The New Economy and Productivity: 
Current Debates and Future Prospects 

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Introduction

Both the academic and popular press have produced a spate of articles debating the role information technology played in fueling the economic expansion of the last decade. It was not all that long ago that many commentators claimed that the emergence of a “new economy” was responsible for the abolition of the business cycle. Shifting fortunes in the stock market and the threat of an economic slowdown however, have inspired increasing skepticism towards this view. Indeed, some observers now argue that the rapid diffusion of information technology has had little or no effect on the productivity growth responsible for increasing the size of the nation’s economic pie nor likely will it in the future. As often is the case, the truth probably lies somewhere between these extreme views. Though the early euphoria clearly was unrealistic, recent analyses by skeptics have been too narrow in their assessment of the impact of information technology on economic growth. The dramatic acceleration of investment in computer and information technology over the last decade promises to have positive economic benefits that extend well into the future. Analyzing the economic ramifications of this transformation is important if policy makers are to make wise decisions.

This paper begins by defining productivity and discussing the importance productivity growth plays in enhancing a nation’s standard of living. It then examines work by academic economists that analyze the effects of the computer revolution on productivity. The paper also assesses the prospects the “new economy” holds for future economic progress. Last, the paper considers policy options for Wisconsin.

Productivity

One way of assessing the economic health of a nation is by measuring changes in the productivity of its workers. At the aggregate level, the “economy’s productivity is calculated by tallying the value of the final goods and services produced in the country – the gross domestic product – and dividing this figure by the total number of hours worked in the business sector. If output grows faster than hours worked, productivity rises. If hours worked grow faster than output, productivity falls” (Cassidy, 2000, 108). To a great degree, the standard of living enjoyed by the citizens of the United States is a function of the productivity of its workers. Historically, earnings have followed increases in the output per hour worked. The demand for labor by firms is directly related to the productivity of labor. Labor as a resource becomes more valuable to firms when labor productivity increases. Assuming the number of laborers is given, increases in the
demand for labor that stem from productivity increases will lead to increases in the average level of wages. The greater the output produced per hour worked, the more income there is to distribute.

Three factors in particular affect labor productivity. First, the larger the amount of capital employed per worker, the more productive labor will be. In economics, capital represents the machinery and equipment used in the production process. If the economy’s stock of capital increases at a faster rate than the growth of the labor force, output per worker will increase because each worker will have more tools to use in their work. Increasing the stock of capital per worker is known as capital deepening (O’Sullivan and Scheffrin, 1998, 463). Second, the quality of the labor force known as human capital also is an important determinant of productivity. Workers who are highly skilled tend to be more productive than unskilled workers. Education obviously plays a large role in determining the productivity of a nation’s workforce. Third, technological progress, broadly defined, refers to “any change in the application of information to the production process in such a way as to increase efficiency, resulting either in the production of a given level of output with fewer resources (i.e. lower costs) or the production of better or new products” (Mokyr, 1990, 6). The introduction of new ways of producing goods and services increases productivity by allowing an economy to produce more output without increasing the amount of capital and labor used.

The rate of growth in labor productivity is the key factor in determining standards of living. The power of compounding allows small absolute changes in the rate of growth in productivity to have large effects on standards of living over time. Following the “rule of 72,” one can approximate the number of years it takes for real income to double by dividing the annual rate of productivity growth into 72. An average annual rate of increase in labor productivity of 1% doubles real income in 72 years. At 3%, real income doubles in only 24 years.

**Annual Percent Change in Labor Productivity (Five Year Averages)**

![Graph showing annual percent change in labor productivity (Five Year Averages)]

The stagnation in growth rates that occurred during the 1970s and 1980s became a major area of concern for economists and policy makers. Labor productivity from 1951 to 1973 grew at a rate of 3.2 % per year. However, the annual rate of productivity growth fell to only 1.3 % between 1973 and 1998. Though disagreement among economists about causation persists, the effect of the slowdown on standards of living is well understood. “Because it has accumulated over so many years, this fall in productivity growth of 1.9 percentage points has had a large effect on incomes. If this slowdown had not occurred, the income of the average American would be 60 percent higher” (Mankiw, 1998, 546). Despite the poor overall performance since 1973, the economy has experienced impressive growth in labor productivity since the middle of the last decade. “Between the second quarter of 1995 and the second quarter of this year, output per hour in the non-farm business sector of the economy (the sector that economists usually look at) rose at an annual rate of 2.9 percent...”(Cassidy, 2000, 108). The recent macroeconomic performance has sparked debates over the role information technology played in reviving productivity growth.

