

# Technology and Economic Growth in the Information Age

## Introduction

The idea of rapid progress runs counter to well-publicized reports of an American economy whose growth rate has slipped. Pessimists, citing statistics on weakening productivity and gross domestic product growth, contend the economy isn't strong enough to keep improving Americans' standard of living. They offer a dour view: the generation coming of age today will be the first in American history not to live better than its parents.<sup>1</sup>

Yet there is plenty of evidence that this generation is better off than any that have gone before, and given the technologies likely to shape the next quarter century, there are reasons to believe that progress will be faster than ever — a stunning display of capitalism's ability to lift living standards. To suppose otherwise would be to exhibit the shortsightedness of Charles H. Dull, commissioner of the U.S. Office of Patents, who in 1899 said, "Everything that can be invented has been invented."

Ironically, though, our economic statistics may miss the show. The usual measures of progress — output and productivity — are losing relevance in this age of increasingly rapid technological advances. As the economy evolves, it is delivering not only a greater quantity of goods and services, but also improved quality and greater variety. Workers and their families will be better off because they will have more time off, better working conditions, more enjoyable jobs and other benefits that raise our living standards but aren't easily measured and therefore often aren't counted in gross domestic product (GDP).

The next quarter century of capitalism promises a silent boom — a rapid economic advance that will improve everyday life but elude the regular readings of the economy's vital signs. Statistical tools simply can't keep up with an economy moving at light speed.<sup>2</sup>

"The usual measures of progress — output and productivity — are losing relevance in this age of increasingly rapid technological advances."

## Technological Change Raises Living Standards

In this era of supercomputers, space travel and cloning, technology isn't always seen as a boon. Amid the modern world's hustle and bustle, nostalgia for the simpler ways of times past is not uncommon. Technophobes cringe at programming the VCR or installing new peripheral devices on their personal computers. Apocalyptic literature, science fiction movies and neo-Luddite rhetoric portray technology as a dark, dehumanizing force.

That is the technology of myth. The technology of reality is a vital part of what spurs economic progress and raises living standards. Stone Age "high-tech" was knowing how to strike flint on rock to produce a spark and ignite a fire. But even at that basic level, technology improved the lives of those who used it. They kept warmer at night, ate hot food and slept more soundly, worrying less about attacks by saber-toothed tigers and marauding tribes. Fast forward through the millennia, and the story is similar. Today's technology is much more complex, but it still makes those who use it better off. We are warmed by gas and electric furnaces, nourished by food heated in microwave ovens and protected by locks, alarm systems and 911 operators. Technology leads to new products and services that improve our everyday lives. It must. After all, every innovation must pass the test of the marketplace: if people don't want it, they won't buy it. There are plenty of patented inventions for which there wasn't much of a market, including the boomerang bullet, eye-glasses for chickens, coffins with escape hatches and fire escape suspenders.<sup>3</sup>

## Capitalism Makes Technological Change Possible

As with most economic activities, putting technology to work has a lot to do with incentives. An economy will produce technological change faster when the costs of doing so go down or the benefits go up. Technological know-how doesn't just happen. Ideas produce nothing until an entrepreneur or a company transforms them into new goods and services or better production methods. The process involves discerning consumer tastes, researching, designing prototypes, obtaining financing, manufacturing, marketing and, often, starting all over again. Entrepreneurs and companies go through this process because capitalism gives incentives to innovate by bestowing profit on those who bring successful products to market.

Just as important, capitalism readily shifts money, people and other resources from producing yesterday's goods and services to what consumers will buy today and tomorrow. Capitalism's ability to unleash innovation and invention lies at the very heart of economic progress. Understanding this fact will help us see what speeds it up or slows it down.

**Role of Competition.** In a free enterprise system, there is always competition among inventions and innovations that meet consumers' needs in a

"Capitalism's ability to unleash innovation and invention lies at the very heart of economic progress."

different way or make it cheaper and easier to manufacture existing products. Most of us overlook this “minor” feature of a market-based economy. When we catch a bargain on airfare, see our long-distance phone rates plummet, get a good deal on a car and so on, we welcome the low prices that result from companies competing for market share. However, we owe the existence of airplanes, telephones, automobiles and other amenities to another kind of rivalry capitalism promotes. That’s the competition from the next generation of goods and services, made possible by the relentless impulse in human beings to make themselves better off by improving life for everyone else.<sup>4</sup>

**The Case of Transportation.** Successive generations of transportation show how new products come along to compete with existing ones. Suppose bankers in New York and San Francisco want to enter into a merger. In California’s Gold Rush era, meeting might have meant a boat trip around the tip of South America. As time went by, the bankers would have found the train faster, then the airplane faster still. With the advent of teleconferencing, they can now convene in a matter of seconds, skipping the hassle and expense of transcontinental flight. Sometime beyond 2020, virtual meetings and all modes of shipping may be made obsolete by a Star Trek-like “transporter” that zaps people and products from one place to another.

## Factors Affecting the Speed of Technological Change

Because technology in large part drives growth, stepping up the pace of invention and innovation increases the speed of economic progress. Several factors influence this process: the breadth and depth of a society’s existing endowment of technology, new discoveries or inventions with wide-ranging uses, the integration of various technologies to create new products, the time it takes for products to spread throughout society and the overall market size. In assessing future possibilities, it is useful to look at the dynamics of accelerating technological changes.

