organizational improvements have been introduced and utilized in the U.S. Some attempted to analyze productivity in connection with losses that occurred during the production process. The main idea of this approach is to base productivity improvement on a new measurement system that fully describes the productivity behavior according to loss variation. The system should be able to produce scientifically based recommendations in productivity improvement (Stainer, 1997).

The currently low productivity levels are symptomatic of an economy in transition, in the information era (Brynjolfsson, 1993). Parallels can be drawn between the recent adoption of the computer and the adoption of electric power a century ago. When electricity came into general use, major productivity gains did not occur for many years. During 1890-1913, when the world's leading economies, the United States and Great Britain, rapidly increased their use of electricity, there was a pronounced slowing in aggregate productivity (Stainer, 1997). New factories were designed and built to take advantage of electricity's flexibility, which enabled machines to be located based on workflow efficiency instead of proximity to waterwheels and steam engines. This is a historical example of a revolutionary new technology that significantly raised output in the end, although the introduction may have temporarily depressed measured productivity (Brynjolfsson, 1993).

## CONCLUSION

Productivity statistics can help in understanding the growth and prosperity of nations. With a firm grasp of the most widely used statistics, one can better understand current debates such as those on the causes of lower productivity growth in the last quarter century. The controversy over the slowing productivity growth may remind people of the old line that if all the economists in the world were laid end to end, they would not reach a conclusion (Webb, 1998). In this case, the importance of the problem has led economists to explore possible explanations, but lack of definitive data has prevented a consensus from emerging. More research is needed.

In particular, it would at least be useful to have boundaries on the probable amount of bias in price, output, and productivity statistics for indirect evidence. To illustrate the value of such boundaries, consider the behavior of real interest rates. Economic theory states that real rates should move with productivity growth; thus, for example, if the trend in the rate of productivity growth were to increase, that would tend to raise real interest rates. Now suppose that one knew that there was no ongoing change for bias in the core CPI. One could then look for a trend in real rates. One could look at other relationships as well, such as real wages tracking the trend of productivity growth. The point is to have some limits on movements of measurement biases over time. Naturally, the tighter the boundaries, the sharper the inference that can be made (Webb, 1998).

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