The New Economy and Productivity: The Debates

The belief that the widespread adoption of information technology has been the central factor behind America’s improved productivity growth has shaped Federal Reserve policies. In a recent speech, Greenspan argued that the “major contribution of advances in information technology and their incorporation into the capital stock has been to reduce the number of hours required to produce the nation’s output, our proxy for productivity growth” (Cassidy, 2000, 106-7). According to the Federal Reserve Chairman, the significant increase in productivity has diffused upward price pressures normally associated with tight labor markets, thereby allowing the Fed to implement monetary polices that simultaneously maintain the inflation and unemployment rates at historic lows.

A recent study by Federal Reserve economists Stephen Oliner and Daniel Sichel strongly confirms this story. “Business investment in computers and peripheral equipment, measured in real terms, jumped more than four-fold between 1995 and 1999. Outlays have risen briskly for software and communication equipment, which are crucial components of computer networks” (Oliner and Sichel, 2000, 3). Empirically testing a growth accounting model using Census data, the authors find that the increased investment in information technology was responsible for about two-thirds of the acceleration in labor productivity that occurred during the second half of the 1990s. Capital deepening associated with increases in the amount of capital used per labor hour accounted for approximately fifty percent of these gains while much of the balance reflected improved efficiency in the production of equipment in the computer industry itself (Oliner and Sichel, 2000).

Economists Erik Brynjolfsson and Lorin Hitt have taken a different tack in their analysis of the new economy. Instead of examining aggregate data, these authors have focused on the effects of information technology on business organization at the level of the firm. They argue that macroeconomic growth accounting methods typically have
underestimated impacts on productivity because they treat information technology as a traditional capital investment. The authors contend that formal models should characterize information technology as a general-purpose technology. “In most cases, the economic contributions of general purpose technologies are substantially larger than would be predicted by simply multiplying the quantity of capital investment devoted to them by a normal rate of return. Instead such technologies are economically beneficial mostly because they facilitate complementary innovations” (Brynjolfsson and Hitt, 2000, 24). The value of information technology lies in its ability to foster organizational innovations at the firm level that ultimately reduce costs and increase product quality. By dramatically reducing communication and coordination costs, information technology has increased productivity by transforming supply chain and customer relationships. Information technology has led to a more efficient use of society’s scarce resources by facilitating outsourcing and the implementation of “just-in-time” inventory methods. Traditional growth accounting models also tend to understate the benefits of information technology by failing to consider improvements in product quality.

There are a number of economists who seriously question the benefits attributed to the widespread diffusion of information technology. Reservations about the favorable effects of computer technology on productivity growth are not new. In the late 1980s, Nobel-prize winning economist, Robert Solow popularized the notion of a “productivity paradox” associated with the computer revolution when he stated that, “we see the computer age everywhere but in the productivity statistics” (David, 1990, 355). One economist who has maintained his skepticism during the last decade is Northwestern University’s Robert Gordon. Gordon has argued that previous studies using growth accounting methods have ignored cyclical factors in their models. Productivity normally rises during the expansionary period of a business cycle because firms push their employees to work harder. Gordon attributes most of the productivity growth during the second half of the 1990s to economic good times, not information technology. “While the aggregate numbers are impressive, the productivity revival appears to have occurred primarily within the production of computer hardware peripherals, and telecommunications equipment, with substantial spillover to the 12% of the economy involved in manufacturing durable goods. However in the remaining 88% of the economy, the New Economy’s effects on productivity growth are surprisingly absent, and capital deepening has been remarkably unproductive” (Gordon, 2000, 50).

The computer revolution simply does not compare favorably with the great inventions of the late 19th and early 20th century according to Gordon. Inventions like electricity and automobiles were largely responsible for the unprecedented high rates of growth from 1913 to 1972. By comparison, the productivity gains associated with the use of computer technology are rather limited. The need to combine human effort with computer technology causes diminishing returns to set in quickly for most computer applications. Gordon explains, “In performing two of the activities that were revolutionized by the personal computer, namely word processing and spreadsheets, I cannot think or type any faster than I did with my 1983 personal computer that contained 1/100th of the memory and operated at 1/60th of the speed of my present model” (Gordon, 2000, 62-63). Similarly, the productivity impact of the Internet is limited since many of its current uses
simply replace existing functions handled elsewhere. The ability to buy books on-line at Amazon.com, instead of driving to a bookstore, will have modest effects on productivity growth.