“Stepping up the pace of invention and innovation increases the speed of economic progress.”

**Applications for Existing Technologies.** Our inventory of technology is large and growing. Despite the rapid-fire introduction of new products in recent decades, we still have a large, relatively untapped stock of technology in the pipeline. By one estimate, more than half the store of human knowledge has been produced over the past 50 years. In the United States, the number of scientists and engineers working in research and development has doubled since the early 1970s; more than half of U.S. patents have been issued in the past 40 years; and the number of new products put on the market annually has tripled since 1980.<sup>5</sup> With so much R & D occurring, companies are likely to keep offering innovative goods and services at a furious pace.

In the future, daily life will include applications for dozens of modern-day breakthroughs — such as magnetic resonance imaging, powerful micro-processors, artificial intelligence, voice recognition, speech synthesis, holog-

raphy, virtual reality, fiber optics, high-definition TV, flat-screen displays and the Internet. New applications for all of these technologies exist, at least in prototype. For example,

- The National Automated Highway Systems Consortium, led by General Motors Corp., is at work on a self-driving automobile.<sup>6</sup>
- The satellite-based Global Positioning System already helps truckers, taxi drivers and farmers, and navigational systems using GPS are an option on some new car models.<sup>7</sup>
- Scientists at New Mexico's Sandia National Laboratories already produce micromachines with gears the width of a human hair.<sup>8</sup>
- The Human Genome Project is expected to map the location and sequence of all the genes on the 23 pairs of human chromosomes by 2003, allowing doctors in the future to detect and treat diseases through DNA analysis.<sup>9</sup>

Many of the most promising projects involve tinkering with the basic elements of life and matter.<sup>10</sup> In molecular engineering, for example, scientists are creating whole new materials forged atom by atom, including a fiber stronger than steel yet more elastic than a spider's web, and one-molecule-thick coatings that virtually eliminate friction. Biotechnology researchers are working within the cells of living organisms. This may lead to treatments for diseases and the production of synthetic organs, but it is already making possible clothing that kills germs, bugs that gobble up toxic waste, enzymes that soften blue jeans and cholesterol-eating peanuts with a shelf life measured in years, not months.

"Many of the most promising projects involve tinkering with the basic elements of life and matter."

**Discoveries and Inventions with Wide-Ranging Uses.** From chewing gum to electricity, all inventions are an effort to raise our living standards — but some inventions are clearly more earthshaking than others. The parachute is a very useful product, especially when an airplane's engines conk out at 10,000 feet, but it hasn't had the same impact on the way we live as the internal combustion engine, the telephone or the jet airplane. Every so often, an invention comes along that really rocks the world because it has far-reaching applications and serves as a building block for further invention. The wheel, the plow, the printing press and the steam engine are examples of such technologies. Had electricity not been harnessed for use more than a century ago, the modern household would have few of the conveniences we take for granted. No televisions. No refrigerators. No phones. Simply put, some inventions carry more weight than others. [See "The Microprocessor: An Invention with Many Applications"]

Perhaps the best way to judge an invention's significance is by the extent of spillovers — its connections to other goods and services that it either makes possible or makes cheaper to produce. Consider the top 10 inventions

“Perhaps the best way to judge an invention’s significance is how it spawns other goods and services.”

and discoveries of modern times — a list open to dispute [See Table I].<sup>11</sup> Note that four of the top 10 are relatively recent — from the past 50 years.

**Technologies Integrated to Create the Personal Computer.** Each invention makes the next one easier because spillovers kindle a fire that feeds on itself — one technology fueling development of another. If there is any alchemy in free enterprise, this is it.

Consider the inventions necessary for the development of the personal computer. In 1801, J. M. Jacquard devised a binary control system on punched cards to program a loom to weave a preset pattern. Thomas Edison’s light bulb gave people a reason for installing electric wiring in their homes. Christopher Latham Sholes invented the typewriter in 1867 to produce legible letters more quickly. Ben Logee Baird produced the first working television in 1926. Ted Hoff of Intel Corp. invented the microprocessor in 1971 as the indispensable component of the hand-held calculator.<sup>12</sup> None of these inventors envisioned the personal computer. In fact, in March 1949, *Popular Mechanics* predicted, “Where the ENIAC [the first electronic computer] is equipped with 18,000 vacuum tubes and weighs 30 tons, computers in the future may have only 1,000 vacuum tubes and weigh only 1.5 tons.” Yet binary programming, electricity, the typewriter keyboard, the cathode-ray tube, the microprocessor and hundreds of other inventions were available for the West Coast hobbyists and entrepreneurs who contrived the first crude personal com-

## The Microprocessor: An Invention with Many Applications

In our time, it’s the microprocessor — the tiny “brain” of the personal computer — that’s producing spillovers and spawning waves of new and improved products. Invented just 25 years ago, the microchip already has enabled the invention of thousands of smart consumer products. Just a few are: the answering machine, pocket calculator, caller-ID device, camcorder, CD player, personal computer, digital camera, fax machine, microwave oven, organizer, pacemaker, pager, pocket translator, laser printer, remote control, radar detector and VCR. The microchip resides unseen in most products, its functions vital though increasingly taken for granted.

In cellular phones, microchips translate voices to electronic signals and back, reduce interference and store and execute programmed functions. In automobiles, they control carburetion, timing, transmission, suspension, emissions, brakes, air bags, seat positions, navigational aids, engine diagnostics, keyless locks, instruments and more. In fact, today’s cars have more computing power than the lunar landing module of the Apollo 11 mission that put Americans on the moon. And even more applications are just over the horizon, as time and imagination point us to new ways to use microprocessors.

Meanwhile, the computer chip is getting even more powerful. At the start of the 1990s, the fastest chips could handle 94 million instructions per second. The next generation, due out this year, will increase that computational speed to 1.6 billion.

TABLE I

## Top 10 Modern Innovations and Discoveries

	Year of Introduction
1. Electricity	1873
2. Microprocessor	1971
3. Computer	1946
4. DNA	1953
5. Telephone	1876
6. Automobile	1886
7. Internet	1991
8. Television	1926
9. Refrigeration	1913
10. Airplane	1903

Source: The Authors.

“Four of the top 10 inventions and discoveries are relatively recent.”

puters in the mid-1970s.

Today, the personal computer is part of our technology inventory, contributing to new waves of invention. It would be impossible, for example, to envision the Internet without the computer. The Internet and the computer, in turn, paved the way for the next wave of advances — search engines to explore the World Wide Web, high-speed modems, gadgets that access the Internet through the television set, software to design home pages and intelligent agents that automatically sift through the oceans of information available in cyberspace. The Internet may be particularly powerful in driving technological change because it reduces the cost of new discoveries by putting the latest research online at the touch of a button.

“The computer — product of hundreds of other inventions — is now contributing to new waves of invention.”

And the ripple effects from the personal computer don’t stop with computer-related industries. For instance, computational biology uses computers to locate and code genes, illustrating how its increasing power puts technology and progress on an even faster track. Biologists are already identifying six to 10 new proteins a week, and with more powerful microprocessors the process is likely to be three times faster by the end of this year.

**New Technologies Spread Faster.** New products are spreading faster. Although feasible in the late 1800s, electric power didn’t become universal until the mid-20th century. The first automobiles arrived on American roads in the late 1800s, but the country still had more horses than cars into the 1920s. The technology for television came in the 1920s, but the invention didn’t reach America’s living rooms in large numbers until the early 1950s. These examples illustrate a fact of technological life: the time between invention and diffusion can be decades or more.<sup>13</sup>

But as lightning-fast communications spread information faster and consumers grow more sophisticated, new products are emerging more quickly than in the past [see Table II]. It took 55 years to get the automobile to a quarter of the U.S. population. The telephone required 35 years; the television, 26. Now look at some recent innovations: a quarter of U.S. households owned a personal computer within 16 years of its introduction. For the cellular telephone, the time shrank to 13 years. The Internet is coming into commercial use even faster than the personal computer or the cell phone.

The microwave oven and VCR illustrate the speedup in diffusion with the introduction of the microchip. The VCR was invented in 1952 and the microwave in 1953. When the microchip was introduced in 1971, less than 1 percent of households had either. Riding the cost-cutting wave of the microchip, however, a quarter of American homes enjoyed both by 1986 — in just 15 years.

New products follow a pattern. At first, the latest innovations are expensive and perhaps tricky to use, so their market consists of a handful of wealthy gadget lovers. Over time, the products become cheaper and more consumer-friendly through mass production and improved design. What was once a luxury becomes an everyday necessity. The companies that make the products can then expand rapidly, chalking up sales and adding new jobs and more capital for future progress.

Market Size Matters. Markets are getting larger, increasing the incentive to introduce new technology. It's simply a matter of payoff. Had Alexander Graham Bell lived on a small island with a population of 10, he'd have

TABLE II

### Spread of Products to a Quarter of the Population

Product	Year Invented	Years to Spread
Electricity	1873	46
Telephone	1876	35
Automobile	1886	55
Airplane	1903	64
Radio	1906	22
Television	1926	26
VCR	1952	34
Microwave oven	1953	30
PC	1975	16
Cellular phone	1983	13
Internet	1991	7

"It took 55 years for the automobile to get to a quarter of the population — and only seven for the Internet."

had little to gain from inventing the telephone. Fortunately Bell introduced his invention into a time with millions of potential customers, spread out on a continental scale. In the 1990s, of course, many new products enter a market of hundreds of millions of customers.

Said another way, Thomas R. Malthus had it exactly backward when he predicted that Earth's population would outstrip its resources, leading to ever-growing poverty. In a free enterprise system, growing population (market size) prompts more innovation, which stimulates the growth process. There is no guarantee of avoiding Malthus' dismal scenario in anything other than a market-based system.

Population is only one way markets grow. Rising incomes add to the number of people who can afford to splurge on the latest bells and whistles. Falling transportation costs and quickening information flows can enlarge markets. The dismantling of trade barriers can open whole new markets to U.S. producers. For many products yet to come, the market will be global, so the rewards for successful innovation figure to be even greater.

## Why Economic Progress is Understated

Understanding how free enterprise stimulates progress gives us good reason for optimism about America's future. The system is working to perpetuate and even accelerate advances in living standards. The irony is that the numbers don't agree. Progress is showing up everywhere but in the statistics.