Other economists have argued that inaccuracies in labor data have exaggerated productivity growth statistics. By undercounting the actual number of hours worked, the accounting methods used in most models have produced inflated productivity numbers. The increasing number of employees working in the service sector of the economy has complicated the process of collecting accurate information on the number of hours worked. “Many of these workers, such as investment bankers, editors, and insurance salesmen are not paid on an hourly basis; they receive an annual salary, or commission, and they organize their own schedules. With the aid of faxes, cell phones, and laptop computers, they can work at home, or on the road as well as in the office” (Cassidy, 2000, 108). Additionally, a study by M.I.T. economist, Dora Costa, has confirmed what many have already expected: information technology creates more work, not less (Cassidy, 2000, 109).

Pessimists, like Gordon, underestimate the potential of information technology by narrowly characterizing the ways it can be implemented. His “diminishing returns” argument fails to consider the dramatic increases in productivity resulting from the application of computer control technology to automated systems of production. By limiting his analysis of the internet to the retail sphere, Gordon ignores the enormous progress that has occurred in business to business relationships. Additionally, studies showing increases in the number of hours worked do not consider the offsetting benefits of increased flexibility.

**Future Prospects**

Can the revival in productivity growth be sustained? In assessing the contributions of information technology to economic growth, it is important to take a long-term view of things. Recent macroeconomic forecasts suggest that a recession may be imminent. The reduction in capital spending that accompanies economic downturns implies that productivity gains will not be fueled by capital deepening in the short run. Rather, the medium and long run impacts of information technology ultimately depend upon the effect of information technology on technological progress in all sectors of the economy. In fact, historical studies on the economic impact of new technologies show that there often is a lag between the adoption of a new technology and its effect on the economy. The work of economic historian Paul David, for example, demonstrated that electrical technology did not have an immediate impact on economic growth after the introduction of the dynamo in the 1880s. The “transformation of industrial processes by the new electric power technology was a long-delayed and far from automatic business…Furthermore, factory electrification did not reach full fruition in its technical development nor have an impact on productivity growth in manufacturing before the early 1920s” (David, 1990, 357). The ability to exploit fully the potential of a general purpose, network technology like electricity or computer technology requires costly, time-intensive investment to create the necessary infrastructure. It also takes a considerable
amount of time and effort to figure out how to use a new technology after its introduction. Additionally, the reach of information technology ultimately may have more pervasive effects on the economy than other technological revolutions. “The productivity gains of steam, electricity and railways were mainly concentrated in the manufacture and distribution of goods. This could be the first technological revolution to boost productivity in services, from health care and education to finance and government. That would be no small matter: services account for nearly three-fifths of America’s GDP” (Economist, 2000, 2).

The Internet has been responsible for transforming information technology into a truly global network technology. By spurring technological progress, the worldwide integration of information technology potentially has far reaching implications for economic growth. Macroeconomist Paul Romer, a pioneer in the New Growth Theory, has identified three special features that make economic growth possible.

First, we live in a physical world that is filled with vastly more unexplored possibilities than we can imagine, let alone explore. Second, our ability to cooperate and trade with large numbers of people makes it possible for millions of discoveries and small bits of knowledge to be shared. Third, and most important, markets create incentives for people to exert effort, make discoveries and share information (Romer, 1998, 4).

The emergence of the Internet as a global network technology promises to have a strong positive effect on all three features.

Economic growth spurred by technological progress is a disequilibrium process that calls for a continual reallocation and rearrangement of scarce resources. Romer uses the metaphor of the kitchen recipe in describing the relationship between technological change and economic growth. “To create valuable final products, we mix inexpensive ingredients together according to a recipe…. Human history teaches us, however, that economic growth springs from better recipes, not just from more cooking” (Romer, 1993). By dramatically reducing communication costs, the Internet can facilitate the multiplication of new recipes by bringing together disparate ideas from people all over the world. Both invention and innovation tend to be largely incremental, cumulative processes that greatly benefit from the input of multiple, heterogeneous sources. As Friedrich Hayek long ago recognized, knowledge “never exists in concentrated or integrated form but solely as the dispersed bits of incomplete and contradictory knowledge which all the separate individuals possess” (Hayek, 1945, 520). The phenomenal success of industrial districts like Silicon Valley springs from the exchange of ideas and rapid trial-and-error learning that localized settings encourage. A truly integrated network technology can help to foster innovation by facilitating information sharing on a much larger scale. Additionally, information technology “speeds up innovation itself by making it easier and cheaper to process large amounts of data and reducing the time it takes to design new products. Thanks to ever more powerful computers, the mapping of the human genome, completed earlier this year, took much less time than first expected” (Economist, 2000, 3).
Similarly, the Internet should positively affect the market incentives that induce the creation of new recipes. The Internet increases the extent of the market by bringing buyers and sellers together in a truly global economy. By increasing the potential rewards for success, the globalization of markets provides strong incentives for entrepreneurs to undertake risky and expensive investments in new products and processes. Information technology also intensifies competitive pressures on firms by reducing search costs for customers. Greater competition puts strong pressure on firms to innovate if they are to survive in the new environment.