One notable exception is Wall Street, where a bull market has pushed the Dow Jones Industrial Average up over 300 percent since the start of the decade. But other economic statistics, particularly those measuring GDP growth, prices and productivity, paint an increasingly distorted portrait of our progress.

**Intangibles Are Difficult to Measure.** The problem, in part, lies in the tools we use. The National Income and Product Accounts, developed in the 1940s, arrive at GDP by toting up the value of goods and services the economy produces. These accounts do a reasonably good job of measuring traditional output — tons of steel, bushels of wheat, cases of toothpaste, tables, chairs, haircuts. Add it all up, and you've got GDP.

Much of what we get, however, isn't actually what we buy. We don't really want cars — we want transportation. We don't really want telephones — we want to communicate. We don't really want light bulbs — we want light.

The distinction isn't facetious. The ordinary light bulb, for example, is a readily countable object that can be easily included in GDP: all we need to know is how many are sold and at what price. The light it produces, however, isn't so tangible. Yale University's William Nordhaus looked at the price of light and concluded it has fallen from 40 cents per 1,000 lumen hours in 1800 to a tenth of a cent today, a decline of 99 percent.<sup>14</sup> Meanwhile, our

"Progress is showing up everywhere but in the statistics."

TABLE III

## Estimates of Bias in the U.S. Consumer Price Index

<u>Author(s)</u>	<u>Point Estimate</u>
Advisory Comm. to Study the CPI (1996)	1.1
Michael Boskin (1995)	1.5
Congressional Budget Office (1994)	.5
Michael R. Darby (1995)	1.5
W. Erwin Diewert (1995)	1.5
Robert J. Gordon (1995)	1.7
Alan Greenspan (1995)	1.0
Zvi Griliches (1995)	1.0
Dale W. Jorgenson (1995)	1.0
Jim Klumpner (1996)	.4
Lebow, Roberts and Stockton (1994)	1.0
Ariel Pakes (1995)	.8
Shapiro and Wilcox (1996)	1.0
Wynne and Sigalla (1994)	1.0
Equally weighted average	1.1

Source: Moulton (1996).

“Most economists agree that the Consumer Price Index overstates inflation and thus understates the growth rate.”

measures of inflation show a 180 percent increase in the price of light bulbs and fixtures. By progressing from less to more expensive lighting equipment — from candles to lamps to light bulbs — without accounting for the service each provides (lumens), the price of light is recorded as rising, even though it in fact has sharply declined. The result is an overstatement of inflation and an understatement of true growth.

**Inflation Is Overstated.** To arrive at “real” growth, a common proxy for how well the economy is doing, statisticians adjust the GDP numbers to account for rising prices. If the numbers overstate inflation, growth will come out equally low, suggesting that the economy is weaker than it really is. For example, most economists agree the U.S. Consumer Price Index overstates inflation and thus understates the growth rate [see Table III]. The CPI is determined by taking a sample of prices for a weighted basket of goods and extrapolating from that the general movement of prices. The CPI and other price indices affect our estimates of GDP and thus the measured rate of growth.

Economists have recommended changes that would lower our estimates of CPI inflation by an average of 1.1 percent, thus crediting more real growth to the economy.<sup>15</sup> That’s a huge revision — indeed, a doubling of our

estimated growth rate — considering the fact that GDP per capita grew at an average annual rate of just over 1 percent during the 1973-96 period. It means that per capita GDP could be one-third higher than we had thought possible by 2020 and double what we had expected by 2055.

Statisticians are also likely to reduce the gap between revisions of the basket of goods in inflation index from 11 years to four or five. But even with the changes, they will miss a lot of what's going on.

**New Products Are Overlooked.** The measurement problems are particularly acute when technology is progressing rapidly. Take, for example, new goods.

- Today's VCRs provide better service than those that sold for \$1,125 in 1981. But the VCR didn't make it into the consumer price index until 1987, after its price had fallen to under \$300.
- The pocket calculator, invented in 1971, harnesses more computing power than a \$750,000 room-sized mainframe of the 1950s but didn't show up in the consumer price statistics until 1978, after its price had fallen from more than \$600 to well below \$100.
- The personal computer was ignored by the statistics until 1987, when its cost to the average American had fallen from a lifetime of work to little more than two weeks' pay.

When cellular telephones came on the market in 1984, consumers paid as much as \$3,995 for the convenience of on-the-go communication. Now the phone often comes free with cellular service, and the average local cellular service bill went from nearly \$100 a month in 1987 to under \$50 by 1995. But cell phones won't be added to the price index until 1998, when at least 30 percent of Americans will own one. The result, in each of these cases, is an overestimation of inflation and an understatement of real growth and progress.

Our statistics would be more accurate if these gains could be instantaneously tallied in the numbers that track the economy. It simply cannot be done. With rapid advances in technology, new and better products are coming at a dizzying rate. We buy cars that last longer and require less maintenance, manufacture stereos that reproduce truer sound, grow tomatoes that don't turn to mush when frozen, make clothes that fit better and require less care, improve mammograms to detect tumors at an early stage and pluck free information from cyberspace. In each case, we're getting more of what we want at the same or lower prices, befuddling the well-intended number crunchers.

**Variety and Customization Aren't Measured.** More measurement difficulties stem from the GDP's failure to value variety and customization. American consumers can enjoy the cuisine of more than 40 countries today, compared with just a handful in the 1970s. We can choose from among twice as many automobile producers, which offer more makes and options than ever. Micro-breweries have brought us an extended array of beers, with some outlets carrying nearly 400 kinds. We have more variety in soft drinks, tennis

"Technology advances so fast, with an effect on prices, that it befuddles well-intended number crunchers."

shoes, magazines, radio stations, martial arts classes, coffee, amusement parks, cereal, sport utility vehicles, toothbrushes and on and on. Variety and customization enrich our lives because they allow us to select characteristics we value highly, but to the statisticians every car is a white Chevrolet.

**Improved Prevention Isn't Measured.** Then there are preventive goods and services. Antilock brakes and air bags help prevent collisions and injuries. Safety caps on pill bottles keep children from ingesting poison. Fat-absorbing proteins allow overweight people to avoid expensive diet programs. Statisticians can't measure goods unseen: the accident that doesn't happen. A vaccine might someday eliminate tooth decay. Instead of fixing cavities, dentists might build houses or design Web sites, with no effect on overall GDP. But, meanwhile, we would have the benefit of the holes that aren't in people's teeth. What aggregate statistic could show this gain?

Statisticians keep track of cost — that's all they have to count. The economy produces worth — that's what people want. Cost and value aren't always related, and they diverge even more as technology enables the economy to deliver more worth at less cost. For instance, if medical science invented a 1-cent pill that cured all our ills, it would be worth a lot but cost virtually nothing. Sound ludicrous? Consider the Internet. In trying to find a way to charge customers for accessing Web sites, companies have decided our smallest unit of money — 1 cent — is too much. A 1/10-cent unit is needed. On GDP's radar screen, the Internet is barely registering a blip.<sup>16</sup> It is ironic that just when the economy is most successful — when it produces the most worth for the least cost — the gap between true and measured GDP growth is the greatest. The economy gets the least credit when it's accomplishing the most.

"Statisticians can't measure goods unseen: the accident that doesn't happen."

## Intangible Benefits of Economic Progress

A more fundamental problem is that our economy is not simply mismeasured, it is misunderstood.

The economy has never tried to produce GDP: it tries to produce happiness, or satisfaction. And there's a lot more to life than GDP.

In the information age, our economy is providing benefits beyond those easily captured by GDP. When making a list of needs and wants, most people start with food, clothing and shelter. After that, they move on to safety and security and leisure time, then perhaps to some of the "fun" aspects of life, such as entertainment, travel and cultural enrichment. Beyond that, most of us seek personal fulfillment, such as the satisfaction that comes from a worthwhile or enjoyable job. This hierarchy of needs and wants reflects the influential work of the American psychologist Abraham Maslow (1908-70). Maslow's pyramid, a staple of psychology, consists of a hierarchy of needs that motivate human behavior. At the most basic level are the physiological needs. With those met, we move up to safety, social needs, self-esteem and, at the pinnacle of the pyramid, self-actualization.

“It is difficult to measure the value of increased leisure and better working conditions.”

**Increased Leisure.** As Americans grow wealthier, our physiological needs are being increasingly met, and there’s a shift in wants from basic products to ever more intangible outputs. There are plenty of examples — from personal physical fitness gurus and Internet chat rooms to ecotourism and early retirement. For example, Austrian economist Joseph Schumpeter said, “The reduction of working hours is one of the most significant ‘products’ of economic evolution.” Hours at work have fallen for decades. The average workweek fell from 36.9 hours in 1973 to 34.5 hours in 1990. An equal percentage decline over the next 25 years would yield a 31.4-hour workweek in 2020. Many workers have flexible schedules, including regular breaks. Yet GDP gives the economy no credit for gains in leisure.

**Better Working Conditions.** Another of the biggest yet most overlooked examples of gains in living standards missed by GDP figures is improvement in our working conditions. For most of us, work is a major part of life. And better working conditions have routinely been a product of progress, right along with more GDP. This is evident not just from the steady decline in worker death rates but also from a comparison of our work concerns today versus yesterday. In the early 1900s, our work worries centered on safety, fatigue, long hours, excessive heat, poor ventilation, high humidity, bad lighting, exposure, disease, lack of adequate toilet facilities and rigid schedules. Today, we seek interesting and fun jobs with meaningful work, nice offices, employee activities, flexible hours, empowerment, wellness classes, communication, employee counseling and the ability to telecommute. Americans have progressed from narrow productivity concerns to “have a nice day.”

**Work-Time Leisure.** Although measures of productivity — output per hour at work — credit time off, they generally miss leisure time taken at work. Time-diary surveys show that Americans today take up to six hours per week of leisure on the job, as compared with only one hour in 1965.<sup>17</sup>

What are some of the ways employees use their recorded work hours other than to work?

Arrive late after dropping off the kids. Leave early to pick up the kids. Go to parent-teacher conferences. Visit the doctor or dentist. Talk on the phone to friends. Chat with coworkers. Go outside to smoke. Give blood. Play solitaire on the computer. Browse the Internet for personal stuff. Attend wellness classes. Sell cookies for the kids. Raise funds for charities. Visit with friends via the Internet. Call automated tellers. Exercise (even in employers’ facilities). Call talk radio programs or contests. Read the paper, a book or a magazine. Attend parties or showers. Write personal correspondence. Leave to run errands. Make a grocery list. Perform club duties. Take long breaks. Pay bills. Nap.