**Public Policy Implications for Wisconsin**

Understanding the sources of economic growth is extraordinarily important for guiding public policy initiatives designed to enhance the benefits of information technology. Economist Nathan Rosenberg argues that the ability of our nation’s institutions to secure its citizens the freedom to conduct “economic experiments” largely has been responsible for the technological progress that has sustained long term economic growth. The process of coming up with new recipes is plagued by uncertainty. “This uncertainty, by which we mean an inability to predict the outcome of the search process, or to predetermine the most efficient path to some particular goal, has a very important implication: the activity cannot be planned” (Rosenberg, 1982, 93). Our nation’s strong reliance on a market economy ensures that most economic activity is based upon decentralized decision-making. Markets deal well with uncertainty by relying upon input from a diversity of individual decision-makers. Too many chefs do not spoil the pot but instead provide a variety of perspectives that would not be available under centralized efforts. The uncertain nature of the innovation process implies that government policy needs to facilitate private efforts rather than being narrowly prescriptive.

Policy initiatives should focus on promoting economic activity in general while building on the state’s current strengths. Wisconsin should avoid industrial policies that attempt to bet on future winners. The unpredictable nature of economic activity makes such efforts notoriously risky and often results in expensive failures. “Enhancing educational systems and industrial infrastructure are the obvious foundations of any economic development, and Wisconsin’s leaders are quite correct to focus effort in these areas. Maintaining the University of Wisconsin as an elite institution and spending money to make sure the state has power, roads, and up-to-date communications facilities in the years ahead are good, basic investments” (Lank, 2001, 1-2D). Beyond Madison, Wisconsin’s educational infrastructure needs to equip its citizens with the appropriate knowledge to take advantage of information technologies in all sectors. The approval of the biennial operating budget by the UW System Board of Regents last summer based on the theme of “Building the New Wisconsin Economy” is a step in the right direction. “The structure of the proposed budget commits the UW system to assuming an enlarged role in Wisconsin’s overall economic development. This will be accomplished in part by increasing the supply of graduates in such ‘new economy’ fields as biotechnology and information technology” (Wisconsin Ideas, 2000, 1). The ability to apply information technology to Wisconsin’s traditional economic sectors requires that citizens make the
appropriate investments in human capital. Information technology literally has transformed production processes in seemingly moribund, “old economy” industries. The process of 3-D seismic imaging made possible by advances in high-end computing has revolutionized surveying in the oil industry, allowing for more intensive exploitation of existing oil wells as well as leading to the reopening of abandoned wells. As Jonathan Rauch explains, “There was no quantum technological leap, no blinding breakthrough. Instead a suite of interlocking technologies improved incrementally, but to revolutionary effect” (Rauch, 2001, 44). Similarly creative applications of computer technology to Wisconsin’s core industries depend upon the availability of a stable, technologically literate workforce.

A number of papers addressed the challenges the new economy poses for the state during last fall’s Wisconsin Economic Summit. Dr. Donald A. Nichols, Professor of Economics and Public Affairs at University of Wisconsin-Madison, stressed the importance of building upon the state’s current competitive advantage in the machinery industry. Nichols argues that information is an increasingly important input in the production of machinery. The policy challenge is to have Wisconsin based firms make these value-added contributions. “Granted, Silicon valley would sell many products to a vigorous Wisconsin-based machinery industry. But the pipeline between the two industries can be owned and developed from either end. It is as natural to develop information technology for the machinery industry at the home of the machinery industry as it is to develop it at the home of the information technology industry” (Nichols, 2000, 14). According to Nichols, public efforts should promote the development of centers of entrepreneurial and R & D activity necessary to attract a highly educated workforce to the state.

**Conclusion**

It is likely that the effects of new information technologies are just beginning to ripple through the economy as a whole. The state of Wisconsin should focus on public strategies that will facilitate the private exploitation of these technologies by improving overall infrastructure, especially education. Paul Romer summarizes, “The key to the story is that humans have created a market system, supported by hybrid institutions like the university and the research and development lab. Together, these institutions turn self-interest into a powerful force for the improvement of everyone’s lives. This human invention is far more important than the transistor or the steam engine, for it gives us all other inventions” (Romer, 1998).

**References**


__________. “It's All in Your Head.” *Outlook Magazine*, November 1998.