A little bit here, a little bit there, we’re spending our day more the way we’d like.

The point is not that American workers are cheating their companies. On the contrary, it's all a part of progress. We're not automatons, enslaved to productivity as if we were still in the fields or on an assembly line. One way we take the gains of technological progress is to simply enjoy life in an economy that, more and more, transcends measurement.

And what about work that's fun? Most folks these days seek work they enjoy. Yet the standard statistics are apt to register economic regression if we quit a job we're good at but don't like in order to take one that's more enjoyable. It just doesn't make good sense. We take our progress in ways other than GDP.

The economy today reflects our wealthier society's preferences for harder-to-measure consumption. As we grow richer still in the future, we can expect society to spend more of its time, energy and income addressing needs that are farther and farther from the physiological. Pity the poor statistician with the job of tracking our increasingly elusive economy.

## Conclusion: A Future of Faster Growth

The very notion of economic progress is an artifact of the modern, technology-rich era. Until the advent of capitalism in the 18th century, the world's living standards changed only slowly. The French farmer of the 17th century lived, worked and died pretty much like the Roman farmer of the 1st century B.C.<sup>18</sup> The same cannot be said for our world: living standards rise from generation to generation. We are in the throes of one of history's great bursts of technology, put to use quickly and effectively by a vibrant market economy.

It would, of course, be good to have statistics that capture all the nuances of the economy as it evolves to meet our needs. That's probably too much to expect. Expense and complexity make a daunting task of tracking an American economy centered less and less on tangible output. Our measurement technology cannot keep pace with the rest of our technological progress. Relying on our existing measures, we're going to miss a lot of what happens in the economy as it moves into the 21st century.

We are fast departing a time when progress can be measured by GDP or any other simple tally of what the economy produces. If we become fixated on the numbers and fail to imagine the possibilities, we may miss one of the greatest periods of economic advancement in history. Worse yet, if we judge 21st century progress by 20th century measures, we may infer that our system is failing and in need of repair by government.

That is the bad news.

Free enterprise is America's greatest welfare program. For more than two centuries, the system has worked to make our lives better. Whatever

"The very notion of economic progress is an artifact of the modern, technology-rich era."

we've wanted — new and improved products, more leisure, better jobs, easier lives — it has provided in abundance.

The pessimists fret that our best days are behind us. They are wrong. We stand poised on the brink of a new era, one endowed with technology and teeming with opportunities. The future offers even faster economic progress.

That is the good news.

"Free enterprise is America's greatest welfare program."

W. Michael Cox  
Federal Reserve Bank of Dallas  
NCPA Senior Fellow

Richard Alm  
Dallas Morning News

The views in this paper are not necessarily those of the Federal Reserve Bank of Dallas or the Federal Reserve System.

Advisory Commission to Study the Consumer Price Index, "Toward a More Accurate Measure of the Cost of Living: Final Report to the Senate Finance Committee," December 4, 1996.

Batra, Dr. Ravi, *The Pooling of America: Competition and the Myth of Free Trade* (New York: Collier Books, 1994).

NOTE: Nothing written here should be construed as necessarily reflecting the views of the National Center for Policy Analysis or as an attempt to aid or hinder the passage of any bill before Congress.

Dallas Economic Review, Second Quarter 1994, pp. 1-22. **Notes**

1 Just the doomsday book titles alone are enough to scare us to death. A long list, it would include: Dr. Ravi Batra, *The Pooring of America: Competition and the Myth of Free Trade* (New York: Collier Books, 1994); Jeffrey Madrick, *The End of Affluence: The Causes and Consequences of America's Economic Dilemma* (New York: Random House, 1995); Katherine S. Newman, *Declining Fortunes: The Withering of the American Dream* (New York: Basic Books, 1993); Wallace C. Peterson, *Silent Depression: the Fate of the American Dream* (New York: W.W. Norton, 1994); and Juliet B. Schor, *The Overworked American: The Unexpected Decline of Leisure* (New York: Basic Books, 1993).

2 For a discussion of these aspects, see W. Michael Cox and Richard Alm, "The Economy at Light Speed: Technology and Growth in the Information Age and Beyond," Annual Report, Federal Reserve Bank of Dallas, 1996, pp. 2-17.

3 The list of inventors' failed endeavors would fill books. For an amusing and instructive exploration of this topic see Kenneth Larson, *Mousetraps and Muffling Caps: One Hundred Brilliant and Bizarre United States Patents* (New York: Arbor House, 1986).

4 Joseph Schumpeter understood the capitalist mechanism quite clearly when he wrote "Economists are at long last emerging from the stage in which price competition was all they saw. In capitalist reality...it is not that kind of competition which counts but the competition from the new commodity, the new technology, the new source of supply, the new type of organization.... Competition which...strikes...existing firms...at their foundations and their very lives. This kind of competition is ... much more effective than the other... and [is]...the powerful lever that in the long run expands output." Joseph A. Schumpeter, *Capitalism, Socialism, and Democracy* (New York: Harper & Brothers Publishers, 1950), p. 84.

5 U.S. Bureau of the Census, *Statistical Abstract of the United States: 1996* (116th edition) (Washington, D.C., 1996), Table No. 855, "New Product Introductions of Consumer Packaged Products: 1980 to 1994," p. 548.

6 Otis Port, "Look Ma, No Hands," *Business Week*, August 14, 1995, pp. 80-81.

7 John Carey, "Tilling the Soil by Satellite," *Business Week*, December 11, 1995, p. 112; Phil Scott, "Never Get Lost Again," *Reader's Digest*, August, 1996, pp. 54-59; "Who Uses GPS and for What?" Time Service Department, U.S. Naval Observatory, [http://tycho.usno.navy.mil/gps\\_apps.html](http://tycho.usno.navy.mil/gps_apps.html) (17 Feb. 1997); "Cadillac Systems Integration and Engineering Preeminence," press release, August 14, 1995, Cadillac Motor Car Division, General Motors Corp., Detroit, Mich.

8 Neil Singer, "Sandia team produces intelligent micromachines," March 15, 1996, Sandia National Research Laboratories, Albuquerque, N.M., <http://www.sandia.gov> (Dec. 17, 1996).

9 "The Human Genome: the proper study of mankind," *Economist*, September 14, 1996, p. 19; Naomi Freundlich, "Die young — at an old age," *Business Week*, October 7, 1996, pp. 154-156; "The Human Genome Project: From Maps to Medicine," U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, NIH Publication No. 96-3897.

10 For other examples of recent technological progress, see "Measuring atoms: micro, nano, pico, femto," *Economist*, October 14, 1995, pp. 98-99; John Carey, "Science's New Nano Frontier," *Business Week*, July 1, 1996, pp. 101-102; "Sowing cells, growing organs," *Economist*, January 6, 1996, pp. 65-66.

11 Authors' own ranking based on the extent to which the invention is subsequently connected to other inventions or industries. For a discussion of the subject, see James Burke, *Connections* (Boston: Little, Brown and Company, 1978).

12 For a list of inventions and their dates, see W. Michael Cox and Richard Alm, "The Service Sector: Give It Some Respect," Annual Report, Federal Reserve Bank of Dallas, 1994, Exhibit 10, "Tools of the Ages," p.15, and Peter North, *The Wall Chart on Science and Invention* (New York: Dorset Press, 1991).

13 U.S. Bureau of the Census, *Statistical Abstract of the United States*, various issues; *Historical Statistics of the United States: Colonial Times to 1970*, Part I, 1975; Cellular Telecommunications Industry Association, "Wireless Growth Sets New Annual Records," media release, September 19, 1996; and *The World Almanac Book of Facts 1997*, ed. Robert Famighetti (Mahwah, N.J.: World Almanac Books, 1996).

14 William D. Nordhaus, "Do real output and real wage measures capture reality? The history of light suggests not," Yale Cowles Foundation Discussion Paper No. 1078, September 1994.

15 Michael J. Boskin, prepared statement in "Consumer price index: hearings before the Committee on Finance, United States Senate," Senate Hearing 104-69, U.S. Government Printing Office, 1995, pp. 109-115.

16 U.S. researchers, say, can travel in seconds from Ukraine to the U.K. in cyberspace at virtually no cost, whereas alternative modes of travel would cost thousands of dollars. As living standards rise, the needs fulfilled are more intangible.

17 John P. Robinson and Ann Bostrom, "The overestimated workweek? What time diary measures suggest," *Monthly Labor Review*, No. 117, August 1994, pp. 11-23.

## Selected References

- Berndt, Ernst R., Zvi Griliches and Neal Rappaport, "Econometric Estimates of Prices Indexes for Personal Computers in the 1990s," National Bureau of Economic Research Working Paper Series, No. 4549, November 1993.
- Boskin, Michael J., prepared statement in "Consumer Price Index: Hearings Before the Committee on Finance, United States Senate," Senate Hearing 104-69, U.S. Government Printing Office, 1995, pp. 109-115.
- Burke, James, *Connections* (Boston: Little, Brown and Company, 1978).
- Burns, Arthur F., *Production Trends in the United States Since 1870* (New York: National Bureau of Economic Research, 1934).
- Cellular Telecommunications Industry Association, "Wireless Growth Sets New Annual Records," media release, September 19, 1996.
- Congressional Budget Office, *Is the Growth of the CPI a Biased Measure of Changes in the Cost of Living?* (Washington, D.C.: Congressional Budget Office, October 1994).
- Darby, Michael R., prepared statement in "Consumer Price Index: Hearings Before the Committee on Finance, United States Senate," Senate Hearing 104-69, U.S. Government Printing Office, 1995, pp. 173-176.
- Diewert, W. Erwin, prepared statement in "Consumer Price Index: Hearings Before the Committee on Finance, United States Senate," Senate Hearing 104-69, U.S. Government Printing Office, 1995, pp. 115-118.
- Famighetti, Robert, ed., *The World Almanac and Book of Facts 1997* (Mahwah, N.J.: World Almanac Books, 1996).
- Foulkes, Fred K., *Creating More Meaningful Work* (New York: American Management Association, 1969).
- Gordon, Robert J., prepared statement in "Consumer Price Index: Hearings Before the Committee on Finance, United States Senate," Senate Hearing 104-69, U.S. Government Printing Office, 1995, pp. 122-126.
- Greenspan, Alan, prepared statement in "Review of Congressional Budget Cost Estimating: Joint Hearing Before the House of Representatives Committee on the Budget and the Senate Committee on the Budget," Serial no. 104-1, U.S. Government Printing Office, 1995, pp. 130-149.
- Greenwood, Jeremy, and Mehmet Yorukoglu, "1974," Carnegie- Rochester Conference Series on Public Policy, forthcoming.
- Griliches, Zvi, prepared statement in "Consumer Price Index: Hearings Before the Committee on Finance, United States Senate," Senate Hearing 104-69, U.S. Government Printing Office, 1995, pp. 129-132.
- Jorgenson, Dale W., statement in "Consumer Price Index: Hearings Before the Committee on Finance, United States Senate," Senate Hearing 104-69, U.S. Government Printing Office, 1995, pp. 36-41.

Klumpner, Jim, "Fact and Fancy: CPI Biases and the Federal Budget," *Business Economics* 31 (April 1996): pp. 22-29.

Larson, Kenneth, *Mousetraps and Muffling Caps: One Hundred Brilliant and Bizarre United States Patents* (New York: Arbor House, 1986).

Lebow, David E., John M. Roberts and David J. Stockton, "Monetary Policy and the Price Level," mimeo, Federal Reserve Board, 1994.

Madrack, Jeffrey, *The End of Affluence: The Causes and Consequences of America's Economic Dilemma* (New York: Random House, 1995).

Moulton, Brent R., "Bias in the Consumer Price Index: What Is the Evidence?" *Journal of Economic Perspectives* 10 (Fall 1996), pp. 159-177.

Nakamura, Leonard, "Is the U.S. Economy Really Growing Too Slowly? Maybe We're Measuring Growth Wrong," *Federal Reserve Bank of Philadelphia Business Review*, forthcoming; "Is U.S. Economic Performance Really that Bad?" *Federal Reserve Bank of Philadelphia Working Paper No. 95-21/R*, April 1996; "Measuring Inflation in a High-Tech Age," *Federal Reserve Bank of Philadelphia Business Review*, November/December 1995, pp. 13-25.

National Safety Council, "Work, 1995" in *Accident Facts, 1996 edition* (Itasca, Ill.: National Safety Council, 1996).

Newman, Katherine S., *Declining Fortunes: The Withering of the American Dream* (New York: Basic Books, 1993).

Nordhaus, William D., "Do Real Output and Real Wage Measures Capture Reality? The History of Light Suggests Not," *Yale Cowles Foundation Discussion Paper No. 1078*, September 1994.

North, Peter, *The Wall Chart of Science and Invention* (New York: Dorset Press, 1991).

Paepke, C. Owen, *The Evolution of Progress* (New York: Random House, 1993).

Pakes, Ariel, statement in "Consumer Price Index: Hearings Before the Committee on Finance, United States Senate," *Senate Hearing 104-69*, U.S. Government Printing Office, 1995, pp. 44-48.

Peterson, Wallace C. Peterson, *Silent Depression: the Fate of the American Dream* (New York: W.W. Norton, 1994).

Price, C. W., Orval Simpson, Dale Wolf, Charles Woodward, F. J. Moss, W. R. Basset and Others, *Working Conditions, Wages and Profits* (Chicago: A. W. Shaw, 1920).

Robinson, John P., and Ann Bostrom, "The Overestimated Workweek? What Time Diary Measures Suggest," *Monthly Labor Review* 117 (August 1994), pp. 11-23.

Schor, Juliet B., *The Overworked American: The Unexpected Decline of Leisure* (New York: Basic Books, 1993).

Schumpeter, Joseph, *Business Cycles: A Theoretical, Historical, and Statistical Analysis of the Capitalist Process*, vol. 2 (New York: McGraw-Hill, 1939).

Schumpeter, Joseph A., *Capitalism, Socialism, and Democracy* (New York: Harper & Brothers

Publishers, 1950).

Shapiro, Matthew D., and David W. Wilcox, "Mismeasurement in the Consumer Price Index: An Evaluation," NBER Macroeconomics Annual 1996 (Cambridge, Mass.: MIT Press, 1996), pp. 93-142.

Sherwood, Mark K., "Difficulties in the Measurement of Service Outputs," Monthly Labor Review 117 (March 1994), pp. 11-19.

Slifman, L., and C. Corrado, "Decomposition of Productivity and Unit Costs," Board of Governors of the Federal Reserve System, mimeo, November 18, 1996.

W. E. Upjohn Institute for Employment Research, *Work in America: Report of a Special Task Force to the Secretary of Health, Education and Welfare* (Cambridge, Mass.: MIT Press, 1973).

U.S. Bureau of the Census, *Statistical Abstract of the United States*, various years; *Historical Statistics of the United States: Colonial Times to 1970, Part 1*, 1975.

U.S. Department of Energy, Energy Information Administration, *Housing Characteristics* (Washington, D.C.: Government Printing Office, various years).

U.S. Department of Labor, Bureau of Labor Statistics, *Compensation and Working Conditions*, June 1996; *CPI Detailed Report: Data for January 1994, March 1994*.

Veblen, Thorstein, *The Theory of the Leisure Class: An Economic Study of Institutions* (New York: MacMillan, 1899).

Wynne, Mark A., and Fiona D. Sigalla, "The Consumer Price Index," Federal Reserve Bank of

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